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BOOK OF ABSTRACTS

This is not an official publication but a working document containing the original abstracts submitted by authors for the review. The aim of this document is only for delegates during the Cingress to understand the contents of talks and posters.

Symposium 01

Disappearing snow and altered ecosystems: Observations, experiments, and outcomes

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Winter snow is a critical component of ecosystem health. It insulates the soil, provides protection from winds, and results in slow water release over the spring melt period. However, climate continues to change rapidly. Snowpack depth, density, and duration are sensitive to small variations in temperature even apart from changes in overall precipitation amounts or timing. Declines in winter precipitation in some areas result in lower snow packs. In others, the warming climate is causing rapid declines in snowpack by causing shifts from snow to rain winter precipitation regimes. The end result is increasing organism exposure to novel winter conditions. Many ecosystems are located near the 00 winter temperature isotherm and vulnerable to this aspect of global change; others are likely to experience shorter snow seasons, resulting in changes in the fall or spring seasons. As a result, some species are likely to decline while others may benefit from the new conditions. In any case, ecosystem change is likely.

The transition from winter snow to low/no snow conditions is a threshold-like phenomena, resulting from only slight warming or declines in precipitation. Yet there are dramatic changes when that threshold is crossed. Soils are not insulated from atmospheric temperature variation, resulting in potential freezing events which alter nutrient availability, damage roots, and can cause widespread mortality. Root damage may lead to increased drought vulnerability. Aboveground communities are exposed to desiccating winds in addition, which can drive dieback or mortality. Vulnerable budding tissue may freeze, resulting in productivity declines over broad areas. These observations are becoming more and more common in a variety of ecosystems.

This symposium brings together a variety of focal systems to look for generalities in the effects of winter snow loss in the European Arctic, Rocky Mountains, Japan, Alaska, and elsewhere. Presentations cover observational data from detailed plot scale analysis to very broad extent remote sensing work, as well as plot to stand size snow manipulation studies. The talks will focus on methods and mechanisms of change from the species to ecosystem level, highlighting generalities which are useful to the global audience. The goal is to showcase regional work and emerging research techniques while providing information that will allow attendees to anticipate upcoming change based on work in other global regions.

Widespread snow loss driving mass mortality of a forest – but might it be temporary?

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The loss of snow is a major physical change in the winter environment of many temperate and boreal forests. Even assuming no change in net precipitation, the lack of insulating snow cover in winter creates fundamentally different abiotic conditions for forest species, especially in the upper layers of soil. Mass mortality can result from freezing injury, herbivory, or other causes, fundamentally changing ecosystem trajectories. The most vulnerable systems are those that fluctuate near freezing in winter, with periodic warming periods that can trigger phenological changes that leave species vulnerable to subsequent freezing. Alaskan forests are especially vulnerable, and mass mortality has been observed over the last several decades. Regeneration is also suffering from low snow, suggesting fundamental ecosystem changes. But other areas within sensitive species ranges, where winter conditions are much warmer, are not experiencing mortality nor regeneration issues. This suggests that the damage associated with snow loss is potentially a temporary phenomena in a directionally changing environment. Here I report on the well-studied snow-loss system of Alaska, USA, where over 400,000 ha have currently died across 10 degrees of latitude, showing similar patterns of mortality in adults and seedlings - yet also healthy forests on the other side of the "transitional mortality zone." Coupled with high-temporal resolution climate modeling, this system suggests that threshold-driven change may be temporary, and faster warming may result in less net mortality as less time is spent in a frequent thaw-freeze climate. However, it also shows the limits of average-based climate models and the need for high temporal resolution data for forecasting short-interval, but extremely important, weather events, especially in environments transitioning from snow to rain.

Keywords: Disturbance, Forest, Snow, Climate change

T0542

Landscapes of fear in novel winters: woody debris addition increases small-mammal winter seed predation in habitats with snow removed

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Decreased snowfall may create underappreciated changes in biotic interactions, such as seed predation, that can impose cryptic limitations on species persistence. Failing to account for biotic responses to climate change may therefore limit our ability to anticipate shifts in forest composition in the Anthropocene. For example, deep snow can facilitate small-mammal foraging by providing a refuge from predators, but as winters become warmer, alternative winter predation refugia (e.g., woody debris) may create hotspots of small-mammal activity in the absence of snow. We tested whether woody debris influences the effect of snow removal on small mammal activity and seed predation. In the winter of 2017-2018, we added Acer rubrum and Acer saccharum seeds to 2m x 2m plots at 10 sites across a 60 km study area in northern Wisconsin, USA. In each plot, we experimentally manipulated snow depth and woody debris volume, and recorded seed predation after snow retreat in May 2018. We monitored winter small-mammal activity with subnivium camera traps.

Conifer basal area was associated with greater winter small-mammal activity, but only at sites with little ambient woody debris. Winter small mammal activity was associated with greater seed predation of Acer saccharum, but not Acer rubrum. Woody debris addition increased Acer rubrum seed predation, but only in plots with snow removed and at sites with more southern red-backed voles (Myodes gapperi). Our results suggest that as more northern temperate forests experience above-freezing temperatures, spatial variation in woody debris volume may become an important predictor of winter seed predation. Moreover, changes in snow depth could interact with climate-mediated range shifts of key seed predators (e.g., M. gapperi) to cause unexpected changes in seed predation. Anticipating biotic interactions in novel winters will therefore require an understanding of how the effects of reduced snow depth vary over gradients of predation risk.

Keywords: Acer rubrum, Acer saccharum, Myodes gapperi, Subnivium, Predation refuge

Winter climate change, snow depth, and prescribed fire affect prairie plant extinction and growth

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The winter season is warming faster than any other season in temperate and polar regions, resulting in an overall loss of snow. In temperate grasslands (prairies), the loss of snow can substantially change the temperatures which organisms experience during winter as soils are exposed to more extreme cold conditions. Fire is another important factor affecting ecosystem function in prairies. The timing of fire relative to winter could have an important interactive effect with lower snow cover, as burning accumulated litter prior to winter leaves plant seeds, buds, and roots even more exposed to extreme cold temperatures. Here we pair long term (60 year) observations of prairie and savanna plant community change across a gradient of winter climate change with a field experiment manipulating snow depth and fire timing to better understand the consequences of winter climate change on prairie plant communities. Over the past 60 years, warming winter temperatures are related to increased extinction probabilities for spring-blooming species, but not summer-blooming species. Also, fire had substantial positive effects in preventing plant extinction. Following the first year of experimental treatments, reductions in snow depth cause colder and more variable soil temperatures but did not significantly affect plant growth. Also, burning prior to winter results in colder soil temperatures when snow depth is reduced. However, fire promoted plant growth for most species. Overall, these results suggest that winter climate has important effects on prairie plant health and that even though snow manipulations affected temperature dynamics in the soil, prairie plants are relatively resilient to these changes for now. Prescribed fire has very important effects on prairie plant dynamics and might counteract the potentially negative effects of future snow loss.

Keywords: Prescribed fire, Snow, Grasslands

T0169

Differential responses of forest understory and overstory plants to advancing snowmelt: a test by stand-scale manipulation

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Climate warming is advancing the timing of snowmelt in spring across a large part of northern hemisphere. Plant-plant interactions such as competition for soil nitrogen between overstory trees and understory vegetation could be an important mechanism governing the response of plant species and communities to advancing snowmelt in forest ecosystems. However, little is known about how advancing snowmelt influences overstory trees and understory vegetation simultaneously in an ecosystem. In this study, we conducted an stand-scale experiment that mimicked advancing snowmelt by about 10 days in snowy cool-temperate forests of northern Japan. We used large manipulation (i.e., 20 m by 20 m) in replicate plots to evaluate the combined response of understory dwarf bamboo and overstory birch trees. Advancing snowmelt treatment led to increased soil temperatures that were associated with increased rates of soil N mineralization and nitrification in early spring. Furthermore, these changes led to lower C:N ratios of leaves and greater growth of understory bamboo vegetation, with no changes in C:N ratios or growth rates of overstory birch trees. Our results implicate that advancing snowmelt in snowy cool-temperate forests are likely to affect N cycling and will benefit understory vegetation without a commensurate change in overstory vegetation, likely due to the increase in available soil N and lack of apparent competition between understory and overstory plants. These results show that in order to predict the future functioning of forest ecosystems and the ecosystem services provided by forests, we should conduct field manipulation experiments that assess both understory and overstory vegetation responses simultaneously.

Keywords: winter ecology, plant-plant interaction, ecosystem function, nitrogen cycle, aboveground-belowground linkage

T0782

The potential for biodiversity loss at landscape scale due to declining snow cover

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Snow is one of the most important ecosystem drivers in Arctic and alpine areas, but its effects are often ignored in climate change impact studies. The warming has been especially strong during the winter months and drastic changes in snow cover dynamics has already been documented through the northern high-latitudes. Yet, it is largely unexplored question whether the local snow conditions can buffer or catalyst the warming induced changes in biodiversity across Arctic and alpine landscapes.

Here, we utilized species distribution models for 273 vascular plant, moss and lichen species to test what are the impacts of different rate of change in summer temperatures and snow cover duration (SCD) on Arctic biodiversity. We fitted the models in current conditions and projected the species occurrences across 38 different temperature and snow cover scenarios. We conducted this study in mountainous tundra landscape in northern Norway using plot-scale vegetation data from 1200 study sites.

Based on our models, warming increased local species richness but the rate of species losing all suitable habitat was strongly dependent on the degree of change in SCD. The number of local extinctions increased rapidly after a tipping point at 20-30% SCD decrease regardless of the temperature scenario. All three species groups showed similar extinction rates, but contrasting species richness responses, lichens showing a decreasing trend in local species richness. Our results indicate that the future biodiversity in Arctic is dependent on the evolution of snow conditions, which should be carefully considered in climate change impact studies of high-latitude and alpine ecosystems.

Keywords: Snow cover, Niche modelling, Vegetation, Remote sensing, Winter ecology

T0273

Climate change and mountain life: the risk comes from permafrost (?)

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The effects of climate change on the alpine life and feature is a subject not yet studied in its potential and broad implications. The paper focuses on current and potential effect on the habits of people living or spending their time for leisure in the Alpine region. Besides the historical cause of the depopulation in mountain area (social-economic, demographic), dramatic lack of snow particularly affected these areas in the last decades, determining the crisis of winter sports and seasonal economy. Considering the southern face of the Alp (Lombardy), these territories suffer of decline and recession, with negative implications on environment, ecosystems, economy and society. Climate change, that in mountain regions means less snow and dramatic ice melting and crisis local tourism economy, implies a further risk already present and not yet clearly perceptible. In fact, it can create future derelict lands and it is the origin of great natural disaster too being the subsidence of permafrost a more or less direct effect of the same phenomenon (catastrophic landslides affected the Alps). The unpredictable spatial -beside environmental- effects of ice melting and permafrost subsidence in short time could cause a radical change in the way of life of Alps' inhabitants. Then is important to investigate and reflect on the state of glacier and permafrost, and in general on the environment variables complexity and less known effects deriving from climate and environmental factors, implying different perspectives on future land uses. This leads to the need to assess scenarios on the potential effects on land uses and creation of derelict areas as well as on landscape, biodiversity and natural resources due to climate change at high altitude, including the effects on the economy and the consolidated life of inhabitants. The analysis implies different perspectives on land uses, with a transdisciplinary approach for tailored innovative purposes “relieving” from anthropic uses.

Keywords: Climate change, snow loss, land uses, planning scenarios, landscape planning

T0735

Snow Cover Distribution in a small basin in South Western Siberia: Field Observations and Isotopic Composition

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In the southern regions of Siberia snow cover is an important factor in runoff formation, sustainable agricultural production and ecosystem functioning. In recent decades snowpack duration has shown a tendency to decrease. However, the average snow depth has been consistently increasing. Considering that snow cover is highly variable at the landscape scale, it's becoming increasingly difficult to predict watershed response to environmental change. In this study we focused on (1) describing general trends in snow cover distribution at the landscape scale, (2) assessing the main affecting factors, and (3) exploring the processes occurring with snow after accumulation. During two years (2017-2018) we carried out snow surveys (about 605 points per year) and assessed stable water isotopic composition (δ18O, δD) of the snow cover (64 samples per year) in 1768.7 km2 plain Kasmala river basin, located in the South Siberian forest-steppe ecoregion. Solving the third problem, we tried to use the isotopic composition. This parameter is widely used in hydrology as a tracer of internal fluxes, while its application in landscape ecology is limited yet.
The results have shown that snow accumulation can be extremely heterogeneous from year to year. In addition, significant factors affecting snow water equivalent (SWE) and isotopic composition distribution have changed considerably. In 2017 we obtained the relationship between SWE, slopes and aspects; in 2018 % of forest cover and aspects were significant respectively. In the isotopic composition variability in 2017 we did not identify significant factors at the landscape level. While in 2018 we found linear dependence with snow depth (an indicator of wind drift). In general, we noticed high uncertainty associated with the assessment of snowpack distribution in the plains. It may make the prediction process difficult in changing conditions. In addition, some factors might operate on a finer scale, which requires further research.

Keywords: snow cover, spatial distribution, isotopic composition, Western Siberia, forest-steppe

T0910

Warming winters can alter the tree species composition in northern boreal forests

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At high latitudes the climate is warming faster than in the rest of the Earth, largest changes observed in autumn, winter and spring. Increasing winter temperatures and wide temperature fluctuations are leading to more frequent rain-on-snow events and freeze-thaw cycles. By decreasing the insulation capacity of the snow and by causing ice layers or ground ice encasement, those events have the potential to lead to colder soil but also to hypoxia and accumulation of trace gases in the subnivean environment. To test the effect of such changing overwintering conditions on seedlings of common boreal forest trees (Norway spruce and Scots pine), we established a snow manipulation experiment in a coniferous forest on the Arctic Circle in Northern Finland. Three snow manipulation levels were applied: artificial ice encasement, snow compaction and complete snow removal. Ambient condition, i.e. intact snow was used as control treatment. The health and growth of the seedling was affected by the snow manipulations but the effect depended on the species, pine being more vulnerable than spruce. Our results demonstrate a negative impact of winter climate change on boreal forest regeneration and productivity. Changing snow conditions may thus counteract predicted positive effect of increasing growing season temperatures on boreal forest productivity. Laboratory experiments carried out simultaneously with the field experiment showed that deciduous species (Downy birch) performed better in changed snow conditions than coniferous species. This suggests that winter time climate change can favour the survival of deciduous species at the expense of coniferous species altering the species composition in future coniferous forests.

Keywords: Climate change, Winter, Snow, Boreal forests, Forest regeneration

Experimentally Simulating Warming and Snow Loss in a Mountain Meadow Ecosystem

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Climate predictions for the mountains of the western United States indicate that temperatures, particularly daily minimum temperatures, are on the rise and available snowpack is decreasing. The ecological effects of climate change could include shifts in distribution, phenological changes for many plants and animals, and advancement of spring events. Rocky mountain ecosystems may be particularly sensitive to climate change, as they have especially diverse and productive plant communities that serve as important food sources for a diversity of herbivores, including everything from insects to large mammals. Temperature increases associated with climate change will likely lead to a decrease in the duration of snow cover in mountain meadows and this change could have a significant effect on the ecology of the systems. Observational studies of climate change responses under field conditions can require long-term research at large geographical scales, and it can be costly to maintain such studies. Experimental field manipulations can provide a window of understanding into how larger-scale climate change effects may become manifested. We set up a small-scale study with 2.4x2.4 m plots and four treatment types to evaluate the effects of snow removal and passive nighttime warming on mountain meadow plants and abiotic soil characteristics in the Rocky Mountains of the U.S. Given that our ability to replicate the treatments was limited to an N=3, we used a creative statistical permutation analyses to tease out abiotic soil characteristics and the effects of snow removal and passive warming on phenology and floral resources of mountain meadow plants. Our results suggest that earlier snowmelt has a greater impact on plant phenology and resources, while slightly warmer nights may protect floral resources from frost damage. These results will inform future studies on phenology, floral resources and nectar availability, and how that might impact pollinators.

Keywords: snow loss, climate change, flowering plants, mountain ecosystems

T0050

Warmer winters and a disappearing subnivium

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The subnivium is the seasonal microhabitat that exists at the interface between the snowpack and the ground, and provides a refuge for many species. When snow depths are sufficiently high, the low thermal conductivity of the snowpack insulates the subnivium, creating a warmer and more stable microclimate compared to external air temperatures. Warmer winter temperatures due to climate change increase the likelihood that precipitation will fall as rain and result in shallower, denser, and more variable snowpacks. This variability has the potential to disrupt the continuity of snow cover and thus, the thermal stability of the subnivium. To predict how the extent and duration of this sensitive habitat will shift under warmer winter temperatures while incorporating natural variation in temperature and precipitation, we used active warming experiments distributed across latitude and land cover gradients in the Great Lakes region of North America to experimentally examine subnivium temperatures under two different warming scenarios: 3°C and 5°C warmer than ambient. We then used boosted regression tree models to predict the extent and duration of the subnivium under both scenarios. We found reductions in both the timing and distribution of the subnivium; however, areas that receive high amounts of lake effect snow demonstrated increased probability of subnivium existence in the +3°C scenario. In the +5°C scenario, nearly all areas in the Great Lakes region experienced drastic reductions in extent and duration. A disappearing subnivium will have important consequences for overwintering species, as well as a host of ecosystem processes that depend on patterns of soil freezing and thawing. Consequently, predicting the vulnerability of this ephemeral habitat to climate change is critical for understanding the susceptibility of the suite of species and processes that depend on it.

Keywords: snow, climate change, winter climate, active warming, Great Lakes region

Symposium 02

From conservation priority area to ecological security pattern

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With widespread concern about socioeconomic and ecological problems, ecological security has become a focus in regional landscape ecology research. The term 'security' can be interpreted as a goal of preventing ecological risks in the ecological studies. This generalized concept forms a visual target of ecosystem based management. The integrated management for habitat protection at the landscape scale is such an approach of ecosystem-based management. Accordingly, ecological security patterns (ESPs) is a concept considering ecological security in the fields of landscape ecology, urban planning, and landscape design. Based on the interaction between landscape patterns and ecological processes, ESPs will not only provide basic regional protection for necessary ecosystem services and a healthy living environment, but can also be seen as an effective measure to control urban expansion in a sustainable way.

Being advanced to the conventional priority area conservation, ESPs are referring to the elements of landscapes, such as ecological source patches and corridors, which are critical to health of the region's ecological system. The spatial configuration of ESPs is formed by strategic points, lines, polygon, and networks that are critical to maintaining ecological processes. Ecological security sources (the points) are natural areas that play a crucial role in overall ecosystem health. From the perspective of ecological economics, cost and benefit factors must be considered simultaneously in order to make well-informed decisions targeting ecological protection, because both these cost and benefit factors will influence the ecological security sources present within the considered area. Furthermore, ecological corridors (the lines) convey the transfer of ecological flow, ecological processes, and ecological functions in a region, which are usually identified through a least-cost path analysis based on ecological resistance surface.

Generally speaking, the concept of ESPs is currently more commonly used in China, whereas in Europe and the USA other concepts are more widely applied. This difference in methodological approaches are probably the consequence of the general relatively higher severity of ecological problems in China as compared to Europe and the USA. As we know, the enormous negative ecological effects caused by highly intensive construction activities in a condensed urbanization process, have become a serious threat to the maintenance and renewal of natural ecosystems in China. Besides the low recovering feasibility from ecological hazards due to the rather fragile environmental background of many regions in China, societal demand for high environmental quality as well as outdoor recreation opportunities in ecological land is also growing rapidly under the national policies of new-type urbanization and ecological civilization. In recent years, some scholars outside of China have integrated critical ecological infrastructure into ecological security research, and given conservation priority to key ecological elements with important roles in ecosystem maintenance and social development in approaches termed "secure urbanism and resilient infrastructure" (SURI). A conceptual framework of planetary boundaries has also been proposed to regulate the earth system and identify ecological security space that are necessary for human survival and development. This threshold-based concept has great similarity with the minimum bottom line management of ESPs. The priority of conserving key habitats combined with ecological patches and corridors also corresponds with the concept of habitat sustainability or habitat connectivity. Consequently, the concept of ESP has a great potential to be accepted by other fast urbanizing regions in developing countries elsewhere in the world.

T0213

The ecosystem-service performance analysis for sustainably protecting the historical cultural areas: the Three-hills and Five-gardens in Beijing, China

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The Three-hills and Five-gardens, located in the foot of the Western Hills of Beijing that breed Chinese imperial gardens owing to the pictured landscape of hills, sparking streams and paddy fields, has been protected as the cultural relics sites and as the whole, however no negatively, the integral landscape of the Three-hills and Five-gardens surrounded by natural mountains, and rivers and paddy fields have disappeared with the long-time urban growth. Set against the backdrop of a jumble of urban communities, cultural & educational, and commercial lands, this areas might not only be the hub of protecting Chinese classical royal gardens, but also be hoped as the potential key part of green buffers that ecologically benefit dwellers in the Center of Beijing. Then what kind of services the Three-hills and Five-gardens could ecologically perform and how about the capability of ecosystem service?

This work selected carbon sequestration, runoff reduction and air purification to evaluate the regulation and supporting service of the Three-hills and Five-gardens based on the theory of InVEST model and iTree model. The result showed that the total amount of carbon sequestration in the Three-hills and Five-gardens was 2.3 million tons, and the carbon storage per unit was 32 ton/hm2; the total amount of runoff reduction was about fifty-nine thousand cubic meters, and the total amount of atmospheric pollutant- clearance per unit was 0.69 ton/hm2. Then this paper analyzed the relationship between ecosystem services and landscape patterns to reveal the main factors of affecting ecosystem-service performance. The result showed gardens such as the Summer Palace that have (mountain) foests connected to open water bodies, could perform all of three types of ecosystem services better. It is hoped that this quantitative performance analysis and the following results could help to the making-decisions in the future conservation and development management of royal garden areas.

Keywords: ecosystem service performance, historical cultural areas, regulation and supporting service, social culture service, landscape pattern

Urban landscape safe pattern: a case study in Beijing-Tianjin-Hebei region

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Rapid urbanization may cause the loss of green landscape, the decline of ecosystem services and the deterioration of human living environment, and further the impairment of urban ecosystem health. However, how to assess the urban ecosystem health is still a challenge since the complicated relationship in different urban components and between the urban ecosystem and the surrounding regions. As the primary habitat for human, to keep the health and sustainability of urban ecosystem is particularly important for human sustainable development. In fact, the nature of urban ecosystem health is largely dependent on its own status in environmental and geological background, social governance and ecosystem health. It is also important for the urban ecosystem to have a harmonious relationship with the surrounding regions which may provide ecosystem services to the urban areas. In this study, a comprehensive evaluation system was developed on urban ecosystem health that focus on the resilience of urban ecosystem and the stability of the regional coupling ecosystem. The resilience of urban ecosystem was depicted from the ecological sensitivity, social regulation capability and human stress to the ecosystems. The stability of the regional coupling ecosystem was defined by the capability of provision services on substance, source, energy and other ecosystem services from other regions that is affected by the temporal variation and spatial distribution. Generally, the sources of provision service from far regions have a high risk, and further giving a low stability in the regional coupling ecosystem. Beijing-Tianjin-Hebei region was used as case study to make an urban sustainability assessment on the urban health based on the above evaluation system.

Keywords: urban ecosystem, sustainability, health assessment, resilience, ecosystem service

The debate of urban total ecological benefit control based on landscape ecology

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The unconstrained urban expansion has caused serious urban ecological problems. This research takes insights from multiple China urban planning cases and debates employing sustainable and detailed urban planning methodology named TOTAL ECOLOGICAL BENEFIT CONTROL (TEB) by applying software simulation such as ArcGIS, Ecognition, Fragstats and others to define a new urban planning method based on big data analysis. Based on the landscape ecology theory "Process, Scale and Hierarchy", this paper would define urban ecology process into two categories: horizontal eco process and vertical eco process, and would conducts researches on ecology process indicators, appraisal and standards. In addition, this paper reaches comprehensive ecology evaluation by combining other researches on vertical eco process. Last but not the least, the author will introduce the application of this theory in real cases in China.

Keywords: urban ecology process, sustainable planning, ecology evaluation, biodiversity protection

The potential distribution and conservation of endemic plant species in dry-hot valley of Jinshajiang river region under climate change

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The dry-hot valley of Jinshajiang River is located in the upper reaches of the Yangtze River Economic Belt. Due to the special geographical location, the protection and construction of its ecological environment will not only be beneficial for the development of this region, but also play an important role in the ecological security of the middle and lower reaches of the Yangtze River. In the past few decades, increasing of human activities has made it be a typical and fragile ecological area, and the vegetation restoration is difficult. Therefore, it is a key area for ecological environment construction in China. There are a number of endemic plants in this region with the special topographical and climatic conditions. These plants not only play an important ecological role, but also the precious resources with great economic value. Such as medicinal plant Stemona mairei, ornamental plants Hibiscus aridicola Anthony, spicy plant Aristolochia delavayi Franch., edible plant Amorphophallus albus. Recently, the climate change and human activities have fragmented and destroyed the habitats, causing endemic plants to be seriously threatened. In order to use and protect these plants, this study intends to investigate the distribution of 61 endemic plants and their potential distribution under future climate change based on field survey and community-level model. The results can provide useful information for the protection of the endemic plants, the economic development of this region, and the construction of road and hydropower station.

Keywords: endemic plant, climate change, spatial distribution, biodiversity conservation, Jinshajiang River

Linking spatio-temporal change of urban heat island with cooling corridors identification in urban agglomeration

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Urban heat island (UHI) is an important ecological effect of rapid urbanization. Although many studies have discussed the spatial-temporal evolution of UHI and its driving factors, the existing studies lack the cognition of its spatial form and connectivity. Based on the located contour trees algorithm, this paper detects the UHI ranges of the Pearl River Delta urban agglomeration from 2000 to 2015. Landscape indexes (FRAC_MN, LSI, etc.) were used to represent the convergence and divergence of UHI, and then identify cooling corridors, improving the ability to adapt to climate change. Results showed that the average patch fractal dimension of urban heat islands in the Pearl River Delta urban agglomeration decreased by 10%, the shape index decreased by 14.4%, the compactness increased by 5.6%, and the ratio of the newly patch perimeter to the original patch perimeter reached 0.4, indicating that urban heat islands in the Pearl River Delta urban agglomeration was a typical edge-expansion, and the whole area integrated in 2010. At the same time, based on identified cold islands' distribution and prevailing wind direction, we drew a schematic diagram of urban agglomeration cooling corridors, providing more accurate spatial decision support for alleviating UHI in the Pearl River Delta urban agglomeration.

Keywords: Urban heat island, Cooling corridor, Urban planning

Nature-based Regulation to Urban Thermal Risks: A Human Health Perspective

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Urban heat island (UHI) effect has various negative impacts on urban ecosystems and great potential risks, such as heat-related morbidity and mortality on urban dwellers. Nature-based solution is a new environmental friendly approach to mitigate urban heat island, therefore, has increasingly recognized to have great potential to urban human health. It was well known that urban green infrastructure could effectively mitigate UHI effect. Urban blue infrastructure (UBI), i.e. urban surface water, has similar function with urban green infrastructure; its mitigation effect on the urban thermal environment is being recognized recently. However, how to use the UGI and UBI, the nature-based solution, to alleviate urban thermal risks on human health is still unclear. This study which was conducted in Shanghai, China aims to identify the spatial pattern of urban hot spots and the associated human health risks, to explore the relationship between UGI and UBI and land surface temperature, to examine the mitigation effect of UGI and UBI on surface urban heat island (SUHI), and finally, to examine the effect of UGI and UBI on human mortality. Our results showed that (1) multiple urban heat island-related hot spots were identified and human health riskscape was mapped. (2) There was significant negative relationship between mean land surface temperature and UGI and UBI, but varied relationships existed. Therefore, UGI and UBI have potential to mitigate SUHI. (3) The UGI and UBI have excellent mitigation effects by forming marked local cool island intensity and large cooling distance. For UBI, the examined maximum cooling distance (MCD) can range from 555m to 1275m, and the maximum local cool island intensity (MLCII) can vary from 7.2 ℃ to 12.8 ℃, while for UGI the MCD and MLCII were 64m to 1405m, and 1.0 ℃ to 5.2 ℃, respectively. These new findings can provide insights for urban landscape planning and urban human health protection using nature-based solutions.

Keywords: Urban green infrastructure, Urban Blue infrastructure, Urban heat island, Human health risks

T0413

3-D ecological security pattern construction in Shenzhen based on a birds view

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The rapid process of urbanization, accompanied by the sharp increase of impervious surface and vertical buildings, has resulted in the loss of natural ecosystems and habitats. It is great challenges to Identifying and protecting key places that have high importance for ecological conservation. Ecological security patterns (ESPs) are such an integrated approach to protecting ecological priority area. However, most of currents ESPs are focus on ecological priority area all species, which have not considered the particularly demand such as for migratory bird. In this study, taking Shenzhen City, China as a case study area, migratory bird flight altitude and accessibility into habitats area were used to identify ecological source. Ecological corridor, pinch point and barrier were identified by a 3-D architectural landscape type. Based on a bird view and 3-D architectural landscape barrier, this study provides a new approach to identifying the spatial range of ecological corridors and the specific location of key nodes for effective ecological conservation and restoration. The protection effects of national Birdlife Nature Reserve in Shenzhen were assessed by ecological security pattern method.

Keywords: Ecological Security Patterns, Urbanization, Migratory, 3-D architectural landscape, migratory bird

Identifying the hotspots of anthropogenic heat in urban regions

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Although energy-induced anthropogenic heat emissions form localized hotspots, they can influence the variability of urban climates. A lack of a quantitative attribution of anthropogenic heat in different locations and times has created a barrier in current research. This study presents a distributed model of anthropogenic heat (DMA) that can be used for quantifying the seasonal and spatial variations of that heat. The intensity of anthropogenic heat was estimated by separately considering the major sources of waste heat generated in urban environments from vehicular traffic, buildings, industry, and human metabolism individually. The contribution of anthropogenic heat to urban environments was assessed by the ratio of the intensities of anthropogenic heat to solar radiation (δ). We conducted this model in China's megacities. The hotspots were identified and designated as the priority areas to heat control in urban regions. This study indicates that a greater focus on energy reduction would be most effective in mitigating the effects of anthropogenic heat in commercial and industrial zones and in winter. The DMA is a feasible tool that can be used to quantify the temporal and spatial variations of anthropogenic heat based on energy consumption data in other urban regions.

Keywords: urban heat, urban ecology

T0643

Regional vulnerability assessment of terrestrial biotopes regarding landscape change

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To halt biodiversity loss, landscape planning and ecosystem management could benefit from a condensed measure that tracks regional and cumulative habitat loss from landscape changes. A vulnerability map of the remaining biotopes will identify those with a high potential to be adversely affected and a low capacity to recover. These vulnerability hot spots may require specific protection and maintenance interventions to be sustained.
Biotope maps are available across large areas of Europe, primarily recorded for nature conservation purposes. However, applications of biotope vulnerability analyses are rare and geospatial tools to analyse large extents of biotope maps are underdeveloped.
Following the interdisciplinary vulnerability concept, the analysis was structured into biotope exposure, biotope sensitivity, and biotope adaptive capacity. The applied indicators covered patch and class metrics and served as proxies to describe the vulnerability of terrestrial, (semi-) natural biotopes to landscape change. The indicators were calculated and transformed into a vulnerability index for almost 350,000 patches of 32 different biotope groups, covering the area of the German federal state of Brandenburg (~30,000 km²).
Next to presenting results on particular biotope groups and hot spots of vulnerability, the symposium perhaps profit most from a discussion on the applied methods and underlying theoretical frameworks. The biotope vulnerability index developed for this study area is intended for application at large spatial scales and has the potential for a straightforward transfer to other countries and regions, which the conference may reveal.

Keywords: landscape metrics, habitat loss, vulnerability mapping, biotope

The observation and valuation of karst ecosystems from local to global scales

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The fragile karst ecosystem in Southwest China is one of the largest exposed carbonate rock areas in the world, hosting more than 220 million people. Rocky desertification is the most serious eco-environmental problems in China karst. For the ecological restoration and sustainable development of karst ecosystem, Chinese Academy of Sciences built a long-term ecological research station since 2004 to observe the karst ecosystem. Combining with the long-term continuous observation, remote sensing and ecosystem models, we identified the changes of ecosystem spatial pattern, progresses and functions under the coupled impacts of climatic and human disturbances. The results showed that ecological restoration projects had positive effects on China karst restoration, especially at local and regional scales. The ecosystem structure and functions had been improved with the implementation of ecological restoration projects, despite a decline trend in rainfall and soil moisture in China karst during 2000-2015. The vegetation greenness and carbon stock increased with conservation projects. We found southern China karst was one of the globally largest increases in biomass to occur in the world (on average +4% over 0.9 million km2), which accounts for ~5% of the global areas characterized with increases in biomass, despite a decline in rainfall (-8%) and soil moisture (-5%) between 1999 and 2012. Then we revealed how different forest management strategies considerably increased C stocks via (harvested and unharvested) tree plantations. We found the changes in C uptake and cooling effects were low in old-forests and highest in undisturbed afforestation areas. The intensive land and forest management in southern China has offset ~30% of the fossil CO2 emissions from the region. However, soil water depletion challenges the sustainability of this region. It is needed for comprehensive assessment for understanding of conservation projects' functional and biodiversity effects.

Keywords: China karst, ecosystem valuation, ecological restoration projects, carbon sequestration, forest management

T0913

The role of nature-based solutions for water and wastewater treatment in delivering ecosystem services and habitat connectivity in their wider landscape context.

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Combined natural and engineered water and waste water systems (cNES) are nature-based solutions that utilise naturally occurring processes to remove impurities from water and therefore contribute to the ecosystem service of water quality enhancement. We hypothesise that these systems may also have a potential to deliver ecosystem services other than their primary purpose and we use spatially-explicit modelling tools to determine these benefits. We investigated the spatial distribution of multiple ecosystem services for three different types of cNES: bank filtration (BF), managed aquifer recharge/soil aquifer treatment (MAR/SAT), and constructed wetlands (CW), including the role of habitats present within the sites in wider landscape's connectivity, as well as public perception of the aesthetic value of two of the cNES technologies. We also attempted to link the determined ecosystem services to their likely beneficiaries. Our results indicated that the sites characterised with semi-natural ecosystems had a good potential for ecosystem services provision and that the selected cNES technologies were favourably received by the public as compared to their engineered equivalents. We concluded that determination of ecosystem services potential from nature-based solutions, such as cNES technologies, should be done in consideration of various contextual factors including the type of habitats/ecosystems present within the proposed solutions, the location within the landscape as well as properties and ecosystem services potential of the areas surrounding the sites, all of which can be facilitated by deployment of spatially-explicit ecosystem service models at early stages of the planning process. Moreover, determination of actual ecosystem services provided by the sites should follow from the analysis of stakeholders present within and the socio-economic context of the study area.

Keywords: ecosystem services, landscape connectivity, combined natural and engineered water and wastewater treatment systems , InVEST models, Circuitscape

P0174

Delineation of urban growth boundary based on ecological security pattern

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Rapid urbanization has promoted China's social and economic development, and it has also brought about a series of problems such as the urban sprawl and ecological environment deterioration, which has seriously restricted the sustainable development of cities and regions. How to guide the rational urban expansion, effectively maintain the basic ecosystem services of the city, balance ecological protection and economic development is a difficult problem that must be faced and urgently solved by contemporary academic and government departments. The relevant researches and practical experiences have shown that scientifically delineating urban growth boundaries (UGBs) is an important strategy to solve the aforementioned problem. The traditional methods of delineating UGBs in China often lack sufficient quantitative analysis and scientific basis. As a result, the UGBs often fail to contain urban growth, and substantial urban development occurred outside of UCBs and occupied a large number of ecological land. Therefore, this study proposes a new UGBs delineation method that couples land use prediction models and ecological security patterns. The purpose is to transform the traditional passive defense of ecological protection into active restraint, effectively control the disorderly urban sprawl and guide the rational urban growth. The results show that the UGBs obtained by this method can achieve the maximum protection of land with important ecosystem service functions while meeting the urban growth demand. The UGBs delineation method proposed in this study can effectively promote the win-win situation of urban smart growth and ecological protection, although there are significant differences between the simulated UGBs and those in the in the urban master plan. We believe that the method proposed in this paper is not only an effective policy tool, but also an important practical exploration of the core theoretical research of pattern and process of landscape ecology.

Keywords: Ecological security pattern, Urban growth boundaries

Symposium 03

Integrating food systems into landscape research

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Landscape sustainability and sustainable food systems are closely related issues, but they have been treated separately in most of the scientific literature. While landscape research typically focuses on understanding the dynamics of changes and landscape actors, patterns, and functions at different spatial scales, research on food systems typically investigates activities ranging from production to consumption and including multiple environmental, social, political, and economic determinants. With ongoing economic globalization, larger spatial distances and complexity increasingly characterize the value-chains of food. The nature of value chains across food systems differs considerably (e.g., between mass-market and niche products). Analysing these global value chains (i.e. networks through which enterprises organize across different places to produce, transform, distribute, and deliver a specific good) is therefore a central approach to the integration of food system and landscape studies.

The overall objective of this symposium is to present and discuss novel research approaches that investigate the role of food systems and value chains in landscape dynamics and sustainable landscape management. We particularly welcome contributions that:

- Elaborate on the interrelations between food systems and landscape sustainability,
- Assess ecosystem services trade-offs that food systems create in landscapes,
- Link changes in food systems spatially to landscape changes
- Study the effects of governance mechanisms such as certification on landscapes
- Investigate movements toward sustainable food systems and landscape management

T0451

Exploring tradeoffs and synergies between food production and carbon sequestration in a grassland-dominated landscape based on extensive beef-cattle systems.

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Managing land use to address tradeoffs among ecosystem services in agricultural landscapes is challenging, as land cover decisions are often choices between mutually exclusive options. We used an optimisation modelling approach to investigate relationships among ecosystem services in a grassland-dominated landscape in the "Massif Central" (center of France) characterized by extensive beef cattle systems, with a special focus on the relationship between food production and carbon sequestration. We developed a data-based statistical model linking drivers (land cover, land use, and climate variables) to three objectives (crop production, livestock production, and carbon sequestration). We ran a multi-objective optimization algorithm (based on evolutionary computation) to explore variations in land use that would make it possible to increase the three objectives at the same time. The optimal solutions represent configurations for which it was not possible to increase one objective without decreasing another. Analysis of the optimal solutions showed that crop production was in tradeoff both between livestock production and carbon sequestration. In contrast, it was possible to increase at the same time livestock production and carbon sequestration thanks to an increasing of the area covered by grassland. Our study thus brings new insights on the key role of grassland in landscapes as a multifunctional land cover for livestock farming and ecosystem services.

Keywords: ecosystem services tradeoffs, food production, agricultural landscape, grassland, multi-functionality

Potential contributions of food systems to sustainable landscape development

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Food producers continuously contribute to the co-creation of place-based social-ecological landscapes through their land use and management practices. With case studies from Australia, the UK, Germany and the Czech Republic we explore how their practices create and define sustainable landscape development. Common to our case studies is that such production reinforces local food supply chains and intentions to protect ecological and cultural landscape values. However, the dynamic realities within ecosystems requires we consider the more complex interactions associated with food and fibre production that impacts ecosystem quality. The Australian introduction of rare tropical fruit to the Wet Tropics provides customers with a greater variety of fruit, contributes to diverse planting structures, and extends habitat for various species but also introduces other invasive species into the island continent, creating serious concerns for native biota. The German "Streuobst" traditional agroforestry-system underpins a cultural orchard landscape where trees are maintained; contributing to the conservation of biological diversity as a restoration landscape aesthetic. UK community supported agricultural create 'new' farm landscapes where free-range pigs and chickens provide a constant remanuring system and resources for vegetable production, closing the agro-ecological system, heightening soil conservation but producing at subsistence scales. Trebon carp from the Czech Republic, produced since medieval times, is a famous local product, providing vistas, and attracting many visitors to the region. However, the increase in carp size points to water eutrophication issues. We argue that these examples reinforce the analysis required for a more thoughtful integration of complex cultural, conservation and production goals: issues of scale, multi-functionality and more overt discussion of ecological outcomes in food production and security programs are discussed.

Keywords: Multifunctional landscape, agro-ecology, food security, localism, rural livelihoods

T0607

Local and landscape drivers of biodiversity and ecosystem service trade-offs in urban agricultural landscapes

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Biodiversity and ecosystem functions contribute to human well-being through many ecosystem services. Both local ecosystem, landscape features, and their interaction affect biodiversity and service provision. The spatial or temporal scale at which local and landscape factors are experienced by service providers vary, suggesting that direction and strength of ecosystem service provision similarly varies across services. Yet we know little about how changes in local and landscape factors produce ecosystem service synergies or trade-offs, particularly in complex agricultural and urban landscapes. In this study, we examine the relationships among ecosystem services in urban agroecosystems, asking how local and landscape-scale factors may synergistically enhance regulating, provisioning and cultural services. We use empirical data collected over 5 years in 25 urban community gardens on the local and landscape factors, biodiversity of ecosystem service providers (e.g. bees, natural enemies), ecosystem functions underlying services (e.g. pollination, pest control), crop yield, and reported human well-being. We show how changes in local factors have varying effects on biodiversity, functions and services, but this is dependent on landscape context. Where pollination services are driven by interactions among local and landscape factors, landscape strongly drives biodiversity of natural enemies and pest regulation services. We provide recommendations for how gardeners can manage local and landscape abiotic and biotic factors to better support service providers and maximize service synergies.

Keywords: local-landscape, biodiversity, ecosystem services, urban gardens

T0236

Towards a framework to connect food value chains to landscape sustainability. An example from the Mediterranean.

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Landscapes sustainability is affected by global dynamics and processes but these cross-scale connections are rarely given the attention they deserve due to the lack of approaches to grasp their complexity. We propose food systems as a key element of study to make these linkages explicit in the context of Mediterranean landscapes. Food production is the main land use shaping Mediterranean landscapes, while the value chains of its products connect them to global markets through a series of distant interactions (telecoupling). Furthermore, when associated to distinct landscapes, food products provide a linkage between the global consumers and the local environment of production.
Therefore, the aim of this study is to provide a framework to study the connections between the value chains of products associated to distinct landscapes and the characteristics of the landscapes of production as a way to understand and enhance landscape sustainability.
To this aim this study integrates knowledge of experts from different disciplines and countries canvassed through in-depth surveys. In a first step 50 Mediterranean food products associated to distinct landscapes are selected (e.g., high quality olive oil, wine and cheese). In parallel, a list of indicators is derived to characterise the value chains of the products and the landscapes of production, and translated into questions for the in-depth expert surveys. In a second step, experts with specific knowledge on the food products and landscapes selected are surveyed by email and phone. Finally, based on their answers and using multivariate analysis, we examine the linkages between the value chains of the food systems under study and the social-ecological characteristics of the landscapes of production. On this basis, we develop a framework to study the connections between places and processes across scales to identify pathways for fostering landscape sustainability.

Keywords: food systems, sustainable landscape management, social-ecological systems, telecouplings

P0031

Agrarian landscape rehabilitation following landscape bionomics

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In the recent past, almost all agricultural activities were traditional and agrarian systems were interspersed across the larger natural landscapes. Due to the so called "green revolution" this landscape configuration was completely changed and now industrialized agriculture is spreading all over the plant with tremendous negative impacts on natural resources. In many cases the agrarian landscape was cancelled or completely destroyed.
The failing of "green revolution", not able to preserve such natural resources as soil, water, biodiversity, due to its excess of environmental simplification brings to an enlarging reaction, towards the new paradigm of agroecology. Agroecology promotes family farms, local supply chains and product quality, that is to say a fully 'sustainable development' for food and agricultural systems in environmental, economic and social way. This new discipline is still limited to update farming systems or agro-food systems, with a still weak analysis of the entire landscape.
At the light of the new scientific paradigm shift, which indicate the necessity to decrease the dominance of reductionism, conventional Ecology must be upgraded. The new discipline of Bionomics and consequent Landscape Bionomics, proposes the integration of the viewpoints of Space configuration, Biotic structure, Functional processes, Cultural-Economic governance, studying directly the Real Environmental System as complex system.
Agroecology, by adopting landscape Bionomics categories, its units of cellular, ecocoenotope and landscape, its indicators (i.e. BTC) could be proposed as a new discipline for facing the new challenge of Planetary Health requiring system approach, new technologies, new educational environment.

Keywords: landscape bionomics, green revolution, agrarian rehabilitation, agroecokogy

T0473

Farmer perspectives on the value of ecosystem services in reservoir landscapes

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Relatively little attention has been given to understanding or quantifying the value of ecosystem services (ES) for human well-being (HWB) in a locally meaningful manner and particularly from the perspective of farmers, despite their role as primary stewards of a large share of the world's terrestrial land. Theory suggests that farmers should place a high value on ES because their livelihoods depend on adequate freshwater supplies, soil nutrient cycling, biological pest control and other services that benefit food, fibre and biofuel production. Yet farmers, including in rural West Africa, are increasingly encouraged to address farming challenges through technological and agrochemical solutions which may erode their sense of reliance on nature with consequences for farmer perceptions, values and behavior regarding ES. We analysed smallholder farmer perceptions of ES, ecosystem disservices (ED), and their HWB importance around community-managed reservoirs in four semi-arid agricultural landscapes in West Africa, using participatory mapping, focus groups and face-to-face surveys. The reservoirs mediate access to supplies of several food and water-related ES that underpin local agricultural livelihoods, including provision of fish and of water for livestock and crops. Farmers identified what ES and ED they perceived across their landscape and ranked the importance of each service and disservice for HWB. Results show perceptions of the importance of several ES and ED varied significantly with farmer socio-economic status, and that several locally available ES (e.g. medicinal plants, firewood) were considered of at least equal importance to reservoir-accessed ES. We discuss the need for careful consideration of trade-offs between HWB outcomes and stakeholders in ecosystem management decisions to foster sustainable food production and development goals in these landscapes.

Keywords: Ecosystem services, Human well-being, Farmer perspectives, Food production landscapes, Community-managed reservoirs

Edible landscapes. Agricultural production and its qualitative representation in food.

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The correlation between landscape and food is not new, Sereni had already outlined how the transformations of the agricultural production system hence the modern times has completely changed the so called mediterranean diet in the case of Naples. This contribution focuses on one particular aspect of this correlation, the symbolic representation of the landscape in the food. The methodology used is that of comparative studies, analysing the analogies between five selected landscapes and five corresponding dishes within a wide selection of case studies in the European territory. Within this correlation it will be possible to deepen the food-landscape link in the Italian experience by examining two traditional dairy products that can never be lacking in Italian dishes and tables: Parmigiano Reggiano and Grana Padano. These are two worldwide famous cheeses, both produced in the territories of Northern Italy. But few people know that these two cheeses are only apparently similar and that their production generates very different landscapes characterized by different degrees of sustainability. This diversity is the direct consequence of the difference between the production specifications adopted by the two respective associations of producers. From this comparison clearly emerges the link between the quality of food and the quality of the corresponding landscape. Therefore, each of us, by choosing one product instead of another, unconsciously takes a responsibility concerning not only his own health, but also the use of the soil and then the features of the landscape. The individual and mass awareness of the link between the daily choice of food and quality landscapes represents an important objective to be pursued as an instrument for safeguarding and governing the land and resources.

Keywords: Rural landscapes, history of agriculture, territorial morphology, foodscape

P0093

Investigating the off-stage landscape service burdens of olive oil production

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Today's globalized world is a large coupled human and natural system consisting of many smaller coupled social-economic-ecological systems linked in complex ways through long-distance flows of resources. The connectivity of these systems, over time and in space, can produce distant, widespread and delayed impacts on landscape services, called off-stage landscape service burdens. They can derive from policies underlying the management of landscape services, such as the management of provisioning or regulating services in the agricultural production through agricultural commodities trade. Given the increase of reliance on imports and exports of agricultural commodities, the main aim of this research is to investigate the "off-stage landscape service burdens" of olive oil production, arisen from the three Common Agricultural Policy (CAP) reforms. The analysis is based on the Virtual Water Flows (VWFs) applied to the imported and exported quantities of olive oil between Italy and the EU 28 countries from 2001 to 2016. The results show that the application of CAPs in Italy has produced a virtual water saving of about 2.603,7 million m3 during the analyzed period. However, during the same period, in some countries, such as Greece and Spain, the national application of the same European policies has favored intensive agricultural practices associated to the production of olive oil with a virtual water loss. This opposite result coming from the same European policy brings to generate off-stage landscape service burdens hidden in the form of virtual water associated with the imports of olive oil. This spatial connectivity among countries requires a new approach for a global landscape management, which should take into account the flow of landscape services among distant places and in different times. Thus, there is a need to recognize and quantify these "off-stage" impacts to avoid unintended and unexpected changes in landscape services' flow.

Keywords: Common Agricultural Policy, Virtual Water Flows , off-stage landscape service burdens

T0059

Fostering biocultural diversity in landscapes through place-based food networks: a ‘‘solution scan’’ of European and Japanese models

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Many Japanese and European landscapes harbor biocultural diversity that has been shaped by human agency over centuries. However, these landscapes are threatened by widespread land abandonment, land-use changes, and urbanization. The aim of this study is to use a “solution scanning” method to identify place-based food networks in Europe and Japan that reinforce linkages between biological and cultural diversity in landscapes. In our analysis of 26 European and 13 Japanese cases, we find that place-based food networks are typically located in heterogeneous landscapes, are driven by civil society (and less by markets), and act at a local scale. Regional identity is the most frequently addressed societal issue. Scenery, rural tourism, and nature conservation are more important motivations in Europe, and physical well-being and revitalization of local economies are more relevant in Japan. European models are typically associated with achieving biodiversity conservation and socio-cultural tradition outcomes, and Japanese models more with public health and nutrition outcomes. We discuss the potential for transfer of approaches from Japan to Europe (e.g., models that tackle the aging of rural societies), and from Europe to Japan (e.g., models that build explicit connections between food production and biodiversity conservation). We conclude with a list of recommended policy measures, e.g., the creation of a flexible legal framework that protects the interests of and reduces political constraints for collaborative efforts to biocultural diversity in landscapes.

Keywords: Landscape stewardship, Cultural landscapes, Alternative food networks, Sustainable landscape management, Food systems

T0840

Effects of land systems dynamics on local food systems: insights from seven Mediterranean local case-studies

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Current land use and land cover changes (LULCC) have been related to different impacts related to food systems, such as water footprint of food consumption (Capone et al., 2013), agricultural carrying capacity (Peters et al., 2007) or self-sufficiency as a means of food security (Zasada et al., 2017). LULCC can act between agricultural and other land use types like urban sprawl, in particular on coastal or metropolitan areas (Salvati et al., 2012). These main changes are not independent and act in a feedback chain: disturbance of traditional agriculture surrounding urban areas due to cities expansion leads to the development of a market-oriented agriculture further away from the cities, while new forms of agriculture linked to the city are created (Monaco et al., 2017). Furthermore, recent findings show that it is possible to recognize which periurban farmland is oriented to local markets (i.e. local food system) and which one is dedicated to global foodstuff supply (Filippini et al., 2014; Sanz Sanz et al., 2018) from a GIS analysis combined with an analysis of the regulations and socio-economic context.

The aim of this communication is to identify the effects of land systems dynamics on local food systems, in terms of local self-sufficiency as a means of food security. Our hypothesis is that certain land systems are more willingly to improve the regionalisation of food systems for shortening supply chains.

We will present the results of a comparative study of 7 urban regions, 4 in Europe (Avignon, Pisa, Madrid, Malta) and 3 in Africa (Tunis, Sétif and Annaba), representative of the Mediterranean land system diversity (project Divercrop, Arimnet 2, 2017-20). We developed a qualitative and quantitative analytical framework in order to identify the determinants of local provision of specific locally grown food products along the three major levels of the supply chain (agricultural production, food chain organisation and commercialisation), over the last 10 years.

Keywords: food sufficiency, local food system, land systems, metropolitan, Mediterranean

Symposium 04

Reconstructing past landscapes to simulate future sustainable scenarios through multidisciplinary approaches.

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Land degradation driven by rapid expansion and unsustainable management of croplands and grazing lands worldwide is leading to loss of biodiversity and ecosystem services – e.g. food security, water purification, the provision of energy etc. According to the recent IPBES Assessment Report on Land Degradation and Restoration, this ongoing process is undermining the well-being of up to two fifths of humanity, driving species extinctions and intensifying climate change impacts, and has reached 'critical' levels in many parts of the world. Landscape ecology enquiry contributes to future sustainability objectives by providing tools for understanding past human-nature dynamics and building future sustainable landscape. In this symposium we aim at encouraging the debate on multidisciplinary frameworks to explore multi-spatial and multi-temporal scales landscape dynamics in the Anthropocene, in particular by linking knowledge from the past with future planning. We will present the case study of East Africa including perspectives from paleoecology, archeology, landscape modeling, participatory appraisal, and scenario analysis. In the first session of the symposium (3 talks) we will present frameworks to investigate past landscape dynamics (e.g. paleoecological and archeological archives) and we aim to discuss best practices for integration of appropriate range of disciplines through more holistic approaches that go beyond just multidisciplinary team that comes together. Understanding spatial and temporal patterns of human-nature interactions is essential for landscape sustainability research and practice. Tackling both spatial and temporal scale require multidisciplinary approaches that address the complex interactions between biophysical and socio-economic factors (e.g. including paleoecology, archaeology, sociology, ecology and geoscience). Additionally, integrating appropriate range of disciplines towards addressing challenges is important because it provides a balance between fostering human well- being (e.g. material goods) and nature conservation. Unsustainable natural resources management is largely driven by significantly low uptake of adaptation/conservation practices. Narratives that arise from dissemination and scientific communication are crucial to modifying the values, rules, and knowledge held by the public, stakeholders, and policy makers. In the second session of the symposium (3 talks) we will present novel frameworks to engage stakeholders in envisioning future landscapes that can contribute to decision-making and planning. We will focus on approaches that combine qualitative with quantitative and spatially explicit methods, and on linkages between the local landscape and the global phenomena that affect it (e.g. international policy or global climate change) and are affected by the landscape (e.g. ecosystem services flow).

Developing a dialogue with mixed groups of stakeholders to connect scientific evidence and traditional knowledge in local landscapes can lead to a better understanding of the long-term social-ecological dynamics and the drivers that have shaped the landscape over time and to the envisioning of future sustainable landscapes. On the one hand, the culture of people who live in the landscape (local stakeholders) as well as others who depend on or have an interest in its resources and functions (regional to global tele-coupled stakeholders) is fundamental to identify problems and solutions that undermine or support landscape functions. On the other hand, designing sustainable solutions for the future implies an understanding of physical patterns of landscape multifunctionality that societies value and so requires spatially explicit approaches.

The two sessions will be followed by an interactive session for discussing on challenges and opportunities of the proposed approach, building a community of practice and collaborative actions (ca. 30').

Reconstructing rural landscape: an integrated approach to analyse future scenarios and changes. The case study of Mongardino municipality (Italy)

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Methodological analysis of rural landscape moves from historic evidences of the state-of-art, involving archive studies of maps and related data. If these consolidated methods include historical and statistical data in the contemporaneity, new tools as photos could help to explore the changes occurred during XIX-XX centuries. With the aim to identify sustainable future scenarios in planning and development, an integrated case study on Mongardino municipality (Province of Asti, Piedmont, Italy) was performed. This site is partially included in the UNESCO buffer zone of the "Vineyard Landscape of Piedmont: Langhe-Roero and Monferrato" recognized as a cultural landscape (2014). Firstly, with the aim to reconstruct rural landscape, historical and landscape analysis were performed. Secondly, related to XX-XXI centuries, photos-based-research was conducted in the entire 6.86 km2 of the municipality, obtaining a visual comparison of the same shooting points in a year range (1903 to 2015). After, they were matched with local and provincial statistical data (1967-1982), coupled with the Italian National Institute of Statistics ones (1980-2010), and GIS maps. These comparisons have revealed new integrated possibilities in exploring coeval trends. Principally, it allows to accurately visualizing a steady crop regression in the village surface, in terms of agricultural land use during XX-XXI centuries. That one does not follow dynamics only related to slope or bad exposures of hillside faces, but is also affected by anthropological and economic factors. The methodological framework applied in this research project compare traditional and innovative sources in order to analyse scenarios and explore changes in land cover over time. In fact, it could delivers a practical frame that foster new bottom-up planning processes in medium-long terms, according to 2030 UN Agenda.

Keywords: UNESCO, land uses, historical permanences, cadastral maps, statistical data

P0064

We need to talk about walls: examining the legacy of the Berlin Wall on a peri-urban forest

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The Berlin Wall stood from 1961 to 1990, separating West Berlin from the surrounding communist German Democratic Republic (GDR). The construction, longevity, and falling of this wall is a classic example of the enormous legacy of such divisive socio-political structures. Even though the wall has been down for over almost 30 years, there are persistent marks on the social and physical landscape. Recently, the German Green Belt Berlin has begun incorporating the legacy of the wall into memorial green landscapes, which include linear connections between larger parks and novel urban ecosystems. However, little is known about the ecological legacy of the wall beyond the central metropolitan district. In this project, I set out to investigate Spandau Forst - a peri-urban woodland that was bisected by a ~4 km of the Berlin Wall. Using field samples of contemporary tree communities and aerial imagery from before construction (1959), during GDR occupation (1969/1979/1990), and after the fall of the wall (1996), I answer three questions. Firstly, how does the contemporary tree community and structure differ on opposite sides of the wall? Secondly, does proximity to the wall, regardless of side, impact the contemporary vegetation patterns? Lastly, how does the tree cover and distribution change in the area surrounding the wall over time and are these patterns unique on either side of the wall? Aerial photography of the region demonstrates that forest use in adjacent regions on opposite sides of the wall has been distinct, and the ratio of conifers to deciduous trees reflects these pressures. Furthermore, there is more consistency in the forested area on the former-GDR side of the wall than in capitalist West Berlin. Tree density and age structure reflects prioritization for logging in the region's history, but the changes in tree community structure for trees between 30-60 years old may reveal further interesting discrepancies in forest ecology and use from the Cold War period.

Keywords: Legacy Ecology, Berlin, Border Walls, Forestry

T0251

Loss of forest integrity in NW Amazonia: division of a basin

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NW Amazonia has become one of the most recent hotspots of forest loss in the Amazon basin. Being the wettest part of the basin, is key to understand the causes and consequences of land use change. This is critical in the construction of scenarios for planning the future of the territory and conserving Amazonian forests. We analyze recent changes (2007-2016) and develop a business as usual (BAU2030) scenario and two alternative scenarios for 2030 (PAST50_2030 AND TECH_2030). We used 5 main categories (forests, pastures, secondary vegetation, fragmented forests, and others) and grouped the main transitions of categories into three submodels of change (conversion to pastures, degradation and regeneration). We predict a substantial loss of forests 3,387,898 ha for 2030 in the BAU2030 with an increase in pastures of 2,012,087 ha. The alternative scenarios are an opportunity to stop forest loss and halt pasture expansion. The scenarios project a loss in connectivity and the reduction of intact forest. There is also an increased isolation and a reduction of total forest core but the TECH_2030 scenario is less extreme. The protection of intact patches is key to the future of the NW Amazonia, the reduction in the rate of conversion to pastures in the PAST50_2030 is noticeable but the TECH_2030 scenario is where those areas and connectivity will be less affected. These findings signal the urgent need to find mechanisms to implement effective planning in the region in order to prevent uncontrolled expansion, slow deforestation and fragmentation rates and to ensure the integrity of the protected areas and the connectivity of such key landscapes.

Keywords: Land Use Land Cover, forest loss, Amazonia, fragmentation, policy

T_1009

Implementing landscape conservation approach in southern western ghats of India: achievements, issues and opportunities

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Ecodevelopment, elsewhere known as Integrated Conservation Development Programmes (ICDPs), being implemented in India since 1990s aim at inclusive management of Protected Areas (PAs). These programmes have been quite successful in many PAs. However, growing realization that PAs with their small size and huge surrounding pressures, cannot achieve the larger objective of biodiversity conservation and human well-being, has led to adoption of landscape conservation approach. This study tries to understand the achievements, issues and opportunities of implementing this approach in Periyar-Agasthyamalai landscape (PAL) of Southern Western Ghats of Kerala, India. In the back drop of archival literature and understanding of ongoing participatory programmes, a stratified random sample of Village Ecodevelopment Committees and Vana Samrakshana Samities were studied through focused group discussions.

PAL covers a mosaic of conservation and development landuses including PAs, territorial forests, plantations, village & tribal settlements, revenue enclosures, hydroelectric projects, roads & railways, tourism destinations and pilgrimage sites. It also has a cultural dimension. Ecodevelopment in Periyar Tiger Reserve, one of the major PAs of this landscape, reveals evolution of new paradigms of conservation and development through processes of community participation and institution building. It has also led to significant changes among communities in terms of awareness, empowerment and building of social capital. Study also reveals that expansion of ICDP in PAL has led to improved capacities, community mobilization, emergence of sustainable alternative livelihoods and stakeholder engagement. However, major challenges lie in securing of corridors and connectivities, appreciation of socio-cultural aspects of the landscape and supporting institutional mechanisms for mainstreaming conservation into developmental processes.

Keywords: Community empowerment, Ecodevelopment, Landscape conservation approach

From biocultural to individual rural landscapes: case studies of historical characterisation in the Northern Apennines, Italy

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Rural landscapes in the Northern Apennines have a complex history of management of their environmental resources by local societies. Local practices of control and activation of resources (long and short distance transhumant systems, multiple land uses, common-lands, etc.) highly contributed to the historical processes of biodiversification. However, only recently, the role and importance of local actors and their environmental practices in the construction of those landscapes are being acknowledged. The large abandonment of the rural mountain areas and of its management resulted in loss of biodiversity, un-controlled growth of neo-forestry formations, and increase in fire risk and soil erosion.
Reconstructing landscape management practices and their environmental effects is therefore important when it comes to their present sustainable management. The Laboratory of Archaeology and Environmental History (Cir-LASA) of the University of Genoa has developed in the last decades a multidisciplinary historical, archaeological and environmental approach inspired by historical ecology. This approach allows to characterize historically each individual landscape. This appears to be a basic prerequisite for any action of restoration and enhancement of the environmental/cultural rural heritage.
The approach will be illustrated through the study of three individual landscapes performed in three protected areas of the Northern Apennines: the Cinque Terre Natural National Park (Liguria); the Site of Community Importance (SIC) in the commonlands between Trebbia and Aveto watershed (Liguria, close to the Emilia border); the SIC of Val Borbera (Piedmont) within a Regional Natural Park. The research approach allowed to evaluate the historical sustainability of local multiple production systems and, through the formulation of guidelines, discussions and meetings with local stakeholders, the research had direct applications for the future development of these individual landscapes.

Keywords: landscape transformations, local rural practices, archaeology of environmental resources, historical process of biodiversification, mountain landscapes

T0088

How to approach reverse transfers of minor landmarks in mining and post-mining landscapes

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Field crosses, wayside shrines, chapels, border stones - all belong in the minor landmarks category. They have historical and artistic value, but the "value of place" predominates. Therefore the minor landmarks are called topical monuments. Originally there stood seven chapels on the eastern shoulder of the pilgrimage route from the Osek Monastery to the Mariánské Radčice pilgrimage site. With the expansion of surface mining at the brown opencast coal quarry in Bílina, four well preserved chapels were moved (rescue transfer) to the church in Vtelno near Most. Mining will cease in the north of the Bílina Mine, therefore the reconstruction of the pilgrimage route Osek Monastery - Mariánské Radčice is being approached. Should the four chapels, originally located along the Osek Monastery - Mariánské Radčice pilgrimage route, return to the reconstructed pilgrimage route, given that they have "settled in a new environment" in Vtelno? They create an interesting architectural ensemble;furthemore, the pilgrimage route will not be restored along its original corridor, because parts of the original landscape have been mined and the social context from the time of the former pilgrimage route has completely changed. A monument's original environment is of value for all monument categories; a relatively new issue is returning a relocated monument to its original location, which is only identical to the original place due to its spatial coordinates, as the landscape has changed. Transfers and possible reverse transfers, especially of minor landmarks, can be a promising methodological indicator of the degree of irreversibility of changes in mining and post-mining landscapes during mining, recultivation and re-socialization. This paper discusses the reasons for and against re-transferring four chapels and attempts to answer "what is the essence of the value of place" in the midst of radical landscape changes.

Keywords: minor landmark, reverse transfer, mining landscape

T0166

Which future for the terraced landscape? From historical analyses to future scenarios simulation for the Ivrea's Morainic Amphitheatre (Piedmont, Italy)

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In Europe, many agroforestry systems are characterized by traditional agricultural crops and practices. Vineyards terraced landscapes belong to this category and have multiple values, so much so that the "Art of dry stone walling" was inscribed by Croatia, Cyprus, France, Greece, Italy, Slovenia, Spain and Switzerland, during 2018, in the UNESCO's "Representative List of the Intangible Cultural Heritage of Humanity". Concerning traditional landscape's assessment, the Italian Ministry of Agriculture, Food, Forestry and Tourism instituted the "National Observatory of Rural Landscape" (2012). The vineyard terraced landscape located in Ivrea's Morainic Amphitheatre (Piedmont – Italy) was studied, in order to develop a scientific methodology to evaluate them and define analytical process of enhancement and management. It is extended over about 510 ha into four municipalities in the North Turin's Metropolitan City, involving about 6300 inhabitants. Wall stone terraces used for traditional winegrowing and the presence of historical landmarks (stone columns) associated to typical cultivation's techniques characterize this site. A multidisciplinary study was performed to identify a set of indicators (land use, viticulture characteristics, historical landmarks and farmers' tendencies). It was highlighted the landscape's geographical, environmental, historical and cultural representativeness to prove its traditionality. The study was carried out with cartographic and archival analyses, field inspections and farmer's interviews. For predicting landscape's dynamics, the simulation of future landscape scenarios was performed. The research allowed to understand that terracing's art knew moments of expansion, contraction and now the abandonment. It also emerged that some farmers are proving new vineyard pruning and training systems and new crops. The research proposed an innovative approach for identifying sustainable strategies for historical landscapes.

Keywords: Landscape dynamics, Planning strategies, Rural landscape, Traditional knowledge, Winegrowing

Symposium 05

The ecological role of sound in terrestrial and aquatic landscapes: theories, methods and application of ecoacoustics

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Ecoacoustics aims to investigate the ecological role of sounds in environmental functioning across multiple scales -- from species interactions to landscape networks. It is a young discipline, built upon robust theoretical foundations and serviced by advanced automated sound recording technology; current research is developing powerful metrics for big data processing, establishing methodological protocols. The potential for ecoacoustic approaches to support monitoring and management of natural and human-modified terrestrial and aquatic landscapes is becoming widely recognized.

This symposium aspires to:

• share the state of the art of ecoacoustics research and application in terrestrial and aquatic landscape management

• describe ecoacoustics methodologies

• characterise acoustic processes and patterns emerging from terrestrial and aquatic landscapes for different biomes

• illustrate the potential of ecoacoustic analysis in long term monitoring schemes, focusing on climate change, landscape transformation, and biodiversity decline

• discuss application of ecoacoustic approaches to support policy and management actions

The symposium aims to develop the logic of the ecoacoustics framework by considering theories, models and methods alongside key studies of terrestrial and aquatic landscapes across difference levels of habitat disturbance and in different eco-regions.

Practical examples of ecoacoustics to manage, remediate, improve and conserve natural and human-modified dynamics of the environmental systems will be discussed. In particular analyses of soundscapes that emerge from interactions between acoustic signals produced by biotic and abiotic processes (biophonies, geophonies) and human-made industrial/ mechanised processes (technophonies) will be presented and offered as a new, productive perspective for describing the dynamics of terrestrial and aquatic landscapes.

T0847

Evaluation of anthropogenic disturbances on the soundscape of urban parks

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In urban parks, besides the typical anthropogenic noises, there are those generated by the local wildlife (biophonies), in particular birds. Soundscape analysis allows to characterize the acoustic footprint of a landscape and to highlight the presence of a multitude of sound sources.
In this study we present a measurement technique that allows to describe the soundscape by quantifying the complexity of the singing activity of a bird community by ACI (Acoustic Complexity Index). Recordings are made using specific devices (SET, "Soundscape Explorer Terrestrial"), equipped with two microphones (active in the sonic and ultrasonic range) and atmospheric sensors for pressure, temperature, relative humidity and ambient light. The study area is a large peri-urban park in Northern Milan (Italy), characterized by wooded land rich in biodiversity and exposed to different sources and degree of anthropogenic disturbances like traffic noise and artificial light. Records are made in spring, when the singing activity of birds is at peak and it is easy to detect their presence and study their singing dynamics. Each session consists in two SET recorders that record continuously for 1-3 days, and repetitions of the measurements are made during the whole season. To integrate SET records, additional low cost recording devices are used.
A series of measurements are made using the SET recorders to correlate the ACI values with environmental parameters that can affect ecosystem quality. In order to determine whether different environmental stressors affect the singing activity of birds community, we relate ACI values to traffic noise and artificial light. Spot mapping of soundscape levels with an appropriate indicator will allow to evaluate the influence of disturbing factors. It will be possible to detect and analyse the variation in singing activity and to study the adaptation of the bird community in case of disturbing factors.

Keywords: soundscape, urban parks

T0923

Optimization of temporal sampling regimes for temperate forest and grassland preserves

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Soundscapes are composed of acoustic signals generated by geophysical, biological and technological processes happening within a landscape. Ecologists have proposed passively recording soundscapes will promote the success of monitoring programs, yet little work has been done to assess the efficacy of temporal sampling regimes relevant to researchers operating under practical constraints. Our goal was to identify optimal sampling regimes, which we defined as those that are not too sparse such that we lose acoustic information, but also avoid oversampling such that little or no knowledge gains are made despite additional effort. Grassland and forest soundscapes were continuously collected from ten nature preserves in southwest Michigan during two independent 24-hour periods in spring and summer using 30 Wildlife Acoustics SM2+'s. We compared recording schedules (continuous vs. 1 every 5, 10, 15, 20, 30, and 60 minutes) by quantifying Spearman's correlations and percent differences for hourly means using six acoustic indices. We used a linear mixed effects model to test the random effects of recorder within preserve and the fixed effects of subsampling regime, habitat and season. We found that sampling 1 every 5 minutes was highly correlated with continuous recording, which suggests information loss was minimal, while indices calculated based on sampling 1 every 60 minutes were poorly correlated with continuous recording. Additionally, lowered sampling schedules in forest locations were regularly less correlated with continuous sampling as opposed to grassland locations, providing evidence that optimal sampling may differ based on habitat. We provide evidence for optimal sampling regimes that will allow researchers and managers to realize significant savings in storage costs and processing time without compromising data quality.

Keywords: soundscapes, sampling, optimization, monitoring, acoustic indices

T0104

An ecoacoustics approach to investigating the environmental complexity of landscapes

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Sound is considered to be a carrier of information for describing environmental patterns and processes on large scales; however, soundscape theory (Farina 2014) assumes that sonic components can copy landscape features at unexpectedly fine-grained resolutions, providing abundant opportunities for investigating the relationships between soniferous species and their habitats.
To test this hypothesis, 12 synchronized digital acoustic recorders (Soundscape Explorer Terrestrial units, www.lunilettronik.it) were located along a grid of points, distributed at approximately 30 m apart, for one year (October 2017–September 2018). Microphone capsules were set to capture the majority of the biophonic signals within this grid. At total of 780,960 one-minute acoustic (.wav) files were recorded during 3254 daily sessions.
The Acoustic Complexity Indices (ACIft and ACItf) and the Ecoacoustic Event Detection and Identification procedure were utilized to evaluate the acoustic signature and the typology of the ecoacoustic events (EEs) (Farina et al. 2017).
A wide variety of acoustic signatures emerged from each sample location, and different EEs were found that are usually not obtained from soundscapes of wide areas, confirming the utility of fine-grained ecoacoustic information, based on the subdivision of a soundscape into soundtopes and sonotope subunits. Finally, well differentiated EEs bring to light the presence of a local biosemiotics text that sonifeorus and non-soniferous species probably utilize to construct their acoustic habitats.
This evidence opens up new perspectives for the application of ecoacoustic methodology to describe the temporal dynamics of the processes occurring in a landscape.

Keywords: Ecoacoustics, Soundscape, Acoustic Complexity Indices, Acoustic signature, Ecoacoustic events

A changing chorus for peri-urban native forests: an ecoacustic examination of the effects of urbanisation on biodiversity

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Increasing urban expansion in South East Queensland, Australia, is resulting in wide scale landscape fragmentation. In this study we examined the effects of landscape configuration and ecological condition on two ecoacoustic indicators in fragmented, native peri-urban forests.

Twelve acoustic recorders were deployed in pairs, at edge and interior locations, in six eucalypt woodland forest patches. These forest patches ranged in size from 2.5 to 471 hectares, and varied in shape, connectivity and vegetation condition. We manually analysed the calling activity of the eastern whipbird at dawn across 6 days to determine whether it could be used as a single species, urban sensitive bioindicator. We also calculated an ecoacoustic index (NDSI), averaged across 12 hour day and night periods over 6 days, to provide an indication of the activity of soniferous species relative to human generated noise and to examine the utility of NDSI as a bioindicator of urbanisation.

Linear mixed effects models were created to assess how the ecoacoustic indicators were related to landscape factors and vegetation condition. We found that eastern whipbird activity was decreased in small, disconnected and circular shaped patches of low vegetation condition. Furthermore, paired edge and interior comparisons at each site showed a significant decline in whipbird calling activity in edge locations, likely associated with edge effects. These results suggest that this species may be a suitable bioindicator for monitoring impacts of urbanisation. Our models also showed a similar pattern for the NDSI index and support previous research linking soundscape and landscape patterns.

These findings provide evidence that landscape fragmentation is having an impact on biodiversity in peri-urban native forests. As urban creep continues into peri-urban areas, future development plans must incorporate ecological design principles to maximise retention of native vegetation and maintain patch connectivity.

Keywords: ecoacoustic, landscape fragmentation, urban sensitive bioindicator

T0380

Acoustic diversity increases with forest patch size - a test of the theory of island biogeography in agricultural landscapes

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Habitat loss and fragmentation are one of the major drivers of current biodiversity loss (i.a. Sala et al. 2000). Yet small forest patches of different size can act as refugia or stepping stone habitats for wildlife in agriculturally dominated landscapes and have been acknowledge for their conservation value. The contribution of such forest "islands" within a "sea" of intensively managed fields to biodiversity conservation might depend both on patch size as well as distance to other forested areas as predicted by the equilibrium theory of island biogeography (MacArthur & Wilson 1967).

To test this theory and its applicability on acoustic diversity we established a study system composed of forest patches of different size within an agricultural landscape in SW Germany that might serve as a model for a coordinated distributed network of soundscape study sites. We recorded sounds over a period of four weeks in autumn 2017, a period dominated by abiotic sounds from wind and rain (geophony), during which forest patches could act as refugia for migratory birds. A second recording period covered the mating season of birds in spring 2018. We calculated different indices of acoustic diversity, and quantified several structural features of the forest patches.

Forest structural diversity increased with patch size. During both seasons the Acoustic Diversity Index (ADI, Villanueva-Rivera et al. 2011) increased with increasing size of forest patches. In contrast, the Normalized Difference Soundscape Index (NDSI, Kasten et al. 2012), which quantifies the ratio of anthrophony to biophony, was independent of forest patch size. For both indices, values were higher during spring than in autumn.

Our results suggest that the central prediction of the theory of island biogeography also applies to acoustic diversity. Moreover this supports the view that acoustic diversity can be used as an integrative measure of biodiversity of habitats.

Keywords: acoustic diversity, theory of island biogeography, forest structure, biophony

Soundscapes for the assessment of diversity and functionality of marine ecosystems

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Passive acoustic monitoring (PAM) has recently provided a supplemental tool to tackle critical issues in marine conservation, such as ecosystem functioning and biodiversity trends. Due to its applicability in remote areas and over long timescales, PAM owns the potential to address changes in species richness and abundance caused by human activities. However, there are many critical aspects that need to be taken into consideration when monitoring acoustic habitats at large spatiotemporal scales, such as how to disentangle the simultaneous presence of diverse sound sources (i.e., geophysical, anthropogenic, and biological). Several sound-extraction procedures have been recently developed with the aim of automatically quantifying and tracking biological sounds and noise pollution levels. This presentation provides a comprehensive analysis of the most promising results in the use of acoustics in marine environments to date. Weaknesses and strengths of the methodology will be discussed in detail.

Keywords: soundscape ecology, marine environments, biodiversity, ecosystem functionality

P0210

Forest-bird relationships within two differently managed Natura 2000 alpine sites: an application of the bioacoustics approach at small scale

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The Natura 2000 network was implemented more than 25 years ago, however, some gaps in knowledge about its overall implementation have been identified. Better understanding of forest biodiversity status changes over space and time within Natura 2000 protected areas needs to be achieved through effective monitoring programs, and by reframing current indicators, parameters and drivers. Birds have demonstrated to be reliable and robust indicators of biodiversity. Indeed, forest bird species' composition and richness seem to be related mainly to forest structure – both vertical and horizontal – which is directly dependent on forest management. This paper describes a research project aimed at comparing the impact on biodiversity in two Natura 2000 sites, sharing similar ecological and structural characteristics, but differing in their recent management histories. The study areas correspond to the alpine watersheds of Val Tovanella (SCI IT3230031, 8.845 ha, and SPA IT3230089, 70,397 ha), and Cajada (SCI IT3230083, 31.383 ha). To evaluate the bird-forest relationships for the sites, information about bird species richness and composition are collected through the use of a network of fixed recording devices (AudioMoth, by Open Acoustic Devices) throughout the breeding season (April-June). Considering the position of the recorders as the centroid of the circular sample plots, data about forest structure, vegetation composition, tree-related microhabitats, and information about the presence of deadwood are collected too. The difference in mean species richness between the two forest management types is tested through permutation tests, while differences in species composition are tested by principal coordinates analysis and the permutational multivariate analysis of variance. Based on the results, it should be possible to draw conclusions about the forest management approach that should be adopted to fulfil the requirements of biodiversity conservation in Natura 2000 sites.

Keywords: bioacoustics, biodiversity conservation, birds, forest habitat, forest management

T0702

Loss of a winter wonderland? Soundscapes indexes demonstrate the effects noise pollution on winter populations and communities.

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The emerging field of soundscape ecology provides unique insight toward ecosystem dynamics that have until now gone unrecognized. Most data collection and analyses in soundscape ecology have focused on summer or breeding season in urban or protected landscapes, missing important changes in winter, non-breeding periods and effects in agricultural landscapes, a land use that globally is 39% of ice free surface. To address these latter two gaps, we examined the variation, in space and time, of the winter soundscape in a rural agricultural landscape. In addition, we compared each measure between loud and quiet sites, testing if road noise affects soundscape structure. We chose study sites in Nebraska, USA, recording at paired sites adjacent to and distant from major roadways. We recorded over two years at 14 sites using ARUs from Wildlife Acoustics. We used the soundecology and seewave packages in R to calculate eight measures of the soundscape. We found clear statistical differences ($p < 0.05$) in 7 of 8 soundscape measures between loud and quite sites. Additionally, there was a clear negative correlation between the anthrophoney (or human derived sounds) and biophony (ecologically derived sounds) within and across treatments. There was less variation across winter months and within a given day. These data show that the effects of noise pollution extend into the winter months, a time when communication about food and predators is important for within and between species communication. The application of soundscape measures to the winter season in an agricultural landscape demonstrates the capacity for acoustic sampling to contribute to biodiversity monitoring, with soundscape indexes as surrogates for biodiversity that can be difficult to sample when species are more mobile and detectability is lower.

Keywords: Soundscape, Agricultural, Roads, Biodiversity

T0608

First assessment of the soundscape of the Integral Nature Reserve “Sasso Fratino” in the Central Apennine, Italy

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Ecoacoustics is an increasingly emerging interdisciplinary science that investigates natural and anthropogenic sounds and their relationship with the environment. It can become also a powerful tool for biodiversity monitoring, management and conservation efforts related to the climate change issue. By the use of passive acoustic monitoring of habitat, it is possible to get a picture of its soundscape, that is composed of the sounds produced by the animals (biophony), the sounds produced by atmospheric and physical events (geophony) and by human activity (anthropophony). This study is the first attempt to describe the soundscape of the Sasso Fratino Integral Natural Reserve (in the National Park of the Casentinesi Forests, Italy), an area characterized by the almost absence of anthropogenic noise (with the exception of aircraft overflights), where we selected three recording sites within and around the reserve’s borders. We adopted a double approach, one qualitative based on visual screening of compact daily spectrograms and the other quantitative by the estimation of the acoustics indices and the analysis of spectrum energy for each 1000 Hz range (from 0 to 24 kHz).
In general, all sites are characterized by quiet nights and very acoustically dense daylight hours, with a composite biophony continuously occupying the range 1500 to 9000 Hz. But, although the acoustics indices trends are similar, the PCA analysis shows that the three sites are well characterized and represented by different patterns, that also reflect the altitude and physical characteristics differences.
Lastly, the acoustic data, collected from 2014, represent a reference for monitoring the INR's biophony status: in fact, since it is forbidden any human presence nor interventions of environment’s alteration, global changes could be considered as possible factors influencing any future shift in the species' presence and distribution inside the reserve.

Keywords: Ecoacoustics, Soundscape Ecology, Acoustic Patterns, Acoustic Meters, National Park

T0343

Modeling the Acoustic Complexity Index to analyze the avian dawn chorus: a phenological approach to identifying differences between vocalizing bird communities in managed temperate forest plots.

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European forest managers are tasked with maintaining productive forests while simultaneously preventing biodiversity loss. This requires repeated and resource-intensive biodiversity monitoring, which is often expensive and limited to a small spatial and temporal scales. As acoustic monitoring can be implemented at a relatively low cost at very high spatial and temporal resolutions, this study examined how acoustic diversity can be a useful monitoring tool in managed temperate forest context. The study sought to evaluate the effectiveness of the Acoustic Complexity Index (ACI) in monitoring avian response to management-driven forest structural elements such as canopy connectivity and retained standing dead wood. A stratified random sampling of forty-five sites were selected for acoustic monitoring along two gradients: forest connectivity (% forest cover in 25 km2 radius) and structural richness (number of standing dead trees/ha). Acoustic recording devices were programmed to record every tenth minute from 4:00-9:00 to capture the dawn chorus from May-June 2018. Twenty days and 40 devices produced usable data, from which ACI values were generated for each recording. Generalized Additive Mixed Models (GAMM) were created to analyze ACI values by gradient category throughout the morning across the study period. A phenological comparison of dawn choruses was possible by comparing final model plots, which allowed for a fine-scale identification of differences between the timing of dawn chorus events (e.g. chorus onset, peak, and plateau), as well as maximum peak values and post-peak plateau values. Results showed significant differences along both gradients between onset of peaks, peak values, and post-peak plateau values. This novel method can reveal fine-scale differences between vocalizing communities in forests under different management regimes, and allow managers to track changes in these communities as a long-term biodiversity monitoring tool.

Keywords: dawn chorus, Acoustic Complexity Index, GAMM, phenology, ecoacoustic

Acoustic metrics to characterize underwater acoustic diversity in the Southern Ocean

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Acoustic metrics (AM) assist our interpretation of acoustic environments by aggregating a complex signal into a unique number. Numerous AM have been developed for terrestrial ecosystems, with applications ranging from rapid biodiversity assessments to characterizing spatial acoustic heterogeneity. However, there has been comparatively little research aimed at understanding how these metrics perform to characterize the acoustic features of marine habitats and their relation with ecosystem biodiversity. Here, we first assess how existing AM vary with different natural marine soundscape compositions. Second, we evaluate how AM perform compared to the signal frequency spectrum to discriminate between marine mammal acoustic assemblages' composition. Basin-wide passive acoustic monitoring data sets from the Antarctic Weddell Sea spanning 8 years and 5 sites were used to develop a supervised machine learning approach to discriminate between acoustic environments. AM performed better than spectral signatures, achieving correct classifications of species richness levels (0-5) of 65%. The relative importance of particular AM to characterize the acoustic environment varied greatly between sites, indicating at least two distinct acoustic environments in our study area. Models to discriminate species richness levels in near-shore sites achieved correct classifications of 90%. Discrimination of species identity based on AM achieved >85% correct classifications for 7 marine mammal species. While there was not a single AM that accurately classified acoustic community composition for all sites and years, this study shows that a combination of AM is a promising approach to characterize underwater marine habitats. AM allow an intuitive ecological interpretation of passive acoustic data, which in the light of ongoing environmental changes, supports the more holistic approach needed to detect and understand trends in species diversity and underwater habitat quality.

Keywords: Ecoacoustics, marine acoustic environments, aquatic soundscapes, acoustic metrics

Listening to biodiversity under extreme weather

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Climate change is one of the major threats to biodiversity. Besides increasing air temperatures, the magnitude and frequency of extreme weather events have been increasing, and are predicted to increase further in the future. To understand impacts of extreme weather on biodiversity, long-term and frequent data collections on the environment and biodiversity responses are needed. In this study, we used the environmental ultrasounds collected at ten sites across Taiwan to evaluate the usefulness of passive acoustic monitoring for accessing ecological impacts of heavy rains, which are one of the deadliest weather events. We separated acoustic signals from bats, insects and raining using a machine-learning tool, and then investigated their temporal changes in the intensity and frequency compositions over a heavy rain event. We found significant impacts of the event on the acoustic signals produced by bats. Bat signals took a longer time to recover from the event at the places experiencing heavier and more temporally concentrated rains than at the places with lighter and more spread out rains. This study shows the potential of passive acoustic monitoring for improving our understanding of the responses of biodiversity to extreme weather events under climate change.

Keywords: acoustic monitoring, bats, heavy rains, machine learning, resilience

T0301

What does an eradication sound like? Monitoring the French Island landscape with acoustic monitoring preceding a feral cat eradication.

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Changes in landscape can be attributed to many disturbance factors – climate change, human-induced reclamation or degradation or natural stochastic events. The arrival of invasive mammalian predatory species onto islands has historically resulted in significant changes to the landscape and also the biota. Species such as the feral cat (Felis catus), have caused population declines and extinction of insular wildlife species. The Australian Government has recognised the environmental significance of French Island and included it as one of five Australian islands from which feral cats should be eradicated by 2020. Here we investigate the abundance and distribution of feral cats and wildlife species, specifically ground-dwelling birds with the application of transect surveys, camera traps and acoustic sensors. To compare the islands biota pre and post eradication, we collected long-duration acoustic recordings to monitor significant bird species and also to monitor broad scale changes in the soundscape. We generate a baseline of acoustic data using a visual analytical technique, long-duration false-colour spectrograms. In addition, template and call binary recognisers are used specifically for the detection of cryptic ground-dwelling birds. These species are particularly vulnerable to feral cat predation, and population decline and recovery are seldom able to be quantified. Islands provide critical habitat for biota worldwide with fauna particularly susceptible to predation and other impacts that follow the arrival of invasive species. Our findings will present a thorough case study into methods for interpreting the acoustic landscape biota change over a broad spatial and temporal scale.

Keywords: ecoacoustics, terrestrial soundscape, invasive species

Symposium 07

Anthropocene or Urbanocene? The need of a new theory of global sustainability, including urban metabolism.

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Anthropocene is a proposal to define a geological era that started with human development as agricultural sedentary specie. Industrial revolution possibly translates us into a new era, which should be called Urbanocene (West, 2017). With this in mind, the study of the urban metabolism seems to be a key discipline in the formulation of a new theory of global sustainability. Landscape ecology is involved in the formulation of a sustainable future, by analyzing the relationship between cities and surroundings under the metabolic functions that urban structures develop. This symposium tries to put together different visions that contribute to the definition of the urban phenomenon and its metabolism cross scales and disciplines. Contributes, in the format of experimental case studies, methodological work or theoretical essays, are expected to cover one of more of the following aspects/topics:

- Theories and models for urban metabolism
- Multidisciplinary approaches including social and engineering science
- Urban ecology in contemporary urban systems and agglomerations
- Making UM actionable: ways to inform urban planning and policies
- Urban design and urban regeneration

T0090

Port-City interface: the water-front area in Haifa as an ecosystem between the mountain, the port and the city

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Haifa is the third largest city in Israel. Its character integrates green landscapes, religious sites and the sea, together with its ongoing maritime heritage. The city has a multi-dimensional image which is reflected in a unique topography: the connection between the Carmel Mountain ridge and the sea, through a network of "wadis".
The wadis are minor water flows, or creeks, that cross the ridge, function as an ecological corridor across the land and represent the essence of the open spaces of Haifa – they are the green lungs of the city. In the Master Plan of Haifa's Wadis (2015), the municipality, together with public institutions and NGOs, aims to define development principles, in order to conserve the function of the wadis, to create an interface between the open and urban areas.

The local stakeholders, over the past few years, have developed the Sea-Front Project – the regeneration of the waterfront. Running this project, in parallel to the developing of the Wadis' Master Plan, can create a unique environment and a new local ecology for the city interface – the port-city dynamics based on the watery network, in which "water goes into water".
The paper presents the two processes based on the restoration of the multiple interfaces between city areas and its water system. It will discuss how they will reconnect the local communities to the nature and the sea in an accessible way, alongside making the wadis a space that the inhabitants will be aware of, enjoy and help preserve its nature and local biodiversity.

Keywords: Port city, Wadies, Sea, Regeneration, Ecosystem

T_0952

Urban microclimate and overheating in urban canyons in Valparaìso, Chile

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Downtown has higher air temperatures than the outskirt, conforming the urban heat island phenomenon this being one of the phenomena that shows the human impact on global warming. Maybe, all cities will can shows this behaviour. Chile is located in southern hemisphere. The largest amount of population cities and population of Chile (over 70%) is concentrated in the central zone of the country where the climate is mainly of the Mediterranean type.
At the same time Chile presents a significant number of coastal cities due to its geographical condition. Valparaíso Metropolitan City, is located in this central coastal area (-33°03′). has 700,000 inhabitants. The latest report from the IPCC indicates that the central zone of Chile is one regions that will be most affected by major environmental risks due to climate change. This research aims to collect, analyze and present the urban heat island phenomenon in this city and its relationship with urban canyons and urban materials. A study of this phenomenon has been made on winter and summer days, cloudy and sunny and the temperature difference between the outskirt and downtown was registered: in winter the air temperature difference is 5.2°C and in summer 8.8°C. At the same time, the thermal behavior of streets downtown is determinated. The canyon form and the urban materials have been studied : At day, canyon form is important: streets with sky view factor (SVF) higher, larger heat radiation is registered. At evening, in downtown, the materials of urban cover is more important than SVF. The canyons form and materials are determinants of this thermal performance, favoring negative impacts and environmental risks in the urban population.

Keywords: Urban heat island phenomenon, Urban form, Urban materials, Urban microclimate

Anthropocene, its 40 alternatives and planetary urbanization – considering the urbanocene proposition

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There are now around 40 alternatives to anthropocene (Crutzen, Stoermer 2000) proposed, following critique of the notion made in social sciences. The most popular one is the capitalocene (Moore 2016), but there are many others: technocene (Hornborg 2016), homogenocene (Mann 2011), eremocene (E.O.Wilson 2015), entropocene (Stiegler, 2017), anthrobscene (Parikka 2014), chthulucene (Haraway 2015) and others (Bonneuil, Fressoz 2016). In the first part of my presentation I categorize all those I have found with the very simple 5W+H method. And I want to focus here on those answering the „Where?" question – especially on three concerning urbanization: urbanocene (West 2017), metropocene (Whitehead 2014), astycene (Seto et al. 2010). In the second part I'd like to show that there is another contemporary discussion and research going on with very similar scope, concerns and results - the one about planetary urbanization (Brenner, Schmid 2014). And here's the crucial thing: Wests urbanocene nad SFI research (Bettencourt 2013) talks about some important intrinsic properties of cities (scaling effect), but neglects its relation with (especially "outer") environments. Planetary urbanization focueses on that and talks about extended urbanization, but doesn't focus on the "inside". Only combination of both seems promising in giving some coherent vision and possiblity to reformulate anthropocene as urbanocene.

This allows me to show briefly, in the third part, how one can speculate that ubanisation is one of the main causes of anthropocene (urbanocene). To exemplify all that I will use the example of one of the nine planetary boundaries (Steffen et al. 2015). I will try to show how exceeding levels of phosphorus and nitrogen in planetary ecosystem can maybe be linked with urbanization through historic changes in relations of cities with farmland (Mumford 1956) and changes in manure/fertilization ('night soil collectors') and sewers infrastructures (Gandy 1999, 2004).

Keywords: anthropocene, urbanocene, planetary urbanization

Public spaces and common scapes. Five questions in [scalar] transition.

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The essay ponders over the demand of reinterpreting urban ecosystems through the construction of new problematic proposition, that clearly emerge around international commissions and roundtables. The reasoning refers especially to the report "Strategic Research and Innovation Agenda 2.0" developed within the JPI Urban Europe. Primarily, the document states a cognitive and terminological framework to address the governance of transition towards liveable and sustainable perspectives for European cities. Thereby, the theme of inclusive public spaces entitles one of the four Urban Dilemmas accounted in the report and responds to two different thematic and operational registers:
- The first one involves the issues related to the individual and collective redefinition of public space and immaterial field of democratic, relational and inclusive expression;
- The second one concerns the contemporary living practices due to the ICT and IoT revolution, that affects the connective physical spaces and gains the technological interstitium of the Positive Energy Neighbourhoods to come. The first deliverable outlines the reconnaissance on the European ontologies and strategies to enhance the public space liveability. In this context, actual implementation cases will be provided.
Thus, five triggering questions will explore just as many critical issues, related to the transition towards new urban economies, different social models and emerging productive organizations.
Looking ahead, a logical taxonomy of tools, competences and solutions for the Smart and Sustainable Cities and Communities will be suggested: integrated visions affect the practice and the metabolic rate of material and soft infrastructures. This issue supports a deep recognition of spatial, morphological and behavioral impact of ICT e IoT solution fitted to the district, urban and social scale. Therefore, improves the anticipation techniques and the underlying reasoning about the emerging plan dimension.

Keywords: urban transition, inclusive public space, dilemmas, Smart Cities and Communities solution, robustness

A Green Infrastructure and urban metabolism strategy for urban retrofitting

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Historically, urbanization processes in Italy resulted in built environments with high level of seismic vulnerability, low energy efficiency and common lack of green spaces. The latter represent the main providers of ecosystem services in cities and play a relevant role in reducing the effects of climate change by regulation of microclimate and urban heat islands that are responsible of building energy consumption. Despite their importance in providing ecosystem services, the implementation of a green infrastructure has to challenge limited financial resources for the public acquisition of private plots.
This paper proposes a strategy for implementing an urban green infrastructure aimed at generating a double positive effect on cities by triggering seismic and energetic retrofitting of the existing urban fabric. This is achieved through a transfer of development rights program: landowners get economic incentives to adopt seismic retrofitting interventions and, at the same time, public administrations implement the green infrastructure in the portion areas transferred to municipality. The energy efficiency of buildings closer to the green infrastructure therefore benefit from the cooling effects of the new greenery. The strategy is tested under different scenarios of acquisition of private land by public administrations in the metropolitan area of Catania (Italy).

Keywords: Urban green infrastructure, Metabolism, Retrofitting, Seismic Vulnerability, Energy deman

Constructed wetlands How close can be industrial sites and protected areas: the case study of Pialassa Piomboni in Ravenna Constructed wetlands produced by excavation mud in commercial docks

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In current circumstances, man has the great responsibility of better managing effects and products of those intense anthropic processes - such as waste disposal, excavation materials, etc - which cannot be assimilated in reasonable time by spontaneous renewal cycles.
A systemic approach is needed for coordinating the man-made metabolic procedures concerning inevitable phenomena of urban and territorial transformation and ecosystems protection, admitting that one can be consequent and functional to the other. The landscape design, by opening to a strong interdisciplinary approach, can offer precise and contextualized design solutions which can involve large temporal and spatial scales in reference to the extension of the problem.
The proposed case study of Ravenna commercial Docks shows how the progressive expansion and continuous maintenance of the seabed through dredging has led to the creation of new constructed wetlands in continuity and balance with the existing ones. In particular, the excavated material was transferred in Pialassa Piomboni through a topographic modeling suited to improve the ecological state of the humid area, also by damming the water exchanges between it and the channel. After the intervention, the Pialassa area has increased its ecological potential and has been declared pSCI and SPA. Such approach has turned the waste treatment into an opportunity giving the chance of strengthening the wetland system and reducing the costs related to the material transport to a more remote site.
At the light of this experience, the contribution discusses different solutions for integrating the soil handling in the spatial planning and activating new metabolic processes in its replacement into the environment.

Keywords: Landscape design, Landscape Ecology, Urban Metabolism, Novel landscape, Hypernatural landscape

Anthropocene, urbanocene, capitalocene

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Anthropocene is a term used to define a new geological epoch that would follow the Holocene. The beginning of the Anthropocene is fixed by most of the proponents the term in the great acceleration that was generated in the second half of the 20th century. The geological signal of the change of epoch would be the presence of radioactivity due to the civil and military human activity from that period. However, other visions propose a start of the Anthropocene in a more remote past, such as the industrial revolution or even the agricultural transformation that saw humanity cease to be composed by hunter-gatherers and begin to cultivate the land and reside in a stable manner. In that case, the geological signals of the change of epoch could be found in the change of land use associated with such transformation. Following this approach, recent studies have come to propose the end of the Anthropocene with the industrial revolution and the beginning of another epoch: the Urbanocene. This would be characterized by the deposition of asphalt and concrete layers on the vegetal soils in order to consent to the growing urbanization. Capitalocene is a term of a different nature. Its coinage does not intend to refer to a geological epoch, but rather to the hidden motor that generates the Anthropocene. This paper proposes a still different vision, considering the Capitalocene as the transition between Anthropocene and Urbanocene, interpreting that the main characteristic of capitalism is precisely to generate the deposition of tecnomass as a result of the appropriation functions of natural resources. The rural environments are stripped of the resources they contain and the successive economic transformations of these end up turning them into money, in turn finally invested in real estate speculation - hidden motor from contemporary urbanization processes. From the definition of the terms used, an ecological diagnosis of the current urban metabolism is proposed.

Keywords: Anthropocene, Urban metabolism, Capitalism

A circular and Nature-based view of urban systems: The low-entropy city

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Cities need to adopt more sustainable environmental practices to convert their linear metabolisms into circular ones and translate Circular Economy objectives in the land use planning process. Moreover, the role of the urban systems and humans within Nature should be considered to address economic development, social progress and environmental responsibility.
Thus, it is necessary to consider the cities as part of Nature, modified ecosystems instead of mere human products, and to develop solutions to real-world urban development issues taking advantage from an understanding of cities as complex socio-ecological systems, which continuously evolve and continuously exchange matter and energy with the surroundings. We propose thermodynamics of open systems as the ground on which to build the sustainable concept of Low-Entropy City. Indeed, the second law of thermodynamics and the entropy principle provide a theoretical context which helps to clarify and unify a wide range of theories and studies, that go from ecology to social science and economy, connecting them to fundamental principles of Nature's evolution and functioning, and to define a long-term and solid sustainability concept of human-provoked land use changes and consequent biosphere alterations.
The objective of this contribution is to present a first application of the low-entropy city view in the context of urban green infrastructure planning aimed at optimizing the storm water cycle and thus reducing its negative impacts on urban and extra-urban systems. Accordingly, some new indicators, derived from SWMM model application, are used to evaluate the entropy of a Bari urban district (South Italy) in terms of water quantity and quality parameters in a base scenario and a Nature-based scenario.

Keywords: Second Law of Thermodinamics, green infrastructure, SWMM, urban planning

Anatomy of a Mutating Landscape

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Focus of this paper is the exploration of the complex reciprocities between processes of urban transformation, socio-political and economic dynamics and environmental risks at global scale, and their effects on the local dimension of our urban ecologies and structures, through the lens of landscape urbanism. This places architecture in a dimension concerning diverse fragile constructed environments of the post-industrial era, and includes issues not only related to the history of urban settlements and their evolution, to sociology and technologies, but also to effects connected to natural phenomena, pollution, waste, space reclaiming/ reuse/ recovering, material recycling, land productivity and consumption, and alternative processes of energy production for a more sustainable growth. New methodologies and regulations for performative and networked operational procedures need to be created and experimented through critical designs proposals which deal with processes of territorial transformation and our complex "data-scape." New urban morphologies and building typologies need to be strategically integrated and coordinated into our landscapes understanding their proactive rule in defining and modifying a wider complex environmental system, initiating and/or promoting the change. The consequences of these processes on the structure and quality of spaces and life could be described as part of a complex "urban metabolism," which should be systematic, creative and participative, identifying material and "immaterial" issues that give form to rhizomatous and diverse process of change. These new dynamic landscapes continuously shaped/reshaped by the flows of people, resources, real and virtual goods and at the same time of powers, and strategies of control, has reached a high level of complexity where natural and cultural environments need to be synergistically understood as articulated ecological system.

Keywords: Mapping Mutating Landscapes, Territorial Metabolism, Global Actions and Local Reactions, Systemic Environments, Data-Scapes as Design Realm

Symposium 08

Towards a 'traits' framework that is both ecologically and socio-culturally relevant: Functional traits beyond life history characteristics. Join a discussion on theory and application.

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Biodiversity provides the principal basis for ecosystem services important for human health and well-being. Despite substantial scholarly progress, we do not adequately understand the relationship between different types and levels of biodiversity – ecosystem, functional, taxonomic or genetic – and the many aspects of public health and human well-being. We need a framework complete with a detailed and explicit language, shared meta-theories and a transdisciplinary portfolio of methods to address and comprehensively account for the two-way relations between people and the rest of nature. Among the primary knowledge needs are (1) a more nuanced understanding of the multi-dimensional and rich contributions of biodiversity to human well-being, (2) better ways of assessing the ecological consequences of human preferences and respective behaviour, and, more broadly, (3) operational knowledge on the multiple system dimensions that can make these linkages resilient. Multiple studies suggest that instead of traditional taxonomy based descriptions of biodiversity an approach focussing on the idea (assumption) that functional traits – those abilities and features of organisms with demonstrable links to their ecosystem role and performance and, in turn, fitness – may provide a useful and more mechanistically informative alternative. This approach has been adopted historically for descriptive reasons, to enable broader global comparisons that transcend the constraints placed on such studies by regional taxonomic diversity, and allow for the types of generalizations (e.g., responses to environmental change, ecological implications of trends and patterns) sought after in ecology. More recently, the functional traits approach has been extended to address also ecosystem services, system dynamics and effects of different legacies over time, and we believe a continuation of this development may help bridging several research fields and knowledge traditions (e.g. sustainability science, systems ecology, environmental psychology, anthropology, architecture and arts). Instead of focusing on life history characters, we suggest that a traits approach that builds on attributes and features (at different ecological levels) that both have ecological relevance and are socio-culturally meaningful can provide a unifying common ground for discussion of system dynamics. Such an approach could address and connect a broad suite of issues, from biocultural relations and relational values to time dynamics and the resilience of ecosystems and their service provisioning. Drawing on a rich set of case studies, primarily from within the Biodiversa funded project ENABLE, we want to discuss the different ways we can use traits as an analytical tool as well as a boundary object. We will unpack our suggested framework and talk through the constituent parts, their need of further development how they can be combined in different ways to address basic research as well as knowledge implementation and operationalization in governance and planning. The case based reflections will conclude with a set of suggestions and hypotheses, which will serve as the foundation and framing for an open discussion in two stages. First we will divide in thematic groups to then join in a final group discussion and synthesis of insights and idea. Most of the cases we will present are situated in urban or peri-urban landscapes. However, we argue that our approach is particularly relevant for cultural and human dominated landscapes where processes and qualities are in constant negotiation between biophysical conditions and the human activities and understanding of the systems we live in.

T0318

Functional traits as a boundary object

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Can traits serve as a bridge for connecting biodiversity response to drivers of change to ecosystem functions and the potential benefits for people these functions support? Can traits serve as a boundary object for connecting a deep understanding of ecological mechanisms and dynamics to a broad and solid understanding of human perspectives, sense making and preferences? Traits, here broadly understood as different characteristics (abilities and features), of organisms (by far the most common focus), communities and ecosystems, have been used (under different names) across disciplines to provide a 'relational' handle on biodiversity, recasting and connecting the usual levels of biodiversity (genes, species and ecosystems) to a range of questions and concerns. As such, traits may offer new ways of framing and discussing targets and perhaps help make 'biodiversity' easier to relate to for a broad range of interests.

Hence, instead of focusing on life history characters, we suggest that a traits approach that builds on attributes and features (at different ecological levels) that both have ecological relevance and are socio-culturally meaningful can provide a unifying common ground for discussion of system dynamics. Such an approach could address and connect a broad suite of issues, from biocultural relations and relational values to time dynamics and the resilience of ecosystems and their service provisioning. Among the primary knowledge needs are:

(1) A more nuanced understanding of the multi-dimensional and rich contributions of biodiversity to human well-being;

(2) Better ways of assessing the ecological consequences of human preferences and respective behaviour, and, more broadly;

(3) shared language for exploring how interactions are framed and moderated by traits;

(4) Operational knowledge on the multiple system dimensions that can make these linkages resilient.

We draw on recent work to present some conceptual models and analytical frameworks that we hope will

Keywords: Functional traits, Social-ecological, boundary objects

P0170

Enhancing tree health and urban biodiversity along with citizen wellbeing: analyzing tree functional traits to support urban forest planning and management in Padova (Italy).

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Urban trees are a fundamental component of the urban green infrastructure, especially in densely built-up areas. They provide key ecosystem services to the citizens and contribute to urban biodiversity. Careful planning and selection are crucial to guarantee the health of urban trees as well as an equal distribution of the benefits they provide.
The city of Padova manages more than 47.000 public trees of 255 different tree species, cultivar and selections. All trees are mapped in a GIS database, which collects continuously-updated information about their structural features, health conditions, and maintenance interventions. The study, carried out as part of the project EnRoute (https://oppla.eu/groups/enroute), was aimed at exploring the real potential of such database, not only for informing and directing management interventions, but also for supporting planning decisions, including the prioritization of new planting sites and the selection of suitable species to be used in different areas of the city.
The existing database was integrated by assessing, based on tree species and related functional traits, a set of relevant ecosystem services (e.g., microclimate regulation, carbon storage, visual amenity) and disservices (toxicity, interfering fruit and leaves fall, odour nuisance), as well as some tree needs (e.g., maintenance requirements, tolerance to draught, potential root damage). The spatial analysis of the data revealed unequal distribution of benefits, disservices, and management burdens associated to the presence of trees in the city.

The analysis identifies disadvantaged areas where future interventions should focus and supports a site-specific prioritization of tree species that both increases the provision of ecosystem services and ensures the respect of tree needs. Potential applications include the impact assessment of land use changes and the design of appropriate and locally-tailored compensation schemes.

Keywords: urban forest, tree database, ecosystem services, tree needs, urban biodiversity

Plant patterning and social selection for traits in the urban environment: Comparative reflections from Cape Town and Stockholm

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In order to shape cities that are more sustainable places of greater human wellbeing, better understandings of their social-ecological makeup are required. This study uses social and ecological data from projects in two cities—Cape Town, South Africa, and Stockholm, Sweden—to examine and compare urban social-ecological patterns. It explores the potential of a plant traits approach as a tool to discern social and ecological meaning in cities. Plant traits are defined as characteristics of organisms that determine how they respond to the environment, and how they affect ecosystem processes, functions, and services. In terms of social findings, interviews with residential gardeners in both cities reveal that people select for plants with traits related to common themes of aesthetics, utility, and environmental suitability. Traits identified as socially important across both places may be useful in academic assessments and management interventions concerned with social value. Socially-valued traits unique to place may be important for generating locally and culturally specific management applications. In terms of ecological patterns, vegetation surveys across both cities reveal a shift from local extant vegetation to grass across an exurban to urban gradient. Efforts to synthesize social and ecological findings, and use social data on plant trait preferences to explore ecological vegetation patterns provide some limited, incomplete insights, suggesting other factors and/or spatial scale perspectives may be important for shaping ecological outcomes in the landscape. The study highlights opportunities as well as challenges of using a traits approach, and also of conducting and synthesizing findings from interdisciplinary inquiry. Future research can conduct paired inquiry of socially-preferred traits with corresponding expression in landscapes, in order to further explore the potential of a traits framework as a tool for examination of urban social-ecological patterns.

Keywords: functional traits, preferences, cultural ecosystem services, social-ecological system, environmental management

Relational traits: linking human values to social-ecological attributes of landscape in Melbourne, Australia

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Exploration of ecological traits relevant to urban people has focussed on both ecosystem level traits (such as the role of tree canopy in providing services such as cooling) and highly preferred traits such as tree shape, vegetation colour and texture. Yet the individual and cultural differences that mediate how benefit from these traits are accrued are not well understood. Values in social psychology are commonly conceived of as guiding principles 'held' by people, that is characteristics of individuals that are largely independent of their environment. Here we explored how people's values are related to social-ecological attributes of a range green space types in Melbourne, Australia, and how these 'valued attributes of landscape' mediate a range of attitudes and beliefs. Applying a new psychometric questionnaire (the VALS) across studies of waterways, conservation reserves, urban trees and green spaces (total n=2000), six dimensions of valued attributes were identified through factor analysis: natural (e.g. species diversity), social (e.g. opportunities for social interaction), cultural (e.g. indigenous and European), experiential (e.g. beauty, getting away from it), utilitarian (e.g. timber, cooling), and recreational setting (places to exercise). There were small but significant differences in the intensity of valued attributes across landscape contexts (e.g. timber production was less important in urban environments), and valued attributes between individual respondents. However, at a population level, all valued attributes were important to participants. Valued attributes were useful predictors of both landscape preference, and social acceptability of proposed management actions. These studies demonstrate that different individuals have a different values basis for their interactions with urban green spaces, and these values shape both their response to landscape-level traits and the management of those traits.

Keywords: social values, traits, landscape preference, acceptability of management

T_9014

“Understanding of abiotic/ biotic and human induced traits and their interactions”

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In the face of global change there are two common approaches to the conservation of biodiversity: on the one hand the conservation of species and populations and on the other the conservation of habitats. In order to improve our understanding of the status, disturbances to and resilience of biodiversity for all levels of organisms, it is imperative not only to monitor biodiversity itself, but also to monitor geodiversity in particular and their interactions with each other.

For this, we focus on in that presentation that deal with remote-sensing and data science approaches to monitor the status and disturbances of the essential characteristics of biodiversity – the phylo-diversity, taxonomic diversity, structural diversity, functional diversity and trait diversity on different levels of organismic organization from the molecular and gene level, to individuals, populations, communities, ecosystems and landscapes.

A crucial insight from ecology is that biodiversity and geodiversity are inextricably linked and that feedback processes play a crucial role in the resilience of biodiversity as well as for the entire ecosystem. For this reason we focuses on recording the status and disturbances of abiotic diversity as well as the recording of interactions between biotic- and abiotic diversity using remote-sensing and data science approaches.

As a third component, we show how humans alter biotic and abiotic properties in such a way that they lead to disturbances. Therefore, we show how ecosystems change traits that are influenced by humans.

Keywords: biotic traits, abiotic traits, human induced traits, Data Science approaches, Remote Sensing

T0387

Functional assemblages of plants and birds: responses to past and present landscape structures

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The spatio-temporal landscape structure is one of the main drivers of biodiversity. It affects the dispersal of species and thus can drive their coexistence over time by selecting specific strategies. This study aims to determine the effects of present and past landscape structures on plant and bird communities. We used a functional approach to understand the mechanisms underlying the responses of these organisms to landscape heterogeneity (composition and configuration) and habitat features (amount and isolation). We quantified landscape structure of three years (1963, 1985, 2000) and sampled hedgerow plant and bird assemblages in twenty 1 km² square sites located along the Seine Valley (France). For each site, we calculated functional diversity and community weighted mean for 5 traits and for each taxa. These traits were related to dispersal, phenology and life cycle. Thanks to null models, we detected non-random patterns of functional structure for both taxa due to changes in species occurrence. Most patterns were convergent. Landscapes with a lower average patch area (i.e. higher heterogeneity of configuration) selected a lower functional diversity of phenological traits and lifespan of plants. In contrast, this same type of landscape selected a higher functional diversity of beginning of breeding for birds. Landscape with higher heterogeneity of configuration also selected a low mean of flowering duration for plants and a high mean of lifespan for birds. Landscape structure therefore seems to select traits related to phenology and life cyle rather than traits related to dispersal. Both plant and bird assemblages responded preferentially to past rather than present landscape (1985 and 1963 respectively). It thus demonstrates a delay in their functional response. This study highlights the importance of the landscape temporal component and offers a new understanding of the mechanisms underlying the effects of landscape change on biodiversity.

Keywords: landscape dynamic, dispersal, functional diversity, null models, environmental filters

T0467

Multi-user perspective applied on the maintaining of ecosystem service quality of man-dominated rural landscape, when provision is scattered between contrasting habitat types

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Land-use intensification has led to the degradation and loss of semi-natural habitats and ecosystem services. The challenge in restoration of landscape functionality is in the emphasis on these semi-natural habitats, which simultaneously provide multiple high quality services. Species richness is widely used, but insufficient indicator for such planning. We propose a three-indicator system to evaluate service quality of a habitat, consisting of functional Diversity, functional Intensity and functional Stability, in short the DIS-system.
In special example study from the rural landscape of central and southeast Estonia we asked, whether do mid-field forest fragments and margins around them compensate for the loss of floral ecosystem services provided by semi-natural grasslands? Seven common habitat types were compared using the DIS-indicator system, represented by flower colour richness, flower size, and species richness within colour group. Species richness was a good proxy to describe seasonal variability of other service quality indicators. We also considered the human and pollinator perspective.
Habitats ranked quite similarly from both a human and pollinator perspective. However, the human perspective overstated the service quality of open habitats relative to forest-related habitats, i.e. humans see stronger contrast between forest and all open habitats, while service quality for pollinators contrasts only in flower size (i.e. functional intensity). Only south-exposed close-canopy edges of forests and outer grassy edges of forests can be used as grassland surrogates for both user groups.
We conclude that small mid-field forests only partly substitute for the floral-based services provided by grasslands, though, their role can be easily improved by selectively opening up the overstorey at forest margins and by expanding outer grassland margins around forest.

Keywords: ecosysten services, functional ecology, margin habitats, forest fragments, grasslands

T0738

Understory vegetation recovery after wildfire disturbances in boreal forest

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Understory communities host the majority of species diversity, contribute an important proportion of total ecosystem production in boreal forest, and act as drivers of forest nutrient cycling and overstory succession. However, investigations of the underlying assembly processes, relationships between diversity-productivity (DPRs) of understory vegetation and related determinant factors associated with stand development following a wildfire disturbance are rare, particularly in Eurasian boreal forests. In this study, we measured understory functional traits, abundance, diversity, productivity and environmental variables along a post-fire chronosequence in the Great Xing'an Mountains of Northeastern China. We quantified phylogenetic and functional diversity and trait dispersions of understory communities and tested how these patterns changed along with stand age. Then, we quantified the effects of species richness, community aggregated traits (community weighted mean trait values, CWM) and functional diversity (functional dispersion, FDis) on understory aboveground biomass production (UABP) using structural equation modelling (SEM), which simultaneously accounted for the effects of overstory tree basal area, stand age, and soil fertility. We found that random patterns of phylogenetic, functional, and trait dispersions were dominant for most of our surveyed plots, indicating that stochastic processes may play a crucial role in the determination of understory community assembly. The SEM results showed CWM and FDis had positive effect on UABP. Among the covariates, soil fertility, stand age, and overstory tree basal area had respectively positive, negative, and no effects on UABP. The results provided complementary evidence that stochastic processes are crucial in the determination of community assembly both in tropical and boreal forests. Our results suggested that selection effect largely determined understory DPRs due to the dominant effect of CWM on UABP.

Keywords: Community assembly, Functional traits, Phylogeny, Diversity-productivity relationships, Selection effect

T_8819

Plant traits and natural vegetation in river restoration projects

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Sustaining healthy environment for a growing population of cities has become a challenge for managers and spatial planners. Urban green and blue infrastructure (GBI) offers opportunities for residents to directly and indirectly benefit from various ecosystems services (ES) that it supports. Therefore, attempts are being made to provide the public with access to high quality GBI, especially the areas with high share of natural, diverse vegetation, predominated by native species. This can be achieved by actively modifying existing GBS through various interventions, including ecosystem restoration techniques. The delivery of ES by GBI is strongly influenced by the interplay between abiotic drivers and the functional composition and response capacity of biological communities. The focus of this study was to investigate whether the functional composition of remnant vegetation in cities can provide insight to biological response to existing pressures and how this may translate into ES consequences. The study examines a typical industrial Eastern European City – Lodz, Central Poland. The remnants of former riverine vegetation still exist along the river Jasien, as part of the city's GBI and are planned to serve as a backbone for integrated revitalization of the City district. Multiple sections of the rivers (regulated, underground, semi-natural) were investigated with respect to their capability to provide recreational ecosystem services, based on vegetation survey and functional traits of the vegetation. The vegetation field study was complemented with remotely-sensed and census data. We found the remnants of the natural floodplain vegetation stating less than 5% of the total vegetation, despite strong anthropogenic pressure being revealed in species composition and functional trait analysis. The remnant vegetation was only to be found in the natural river section, still being an essential source to build future restoration upon.

Keywords: urban green infrastracture, ecosystem services, recreation, remnants of natural vegetation, urban water

T0634

Cultural ecosystem services assessment with Earth observation based spectral traits

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Urban green spaces provide key ecosystem services. While supporting and regulating services are partly well quantifiable as they underlie physical laws, cultural ecosystem services remain challenging in terms of spatially and temporally analysis and modelling. One way of deriving environmental data sets in a spatial and temporal continuous manner, are Earth observation (EO) based image analysis routines.
In this study, we use very high-resolution EO satellite imagery to quantify spectral plant traits and their variation in space and time (Wellmann et al., 2018). Using this information, we relate the degree of cultural ecosystem services provisioning potential in Berlin`s urban green infrastructure to plant characteristics, predicting the enabling of passive and active usage. Our results are validated based on a vast webGIS survey on cultural ecosystem services for Berlin (Rall et al., 2017).
We propose a first scheme for a repeatable and cost effective modelling workflow for the derivation of cultural ecosystem services. We are able to link spectral plant characteristics to human usage types and intensity, thus opening up the possibility of transferring our results to cities in similar socio-environmental settings.
Identifying the usage of urban green spaces is of key interest in urban planning as it opens up the possibility of effectively improving urban green infrastructure. Adapting urban green infrastructure and management schemes so that it become more accessible and more diverse in its usage is at the forefront of urban ecological research.

Keywords: Earth observation, spectral traits, cultural ecosystem services, urban green infrastructure, human/nature interactions

Symposium 09

Scoping with future challenges in mountain landscapes

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A significant proportion of the global population depends on crucial goods and services provided by mountain regions, including fresh water (for domestic use, irrigation, hydropower), raw materials, and recreation. However, mountain regions all over the world are facing multiple challenges due to environmental and socio-economic changes with related impacts on human livelihood, economy, and ecosystems. Accelerating climate change leads to melting glaciers, reduced permafrost areas, changing streamflow, vegetation shifts and natural hazards. Extensive land-use changes in the past as well as ongoing land transformations impact biogeochemical cycles alter landscape patterns with broadly unknown feedback mechanisms and interactions with climate change. Moreover, the development of tourism, especially in mountain areas, may contribute to economic welfare but has wide-ranging effects on social-ecological systems, which have developed over centuries. These current developments will result in altered landscapes in the future and a change in the provision of crucial ecosystem services. Here, local initiatives cannot face challenges for mountain people and resources alone, but these must be supported by measures and regulators at different levels of government to assure sustainability (resilience) of ecosystem services provision. This symposium therefore addresses the question how the mountain landscape and associated ES will be affected by future environmental and socio-economic evolutions and how mountain regions can scope with these upcoming challenges.

We welcome contributions highlighting current and future landscape dynamics, ecological impacts driven by global change, as well as societal trends and tendencies. Contributions may present novel indicators, methods and tools to evaluate the services and benefits from mountain ecosystems, to understand the functioning of social-ecological systems and to assess the influence of drivers of change across spatial and temporal scales. To stimulate the discussion for a sustainable use of the natural resources, experiences and examples of sustainable solutions are particularly welcome.

P0135

Benefits beyond borders: global progress with transboundary conservation in mountain areas

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Mountain areas support a disproportionate amount of the world's biodiversity and ecosystem services. Although mountains cover only one quarter of the total land area outside Antarctica, they support half of the world's biodiversity hotspots, and they provide a substantial part of the human population with freshwater – they are the 'water towers' of the world. However, since they are often divided by international borders, the effective conservation of many mountain landscapes requires international cooperation. Transboundary conservation areas (TBCAs), in all their different forms, are therefore a critical instrument to support the effective protection of species, ecosystems and ecosystem services in transboundary mountain landscapes. This includes internationally adjacent protected areas, transboundary protected areas, transfrontier conservation areas and the special case of so-called Peace Parks. Over the past 30 years, several global inventories of TBCAs have been compiled, the most recent one in 2007. Here we combine an updated inventory of TBCAs, created from multiple sources including the World Database on Protected Areas (WDPA), with global datasets on mountain areas and water towers, to assess the current status and trends in transboundary conservation. Our analysis shows the enormous global progress with transboundary conservation in mountain areas since the first-ever TBCA, the Waterton-Glacier International Peace Park, was established in 1932. Moreover, it highlights the important role that international agreements and conventions have played in this process. However, our analysis also reveals important regional differences, and identifies mountain areas (including critical water towers) where more efforts in transboundary conservation are still needed. Our findings have important implications for the governance and management of the world's transboundary mountain landscapes and their role as hotspots for biodiversity and ecosystem services.

Keywords: mountains, protected areas, transboundary conservation, water towers, global change

Effects of Fire Severity and Topography on Soil Black Carbon Accumulation in Boreal Forest of Northeast China

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Black carbon (BC) from incomplete combustion of biomass and fossil fuel is widespread in sediments and soils because of its high stability in nature and is considered an important component of the global carbon sink. However, knowledge of BC stocks and influencing factors in forest ecosystems is currently limited. We investigated soil BC contents in burned boreal forests of the Great Khingan Mountains, northeast China. We collected soil samples from 14 sites with different fire severities, slope positions and aspects. The samples were analyzed by the chemo-thermal oxidation method to obtain their BC concentrations. The BC concentrations of the studied soils ranged from 0.03 to 36.91 mg C g−1, with a mean of 1.44±0.11 mg C g−1. BC concentrations gradually decline with depth, and that was significantly less in the 20–30 cm layer compared to all shallower layers. Forests burned by moderate-severity fires had the highest soil BC, the shady aspect had higher soil BC than the sunny aspect. Our results provide some basic data for evaluating the soil BC sink in boreal forests, which is a useful amendment to current carbon budget and carbon cycle in boreal forest ecosystems.

Keywords: black carbon, the Great Khingan Mountains, fire severity, topography, boreal forests

T0555

Anthropogenic nitrogen deposition increases soil carbon sequestration by enhancing new carbon of the soil aggregate formation in a montane forest

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Since the industrial revolution, atmospheric active nitrogen (N) deposition has continued to increase worldwide, especially in China. N is considered as an essential element for ecosystem, and anthropogenic N deposition has been found to influence many forest ecosystem functions and servises, such as the fate, cycle and storage of soil organic carbon (SOC). It is very important to understand the changes in forest soil C and the potential mechanisms as forest soil holds a large C storage and plays a significant role in global C cycle and global warming.

Anthropogenic N deposition can most likely increase temperate forest SOC storage. Increased SOC is usually suggested to be associated with the suppression of SOC decomposition, which has been hypothesized to be due to the decrease in the activity of lignin-degrading extracellular enzymes and/or the decrease in soil acidity under N-addition. However, the potential mechanism of SOC protection derived from N-addition is less understood. Here, in a low-deposition temperate montane forest, short-term N-addition could increase SOC storage in the aggregate fraction but not in the bulk soil. N-induced SOC accumulation was partly associated with the suppressed SOC decomposition (indicated by lower soil respiration) that resulted from the reduced microbial biomass rather than from decreased lignin-degrading enzyme activity or from reduced soil acidity. In addition, N-addition promoted soil aggregate formation, which could partly suppress SOC decomposition by protecting new carbon that originated from plant litter residue to a greater degree, while dissolved organic carbon retention in the mineral soils played a limited role in the SOC sequestration derived from N-addition, at least in the short term. A conceptual model was proposed and highlighted a new underlying mechanism of new carbon protection by enhanced aggregate formation, other than the role of microbial suppression, to explain the positive effect of anthropogenic N.

Keywords: montane forest ecosystem services, carbon sequestration, N-addition, aggregate fractionation, new carbon

T0823

Analyzing the spatial coincidence of environmental stressors and ecosystem service provision in mountain forests

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With increasing pressure on mountain ecosystems due to growing human populations and tourist flows as well as human-induced environmental changes, both scientists and stakeholders need a better understanding of the interactions between cumulative stress exerted by human activities and ecosystem service provision. In support of these needs, in this study we couple high-resolution spatial analyses of environmental stressors (such as climate anomalies, soil sealing, noise and light pollution) with key ecosystem services assessment (such as protection forest, CO2 sequestration and outdoor recreation) provided by forest ecosystems in the greater European Alpine Region (Alpine Space). Based on spatial overlay procedures we quantify the coincidence of aggregated hot- and cold spots of ecosystem services with the distribution of cumulative environmental stressors. Our results indicate that locations of high ecosystem services delivery are often severely affected by a diverse set of stressors, suggesting that either ecosystem condition or service beneficiaries are resistant even to substantial levels of stress. By overlaying stressors and ecosystem services critical areas of supply will become tangible. The study concludes by identifying possible priority areas for ecosystem intervention that need to be addressed to guarantee ecosystem service delivery on the long term. Moreover, given the urgent need to engage society in conservation efforts, the study will contribute in awareness raising of the importance of mountain forest ecosystems for human well-being and in promoting ecologically oriented conservation polices as foreseen by the EU forest strategy.

Keywords: cumulative impact, mountain landscapes, protected areas, restoration priorities

T0651

Evaluating methods for participatory identification and mapping of ecosystem services from Andean peri-urban forests in Colombia

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Forests in the Colombian Andes are highly altered ecosystems but are home to some of the highest levels of biodiversity and endemism in the world. In addition, they provide several critical ecosystem services to adjacent urban areas such as Bogota, Colombia. Information regarding the spatial distribution, supply, and even demand for ecosystem services-disservices (ESD) in the Andes is increasing, but less known is how different stakeholders value and "spatially" identify specific ecosystem services from peri-urban landscapes. Accordingly, we used geospatial maps, basic 3-dimensional cognitive cardboard landscape models (3-DCM), structured interviews, a smart phone compatible survey with cartographic maps, and the Social Valuation of Ecosystem Services (SOLVES) model. SOLVES uses Maxent maximum entropy modeling to facilitate spatially explicit analyses of socio-cultural values using georeferenced survey data. Specifically we first tested how the use of digital maps or 3-DCMs influence the number of ESD and key landmarks identified by different actors. Second, we assessed whether cartographic literacy using on-line maps significantly affects the number and type of ESD identified across different landscapes. Results from our interviews (n=60) and regression tree and bootstrap aggregating analyses identified that older locals identified more ESD. Millennials identified more landmarks with maps, while highly educated identified more landmarks with 3-DCMs. Filter questions in the smart phone survey (n=4,500) using reference landmarks were used to stratify respondents with differing levels of cartographic abilities. Preliminary results using SOLVES show that differing cartographic abilities among respondents will significantly affect both the number, type and spatial distribution of ESD identified and the landscapes providing them. Our approach and findings shed light on how different sets of actors in the Andes value these peri-urban landscapes and their ESDs.

Keywords: Peri-urban ecosytem services, Participatory mapping, Socio-cultural valuation, Urbanization

Changes in the food supply capacity of alpine grassland ecosystem: A dialectic synthesis of natural and anthropogenic drivers

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Alpine grasslands have provided fundamental goods and services to humankind. However, the anticipated impacts of climate change pose an additional stress to alpine grassland productivities. The source regions of the Yangtze and the Yellow Rivers locate in the hinterland of the Qinghai-Tibetan Plateau with the average altitude of more than 4000 m, exhibiting the distinct features of inland plateau climate. In the context of climate change, few studies have investigated the food supply capacity (FSC) and the role of driving forces for alpine grassland ecosystems from the perspectives of the hydrothermal condition of alpine grassland ecosystem and quantification of main drivers. By using the structural dynamics method, author estimated the changes in food supply capacity of alpine grassland ecosystem and sensitivity to significant variables. The results indicate that: i) the FSC has an increasing trend during the last 30 years (1984-2014), especially after 1998, which is the joint effect of physical and anthropogenic drivers; ii) The sensitivity of the FSC to NPP and precipitation during grassland growing season are 4.06 and 1.89 respectively, that is, once the NPP and precipitation during grassland growing season increase 1unit, the FSC would increase 4.06 and 1.89 units. Conversely, the frequency of snow disaster and the thickness of permafrost active layer have a highly negative correlation with the FSC. As the increase in the frequency of snow disaster and the active layer thickness of permafrost, the FSC is decreased. Compared with natural drivers, the correlation between human drivers and food supply capacity is not significant except for the area of warm barn per adult sheep, the level of information coverage, and the capacity of milk production. Although the food supply capacity of alpine grassland ecosystem is a combination of natural and human factors, natural drivers, especially climate change, is a determining factor in food supply capacity.

Keywords: Food supply capacity, Alpine grassland ecosystem, Structural dynamics, Natural and anthropogenic drivers, Climate change

P0001

Scenario analysis of ecosystem service changes and interactions in a mountain-oasis-desert system: a case study in Altay Prefecture, China

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Scenario analysis of ecosystem services (ES) can provide a scientific basis for ecosystem management. The objective of this study was to reveal the effects of future land use scenarios on ES in a mountain-oasis-desert system (MODS). We first simulated land use changes for the period of 2015–2035 in Altay Prefecture under three different scenarios: business as usual (BAU), economic development (ED), and ecological conservation (EC). We then evaluated water yield (WY), crop production (CP), soil conservation (SC), sand fixation (SF), carbon sequestration (CS), and aesthetic value (AV) and investigated the multiple interactions among ES at the regional and grid scales. The results showed that SC, CS, and AV continually increased, WY continually decreased under the three scenarios. Our study revealed that the multiple interactions among ES were spatially heterogeneous in the MODS and the spatial heterogeneities changed across scenarios. The locations of and causes for the formation of the multiple interactions among ES were identified based on spatial analysis. This information can help decision-makers develop targeted and differentiated ecosystem management strategies. This study can increase the understanding of the multiple interactions among ES. Our findings can provide a reference for studies of other regions with the MODS structure.

Keywords: Ecosystem services, Mountain-oasis-desert system

T0326

Land use intensification rather than land cover change affects ecosystem services provision in the river Adige basin (Italy)

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Humans impaired river basins affecting landscape composition and exploiting natural resources, thus influencing ecological functions and the Ecosystem Services (ES) on which they depend.
Alteration of the ES supply can results from changes in either land cover and/or land use intensity. The understanding of the different role of these phenomena on influencing ecological functions is of a paramount importance for the ES management.
The work aims to model the effects of changes in both land cover and land use intensity (i.e. intensification of food production) in the alpine basin of river Adige (Northern Italy) during the overall period 1960-2012 on four ES: carbon storage capacity, water supply, water regulation and nutrient retention.
Significant changes in land cover occurred during the period 1960-1990, mainly involving pastures abandonment, while intensification of food production was observed during the period 1990-2012, requiring a dramatic increase of fertilizer applications.
The results show that land cover changes caused very limited variation in carbon storage and water-related services. Contrarily, the intensification of food production led to an estimated increase of 198.9% of N export from the basin, despite a parallel increase of N retention capacity of 290.3%. The findings show that the considered ES are influenced differently by land cover and land use.
Intensification of agricultural land use was the main driver of change in river Adige basin, highlighting the magnitude of trade-off between increasing food production and water quality regulation.
Future investigations are needed to better understand the complex relations among multiple ES, as well as their vulnerability to climate change.

Keywords: Land use change, Land cover change, Ecosystem services modelling, Food production, Mountain landscape

T0775

Drivers of orchid population changes in the Alps under a warming climate

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Global change has severe impacts on plant distribution and dynamics in mountain regions. In particular, during the last decades, urbanization and agricultural intensification have profoundly modified Alpine landscapes with potential negative consequences on plant diversity. Here, we investigated the drivers of orchid population changes in the Southern Alps. Between 1977 and 2017, 22,233 plots were sampled to describe orchid distribution in the region of Trentino, Northern Italy. In spring and summer 2018, we re-sampled 374 sites over the whole elevational range of orchids (98 – 2467 m) to test the effects of population size, elevation, habitat perturbation, and protection on species extinction and colonization. Overall, we found a strong decline in orchid populations. Over the last 40 years, orchid species richness has decreased in 235 of the 374 plots. Between the two surveys, 47 % of the sites experienced a habitat disturbance. 40 % of the sites without protection underwent a habitat change, while only 7 % of the sites under protection changed. The main drivers of orchid extinction were size of the original population, habitat disturbance and protection, i.e. large populations in protected undisturbed areas were most likely to survive. Moreover, urban and agricultural habitats had the smallest probability of being colonized by orchid populations. Colonization-extinction dynamics of orchids was not affected by elevation.
Habitat protection stood out as an effective tool to maintain orchid populations across Alpine landscapes irrespective of the habitat identity. However, land use changes occurred in the last 40 years threatened orchid populations, in particular in wetlands and dry grasslands. Hence, we highlight the need of implementing effective conservation strategies to counteract orchid decline. In this context, monitoring data have been shown to be crucial to assess trends in biodiversity loss and to test effects of conservation actions currently in place.

Keywords: conservation management, elevational gradient, land use, protected area, re-survey

T0153

Linking ecosystem services and landscape ecological risk into adaptive management in a mountain-basin area in western China

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Considering the increasing uptake of the concept of ecosystem services and ecological risk in landscape management and environmental policies, it is urgent to integrate ecosystem services and ecological risk management into real decision-making. On the basis of ecosystem service valuation model revised from Costanza et al. 1997 & 2014, InVEST model and landscape ecological risk assessment model and the related geographical data from Bailongjiang watershed, China, we analyzed the spatiotemporal change of ecosystem service and landscape ecological risk from 1990 to 2014. There are some obvious spatial differences of both ecosystem service and landscape ecological risk levels in the watershed. The ecological risk level of the area along the valleys of the Bailongjiang, Baishuijiang and Minjiang is higher than that of the area located in the southern and eastern parts of the watershed. The correlations between different ES type and LER are complex. The zoning of both ES and LER can be used for adaptive management of ecosystem service and human activities for different subareas for the improvement of local ecological conditions and sustainable development. The new framework proposed as the integration of landscape ecological risk and ecosystem service, as "land use change–landscape ecological risk–ecosystem service–policymaking and management", is a useful way for adaptive management on watershed scale for future ecological risk deduction and ecosystem management.

Keywords: Ecosystem services, Landscape ecological risk, Land use change, Adaptive management, Watershed management

P0082

The influence of hiking pressure on wildlife activity in the Baekdudaegan Mountain Range Trail in Korea

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'Baekdudaegan Mountain Range (BMR hereafter)' is a key historical and ecological axis linking the north and south of the Korean Peninsula. It is a habitat for 4,494 flora and 68 fauna species, including 50 endangered species. Due to its symbolic value and scenery, the trail draws a large number of hikers, reaching more than 44 million in 2016. Such high level of hiker traffic can have direct or indirect impacts on the forest ecosystem, which may affect wildlife habitats. Increase in hikers and development of facilities resulted in reduced forest areas and/or fragmentation. In particular, mammals may be more vulnerable to such changes as they require larger habitats. In this study, we investigated the influence of hiker traffic to wildlife activity by comparing mammal's field signs from the main trails of Odaesan National Park (ONP, 6.50km), Taebaeksan NP (TNP, 6.99km) and Deogyusan NP (DNP, 6.01km), all part of the BMR. Survey (linear transect method) was conducted in May and October of 2018, when visitors generally peak. We observed 5 families, 8 genuses and 13 species of mammals in total. From May to October, the number of sign decreased while visitor number increased in all study sites: field sign decreased by 48% (25 to 13), 54% (28 to 13), and 20% (72 to 58), while monthly visitors increased by 240% (138k to 331k), 21% (33k to 40k), and 82% (115k to 210k), in ONP, TNP, and DNP, respectively. While this study suggests that seasonal changes in the number of visitors may have a negative impact on mammals that use the trail area as habitat, species-specific seasonal characteristics and tracking is necessary to better understand the relationships. This study is part of the results from the first year of a long-term monitoring project designed to understand the changes in behaviors and habitat characteristics of mammals in BMR in response to hiker activity and development.

Keywords: Mammal's monitoring, Human activity, Linear transect method, Field sign tracking, Mountainous National Parks

T0044

Upcoming trade-offs between ecosystem services in mountain regions: outdoor recreation vs. habitat provision

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In the European Alps, cultural ecosystem services such as outdoor recreation are of great importance to local inhabitants as well as to visitors. Among the winter recreation opportunities provided by Alpine ecosystems, backcountry skiing is one of the most sought after. Furthermore, surveys predict a rising demand for backcountry skiing in the future, which is often perceived as a close-to-nature and sustainable alternative compared to resort skiing. However, increasing numbers of backcountry-skiers may evoke conflicts with other ecosystem services such as the provision of wildlife habitats. To avoid the disturbance of wild animals, some organizations have already taken action to guide skiers towards a nature-friendly behavior in selected locations, but region-wide assessments of potential conflict zones are still missing. In our study, we aimed therefore at analyzing the trade-off between outdoor recreation and wildlife habitats for the entire region of Tyrol, Austria. We mapped recreational activities based on tracking data of backcountry-skiers from social networks; high-resolution habitat maps of Tetraoninae were used to locate wildlife habitats. To identify focal conflict areas, we applied species-specific disturbance distances between animal sightings and ski routes. Our results indicate strong distinctions in ecosystem service use and trade-off potential between populated and remote areas as well as violations of protected areas. To reduce conflict areas, measures and strategies that guide and inform backcountry skiers need to be developed.

Keywords: ecosystem services, European Alps, wildlife, winter sport, spatial analysis

T_8908

Landscape protection vs mountain economic development – can conflicts be avoided? The Sudety Mountains casy study (SW Poland)

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Mountains are usually very valuable areas with high level of geo- and biodiversity, providing numerous ecosystem and landscape services. However, in recent decades an increased pressure on mountains can be observed in many regions, often related to the intense development of tourist and recreational facilities. This leads to diverse spatial and social conflicts, especially within the protected areas or in their buffer zones. In our research we focus on the Sudety Mountains (SW Poland), where a growing number of conflicting functions between new developments and nature/ landscape protection have been observed in the last several years. The aim of our study was to identify the main conflict areas, to define their causes and driving forces, as well as to assess the potential solutions for future developments in the mountain protected areas. We combined the field investigations and mapping with analysis of documents on spatial planning and development strategies within the communes (gminas) most affected by intense landscape changes due to the recent tourist infrastructure development. We found that the lack of any landscape impact assessments in the strategic documents is in most cases the main driver of conflicts between new investments and landscape protection. The idea of landscape services is completely excluded from any regional or local development plans. The short-term economic benefits for the communes, which can be achieved by the increased tourist infrastructure (i.e. new large-scale hotels and ski areas) definitely prevail over the landscape values, as the economic valuation of landscape services is not performed. Without including the landscape valorisation and evaluation of landscape tangible and intangible values into spatial planning, the increased development pressure on the most precious areas can lead to the irreversible landscape changes and loss of landscape services.

Keywords: spatial environmental conflicts, landscape services, tourist infrastructure, spatial planning, landscape impact assessment

National Park Collaborative Management Functional Zoning Study in China—Taking Shennongjia National Park as an example

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National park construction is an important means of landscape protection and utilization. Functional zoning and systematic design of the national park is a sustainable way of protection and management. The Chinese government has been redefining arid promoting the national parks which are not equivalent to the term of National Scenic Area in the past as a national development strategy.

This study summarizes main methods of national parks and nature reserves, and main problems in used methods. The division of the national park is usually divided by manual intervention, combined with administrative boundaries and natural geographical boundaries. However, in the current research, the integrity of the local ecosystem and human factors are less considered, resulting in unreasonable and unclear boundary division.

Taking Shennongjia National Park as an example, this study established an evaluation index system to comprehensively analyze regional ecological and environmental features, used public participation GIS to identify ecosystem services and identified boundary based on low-altitude Unmanned Aerial Vehicle remote sensing. The research objectives are to establish an approach to select, evaluate and manage the national park by using the methods of RS/GIS calculation and analysis, combined with the application of field investigation, big data and drone.

According to the results, the research has refined function partition and updated the classification system by International Union for Conservation of Nature to the conservation areas, identified a new area called "Collaborative Management Area", which was the adjacent to the national park range and has the same ecosystem as the conservation area.

The research has found that this approach can achieve the spatial manage and control from beginning of identification to the operation to the national parks in China.

Keywords: national park, functional zoning, collaborative management division, Shennongjia National Park

P0088

Study on supply and demand matching of ecosystem services in Loess Hilly Regiona case study of Lanzhou, Gansu Province

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The sustainable supply of ecosystem services is the basis for the sustainable development of society and nature. Human beings meet their needs and improve their well-being through the consumption of ecosystem services. It is of great significance for the management of regional ecosystems and the effective allocation of resources to study the demand and consumption of ecosystem services and to analyze the supply and demand characteristics of ecosystem services and their spatial trade-offs. Taking Lanzhou City as an example, this paper calculates the supply and demand of water, food, carbon sequestration and soil conservation services in the study area by using InVEST model and ArcGIS analysis tools based on multi-source data of land cover of Lanzhou city in 2017, and then analyses and evaluates the matching status of supply and demand of ecosystem services. The results show that: ①The supply and demand of ecosystem services in Lanzhou have obvious spatial heterogeneity. The total supply of services is greater than the total demand, and there are obvious differences between different regions and ecosystem services.②The overall supply-demand matching of ecosystem services in Lanzhou City is good (0.039). There are differences in supply-demand matching of different ecosystem services. Water production service (0.098)>carbon sequestration service (0.066)>food supply service (0.030)>soil conservation service (0.001), and there are significant differences in supply-demand matching between urban and rural areas.③There are four types of spatial matching of supply and demand of ecosystem services in Lanzhou. Which are high-high spatial matching, low-low spatial matching, high-low spatial dislocation and low-high spatial dislocation, and the dominant spatial matching types of services are different.

Keywords: Loess Hilly Region, ecosystem services, supply and demand matching, spatial heterogeneity

T0140

Spatiotemporal variation of heavy metal pollutions and ecological risk assessment in the Qinling Mountains

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Heavy metal pollutions in the environment can degrade the quality of the ecosystems, as well as threaten the health of human beings and animals. Giant panda, which is endemic to China and a global conservation icon, has the largest density in the Qinling Mountains, China. We investigated the seasonal variation of heavy metal pollution in the regional scale with three zones of urban areas, mountain edges and central mountains, to assess the ecological risk for the habitat of giant pandas in the Qinling Mountains. Our results showed that the concentrations of eight heavy metals (Hg, As, Cu, Mn, Zn, Cr, Pb, Cd) in the soil exceeded the background values of Shaanxi Province and the spatial distribution patterns were different in three zones. The concentrations of Hg, Zn, Cr, Pb, Cd in the bamboo surpassed to the reference standard, and the high contents of Hg, Zn and Cd in bamboo might be transferred from the soil. Heavy metals enriched more in the fecal of the captive giant pandas than the wild giant pandas. Ecological risk assessment of soil by geo-accumulation index (Igeo) and risk index (RI) showed strongly polluted by Hg and moderately polluted by Cd. We suggested that a serious attention and all effective measurements should be taken for Hg and Cd in the Qinling Mountains in order to protect the giant pandas and also other wildlife species.

Keywords: heavy metals, spatiotemporal variation, ecological risk, giant panda, the Qinling Mountains

Long-term economic valuation of the protection service of forests against rockfall considering disturbances

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Mountain forests provide a series of ecosystem services, including the protection from natural hazards. Thanks to these forests, structural protection measures can be avoided in many places. In addition to reducing the high costs, negative environmental and aesthetical impacts of such "grey infrastructure" can be diminished. A realistic long-term valuation of this ecosystem-based risk reduction provided by the forest is essential. The aim of this study is to provide a methodology to assess the Net Present Value (NPV) of a protection forest using a risk-based approach and compare it to the NPV of rockfall nets. Costs to be included in the NPV calculation are forest management interventions, net construction and maintenance, and benefits are the risk reduction and wood sales. The risk reduction is monetised as avoided damage, i.e. the difference between the yearly rockfall risk with and without measure. Uncertainties in the protection effect of the forest due to possible forest fires were simulated over a period of 100 years using a Monte-Carlo approach. Both the protection forest and the rockfall nets effectively reduce rockfall risk at the study site by about 75% per year. The NPV of the rockfall nets is highly negative (-124'100 CHF/ha), indicating that they are economically not worthwhile at the case study site. The NPV of the protection forest is highly positive (162'400 CHF/ha) and is only slightly reduced due to the forest fires in the long-term. Consequently, the influence of this disturbance on the long-term efficiency of the protection forest is small. Building temporary nets in case of a large fire can restore the protective effect. Their NPV is, however, lower compared to the situation without nets. By calculating the NPV of a forest considering its risk reducing effect, we provide a a realistic monetisation of this ecosystem service, which can serve as basis to find optimal management strategies of mountain forests.

Keywords: Mountain forests, Protection service, Ecosystem-based risk reduction, Disturbance, Risk analysis

T0026

Biodiversity conservation as a condition for sustainable livelihoods

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Semi-natural vegetation such as meadows, pastures, orchads, agro-silvo-pastoral systems are characterized by high level of biodiversity. Socio-economic transformations, which have been particularly rapid in Central and Eastern Europe – in connection with the political changes - lead to disappearing of semi-natural vegetation. It concerns especially ceasing of small-scale farming in mountainous regions which favours these types of land use. In a result of these changes, reforestation processes occurs and causes the loss of biodiversity influencing ecosystem services provision. In rural areas ecosystem services provided by biodiversity may serve as a basis for sustainable livelihood. It concerns above all recreational and aesthetic values, inspiration for art and design, utilization of plants for cultural purposes (plants in rituals), herbal medicine, wild foods production, etc. However, the importance of the biodiversity and ecosystem services is often underestimated by local people. The aim of the research was to examine which ecosystem services provided by biodiversity are used for making a sustainable living for people. Additionally, in the frame of the project the local people's perception of land use changes, and consequently, biodiversity changes was examined. Results of the survey were juxtaposed with the outputs of desk research analysis based on cartographic materials.
The attention was paid to the underestimated ecosystem services provided by the biodiversity. Consequently, recommendations for biodiversity conservation as a condition for sustainable livelihood were developed.

Keywords: meadows, Carpathian mountains, human well-being, biodiversity, ecosystem services

Networks of Protected Areas as governance instrument for sustainable territorial development and green economy

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Protected Areas are increasingly being considered, connected and managed as systems, rejecting the traditional view that regards them as "islands of nature", fenced off from the outside world. Within networks of protected areas (NPAs), social and economic aims add up to the objectives of maintaining biological and cultural diversity, e.g. the provision of ecosystem services for settlements and human well-being. The new Action Plan of the EU Commission (Action Plan for Nature, People and the Economy, EC 2017), devoted to reaching the EU 2020 goals on biodiversity, identifies the following as its priority: "ensuring better coherence of biodiversity conservation with broader socio-economic objectives". Aiming to achieve this aim, in many cases NPAs emerged as a governance instrument suitable to play a role in the framework of sustainable territorial development. The Authors aim to present the main results of a specific targeted analysis promoted by ESPON. The results of the research highlight the great value and the promising opportunities offered by networks of Protected Areas for implementing "green infrastructure" policies in several fields through a functional approach built on a coherent system of areal components, where PAs are included as core elements. Possible fields of action of NPAs include nature conservation & ecological connectivity, planning for sustainable use of natural resources (e.g. through agriculture, forestry, fishing, human settlement, recreation, etc.), and genuine green economy policies for European SMEs. NPAs show a greater value if considered as powerful tools for integrated landscape management and with a perspective of increasing development of regional green economies and infrastructures.

Keywords: Protected Areas, Landscape, Territorial sustainable development, Green economy, Ecosystem services

P0120

Relationships between habitat structure and ecosystem services: carbon stock in alpine forests and prairies

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Mountain areas provide a large number of ecosystem services and important marketed goods because of their high multifunctionality. They also host a great diversity of habitats and species, many adapted to specific extreme climatic conditions and highly susceptible of environmental changes. Mountain ecosystems are also fragile and vulnerable, and face severe threats from land abandonment, unsustainable exploitation or climate changes. When valuing ecosystem services, most of the attention is focused on the final value itself, missing the mechanisms and relationships that lies behind the ecological processes and that determine the ecosystem functioning. Many of interdependencies between biodiversity, ecosystems structures, ecosystem functions and benefits to humans are not yet fully understood because of their complexity. In particular, forests' species, structural and functional diversity are usually linked with high delivery of ecosystem services, compared to forests with lower levels of diversity. In this study we focus on one of the most important regulating ecosystem service that is carbon storage. We conduct the study in a mountain protected area, the Gran Paradiso National Park, western Italian Alps. We estimate carbon stock for soils for different habitats of forests and prairies by conducting a field campaign and collecting samples in 87 plots (42 of forests and 45 of prairies). We then investigated the relationship between carbon stock, habitat biophysical characteristics and biodiversity. We found differences in carbon stock for different habitats, and forest structure parameters correlated with carbon stocks. Results of this study will have the double goal to improve the estimation accuracy of carbon stock in these habitats for each compartment and to enhance our understanding of linkages between elements involved in ecosystem functioning.

Keywords: Ecosystem services, Carbon stock, Habitat structure, Alps, National park

Valuation of ecosystem services in an alpine protected area: the case of the Gran Paradiso National Park

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The concept of ecosystem services is creeping into policy strategies of government and non-government organisations, and among these there are protected natural areas. Mountain areas are facing increasing pressures and they need knowledge-based conservation and management strategies that aim to support ecosystem functioning and the benefits associated. In this context the valuation and modelling of ecosystem services in order to define the current state and future trends in ecosystem conditions is crucial. We started a project in the Gran Paradiso National Park which is the oldest protected area of the Italian Alps and it is under protection status since about one hundred years. The aim is to map the current status of ecosystem services with selected indicators and to project future ecosystem services delivery under different scenarios of change. In the first year of the project we conduct a field campaign in order to estimate the soil carbon stock in alpine forests and prairies. The relationships between carbon stock, habitat structure and biodiversity were investigated in order to understand the processes that lies behind crucial services. Results show that prairies and forests store a significantly different stock of soil carbon and average stocks are presented. Relationships among soil carbon stock and relative dominance and richness of trees species were found, as well as relationships between biodiversity and litter carbon stock. Indicators of ecosystem services that support the environmental certification process of the Park are also discussed and developed with decision-makers in order to integrate ecosystem services research with valuation for conservation policies.

Keywords: Gran Paradiso National park, Alps

T0543

Current landscape-ecological state of protected areas of the northern caucasus

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The current ecological state and landscape dynamics of the protected areas of the Northern Caucasus as a result of nature processer's activity and anthropogenic impact are revealed on the basis of interpretation of multi-temporal remote sensing data, long-term field landscape mapping and repeated observations on model sites. The national park "Prielbrusie" and Teberda Nature Reserve, one of the most popular areas of the mountain recreation in Russia, and their surroundings are chosen as the main study objects. These protected areas are characterized by high biological and landscape diversity, rich nature resources, historical and culture heritage and must play significant role in the sustainable development of the region. But during the last decades the degradation of landscapes as result of nature processes activity firstly of catastrophic snow avalanches and debris flows including outburst of periglacial Lake Bashkara and formation of powerful debris flow reflecting climatic fluctuations, and of social-economic transformation has been identified. The reduction in area and diversity of forests, the changes of glacier-nival, alpine and subalpine meadow and meadow-steppe landscapes, the increase of degraded pasture lands, the intensification of scree and erosion processes, the reduction of aesthetic properties of nature and recreation complexes are some negative consequences of anthropogenic and nature hazards effect, that lead to the decrease of ecosystem services. Large-scale maps of landscape dynamics on the model sites of the protected areas are compiled and some recommendations on landscape planning of the territory, including correct functional zoning of national park and further improving of ecological tourism and recreation are suggested.

Keywords: mountain landscapes, protected areas, Northern Caucasus, landscape-ecological state

T0502

Impact of climate change on the hydrological response of mountain catchments in the Beskydy Protected Landscape Area, Czech Republic.

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High water demands of the industrial Ostrava region, located outside the Protected Landscape Area (PLA) Beskydy, together with the impervious geological structure of the Outer Western Carpathians mountains make the PLA highly sensitive for future changes. The hydrological response on the impact of climate change was investigated in four catchments, using the regional climate model ALADIN CLIMATE CZ and rainfall-runoff model HEC-HMS for short-term (2021 – 2040), middle term (2041-2060) and long-term (2081-2100) scenario simulation. The HEC-HMS model was calibrated and validated using the twenty years period of observed daily discharges. The Nash Sutcliffe efficiency index (NSE) and Percental bias (PBIAS) were selected as measures of goodness-of-fit. Majority of catchments produced satisfactory or good NSE values and very good water balances (PBIAS). A decrease in simulated annual discharges was simulated in each scenario, due to the decrease in predicted annual rainfall totals. The highest changes were found for long-term scenario and the average value was equal to -24 %, while the lowest was reported during the middle term and was equal to a -13 %. High variability in the magnitude of changes was reported among the catchments in interannual scale. The increase during the June and November and decrease during the August and September were found in all catchments, what will increase the drought stress during these months. In the majority of watersheds, a decrease in January and February discharges were simulated for the short-term and middle-term scenario as a consequence of lower rainfall amounts. Duration analyses revealed an increase of lowest discharges in short-term and middle-term scenarios for two catchments while a decrease was reported in remaining. Similar hydrological response of present and future scenarios was observed for these two catchments during the assessment (R2=0.7), due to the similar slope characteristics and position inside the center of PLA.

Keywords: Climate change, Rainfall-runoff, Interannual, Low flow, Beskydy

T0881

Ecosystem services in the European Alps – a comparison across different socio-ecological sites

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Ecosystem services (ES) provide the foundations on which human societies are built. To better understand these services in the European Alps, the "AlpES project" (Alpine Ecosystem Services - mapping, maintenance, management) aimed to collect, analyze and distribute information on ES in the Alpine Space area. The specific steps included (1) to develop a concept of Alpine ES, (2) to map key ES, and (3) to evaluate ES for the entire Alpine Space area, including pilot regions. The mapping of multiple ES (in total 21 maps of different ES indicators) was carried out at the municipality scale for the entire study area, expanding the basic concept of the ES supply with flow and demand maps to meet the requirements for effectively managing ES.
The evaluation of ES and, in some cases, the economic evaluation focused on smaller pilot regions, where particular circumstances require a more targeted approach. Here, we compare the different pilot regions among each other to identify underlying mechanisms and driving forces. Our results indicate that the Alpine ecosystems are capable of supplying a number of ES at a level that meets the local demand without needing to draw upon external sources. For example, based on the difference between flow and demand for protection forests, natural resource managers in Hallstatt might invest in relatively cheap protection solutions for forest mitigation. International carbon strategists could evaluate the differences in the supply and demand for CO2 sequestration and incorporate this information in the development of regional or international plans for carbon neutrality. Many finer-scale insights are also available to those managers and stakeholders through a dedicated wiki (WIKIAlps) and an interactive WebGIS. This allows for a multilevel and cross-sectoral transfer of AlpES results to the maximum number of stakeholders through a series of innovative, tailor-made and transferable learning tools and targeted activities.

Keywords: ecosystem services, mountain landscapes, protected areas, Alpine space, mapping

P0008

Future trends in the provision of ecosystem services of mountain grassland

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Future goods and services of mountain grassland depend on their resilience facing land-use changes and accelerating climate change. To quantify changes in six ecosystem services and their resilience under three socio-economic scenarios, plant trait-based models were applied in the Stubai Valley (Austria). Especially at high altitudes, a reduced management intensity leads to lower levels of provisioning services but improved regulating services. Whereas land-use changes seem currently to decelerate, changes in land cover can still be expected in the future due to natural reforestation processes on abandoned grassland, causing a shift to forest-related services. Climate change will become more important on the long-term affecting in particular provisioning services. Although the high resilience potential of most ecosystem services will be maintained, climate change seems to have rather negative impacts. Consequently, decision makers and farmers will be faced with a higher vulnerability of ecosystem service provision of mountain grassland. Future policies need to take both socio-economic and environmental dynamics into account to support a sustainable management of mountain grassland and to maintain the provision of related ecosystem services.

Keywords: socio-economic scenarios, land-use change, climate change, ecosystem service resilience, mountain farming

T0157

ALFFA - Holistic (multiscale) analysis of the factors and their effect on the fish fauna in inner-Alpine space

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River ecosystems are strongly influenced by landform and human activities within their catchments. Most rivers worldwide have been severely altered by a combination of different anthropogenic interventions, leading to dramatic changes in the aquatic habitat and the organism community. With information about species composition, abundance, dominance and population structure it is possible to make reliable predictions about the status of the river ecosystem. Therefore, fishes have been established as a biological indicator for the good water status in the European Union and in accordance with the European Water Framework Directive. In this context, the ALFFA INTERREG project between Italy and Austria has the aim of evaluating the effect of human activities on water quality and streamflow regimes, and therefore on the fish fauna, with special focus on Tyrol and South Tyrol. For this study area, 80 sampling points within 56 municipalities, have been selected, where the impacts of all influencing drivers (e.g. land cover, agriculture, fisheries, fish-eating birds, water chemistry, pesticides, hydrology, etc.) needs to be evaluated. From the landscape perspective, a crucial aspect is the estimation of the anthropogenic alteration (i.e. degree of disturbance) of the river ecosystems and their catchments, due to agriculture, housing estates, fertilizer used by farmers etc. To this aim, we used an integrative approach for analysing habitat diversity, landscape structuring, urban sprawl and land use in diverse cultivated and natural mountain areas. Additionally, investigations show that Tyrol and South Tyrol have large differences regarding fish populations and the amount of macrozoobenthos. The Evaluation of these responsible drivers has not been done so far. Lastly, we will incorporate all results into river management plans to provide guidelines for future decisions making.

Keywords: landscape dynamics, river management, river ecosystems, fish fauna

Are forested landscapes protecting against torrential hazards? Empirical, large scale evidence from the Alps

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Forests provide a wide range of ecosystem services to human societies. In mountainous landscapes, protection against natural hazards is one of the most important ecosystem services, since human population growth and limited space for settlements in combination with a booming tourism industry have led to a strong increase of human infrastructure in mountain regions around the globe. While there is broad agreement that forests protect against avalanches and rock-fall, knowledge about the role of forests in protecting against torrential hazards - such as debris flow and sediment transport - remains limited. Here we analyzed the occurrence of 3,768 torrential events for the Eastern Alps covering a total area of 4.8 million hectares, and quantified the effects of forest cover and canopy disturbances using Landsat satellite data. We found strong evidence that the risk of torrential hazards is decreasing with increasing forest cover. Furthermore, forest canopy disturbances elevate the risk of torrential hazards. Our analysis presents the first large scale study on the interactive effects of forest cover and canopy disturbances on torrential hazards, highlighting that forest loss and growing canopy disturbances increase the risk of natural hazards.

Keywords: Disturbances, Forest, Natural Hazards, Ecosystem services

Ground bryophytes regulate soil carbon cycling in subalpine forest ecosystem on the east edge of the Tibet Plateau

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Subalpine mountainous ecosystems are commonly dominated by bryophytes in the bottom layer and are among the most sensitive regions to accelerating climate change. While little is known on how the ground bryophyte layers moderate the ecological processes such as soil carbon (C) cycling in these ecosystems. In this study the CO2 efflux from bryophyte-covered and bryophyte-free (mosses removed) soil surface was analyzed in a subalpine coniferous forest, the dominant forest types on the eastern edge of Tibetan Plateau. In addition soil organic C (SOC) accumulation as well as microbial physiology underlying the C processes were compared among soils with different bryophyte covers. The objective was to determine the roles of ground bryophytes in regulating the soil C cycling processes in subalpine forest ecosystem. Results indicated that bryophyte removal resulted in reduced floor (bryophyte + soil) and mineral soil CO2 efflux, SOC, dissolved organic C, microbial biomass C (MBC) and phospholipid fatty acid (PLFA) concentrations, and caused a change in soil microbial community. Soil with bryophyte covers relative to those without bryophyte covers showed a higher microbial respiration and growth rate, a higher carbon use efficiency, and a higher microbial biomass turnover rate, with a more prominent effect of bryophyte Pleurozium schreberi than bryophytes Rhizomnium tuomikoskii and Hylocomiastrum pyrenaicum. Our results highlight bryophytes are important regulators of soil C cycling in subalpine coniferous ecosystems. Incorporating the effects of bryophytes will help improve the accuracy of current ecosystem C cycling models and improve our understanding on the ecological functions of the ecosystem.

Keywords: Bryophyte, carbon use efficiency, soil organic carbon, soil respiration, subalpine coniferous forest

The Concept of Green Carrying Capacity and Application Framework of Green Carrying Capacity in Three-River-Source National Park

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On the basis of ecological carrying capacity, the concept of Green Carrying Capacity (GCC) is proposed. GCC focuses on the study of the coupling and coordination relationship between the ecological carrying capacity of key carrying elements and the carrying objects in natural ecological systems to maintain the health and functional stability of the natural ecosystem. By revealing the influence of natural operating mechanism and socio-economic and cultural factors on the carrying capacity, identifying the short board elements of ecological environment, effective ways to maintain and continuously improve the sustainable development of regional economy and society under the key functions of ecological system was explored. Taking ecological function maintenance, balance between grass and livestock, and ecological experience as the conceptual framework of GCC, the evaluation index system of grassland GCC was constructed from four dimensions, which were ecosystem supporting conditions, grassland productivity, the carrying scale of wild animals and livestock, the carrying scale of farmers and herdsmen and the ecological experience population. The GCC's application framework of Three-River-Source National Park is put forward, that is based on the assessment of ecosystem service function (Binding Capacity), combined with remote sensing and ground survey method, the spatial distribution data of edible herbage (Carrying Capacity) was collected to evaluate the productivity of grassland resources and calculate the carrying scale of wild animals and livestock (Carrying Object). On the premise of fully considering the sustainable development of the ecological experience area and the ability of the ecosystem to maintain self-balance and self-regulating, combined with the population carrying capacity model, the optimal carrying scale of farmers and herdsmen and the maximum number of tourists (Carrying Object) that ecological experience activities can accommodate were calculated.

Keywords: Green Carrying Capacity, Three-River-Source National Park, Ecological Function, Balance between Grass and Livestock, Ecological Experience

T0057

Effects of habitat structure and human disturbance on wintering black necked cranes in protected areas, Southwest China

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Food shortage, human disturbance and inappropriate habitat structure threaten the survival of wintering birds. Habitat structures, human disturbance and black necked crane abundance were studied, based on statistical data remote sensing images and field survey data from 20 sample sites (1.0 km2) in 3 protected areas in the Centre Yunnan Plateau. We got four significant understandings. (1) The cranes preferred land mosaic of water, swamp meadow and arable land, and never entered habitats with dense forest, thickets and tall grass. (2) Arable lands provided main food for the cranes but more disturbance including roads, buildings, traffic and people's activities would drive them away. (3) Pearson's correlation coefficient showed a significant relationship ($P<0.05$) between the percentage of water area and bird species, percentage of arable land and crane abundance. (4) Strict habitat management can not only benefit black-necked cranes protection but also improve living environment for residents in and around the protected areas. We therefore come to conclusion that to protect or construct a habitat mosaic of water, swamp meadow and arable land is an important way to protect the wintering cranes and to improve the living environment for residents in and around the protected areas.

Keywords: protected areas, wintering black necked crane, habitat mosaic, local residents

Plant responses in reproductive phenology to warming and cooling in alpine grassland community

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Climate warming has increased mean global temperature and climate variability such as cold spells affecting phenology in multiple species. Plants generally advance phenology with warmer temperature, but species response to cooling is less well studied. Here, we record reproductive phenology (budding, flowering and seed maturation) in alpine plant communities at three sites along an elevation gradient between 3500 and 4130 m a.s.l. in the Himalaya over two growing seasons on vegetation turfs that have been warmed in (i) OTC's or (ii) by transplanting to lower elevation and turfs that had been cooled by (iii) transplanting to higher elevation. Both warming methods advanced while cooling delayed the occurrence of the peak phenophase in most species. Species did not differ in their response across year, or sites, and all phenophases showed very similar responses. The duration of the phenophases changed for a few species. Species response to warming in the two methods only differed for flowering, because of 2 species that responded opposite in the transplant treatment. Finally, graminoids advanced peak phenophases more than herbs. These results suggest that future studies on climate change should consider different temperature change modes that can cause such warming–cooling asymmetries on plant reproduction and growth.

Keywords: Reproductive phenology, Alpine grassland, Warming and cooling

Comparative Study of Ecosystem Service by Scientists' Evaluation and Managers' Perception: a Case Study of Mount Huangshan Scenic and Historic Area

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Mountainous Scenic and Historic Area is one of the most important protected area types in China. This type of protected areas has a long history and is characterized by the harmonious integration of culture and nature. Mountainous Scenic and Historic Areas play an important role in ecosystem services, not only of regulating services and supporting services, but also highlighted in the provision of cultural services and provisioning services.

However, the present evaluation method of ecosystem services is disjointed from the actual protection and management of Scenic and Historic Areas, and there are also some biases in managers' understanding of ecosystem services. This paper takes Mount Huangshan, one of the most typical mountain Scenic and Historic Areas in China, as an example, to have a deeper understanding of these problems, and provide improvement suggestions.

Firstly, the results of "Ecosystem Service Evaluation of Mount Huangshan Scenic and Historic Area" completed by a scientists group are analyzed, including the total service value, the composition and proportion of service values, and the corresponding protection and management measures and policies of service value. Secondly, 10 representatives from various departments of Mount Huangshan Management Committee were selected for questionnaire survey and interview, to understand managers' perception of the ecosystem service value of Mount Huangshan, using the corresponding indicators as the former Evaluation, but in more qualitative description. Then, a comparative study is made on the above two results, to analyze the similarities and differences between the evaluations by scientists and managers, and the root causes. Finally, the paper proposes optimization suggestions for the evaluation methods of ecosystem services in Scenic and Historic Areas, and suggestions for improving the awareness of ecosystem services of managers, and for improving the management policies of ecosystem protection.

Keywords: Ecosystem Service Evaluation, Manager Perception, Comparative Study, Mount Huangshan Scenic and Historic Area

Symposium 10

Using landscape simulation models to help balance conflicting goals in a changing forest: from timber production to carbon sequestration and biodiversity conservation

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Ongoing intensive forestry practises have significantly altered forest ecosystems, and continues to do so, which is amongst others illustrated by increasing landscape fragmentation and homogenization of forest stands, and by reduced species diversity. In addition to intensive forestry, climate change is able to alter forest dynamics and affect forest biodiversity as well as growth yield and disturbance cycles in forest ecosystems. Different climatic conditions will not only affect the distribution of tree species, it will likely also have an impact on disturbances such as the frequency and severity of forest fires, wind-throw and pest infestations, which will have strong economic and ecological implications. Consequently, there is a strong preoccupation to adapt forest management practices to mitigate negative effects of climate change, through for instance increasing uptake of carbon by vegetation and through attempts to minimize tree damages and losses by natural disturbances such as wind throw and pest outbreaks. However, such adaptations may have uncertain effects on other ecosystems services provided by forest ecosystems like timber production, carbon sequestration, and wildlife conservation. Thus, a good understanding of how forestry practices and climate change may affect forest dynamics is required if we want to safeguard ecosystem services forests provide and biodiversity they host. It is therefore essential to develop new decision support tools that are able to predict future scenarios in forest ecosystems.

Landscape simulation models can be used to assess the effects of future climate change, alterations in disturbances and management practices, and establishment of new species of flora and fauna on forest ecosystems. They can give valuable information on e.g. possibilities for increased carbon sequestration, and which restoration practices need to be used after forests sustained damage. There is a multitude of such models. Although they are primarily used in forestry management, they may be highly valuable for other purposes as well, e.g. to increase the resilience of forest ecosystems and to aid biodiversity conservation planning.

In the proposed symposium, we outline the current work on using landscape simulation models to assess the effects of forestry practices and natural disturbances on ecosystem services provided by temperate and boreal forest ecosystems. The goal is to establish a platform for further advancement of how to balance the conflicting goals in forest landscapes that are facing climate change. We will cover various topics, targeting a multitude of ecosystem services, silvicultural practices and forest ecosystems, and discuss the challenges and benefits of current methodological approaches, research directions, practical sector implementation, and needs for future research.

The effect of climate, the modern land-use regime, and alternative future scenarios on forest carbon in New England, USA

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Species composition change following the recovery of colonial era land use, changing climate, and a geographically variable land-use regime will shape future forests of eastern North America. Recent land use has included variable rates and intensities of forest harvesting, clearing for development, and land protection. We evaluated the importance of these factors for the future forests of New England, USA by simulating a continuation of recent trends along with four alternative future scenarios of land use. We incorporated the modern distribution of tree species and the geographical variation in climate and land-use change. Using a cellular land-cover change model in combination with a physiologically-based forest landscape model, we conducted a factorial simulation experiment to assess changes in aboveground carbon (AGC) and forest composition. In a control scenario that simulates an absence of future land use or future climate change, the simulated landscape experienced a 53% increase in average AGC from 2010 to 2060. Under the recent trends scenario, the land-use regime reduced AGC by 16%. Among land uses, timber harvesting had a larger effect on AGC storage and changes in tree composition than did forest conversion to non-forest uses, however varied by landowner. Our results demonstrate a large difference between the landscape's potential to store carbon and the landscape's current trajectory, assuming a continuation of the modern land-use regime. Alternative future land-use scenarios experienced additional variation in stored forest carbon and species composition. These scenarios and results will help policy-makers and land managers evaluate trade-offs between commodity production and mitigating climate change through forest carbon storage.

Keywords: New England, Disturbance, Land-use regime

Economic benefits of mitigating climate change through adaptive planting in forestry

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Previous studies have examined the economic trade-offs of climate change mitigation in forestry, or the costs of adaptation. However, they have not necessarily taken into account the value of carbon sequestration when considering the higher costs of adaptive planting. Here we build on previous studies from north-western Canada, using the Woodstock optimization model to assess the economic trade-offs of the standard and two adaptive planting regimes under historic and severe climate change scenarios over 200 years. We considered planting and harvesting costs and revenue from timber and carbon sequestration. Our results showed there are potential negative climate change risks to: harvest volumes, net present value (NPV), growing stock, and ecosystem carbon sinks. We found some risk mitigation through adaptive planting, with the greatest benefits through diversification of the planting regime (higher NPV, growing stock and ecosystem carbon than historic climate with standard stocking). This was a result of planting more valuable species and higher growth rates in mixed stands. These results are expected to support forest managers in temperate coniferous forests who wish to adapt to climate change, particularly if they are working within a carbon-pricing context.

Keywords: Forest, Climate change, Carbon, Economics, Modeling

T0108

Disturbance interaction research within forested landscapes

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Disturbances (natural and anthropogenic) affect the landscape structure (configuration), composition, and function of forested ecosystems. Complex system behaviors emerge from the interactions between nonstationary disturbance regimes, the vegetation response to those disturbances, and their interplay with multiple drivers (climate, topography, pollution, etc.) across spatial and temporal scales. A recent surge in interest has led to conceptual guidance for disentangling the apparent complexity of disturbance interaction research. Empirical approaches include serendipitous observational studies, retrogressive disturbance reconstruction, prospective modelling applied to disturbance legacy data, data-mining, hybrid modelling, and case study synthesis. Spatially-explicit modelling frameworks integrate the interactions among natural and anthropogenic disturbances by coupling these processes to account for disturbance stochasticity, disturbance within and across scales, and non-linear landscape responses to climate uncertainty. Still, the choice of which processes to model explicitly and which processes to aggregate remains a fundamental challenge of our time. Uncertainties related to threshold behavior complicates disturbance interaction research, but may be addressed in part by a combination of hybrid statistical and process-based modelling, inter-model comparison, and validation with independent data. Here, we summarize the key advantages of these modeling advances in forest landscape disturbance-interaction research using examples from boreal forest.

Keywords: forest models, across scales

T0118

Moose browsing and insect outbreaks as drivers in forest landscapes

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Moose and insect outbreaks play a major role in forest ecosystems across the northern hemisphere. Moose represent a popular game species, induce spatial heterogeneity in forest structure, and create vital substrate to a wide range of organisms. However, high levels of browsing can have substantial economic and ecological effects on timber production and forest dynamics. Spruce budworm is one of the main defoliators of coniferous trees in the North American boreal forests, affecting large areas and causing marked losses of timber supplies. However, the impact and the spatiotemporal patterns of both species at the landscape scale remain poorly known. For moose, we performed forest landscape simulations and predicted the future forest dynamic and productivity for the next century under different moose density scenarios in Sweden. Our results evidenced the high vulnerability of Scots pine to moose browsing. With high-level moose densities, the distribution area of Scots pine was reduced by 6% in only 40 years. The forage availability did not experienced changes when browsing was higher than 66% of the current capacity of forests. For spruce budworm outbreaks, a dendroecological approach was used to reconstruct the spatio-temporal pattern during the last century in Canada. We highlight different spatial patterns the major outbreaks, and we reveal the importance of climate as a triggering and synchronizing factor. Our major finding was the first solid evidence of a northward shift of the distribution area of spruce budworm, maybe due to climate change, and the severity and frequency of insect outbreaks is higher than in the past. Overall, our research confirms that moose and insect outbreaks are a complex and dynamic ecological phenomena, which makes the understanding of natural disturbance cycles at multiple scales a major priority for planning forest management in boreal forests.

Keywords: Natural Disturbances, Ungulates, Forest Ecology and Management, Dendroecology, Boreal forests

Are there potential conflicts among renewable energy, biodiversity, and ecosystem services? Scenario analysis of land use management and selection among renewable energy alternatives

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The use of renewable energies has been promoted in Japan to meet the Paris agreement. However, the unplanned introduction of renewable energies, such as solar power and woody biomass energy, can cause conflicts among energy production, biodiversity, and ecosystem services (BES). In this study, we conducted a scenario analysis of land use management and the selection of renewable energy alternatives to identify such potential conflicts. The case study area was the Bekanbeushi River Watershed in northeastern Japan. In this watershed, major industries include fishery, forestry, and pasture grass production for dairy farming. However, the population of workers in the primary industry has continuously decreased since 1960. The expansion of abandoned pastureland is a considerable issue in this area. In this study, we defined this trend as a business as usual scenario. Two alternative scenarios were set to utilize those abandoned pasture lands according to the regional energy plans. One scenario promoted the introduction of the solar power plant on abandoned pasturelands. The other scenario utilized the production of woody biomass from pioneer species established on abandoned pasturelands. The LANDIS-II NECN succession extension was applied to express the plausible scenarios. The simulation duration was from 2016 to 2100. The balance of regional energy demand and renewable energy supply, a habitat suitability index for Blakiston's fish owl and the Satoyama Index were calculated. Moreover, ecosystem services were estimated using expected NEE, timber and pasture grass yield, and landscape change.

Using those results, we evaluated the energy balance and detected the potential conflicts among renewable energy production and BES. This quantitative, spatially explicit, and dynamic ecosystem impact assessment will contribute to the regional stakeholder's decision making for implementing sustainable renewable energy in harmony with nature.

Keywords: farmland abandonment, solar power generation, woody biomass energy, forest landscape model, LANDIS-II

T0081

Simulating impacts of restoration efforts on the suitability of forest landscapes for a locally critically endangered umbrella species

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Habitat restoration is often implemented to mitigate the negative effects of intensive forestry on biodiversity. It may be increasingly adopted in future to alleviate additional negative effects of climate change. Ascertaining the restoration effort needed to fulfill project goals is difficult. Insights may be gained through simulating the effects of restoration efforts on landscape dynamics through time. Here we used a spatially explicit landscape simulation model to simulate the effects of different restoration efforts on forest landscapes in Sweden to assess the level of mitigation that is needed to allow viable populations of the locally critically endangered White-backedWoodpecker (Dendrocopos leucotos); an umbrella species whose protection may serve the protection of a range of other species. Based on the goals of the protection plan for the species, which reflect its habitat requirements, we evaluated which of several restoration scenarios could fulfill goals with respect to (1) the amount of deciduous forest; (2) the amount of dead wood; and (3) the age of the forest. We found that whereas it may be relatively easy and quick to acquire high levels of dead wood, increasing the proportions of deciduous forest and of old forests require considerably more time and effort. Also, current management actions would not be sufficient to create the required amount of habitat to conserve the White-backedWoodpecker in our study region. Simulations like ours can provide valuable information about the levels of restoration needed through time to fulfill project goals and may prevent wasting valuable resources, time, effort, and money.

Keywords: landscape modelling, forest restoration, conservation

T0510

Forest decision support system as tools for multi-objective landscape level planning - applications of the Swedish Heureka system

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Analyzing different forest management strategies is a complex task due to the variety of silvicultural management options, spatial aspects and long time horizons. Heureka is a forest analysis and planning system that can be used to identify the best approach based upon different objectives and restrictions. In Heureka the future state of the forest and the provision of ecosystem services are predicted by using data on current conditions, models for applied management actions (regeneration, thinning etc.), and models for different ecological processes (forest growth, mortality etc.). Due to its versatile and advanced functions, the system is unique in an international perspective.

If the society is going to change to a bio-based economy there is a need to change to more sustainable fuel alternatives like wood instead of fossil based. For forest-rich countries like Sweden, there are good opportunities to use wood. However, at increased extraction rates of biomass, the ecosystem and its ability to contribute with fundamental services will be affected, and a key question is: Can an increased production of forest biomass be done in a sustainable way? One way to answer questions like this is to use planning systems that both can evaluate alternative management strategies and the effect on different ecosystem services. Heureka could provide important insights of the potential of forestry to contribute to a sustainable provision of ecosystem services. To demonstrate the possibilities of Heureka we will present result from a study using data from the Swedish National Forest Inventory investigating the effects of increasing the use of biomass from the forest based on different global bioenergy demand scenarios. In the study, long-term effects on a set of different indicators for biodiversity and the provision of ecosystem services were analyzed. Preliminary results indicate that the effect on other ecosystem services was negative when the demand for bioenergy increased.

Keywords: Bioenergy , Bioeconomy

T0043

Application of the space-for-time substitution method in validating long-term biomass predictions of a forest landscape model

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Validation of the long-term biomass predictions of forest landscape models (FLMs) has always been a challenging task. Using the space-for-time substitution method, forest biomass curves over stand age were generated from a forest survey dataset (FSD) in the Lesser Khingan Mountains area (LKM), Northeastern China and compared with long-term biomass predictions of LANDIS-II model. The results showed that mean forest age and mean biomass of the LKM in 2000 were 51.6 years and 84.2 Mg ha 1, respectively. Significant linear correlations were found between FSD derived biomass and simulated biomass in the aggradation phase for the entire LKM and most subregions. However, a considerable difference in the mean maximum biomass (53.45 Mg ha 1) existed between from FSD and simulation
during the post-aggradation phase. The space-for-time substitution method has potential in validating time series biomass predictions of FLMs in aggradation phase when only limited forest inventory data is available.

Keywords: Forest landscape model, Forest biomass, Stand age, Space-for-time, Northeastern China

P0046

Temperate European floodplain forests face the threats of water management projects

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The project of the Danube-Oder-Elbe water canal is aimed to connecting the three large European rivers (the Danube, Oder and Elbe) by artificial water transport route. This project is incorporated in a planned trans-European transport network system. Geographically, the course of the planned canal stretches into the territory of four European countries (the Czech Republic, Slovakia, Poland, and Austria). The environmental impacts of the potential construction and operation of the Danube-Oder-Elbe water canal (DOEWC) is currently widely discussed by experts from various fields of science and policy makers. This paper is focused on environmental assessment of some impacts of the DOEWC on the floodplain forest habitats based on the case study from the Czech Republic. The method of assessment applies GIS analyses at the landscape scale. Based on the analyses of land-use changes in lowlands along large rivers induced by DOEWC, the study revealed the fluvial river dynamics changes, changes in extent of floodplain areas and consequences for floodplain forest habitats (using habitat mapping under Natura 2000 network creation). The DOEWC will hydrologically affect a total of 1975.4 km2 of lowland riparian areas in the Czech Republic, including 188.1 km2 of floodplain forest habitats in 157 sites of Natura 2000 network. Results are discussed in the context of some landscape analogies from the important central European water management projects.

Keywords: Environmental assessment, Floodplain forests, GIS analyse, Hydrology, Riparian landscapes

P0034

Integrated assessment of forest bioenergy options using the Landscape simulation and Ecological Assessment (LEcA) tool – a study of Lithuania

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Forests management tends to intensify in many countries due to climate change mitigation, which require more forest bioenergy as substitution for fossil fuel. However, the intensified forestry may be detrimental to biodiversity, especially for species dependent on old forest habitat. In order to simultaneously assess production of forest bioenergy feedstock and habitat potential for biodiversity, we developed the Landscape simulation and Ecological Assessment (LEcA) tool, linking simulation of forest growth and management (LandSim), a yield calculator, and a habitat assessment model. The aim was to integrate production of forest bioenergy feedstock, industrial wood, and biodiversity tied to mature and old forest, in a sustainability assessment of forest bioenergy options. The study area was the country of Lithuania where two forest management scenarios were applied, business-as-usual (BAU) and intensive-forestry (INT). The landscape simulation was run for a 100 years period with 5 year time steps. Forest biodiversity was represented by area of old forest as well as nesting habitat for two model species, Lesser Spotted Eagle (Clanga pomarina) preferring forest edges, and Black Stork (Ciconia nigra) preferring interior forest. The results showed that forest bioenergy yields may be higher in the INT scenario during the first decades of the simulation period, but in the long run will only be slightly higher compared to the BAU scenario. However, the impacts on the habitat of the forest birds would be considerable, where the habitat area would be 14% smaller for C. pomarina and 17% smaller for C. nigra, in the INT scenario compared to BAU. The landscape simulation showed that there may be conflicts between sustainability objectives related to climate change mitigation and biodiversity, and that intensive forestry may not necessarily be an effective mitigation measure. The model results has potential to inform policy and planning concerning several sustainability aspects.

Keywords: Landscape simulation, Landscape planning, Forest bioenergy, Forest biodiversity, Integrated sustainability assessment

P_8221

The role of landscape and relief aspects on carbon stock in secondary tropical forests of human-dominated landscapes

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Although the importance of tropical forests to regulate greenhouse gases is well documented, little is known about what factors affect the ability of secondary forests to store carbon in human-dominated landscapes. Among those factors, landscape structure, forest disturbance, and topography aspects can have important roles. This study aims at testing the intensity and extent of edge effects on the carbon stock resulting from human activities with high and low levels of disturbance as well as testing whether that edge effect differs between regenerated and remnants forests. Here we evaluated how landscape effects (composition and configuration) and relief effects (elevation, slope and aspect) affect directly forest carbon stock in human-dominated landscapes of two areas in the Brazilian Atlantic forest. These areas consist of protected and mature forests (> 100 years of regeneration or not clear cut) as well as secondary forests (a result of recent regeneration, about 20-40 years) in private properties under strong and constant human influence. It is expected that the carbon stock decays more intensively in the case of high-intensity disturbances when compared to more punctual and low-intensity disturbances and this decline should vary in a non-linear curve with the proximity to the disturbed area. The preliminary results suggest that carbon stocks in human-dominated and fragmented landscapes can be highly affected by the landscape composition (forest cover) and landscape structure (edge distance). Surprisingly, the edges conditions can favor carbon sequestration in regenerating tropical forests. The final results will be present at the conference.

Keywords: tropical forest, fragmented forest, above-ground biomass, lidar

T0558

The Scandinavian mountains intact forest landscape green infrastructure

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The global human footprint and land surface modification during the Anthropocene immensely impact ecosystems and ecosystem functions. The consequences of forest fragmentation and loss have been debated at growing intensity. In the boreal biome, the continued fragmentation and loss relocates natural forest frontiers at critical rates and modifies the natural configuration of forest landscapes and habitats. Given the boreal circumpolar cover, this profoundly impacts a rich global biodiversity and ecosystem services resource, contests sustainability and conservation policies and environmental targets, and risk natural ecosystem capacity to climate change adaptation. Continued fragmentation and loss may, in combination with climate warming and other drivers of ecosystem change, trigger a sledgehammer effect where boreal ecosystems enter into new and potentially irreversible ecological states. Thus, identification and protection of the remaining intact, contiguous natural forest areas is highly needed. The boreal forest landscape of northern Europe has experienced long term and high degree impact of forest management. For northernmost Sweden, dominating forest clearcutting with associated profound landscape changes is ongoing from the middle of the 20th century and continues into the present day. Our studies show that large, contiguous natural and semi-natural forest areas remain in a south to north belt along the foothills of the Scandinavian mountain range, whereas only fragments remain in the inland and coastal areas. In a green infrastructure context, this belt provides a key resource for forest landscape biodiversity conservation. By combining a proxy continuity forest model based on remote sensing generated data on not clearcut forests with field inventory woodland key habitat data, we identify biodiversity hotspots and intact natural forest components for northwest Sweden, as input to national and sub national forest landscape green infrastructure planning.

Keywords: Continuity forests, Woodland key habitats, Mountain forests, Forest connectivity, Boreal

Symposium 11

From urban agriculture to edible cities – challenges and chances for approaching sustainable urban socio-ecological systems

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Today´s society is facing a range of challenges connected with urbanization such as climate change, social segregation or resource depletion. Due to the complexity of societal challenges and urban systems there is an increasing need to foster systemic solutions evolving multidimensional benefits for society, nature and economy. The production of food within cities through urban agriculture can be considered as nature-based solution contributing to climate change mitigation and adaptation, food security, biodiversity and ecosystem services, agricultural intensification, resource efficiency, urban renewal and regeneration, land management, public health, social cohesion, cultural traditions and economic growth. Cities can be composed by a mosaic of different forms of urban agriculture depending on a spatial (e.g., roof top gardens, house gardens, vertical farming), actor (e.g., family farm, community garden), or organizational perspective (e.g., market-, prosumer- or subsistence-based production with different foci of production such as hobby or education aimed production). Urban agriculture can then be technological oriented (e.g., aquaponics) or take a natural agriculture approach (e.g., permaculture). To support the systemic potential of urban agriculture, two major questions arise: 1) Which benefits and risks are connected with different forms of urban agriculture? 2) How can we upscale urban agriculture from a mosaic of single forms of food supply to an edible city approach?

This symposium aims to show up the current international state of art in conceptualizing different types of urban agriculture, evaluating its different multifunctional impacts and ecosystem services as well as developing and evaluating planning strategies for implementing urban agriculture on different scales. A main concern of this session is to reflect on urban agriculture from a systemic perspective considering cities as socio-ecological systems.

We welcome presentations and papers dealing with different forms of urban agriculture:

- Spatial monitoring and categorization of different forms of urban agriculture
- Assessment of impacts of different forms of urban agriculture in terms of
- Social benefits and risks
- Environmental benefits and risks
- Economic benefits and risks
- Urban ecosystem services
- Systemic approaches and planning practices to promote sustainable urban agriculture
- Dealing with the concept of edible cities, its conceptualization, impacts and possibilities of implementation
- Providing case studies from shrinking and growing, small and big cities
- Providing case studies from regions with different cultural, economic and political history and environmental conditions

We welcome presentations and papers of various disciplines, such as landscape and urban ecology, environmental science, agricultural science, geography, economy, sociology, political ecology, planning and development, urban studies and public administration.

Edible cities – a leverage for urban food supply and human-food connection?

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Under the light of rapid urbanization and unsustainable food systems there is an increasing need to (re-)localize agriculture in cities and to (re-)connect urban society with food to increase consciousness on sustainable food consumption. In this regard the concept of edible cities is increasing in momentum in planning practice. By using public spaces for urban agriculture, edible cities propose to bring food back into the city. Consequently, edible cities can contribute to food sovereignty and human-food connection. However, the concept of edible city is not well researched yet. To fill this gap this study will present findings about the potential of the case study Andernach (Germany) to support local food supply and to re-connect people with food. Andernach can be considered a frontrunner city in implementing the edible city in Germany providing free food on public spaces in the city center. Based on GIS analyses the urban food supply potential of the concept of the edible city will be assessed and compared with the potential food supply by urban farming and allotment gardens. To analyze social benefits of the concept of edible city, results of a standardized survey among residents in Andernach will be presented. The survey is based on the concept of place attachment introducing food bonding as a new dimension of place attachment. Thereby, the influence of edible cities on human-food connection and pro-environmental behavior will be evaluated. The study provides important lessons for urban planning and research on the performance of edible cities and its assessment methods.

Keywords: Urban agriculture, urban food supply, place attachment, assessment, socio-ecological system

P0202

Epigeal fauna of urban food production sites show no obvious relationships with area or soil characteristics

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The potential of urban farms and community gardens to contribute to sustainable food systems is being increasingly recognised. In rural agricultural landscapes, the functional role of macroinvertebrate biodiversity in supporting food production is well established, with invertebrates such as spiders (Aranae), ground beetles (Carabidae) and springtails (Collembola) being considered beneficial groups for pest control and soil conditioning. However, we have much to learn about the relationship between urban agriculture and biodiversity.

In this study we addressed the interactive effect of soil habitat quality and size as determinants of the abundance and diversity of epigeal invertebrates around the medium-sized city of Leeds (UK). 17 sites of different size were randomly selected from an open source urban food production database. Pitfall traps were placed at regular intervals to collect beetles, springtails, and spiders. Invertebrates were counted and identified adjusting total counts for number of traps in each site. Soil samples from the trap locations were homogenized, dried, and analysed to measure organic carbon content, moisture content, and pH. Soil productivity was determined with root:shoot ratio of Raphanus sativus grown for 28 days at constant temperature. 16957 invertebrates were used in the analysis, including 1688 Carabidae. This study found very little evidence of correlation of epigeal invertebrate abundance and diversity with site area and soil chemical and physical characteristics, suggesting that, for the taxa and species considered, the boundaries of green urban food production spaces did not act as dispersion barriers. These findings are important for urban planning, as they suggest that the species-area paradigm that is so important for rural conservation may not apply for the design of urban food production spaces, and even small community gardens may benefit of the services provided by the trophic functions of ground dwelling invertebrates.

Keywords: urban biodiversity, green infrastructure, species-area relationship, soil biodiversity, community gardens

P0098

Designing a tool for the sustainability evaluation of intra-urban agriculture using a participatory approach

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Urban agriculture is presented as one of the solutions to ensure sustainable urban development, based on the multidimensional benefits it provides. However, the evaluation of urban farms performances cannot be carried out by using existing sustainability assessment tools designed for rural farm. Intra-urban agriculture requires a specific tool to assess its sustainability, taking into account the specificities of the urban context, such as pollution management or land scarcity; and the design of such a tool needs involving stakeholders in order to embark a shared vision of sustainability.

The first step of the project involved urban farmers through focus group, online surveys and interviews of local authorities, researchers and advisors to urban farmers at the French scale. It resulted in the identification of sustainability criteria related to agro-environmental, socio-territorial and economic impacts of intra-urban agriculture. It also confirmed the need for an evaluation tool intended for decision makers, i.e. stakeholders who provide land, investments or technical expertise to urban farms, as well as regulatory institutions.

The second step of the project consisted in building a typology of decision makers as future users of the tool, and highlighting their expectations regarding the tool thanks to semi-directive interviews. Then, an evaluation tool will be elaborated including sustainability indicators specific to urban agriculture. The participatory process will involve both decision makers and stakeholders involved in the production, selling or consumption of urban agriculture products in order to ensure that the indicators are both relevant for decision makers and measurable at the farm scale.

Kerywords: Urban agriculture, Sustainability, Assessment, Tool design, Participatory research

P0030

Why preserved and how to preserve in the future? Peri-urban agriculture and its cultural landscape in the shrinking city: A case study in the northeast Kyoto, Japan.

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Urban Agriculture in Japan, has received increasing interests among researchers and city planners as it is a form of green infrastructure with special functions such as food-producing, biodiversity conservation and establishing community connections. In the case of Kyoto, despite the city experienced intensive urbanization, some of the farms on the fringes of urban areas still remain as places where provide local foods and wildlife habitat, and therefore remain with distinctive landscape and culture. However, it is challenging to preserve urban farms due to such characters of urban agriculture; more likely to be performed by informal institutions, highly context-dependent, and insufficiency of relevant statistics. In addition, facing to the aging problem, the decline of the economy and climate change, etc., a better understanding of urban agriculture is needed for policy making and urban planning to manage more alleviate urban agriculture.

The aims of this research are to make it clear 1) the process of the land-use transition in the northeast Kyoto area since the early 20th century, 2) the driving factors of changing of land-use, 3) what is expecting factors may threaten the existence of peri-urban agriculture and how to manage the upcoming challenges. The methodological approach for this work included mapping and analyzing land-use (by using land-use dataset, Google Earth, GIS and field investigation), an in-depth literature review, and informal interviews with farmers and the locals. Taken together, we develop conclusions on how peri-urban agriculture systems has been shaped in Kyoto city and to which factors peri-urban agriculture is vulnerable, and accordingly suggest sustainable urban agriculture management strategies.

Keywords: Peri-urban Agriculture, Agricultural Landscpae, Agriculture Conservation, Shrinking Cities

Community gardens as an adaptation and mitigation measure to climate change: an intention or an unexpected benefit for cities?

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Various types of urban agriculture are considered by researchers and academics as a nature-based solution for climate change mitigation and adaptation. Community garden (CG) is currently a very popular form of urban agriculture. Its primary function has historically been food production. However, CG provides a wide range of co-benefits for their members as well as for other residents. Compared to impermeable surfaces CGs may contribute to rainwater retention, improving air quality, urban heat island mitigation, carbon storage or increase in aesthetic value. These benefits can be generated especially if CG is established in a densely built-up area or a brownfield rather than in greenery. From anthropocentric point of view, the investment will be returned in 3 years in case of CG in Prague, Czech Republic, according to the results of a cost-benefit analysis. But are these benefits perceived also by the founders and regular members of CG? Is an adaptation to climate change an intention or an unexpected benefit of urban agriculture from CG members point of view?

The aim of this paper is to analyse the main motivation of CG members to visit CGs based on a case study from the Czech Republic. A qualitative analysis based on a questionnaire survey among members of nine CGs in the Czech Republic was used to determine the main reasons behind becoming a CG member and members' perception of provided benefits. Analysis involves CGs from the capital city as well as from small cities and covers CGs from both the city centre and suburban areas. The results show that motivations and perceptions do not vary among CGs located in different areas. The main reason for members to visit CG is a possibility of socialisation. The possibility of growing own crops and the awareness of food origin is often indicated as a secondary reason. Although CGs bring various benefits and positive externalities to the city, CG members have little idea about the contribution to climate change adaptation.

Keywords: Urban agriculture, Community garden, Ecosystem Services, Motivation, Preferences

T0432

An evaluation of cultural ecosystem services delivered by urban micro-farms: the research project SEMOIR

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Since two decades urban agriculture (AU) is booming and a wide range of forms: from urban allotment gardens to rooftop farming under greenhouse are developing. Various benefits are recognized for UA integration within the city and a specific reading is dedicated to ecosystem services (Clarke and Jenerette 2015; Langemeyer et al. 2017; Lin et al. 2015). Currently the urban micro-farms (Daniel 2017; Chang and Morel 2018) has not yet directly concerned for these studies. Based on these findings, the research project SEMOIRS (Evaluation of ecosystem services delivered by urban micro-farms and their soils; 2018-2020) aims to define an adapted framework to quantify and characterize the ecosystem services (TEEB 2011; Gómez-Baggethun and Barton 2013; Russo et al. 2017) provided by urban micro-farms. Six micro-farms either on rooftop or at soil level, located in Paris area have been selected. We proposed here a focus on social and cultural ecosystem services one of the 5 categories of ES taken into account within the project. A specific methodology have been designed in order to detect and characterized the cultural ecosystem services. Based on the analysis of specific literature on cultural ecosystems (Bally, 2017; Milcu et al. 2013; Stalhmmar and Pedersen, 2017) and micro-farms and their direct knowledge a first distinction between endogenous and exogenous cultural ecosystem services has become necessary to improve their assessment. The endogenous cultural ecosystem services are all the direct and indirect services rendered by micro-farms to the people who frequent them, and exogenous cultural services are defined as the set of amenities generated by micro-farm for people that do not practice them (these amenities can be apprehended through the notion of landscape). We proposed here to present the methodology as well as the first results of the project aiming to quantitatively and qualitatively evaluate social and cultural ecosystem services.

Keywords: urban micro-farms, cultural ecosystem services, urban agriculture

T0830

Potential of abandoned agricultural land for food provision in urban settings

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The role of urban agriculture is becoming more and more important in the context of increasing interest in urban sustainability and resilience. The reasons behind this rising interest can be placed within wider concerns about global food security. The creation of multifunctional spaces, capable of providing a wide range of services, including food production, is one of the challenges to be addressed in the context of socio-ecological systems. However, there is still a need to advance the knowledge on the rapidly changing capacity of urban regions to provide food through its various forms of agriculture.

The aim of this study was to evaluate the potential of agricultural land abandonment for food provision. Bucharest-Ilfov urban region was chosen as case study, an area increasingly affected by sprawling built-up development and decreased interest in agricultural activities. To conduct our assessment, we first map the agricultural abandoned land in the urban region by using Landsat 8 satellite imagery. The mapping helps to locate abandonment areas and gather information on the spatial characteristics of the parcels. Secondly, we gathered spatial information on soil characteristics, the type of crops cultivated in the area and annual yields dynamics. Information is gathered from statistics offices and the local government. We assessed the impact of abandonment on food provision by calculating the potential yields loss based on information on surface of land affected by abandonment. Finally, by taking into account the average annual consumption of the different crops, we determined the impact on local food provision.

Findings showed that abandoned parcels vary in size, but parcels of 1 to 7 hectares were dominant. Most affected by abandonment were arable lands located in municipalities with high built-up development rates. Our estimations showed that if used for agricultural activities, abandoned lands could increase the yields, on average, by 40%.

Keywords: agricultural land abandonment, food provision, urban region

P0128

Soil invertebrates as bioindicators of biodiversity support in urban agriculture

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Gardening is a very common practice in many industrialised and developing countries. Green roofs, especially productive ones (e.g. of edible biomass), are urban ecosystems developed in response to the scarcity of arable areas in urban environments. The development of urban agriculture, including on green roofs, is also perceived as a possible way to preserve biodiversity in cities. However, the effectiveness of urban agriculture in supporting soil biodiversity has rarely been studied. In order to orient the ecological engineering of urban agriculture, it is crucial to understand the resulting biodiversity patterns. Moreover, we hypothesised that a functional trait-based approach could be used to investigate the ability of urban agriculture spaces to support soil biodiversity.
Of all the taxonomic groups belonging to the soil fauna, we focused on Collembola both because they have been shown to be relevant bio-indicators of human activities and also because they are critical for ecosystem functioning, being at the base of the food chain and playing a determinant detritivore role in soil quality. Thanks to different research programmes, we investigated the taxonomic and functional collembolan biodiversity in both extensive and productive green roofs, in urban vegetable gardens and urban micro-farms. We compared collembolan communities in these urban agriculture land uses to others land uses such as forest, agriculture, and others urban land uses, using data collections from several French national databases (more than 3000 samples). Surprisingly, urban agriculture land uses, on roofs or in the ground, are supporting high levels of soil biodiversity. However, the functional structure tended to vary with the type of urban land use and were influenced by landscape composition. We conclude that stakeholders should take into account soil biodiversity in urban planning in order to improve the functionality of urban agriculture spaces.

Keywords: urban agriculture, soil biodiversity, functional diversity, Collembola, soil quality

T0611

Urban micro-farms: an assessment of ecosystem services provided by in situ soils and constructed Technosols

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Among the forms of urban agriculture, urban micro-farms received little attention. Micro-farms can be defined as small scale production units (<1.5Ha of utilized agricultural land per farmers), that produce vegetables with organic farming systems and provide a diversity of activities (recreational, educational, or cultural, etc.). Urban micro-farms are perceived as an opportunity to meet some of the challenges of urban ecosystems worldwide, especially regarding ecosystem services. However, a comprehensive understanding of the influence of soil and farming practice and their links with ecosystem services is required in order to optimize the environmental benefits delivered by urban micro-farms. Based on these findings, the research project SEMOIRS aims at proposing a framework allowing the quantification of ecosystem services, i.e. food production (quantity and quality), biodiversity (flora and fauna), regulation (water catchment and quality, local climate regulation, use of urban wastes and carbon storage) as well as social and cultural services. Seven micro-farms either on rooftops or at ground level, located in Paris area have been selected as illustrative of various situations. A network of urban farmers and scientists has been set up to acquire, collect and analyze the data. We identified indicators for the targeted ecosystem services: (i) food provisioning, (ii) regulation of water runoff (available water capacity, amount of water used for irrigation and quality of runoff [carbon and nitrate]), (iii) recycling of organic wastes (types and amount of wastes) and (iv) soil carbon storage. We present here the first results, comparing the measured values between soils from the different micro-farms and to reference situations (asphalt roof, green roof, and cropland). Our study shows that the quantification of ecosystem services allows comparing very contrasted soils from diverse micro-farms and allows accounting for the multifunctionality of urban micro-farms.

Keywords: urban agriculture, ecosystem services, micro-farm, green roof, rooftop farming.

Business models in urban agriculture: case studies in Chengdu and Milan

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In the process of global urbanization, both developed and developing countries are faced with environmental and social problems, among which the issues related to public health are brought into focus, such as the devouring of agricultural land, urban food supply, food safety, etc. For this phenomenon, urban agriculture can be considered as an effective and sustainable solution. Obviously, nowadays, urban agriculture in a variety of cities has already made good achievements, due to its outstanding performance in social, ecological, and cultural aspects. But how about the economic benefit?
Additionally, when talking about the business models of urban agriculture, heterogeneity still exists due to different countries' specific social-cultural backgrounds (e.g., markets, policies, etc.). Is it necessary to analyze the distinctions of the business model in the disparate regions? Hence, we'd like to dig into several business models between two cities. By Business Canvas approach, this article mainly focuses on the in-depth analysis and comparison of business models between Milan (Italy) and Chengdu (China). Through investigating the actors, stakeholders, and organizations in the activities respectively, the result shows that, in Milan, the good combination of bottom-up and top-down activities and the network established among different stakeholders are worth learning from, while the application of the Internet in Chengdu's urban agricultural activities is also desirable. Both cities have their own excellent examples in the existing business model of urban agriculture, and even could be a "paradigm" for other cities and put forward the prospect of future development. On the contrary, several risks still exist, strategies will be proposed to contribute to the development of the urban agriculture economy.

Keywords: urban agriculture, business model, business canvas

Evaluation of ecosystem services of urban agriculture land for urban planning in Beijing

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Urban agriculture (UA) landscape can provide diversity ecosystem services have been widely recognized, which are closely related to the well-being of city dwellers. But few quantitative studies on the evaluation these services exist and they are rare included into urban planning. The purpose of this study is to implement a methodology for evaluating six ecosystem services (food provision, recreation, education, climate regulation, air quality reduction, and water regulation) generated by UA for urban planning. The urban development of Beijing is consuming more and more agricultural land and losing their ecosystem services. Reassessment of the services and contributions of UA is needed, not only fresh food supplies, but also regulative functions and cultural services. The research area is the Central City Area of Beijing called in Beijing City Overall Planning (2016-2035), including six administrative districts. Different types of UA land (crop, orchard, vegetable, garden) were identified by Landsat remote sensing (resolution 30 m). Further used were statistical data and a semi-quantitative evaluation of regulative services by vegetation cover. Potential cultural services were calculated by accessibility, reachability and attractiveness. The results show that UA has the ability to improve urban well-being and development. Full consideration should be taken in urban planning.

Keywords: urban agriculture, ecosystem services, city planning, methodology, quantification

P0150

Agricultural areas as Ecosystem Services tanks: considerations on the metropolitan area of Rome through a GIS-based land use change analysis

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Considering the rich variety and value of the landscapes in the metropolitan area of Rome, the purpose of this paper is the investigation of the relationships between land use changes, agricultural areas and ecosystem services in the metropolis from a multi-temporal perspective (1960 and 2012). The main hypothesis at the basis of the study is that, in reference to the considered time period, the protected and agricultural managed areas have played a crucial role in preserving Ecosystem Services (ES) threatened by urban expansion. A GIS-based quantitative study of the changes occurred has been conducted, taking into account six land use transition categories: permanence, intensification, extensification, evolution to complex systems, re-naturalization (or forest transition), urbanization. Different dynamics have been detected observing the protected areas and the rest of the metropolitan area, highlighting the importance of the active management and institutional protection as factors able to foster the provision of ES (carbon sequestration, agricultural and timber production) in a rapidly evolving metropolitan area as Rome. Following the quantitative analysis on the whole metropolitan area of Rome, the paper presents a thematic deepening on the semi-natural areas of Casal del Marmo (an agricultural park inside the urban mosaic) and Decima Malafede (a natural reserve that hosts an historical multifunctional agricultural cooperative). In fact, they are meaningful examples of active landscape and ES conservation and implementation, as well as important providers of cultural services for the population, being respectively in the urban and periurban area of Rome. For these areas, we propose a quantitative analysis of the effects of two hypothetical scenarios (urbanization and rinaturalization), observing the effects on the landscape composition and on the provision of ES.

Keywords: Gis analysis, quantitative/qualitative analysis, agricultural parks, natural reserve

Gradation of urban agriculture – Spatial distribution of various experience farms in the Tokyo Metropolitan Area, Japan

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The range of urban agriculture and gardening options is increasing in response to ecological, social, and cultural conditions of local areas. To have an overview of this changing phenomenon and provide useful knowledge to spatial planning, it is necessary to understand where each form of urban agriculture is located and the reasons. This study focuses on "experience farms" in the Tokyo Metropolitan Area, Japan, that are operated by farmers or private companies to provide gardening experiences to urbanites. In these gardens, the farmers or company staff work as instructors teaching inexperienced users how to grow vegetables. The information of experience farms were gathered from websites of municipalities and the companies and the locations were plotted on a GIS. Experience farms owned by farmers were spread mostly in residential areas in the west of Tokyo; while those run by private companies tended to be found in more urbanized areas near stations. This difference could have arisen from the objective of the founders and original land uses. Farmers started experience farms as a new business to profit from suburban areas where historically urban and rural land uses have been mixed. Here, users can rent relatively large plots (average 30 m2) near their home, so it is easy to enjoy gardening with their family. On the other hand, most private companies prioritize the convenience of users, and therefore, use rooftops of shopping buildings or available lands at walkable distances from a station and it is easy to drop in even after work. The plot size in these farms is smaller (mostly 3-10 m2) and much more expensive; however, the facilities such as tools, water supply, etc. are better organized and the instructors can help when users are too busy to come. In conclusion, experience farms run by farmers and companies have different locations and services. This range can lower hurdles for inexperienced urbanites to try gardening according to their lifestyle and eagerness.

Keywords: urban agriculture, urban gardening, spatial planning, experience farm, lifestyle

P0043

Urban agriculture in Czechia: a colorful mosaic of forms and activities

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Growing activities inside or at the fringe of cities are collected under the heading of urban agriculture (UA). The scope of growing activities within the city is still expanding, showing a huge potential of UA. A fast-growing body of literature documents the benefits of UA from improving individual health, increasing access to fresh fruits and vegetables, opportunities for community building, fostering civic engagement and social learning to critical pieces of the sustainability movement providing green infrastructure and several ecosystem services. This paper represents one of the first and complex attempts to provide spatial monitoring and categorization of different forms of urban agriculture in Czechia. The aim of this paper is to provide the information about the basic forms of UA known and already existing in Czechia. What is their structure from the point of view of location, size, purpose, organizational or managerial type? What is their potential for the local food production and what other functions do they fulfill? What tools can we use to measure and analyze the emergent UA in Czechia?

In this paper, UA is understood as a complex system encompassing a spectrum of interests, from a traditional core of activities associated with the production, processing, marketing, distribution, and consumption, to a multiplicity of other benefits and services that are less widely acknowledged and documented. These include recreation and leisure; economic vitality and business entrepreneurship; individual health and well-being; community health; landscape beautification; and environmental restoration and remediation. A wide variety of forms, types and initiatives will be presented with a potential to upscale from a mosaic of single forms of food supply to an edible city approach.

Keywords: urban agriculture, Czechia, food production, edible city

T0181

Home gardens in Czechia: Quiet sustainability or quiet repose

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Sustainability and the quest for policy decisions to build sustainable cities are among the main points on the current agenda of scholars and practitioners. The notion of urban agriculture (UA) emerges as an often-mentioned concept and nature-based solution within these strategies. Different types of UA can be identified: backyard gardens, community gardens, and small or medium-sized commercial farms in and around cities. Whereas community gardens and urban farms have received positive attention from the part of scholars, private (home) backyard gardens are still rather neglected within the research social sciences and social geography in particular.

This paper presents the first results of a pilot study of Czech home gardens. It aims to answer the questions: What is the current role of a home garden? How is it perceived? Is it understood as an urban curiosity, a leisurely escape from the urban world, or can it stand for a scalable option to counter the mainstream food system? Does it represent a constitutive element of the urban fabric and legitimate use of urban space? How does it contribute to urban green infrastructure? The research uses the data collected from more than 400 questionnaires on home gardens in different settlement types in Czechia. It documents the transitions in everyday micro level practices and sustainability related to households in cities. It shows that the home garden quickly loses its productive role as a food self-provisioning source, the leisure aspect of a home garden becomes accentuated. There are only weak ties to an environmental behaviour or a desired change in this behaviour among urban populations and a limited potential for upscaling from a small food-provisioning form to an edible city approach. A stronger support and effective planning implications to promote urban agriculture is needed even at the scale of home gardens.

Keywords: home gardens, sustainability, urban agriculture, food production

T0320

Urban gardens as a source of self-grown food in Czech towns and cities

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Productive gardening, also labelled informal food production or food self-provisioning, is an important part of urban agriculture concept. In towns and cities gardening mostly takes place in private houses' gardens, allotments or community gardens.
The paper analyses productive gardening in Czech urban areas. Data were collected in national representative survey in 2015. Together 1718 respondents from towns and cities are included the analysis, covering four groups of urban areas according to the size of the municipality, from small rural towns to large cities. The share of gardening among overall urban population is 34 %, ranging from 47 % in rural towns to 25 % in large cities. The contribution of gardening to production ecosystem service is not negligible, 35 % of vegetables and 36 % of fruit consumed in households of gardeners is self-produced. While gardening can contribute to environmental sustainability, environmental protection is an unimportant motivation for the gardeners. On the contrary, having fresh and healthy food, along with gardening as hobby or financial savings, are most important motivations for all groups of gardeners. Type of housing (linked to availability of garden) is an important predictor of gardening. Respondents living in private houses participate in gardening more often than those living in block of flats, though the amount of produced food can be comparatively high also in households living in block of flats. The data show that average amount of self-produced food is 33 % for gardens in private houses (both vegetables and fruit), while this number is 37 / 36 % in allotment gardens and 30 / 28 % from gardens at weekend houses. Based on this results, the importance of food provisioning is discussed within the framework of other ecosystem services, as well as the potential for continuation or expansion of urban home food production, urban food security and implications for urban planning and changes of landscape of towns and cities.

Keywords: urban agriculture, ecosystem services, food self-provisioning, home gardens, allotment gardens

Analyzing landscape services supply-demand and preference factors of urban agriculture parks in Beijing, China

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Urban agriculture park in China is a distinguished type of urban agriculture because of public land ownership system. This paper introduced the operation system of these kinds of urban agriculture forms and give an explanation on what factors influence the preference. We use non-metrical dimensional scale classification for 40 sites in Beijing to get two typical types of urban agriculture parks, including multiple-function agriculture parks and single-function urban garden for planting vegetation. Then we chose one site from each type (elven farms and small donkey garden) and evaluate the culture services by landscape services matrix method based on landscape structure analysis and questionnaires. Landscape services include education, relaxing, and exercising, etc. Gardeners and tourists were interviewed for assessing the demand value of landscape service, while landscape structure and questionnaires of managers were used for supply assessment. Results showed that the supplies of education and relaxing services in vegetation plots were less than the demand for single function garden. There is also a need for mixture landscape suppling an aesthetic value. For multiple-function agriculture parks, the areas with conflicts located in built-up landscape, such as culture walkway, classroom and square. The two main users (85% of the interviewees) of urban agriculture parks are retired persons and parents with their kids. Retired persons were sensitive to exercising, pursuing pastoral life and aesthetic services, that requires more diverse landscape and transportation convenience. Parents and high-educated people demand more education services provided by knowledge board and some science popularization activities. This study deepens the understanding of different forms of urban agriculture from a landscape service perspective, and it also supplies potential for landscape planning within the agriculture parks to balance demand and supply.

Keywords: Urban agriculture, garden, landscape services, demand and supply

Solution for community re-building: Exposing the hidden social value of community agriculture in China

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"Community" contains both space attribute and social attribute. From the perspective of sociology, the community is falling into decay in today's China. As it affects the stability of Chinese society, there is an urgent need to explore a solution for rebuilding community. This paper assumes the community agriculture is crucial for community rebuilding, and aims at uncovering the key factors and mechanism. By introducing "social capital" theory, it reveals that community agriculture contributes to the cultivation of social capital and thus promotes community rebuilding. Our research was undertaken through field investigations in ten communities, and the semi-structured interviews and questionnaire surveys with residents (community agriculture maintainers), residential committees (community agriculture organizers) and cooperation institutions (community agriculture collaborators, including academies of agricultural sciences, planning departments and non-government organizations). Many interviewers responded that co-construction, cooperation, communication and mutual assistance participatory activities of community agriculture help establish trust relationships, foster social networks, and form social norms, which plays an important role in promoting the interaction between the neighborhood and establishing the public spirit of the community, and stimulating the residents' self-governance conscience and self-governance ability. In view of the hidden social value of community agriculture, this paper analyzes the development and planning strategies of community agriculture in China. It is recommended that government and urban planning departments should give their importance in the governance of community agriculture, planners should help establish a long-term participation mechanism, and community agriculture should be integrated with the built environment and provide diverse functions to appeal participants.

Keywords: community agriculture, social capital, community rebuilding

P0228

Spatial context and legal environment of urban agriculture in the Ruhr metropolitan area (Germany)

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Urban agriculture (UA) has been addressed as a practice with multiple benefits, including healthy food and lifestyles, food security, reduction of food miles, higher biodiversity and community building. Nevertheless, UA faces multiple barriers if it comes to the practical implementation of projects. The legal framework and planning context entail numerous uncertainties and regulatory gaps (Specht et al. 2015). Within Germany, The Rhine-Ruhr area is the largest metropolitan area with over 10 million inhabitants and is home to many different types of UA projects (Rogge and Theesfeld 2018). It is characterized by high population density, and prevalence of different types of UA. The poster presents the analysis of food policies, sustainable agendas, and urban development plans and strategies at local and (inter-)national level. The analysis is based on a systematic review of the literature and existing policy documents. In addition, qualitative interviews with local key stakeholders have been conducted. The results show, that on the one hand, there are policies and regulatory frameworks, which are hindering the successful implementation of UA projects. On the other hand, there are planning programs and instruments, which are promoting the establishment of UA in the Ruhr metropolitan area. The analysis also points to regulatory gaps and missing links in the policy and planning context.

Keywords: urban agriculture, policies, legal framework, Ruhr metropolitan region

T0989

New approaches and products in urban food production: A study on perception of sustainability and social acceptability

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The production and consumption of food for cities of the future is an essential challenge against the background of climate change, degradation of arable land, growing world population and changing diets. In cities of Europe and the US, just as in many other countries around the world, new approaches of urban food production are tested and are growing in numbers and relevance. Such innovative approaches include new types of urban farming, such as rooftop greenhouses, vertical farms, indoor farms, aquaponic farms as well as production sites for edible insects or micro-algae. Those concepts are still at an early stage of development and partly unknown among the general public.
The aim of our study was to identify the perception of sustainability, social acceptability and ethical aspects of these new approaches and products in urban food production. Between May and July 2018 qualitative interview were conducted with 19 internationally recognized experts in Germany and the US. The interviews were recorded, transcribed, and analysed applying the principles of qualitative content analysis.
Our results revealed potential benefits as well as conflicts in all three dimensions of sustainability. Major perceived benefits of the new approaches include positive educational effects, revaluation of city districts, the efficient use of resources, exploitation of new protein sources or strengthening of local economies. Major perceived conflicts are related to negative side-effects, technology aversion, legal constraints or high investment costs. The analysis further reveals which factors might negatively influence the acceptance of those new food production approaches, such as assumed health risks, ethical concerns, or aversions related to the application of new technologies.

Keywords: urban farming, innovation, acceptance

Symposium 12

Landscape resilience and ecological governance in Anthropocene

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Nature and society are facing new challenges in Anthropocene due to rapid urbanization and climate change. Resilience assessment has increasingly arisen as valuable framework to better understand human-environment/social-ecological interactions from the perspective of sustainable development. In fact, evaluation and quantification of resilience in human dominated landscapes are involved with adaptive cycle, catastrophe theory, early warning signal and safe operating boundary. Specific resilience analysis should be of great help to emphasis the catastrophic regime shifts in coastal natural systems, as well as understand the impacts of landscape changes on the changes of ecosystem's critical functionality under future landscape scenarios. The integration of resilient transformation into decision-making of coastal ecological governance requires robust quantification of social, economic and environmental trade-offs. The session will be focused on latest developments of this topic and particularly, showing: (i) examples of implementation and use of operational tools and methods for assessment of landscape resilience, and presenting (ii) examples of transferability of such outcomes in real implementation of ecological governance.

T0113

Tree species functional traits and forest network topology to characterize landscape resilience to natural disturbances

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Ecosystem functions provided by forests are threatened by shifting natural disturbance regimes and climate warming. To support resilience-based forest management in a context of global change, new tools and methods to quantitatively describe forest resilience are needed. Here, we present the "functional network approach", a multi-dimensional characterisation of forest landscape resilience based on tree species functional traits (e.g. response diversity and functional redundancy) and forest network properties (e.g. connectivity, modularity, and centrality). Using as a fragmented forest landscape in south-eastern Canada, we applied this approach to evaluate two management strategies: functional enrichment of current forest patches versus multi-species plantations. For both strategies, planted species were either biodiversity-enhancer, drought tolerant, or pest resistant. We also investigated how the reference and managed landscapes responded to drought, pest outbreaks, and timber harvesting. We found that both resilience-based management strategies increased both overall response diversity and functional connectivity. Specifically, when the poorest functionally diverse patches were prioritised to be managed on a first instance, functional enrichment of forest patches was more cost-effective than plantations in increasing ecosystem resilience. Furthermore, overall resilience was doubled when enriching current forest patches with pest resistant species instead of enriching them with drought tolerant or biodiversity-enhancer species. Species that enhanced biodiversity mitigated drought effects equally well as drought tolerant species, while insect outbreak was the disturbance that deteriorates the most functionality and connectivity of the forest landscape. Our "functional network approach" can be applied to forested landscapes across different biomes to evaluate and compare forest management initiatives to enhance resilience.

Keywords: forest landscape, functional redundancy, response diversity, network topology, natural disturbances

P0057

Quantifying the effects of defective planning on pastures using urbanization and landscape indicators

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Pastures in the proximity of urban settlements are facing constant pressures from the society due to constant expansion of human activities. Defective planning and management are causing biodiversity loss and diminishes the quality of agro-systems. Romania has a total pastures area around 3 mil. ha, animal husbandry being a traditional human activity. Due to the decrease of livestock and the presence of retail agents with cheaper imported products in the past decades, many pastures have been abandoned or poorly managed leading to a loss of phytocoenosis quality.

We selected a number of four study area speeded throughout Romania. The sites are located in the Carpathians and their edging landscapes. The selection of the case studies was made in order to be representative for most of the pasturelands in the Carpathians and their edging hilly regions.

The aim of our study is to quantify the effects of defective planning on pastures using urbanization and landscape indicators. In order to apply the indicators we used land use and land cover classes. The results have shown that the selected pastures for our case studies have shrinked their area in favor for the expansion of built-up areas, leading to loss of green mass.

Keywords: landscape indicators, resilience, land use change

T_0981

The dynamics of carbon flows in coastal landscape under rapid urbanization: integrated land-sea and resilience perspective

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Coastal zones is a significant region of mostly global population and carbon emission concentrated and response to global environmental changes. Whereas the process of spatial carbon metabolism has not been understood that cause weak resilience to climate change. In our study, we developed a spatially carbon flux network model of integrated land-sea for the variation of coastal carbon footprint to quantify the coastal resilience under rapid urbanization. Afterward, we chose a typical coastal city of Xiamen in China as an example to demonstrate the spatial network model. Ultimately, ecological network utility method was used to analyze the positive and negative influence of carbon flows on coastal resilience. We found that the total carbon flow between sea and land was 12.78Tg and 9.76Tg for sea to land during study period, and the reclamation had largely negative influence in Xiamen's carbon storage losses (21.59%), which signified the reduction of resilience and increment of vulnerability of the carbon-sequestration service to further perturbations. The competition relationship between cultivated land, mariculture and natural land increased and more than 70% of carbon flows were negative, which signified the negative influence on coastal resilience. The results can provide a reference for better governance of coastal ecosystem and management of carbon emissions in coastal zones.

Keywords: carbon footprint, flows, resilience, integrated land-sea, coastal landscape

Connectivity conservation between coastal protected areas under anthropogenic disturbances and climate change

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Areas of Connectivity Conservation (ACCs) are the essential conservation accessory to protected areas to avert fragmentation of natural habitats by anthropogenic disturbances and climate change. Connectivity of protected area enables critical protection of endangered and threatened species in wider connected landscapes. In order to understand connectivity conservation between coastal protected areas in achieving Aichi Target 11, we predicted connectivity in heterogeneous landscapes between protected areas in coastal area based on scenario analysis-expanding the boundary of existed national protected areas (scenario 1) and increasing the total sites of national protected areas by adding provincial protected areas (scenario 2). The largest contribution of connected patches in terms of ACCs was found at the dispersal distance of 50 to 200 km, where highlights spatial conservation prioritization of connecting key biodiversity areas within metacoupled systems. The efficiency of enhancing ACCs were identified with different patterns in two scenarios: the most notable enhancement of ACCs (pericoupling) in scenario 1 was around the smaller NPAs (< 2 km2); while the newly added protected areas in scenario 2 generated large areas of well-connected patches (telecoupling) where its original connectivity was low or unconnected. Larger areas of well-connected habitats were formed in scenario 2, which suggests higher efficicency of adding new sites in improving ACC. According to the density analysis of Habitat Concentration Area in two scenarios, the most significant improvement of connectivity was appeared within the areas of habitat density below 4000. The metacoupling connections of conservation encompasses cross-scales interlinks between conservation areas while averting biodiversity collapse in a dynamic climate change environment.

Keywords: Areas of Connectivity Conservation, biodiversity conservation, protected areas, Aichi Biodiversity Targets

Landscape resilience and ecological governance in Anthropocene

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Natural and social systems are facing unexpected challenges in Anthropocene due to rapid urbanization and climate change. Resilience assessment has increasingly arisen as a valuable framework to better understand human-environment/social-ecological interactions from the perspective of sustainable development. In fact, evaluation and quantification of resilience in human dominated landscapes are involved with adaptive cycle, catastrophe theory, early warning signal and safe operating boundary. The Urbanization and Regional Environmental Change (UREC) group at Xiamen University, China integrates urbanization, environmental change and ecosystem resilience in coastal cities, and provides scientific understandings in these areas to support decision-making in Chinese government. Our group develops an interconnected Threshold-Resilience-Governance framework involving urban sprawl exploitation, coastal wetland conservation, ecosystem catastrophe release, ecological governance and policy reorganization. We are applying the coastal resilience framework in terms of land-water-biodiversity nexus into many coastal megacities and regions, e.g., Xiamen, Shenzhen, Ningbo, Haikou, Lianyungang and Southern Fujian Coastal region (Xiamen, Zhangzhou and Quanzhou), Guangdong-Hong Kong-Macao Greater Bay Area. Integrating resilient transformation into decision-making of coastal ecological governance requires more landscape scientists to work together and makes positive contributions to the global communities.

Keywords: resilience, ecological governance, urbanization, coastal cities, sustainable development

Effects of China's Payment for Ecosystem Services Programs and Agricultural Subsidies on Cropland Use

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China adopted sweeping Payments for Ecosystem (PES) programs in the late 1990s to incentivize participation in environmental restoration and conservation. In the 2000s China abolished all the rural taxes to reduce the burden of rural population, and provided generous agricultural subsidies to rural farmers for cropland cultivation to stabilize food security. Conversion of Cropland to Forest Program (CCFP) and the Ecological Welfare Forest Program (EWFP) are among the two largest PES programs. CCFP compensates households converting their croplands on slopes to forests. EWFP pays households for forfeiting their commercial logging privilege for natural forests. We conducted a study aimed at understanding the impacts of these programs on cropland use in the Tianma Nature Reserve, Anhui, where all three programs were implemented. We found three types of cropland use decisions may be made in a rural household, reducing cropland area by either abandoning marginal croplands or renting out croplands to neighbors, maintaining status quo, and expanding household cropland area by renting in relatively good quality croplands from neighbors. Based on a comprehensive household survey conducted over 481 households in 2014, we found complex interactions among the three rural agri-environmental policies along with socioeconomic and biophysical factors jointly influence cropland use. Although CCFP slows down cropland abandonment immediately following enrollment in the program, its long-term effect is negligible. Households receiving both high CCFP and EWFP payments tends to reduce household cropland cultivation by abandoning marginal croplands, offsetting the goal of agricultural subsidies. We also identified feedbacks from CCFP and EWFP that enhance the risk of cropland abandonment. Our findings suggests that implementation of multiple agri-environmental policies at the same place needs careful coordination to avoid trade-off effects.

Keywords: Conversion of Cropland to Forest Program, Ecological Welfare Forest Program, Agricultural Subsidies, Land Use Change, China

T0317

Landscape stability analysis based on the mathematical morphology of landscape (a case study of lacustrine thermokarst plains with fluvial erosion within the Cryolithozone)

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The research aims to analyze the complex and controversial landscape dynamics of thermokarst plains with fluvial erosion to assess the stability of its morphological pattern. Two opposite trends are facing within this landscape during the whole Anthropocene: the growth and, possibly, the emergence of new thermokarst lakes and the disappearance of thermokarst lakes due to the descent fluvial erosion.

The research results in the mathematical models of the dynamics of the morphological pattern of thermokarst plains with fluvial erosion, which were developed for a uniform natural environment on the base of the mathematical morphology of landscape using the theory of random processes. The models are done:

1. for a synchronous start of the thermokarst process;
2. for an asynchronous start of the thermokarst process.

The mathematical analysis of the models shows:

- the distribution of a number of khasyreis (drained lakes) corresponds to the Poisson distribution;
- the distribution of khasyrei areas corresponds to the exponential distribution;
- the limit area distribution of thermokarst lakes corresponds either to the gamma distribution (the synchronous start) or to the integral exponential distribution (the asynchronous start).

The empirical testing of the models was done at 19 different key sites (Yamal, Western Siberia, Kolyma).

The mathematical analysis of the second model shows that after a long time of development the majority of morphological landscape metrics of the thermokarst plains with fluvial erosion become stable. The research shows that in case of the synchronous start these landscapes have a directional evolution, while the asynchronous start results in a steady state of the dynamic equilibrium and corresponds to the stable state of the landscape. This conclusion is important for prognostic issues due to climate change.

Keywords: lacustrine thermokarst plain, mathematical morphology of landscape, khasyreis, mathematical model of landscape morphological pattern, landscape metrics

Optimizing the spatial arrangement of trees in residential neighborhoods for better cooling effects

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Trees have long been recognized as effective for mitigating urban heat islands by reducing air temperature through evapotranspiration and intercepting shortwave radiation that heat up land surfaces. Many studies have shown that both the composition and configuration of vegetation can contribute to heat reduction at the city scale. Fewer studies, however, have focused on cooling mechanisms at the neighborhood scale. Here, we integrate modeling with in situ measurements to investigate how different spatial arrangements of trees in residential neighborhoods affect their cooling effects. We conducted the research in a residential neighborhood with high-rise apartment buildings in Beijing. We tested four scenarios with different spatial arrangements of trees, and quantified their effects on cooling. We used the high spatial and temporal resolution microclimate model ENVI-met and validated the model with in situ measurements. We found: (1) Different spatial arrangements had differentiated effects on intercepting shortwave radiation, which led to variations in air temperature. For example, new trees that were completely exposed to solar radiation had stronger cooling effects (air temperature was 0.22 °C lower) than new trees that were located in the shadow of surrounding buildings. (2) Different spatial arrangements led to obviously different effects of sensible heat reduction, with a maximum difference of 14.84 ×108 J/ha. Our results underscore the importance of the spatial arrangement of trees on cooling in residential neighborhoods. These results have important implications in urban planning and design at the neighborhood scale.

Keywords: Urban green space, Spatial configuration, Urban Heat Island, Solar radiation, Numerical modeling

Symposium 13

Addressing the challenges of the Anthropocene with strategic planning: novel ways to couple ecological sciences and territorial governance

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The Anthropocene is the period in which we and future generations live – a time period that is truly human-influenced, based on overwhelming evidence that global ecological, atmospheric, hydrologic, geologic and other earth system processes are now changed by humans. Never before we experienced such a fast and profound alteration of our human and natural environment and arguable the most important processes therein are land change and climate change. The resulting challenges regarding global urbanization, modifications in food regimes and desertification, among others, are indeed critical in our time. Under the territorial governance umbrella resides the capacity of governments and authorities across the world, from local to national level, to formulate, adopt and implement policies that tackle these challenges. Strategic planning serves at setting and implementing long term visions of how regions should develop and is increasingly a means to address the up mentioned challenges to nature and society. In the past two decades it became the worldwide key approach in addressing the green, blue and grey environment because it enables novel ways to couple ecological sciences and governance for regional development. Strategic planning can be defined as a set of concepts, tools, and practices which integrates expert knowledge with tacit/experiential knowledge of the local communities and recognizes change as a fundamental landscape quality. It supports the setting and implementing the visions of how regions should develop in future, but at the same time, it is effective when it addresses incremental and sudden changes as well as unexpected events. This is why strategic plans and designs can be regarded as potential turning points in unsustainable trajectories. This implies that strategic planning and design are conceptualized as adaptive processes which require strong ties to territorial governance to ensure maintenance and necessary modifications. The objective of this symposium is to assemble talks that present and discuss novel theoretical and empirical contributions that address the challenges of the Anthropocene by coupling ecological science methods with governance aspects. We encourage papers which address the green, blue and grey environment, along with the interconnections between them, at various steps of the planning cycle, including governance of regions, actions, implementation and evaluation procedures, through new methods, tools and data. As strategic planning requires a mix of expertise, we encourage contributions which tackle conflicts between the socio-economic and the ecological dimensions, present worldwide examples of successful conservation and planning strategies at regional level, integrate perception studies into the planning process, account for coupled socio-ecological systems in planning scenarios, or develop tools to incorporate ecosystem services approach into regional planning.

Inundation simulation for the riverbed elevation changes caused by quarrying in Panay River, Capiz, Philippines

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Sand mining, the removal of sand from their natural configuration, has economic and social benefits, but also creates environmental problems when the rate of extraction of sand exceeds the rate at which natural processes generate these materials. The morphology of the mining areas have demonstrated the impact of mining with the prowess to destroy the cycle of ecosystems. Numerous publications have been written with respect to these effects, and the next step is what to do to minimize, prevent or correct these environmental effects. With the increasing number of quarrying sites along Panay River, the provincial government of Capiz should start reassessing the process of giving permits to Mining Contractors.
In this study, a flood simulation model is conceptualized using isochrone maps to derive unit hydrographs and interpret what it says about the potential for floods along Panay River. Results show that with just 5 hectares of the river with 1 meter decrease in elevation due to sand mining, there is a change in the unit hydrograph of the river. If this model is applied in several more areas along Panay River, the huge impact in flooding which will affect the downstream area of Capiz will alarm the provincial government on their environmental management plans.

Keywords: River Flooding, Hydrograph, Isochrone Map, River Quarrying, Panay River

T0899

Assessing and monitoring land management on functional urban areas: a suggested framework and indicator

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A growing need to incorporate nature into urban planning suggested to adopt multiple approaches to design appropriate regional planning strategies for the protection of the remaining natural areas and the species therein. We tested a methodological framework and a new indicator to assess the conservation and fragmentation status at multiple spatial scales and study the relationship among landscape conservation, fragmentation status, and beetles' richness.

At landscape level, for each municipality, we calculated the Index of Landscape Conservation (ILC) and landscape metrics; multivariate analyses were performed to combine conservation and fragmentation values.

At species level, fourty beetles indicator species were selected and divided into four groups according to their characteristics: biogeographic (e.g. endemic), conservation concern (e.g. high conservation priority), ecological (e.g. vulnerable species) and management value (e.g. alien or anthropophilic species). We observed a significant relationship between beetles' richness and fragmentation status: the occurrence of “conservation concern” and “management” species provided the most significant relationships between ILC and fragmentation status. Based on the significant correlation, we propose the Human Impact Indicator (HII), ranging from 0 to 2, to assess the distance between the actual value and the reference one of beetles' richness, fragmentation and conservation status.

Landscape metrics can provide biologically relevant information about the corresponding beetles' richness. The HII can be used to suggest an acceptable benchmark to which local authorities should tend to mitigate the negative effects produced at landscape and species level; it can also be used to interpret and characterise the degree of impact in long term monitoring.

Further studies are needed to sustain scientifically-sound decisions to design appropriate planning strategies to preserve biodiversity in the Mediterranean area.

Keywords: Landscape management, Conservation planning, Land use planning, Landscape fragmentation, Landscape and species approach integration

T0861

A novel tool for strategic planning: an agent-based model of land use change explores alternative visions for woodland restoration in Scotland

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Scotland is a stage for fascinating debates around land use and governance. A government aspiration to increase woodland cover is set in the context of contrasting and strongly held values with regards to the Scottish landscape, national aims for Land Reform and Community Empowerment, as well as UK wide uncertainty surrounding agri-environment funding in the face of Brexit. Despite the decade old aspiration, woodland planting goals in Scotland continue to be missed. Indeed, woodland expansion in a Scottish context has been classified as a 'wicked problem', given that it is inherently hard to reconcile different values between stakeholders, predict the consequences of slow and long-term change (woodland growth) under uncertain conditions, and to fully assess and quantify the trade-offs that may occur as a consequence of land use change.

This research aims to support novel approaches to strategic planning by combining alternative stakeholder 'visions' (positive descriptions of ideal futures) with an agent-based model which take account of heterogenous behaviour. The model aims to identify governance pathways that have the potential to meet the aspiration, minimise trade-offs, and maximise synergies. We employed a mixed-method, transdisciplinary approach, combining stakeholder engagement with a large-scale, high resolution agent-based model of Scotland. The model works with multiple data sources, and 'agents' represent a typology of land managers who each have the ability to produce services and take over land, depending on their objectives and the potential productivity of that land.

The presentation will showcase model results, illustrating the land-use change and ecosystem service implications of different visions, and any synergies and trade-offs between them. Reflections will be made on the use of visions and agent-based modelling for strategic planning at a national level, future directions for similar research, and applicability of the model elsewhere.

Keywords: agent-based model, visions, scenarios, land-use change, afforestation

T0896

Urban and rural Landscape Plans at the municipal level. Towards a nature based planning/designing action.

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Currently in Italy planning at the Municipal level is regulated by mandatory Land Use plans called Piani Regolatori Generali. These plans are concerned mainly with the organization of built areas and features, while they only provide standards of "green" (quite generic term in itself) as a simply quantitative measure, which certainly doesn't guarantee an ecosystemic landscape approach of any sort.
A few municipalities have voluntarily developed "Piani del Verde", often just a little more than "Tree Ordinances", technical documents aimed at vegetation management, and only in a few cases plans which have taken on a specific planning of the landscape mainly focused on the purpose of better urban quality.
An increased attention to landscape themes, prompted by more and more frequent disasters caused by climate change, but also consequent to anthropic transformation often inconsistent with the territorial context and managed without the support of specific professional roles, leads to the necessity of going beyond the current regulatory framework and towards a proposal of compulsoriness for municipal landscape plans that deal with the entire municipal territory in its several aspects, natural, rural, peri-urban and urban.
In this context, landscape features are now considered for a multiplicity of ecosystem services to couteract effects of anthropization and climate change and the consequent desertification, UHI, water management issues. This ecosystem multifunctionality has to become the core of new public policies, oriented towards working in accordance and along with natural systems. The local scale will allow a shift from planning strategies to designing site specific intervention.
The proposed Municipal Landscape Plans will be rooted in ecosystem approach and will provide actions and designs to:
1. Counteract climate change effects
2. Enhance the overall ecological state of the municipal territory both urban and rural
3. Identify possi

Keywords: multifunctional/ multiscale landscape planning, nature based site specific design, municipal Landscape Plans

From strategic to operational: innovative approaches to integrate ecosystem service knowledge in urban planning

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Ecosystem service knowledge, which synthesizes knowledge on ecological and socio-economic systems, is increasingly acknowledged as a valuable support to planning decisions at multiple scales. Methods and tools to map and assess ecosystem services are becoming more and more common and usable, to the point that they could be routinely adopted by public administrations in the next future. However, mechanisms and procedures to include ecosystem service assessments as an integral part of formal planning processes are yet to be explored.

The talk presents a case study related to the drafting of the new urban plan of Trento, a middle-sized city in north-eastern Italy. Here, ecosystem service knowledge is being integrated in two different stages of the planning process. First, at the strategic level, ecosystem service mapping and assessment revealed hotspots of ecosystem service provision in areas currently undervalued and subject to urbanization pressures. The hotspots will be included among the "structural elements" of the new plan, along with more traditionally recognized elements (e.g., protected areas, areas subject to hydrological risk).

Second, following the strategic vision, ecosystem service knowledge is used at a more operational level to design innovative performance-based requirements for future urban transformations. The expected impact of each transformation on the current provision of ecosystem services determines the level of performance required. Then, the assessment of demand and beneficiaries in each site allows defining what ecosystem services should be prioritized, hence what actions are required for each transformation.

The case study, carried out in collaboration with the municipal department of urban planning, provides insights on how ecosystem service knowledge can be integrated in current planning processes, revealing opportunities and limitations of an approach that moves from the strategic to the more operational stages of the planning process.

Keywords: ecosystem services, urban planning, hotspots, performance-based planning

T0386

Socio-economic development, knowledge transmission and territorial governance of Social-Ecological Systems at the regional level: the case of the Green Infrastructure Strategy in Galicia (NW Spain)

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One of the current major challenges in the sustainable management of territories is the maintenance and improvement of the ecosystems' capacity to supply services to society. While the scientific understanding of ecosystems structure and function, their relation to services' supply, and the risk associated to their degradation is an essential issue, this perspective would be senseless in absence of an understanding from the society as a whole. A knowledge transmission process is necessary, from the co-production of knowledge to the development of new perspectives and common languages, as well as specific actions. Territorial governance can play an essential role in the development of strategies, embodied in public programs and policies that include not only knowledge transmission, but also the integration of social, cultural and economic aspects.

One example among the initiatives currently developed in this sense at the regional level is the Green Infrastructure Strategy in Galicia (NW Spain). This Strategy aims to define a network of high biodiversity value sites, as well as to improve the capacity of the territory for ecosystem services supply. To enhance its implementation, the capacity of green infrastructure to contribute to socio-economic development is assessed. To do so, a social-ecological approach was taken in order to a) improve the integration of both biophysical analysis and public participation processes; b) integrate different dimensions of value related to ecosystems; and c) acknowledge the diversity of socio-economic settings in the region. Examples worldwide including Payment for Ecosystem Services Schemes, bottom-up self-organizing initiatives or business models were examined and compared with socio-economic characteristics and demands by society. Finally a series of models were designed, whose implementation will entail both opportunities and challenges for management bodies, governance system and society.

Keywords: Social-Ecological Systems, Green Infrastructure, Territorial Governance, Sustainable Management, Landscape Ecological Planning

Town Ecology: For the Land of Towns and Vilages

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The land of towns and villages contains a large portion of the global land, population, and resources used by everyone. Patterns and processes highlighted here are based on literature, plus observations of 55 communities of 20 types worldwide. Town ecology analyzes a town (e.g., 2000 -- 30 000 pop.) interacting with surrounding productive land or water, natural land, and villages. A town's spatial structure highlights the: (1) town center around a central plaza; (2) adjacent older residential area; (3) newer residential area of diverse neighborhoods; and (4) town edge. Outside is an (5) adjacent zone with intense human effects, and (6) surrounding land extending half way to other towns.

Overall towns have: good soil; a relatively high watertable; little air pollution; small impervious surfaces ringed by fill and plant cover; little heat buildup; a flood-prone location; and mature trees. A “species rain” from close-by surrounding vegetation, and often a corridor bisecting town, enhance biodiversity. Both linear and enclosed villages have numerous ditches, on-site waste-disposal, and are permeated by wildlife and weather. The adjacent zone commonly includes: dog/cat effects on wildlife; vacuum effect of night lights sucking insects out of habitats; intensive farm uses; and small fields/pastures. In surrounding land, the local road network connecting town, villages, and farmsteads fragments land, creates metapopulations, and disrupts gene flow. Diverse recreation alters woodland, while aridland is lightly affected overall, but transformed near water sources.

Often towns and villages shrink, farmland shrinks/degrades, and natural land shrinks/degrades/fragments. Town growth and shrinkage relate to major employers in town, nearby communities, or distant forces. Shrinkage increases plant succession and wildlife. Town ecology promises rich research frontiers, teaching/learning opportunities, and residents/professionals making strategic plans, better towns, better lands.

Keywords: town ecology, Land of towns/villages, Town structure

Changing visions: the impact of regional and county planning on land changes in Bucharest urban region

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There is a wildly accepted premise that spatial planning influences land changes. Despite this, studies have devoted little attention to the impact of spatial planning has on guiding development trends, as well as influencing patterns and intensities of land use. The aim of this study is to evaluate the impact of the shifting visions promoted by regional and county planning on two intertwined processes: built-up development and agricultural land abandonment.

To conduct the research, Bucharest urban region is chosen as study area. Over the past decade the urban region has been increasingly affected by sprawling built-up development and decreased interest in agricultural activities. Social (e.g. aging farmers), economic (e.g. low profit obtained from agricultural activities) and spatial planning factors (agriculture not being included on the urban planning agendas) have led to a high rate of abandonment of agricultural land and rapid expansion of built-up land. To fulfill the aim of our research, we resort to content analysis of planning documents, expert interviews, land use mapping by using remote sensing data and spatial analysis. More precisely, we conduct a document content analysis to identify shifts in development visions and objectives proposed by past and in force planning instruments adopted at regional and county level. Land change data is derived from processing of Landsat satellite imagery, aerial imagery and field observations. Spatial regression analysis is used to model the impact of the spatial planning visions in contrast to other social and economic variables, while validation is performed based on information derived from expert interviews. Preliminary results show a significant impact of promoted investments on land abandonment rates and an overall growing interest in shifting the urban region`s profile towards a service oriented one.

Keywords: regional planning, spatial planning evaluation

T0144

Statistical and configurationally relationships between landscape metrics and water quality parameters

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In this paper, the relationships between landscape metric(s) and water quality parameters in sub basins of Mazandaran province in northern Iran has been investigated. For this purpose, at first, the main water quality parameters were determined by principal component analysis (PCA). Then, using the linear regression analysis, the best metric(s) for each of the water quality parameters were determined among the common metrics. Also, the effect of spatial configuration of land use patches on the quantity of the water quality parameters and their variability's was determined. According to the PCA results, SAR, TDS, pH, Po4 and No3 parameters were identified as the best water quality parameters of the rivers in Mazandaran province during sampling period. The results also showed that the IJI_BL, CIRCLE_MN_A, PLAND_F, CONNECT_R and PLAND_A metrics are the best metrics for showing changes in SAR, pH, TDS, PO43 and NO3 parameters at the class level, respectively. As a general conclusion, it can be said that the metrics in landscape level have a lower ability to describe the water quality than the class level. In the other words, metrics at the class level can provide more detailed information on land use existing in upstream water quality measurement stations.

Keywords: Land use, Water quality, Principal Component Analysis, Regression Analysis, Iran

Evolution of strategic planning in a flagship protected area of China

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China is at a critical stage of transition, with of aim of achieving sustainability at all scales. A series of national level land-use master plans have recently been developed, but a major challenge resides in the cohesive integration of these plans at regional and local scales, considering the vast biogeological, climatic, cultural and economic diversity across the country. While integrating multiple plans into one strategic planning is recently promoted for urban spaces in China, few have reported such attempt in rural and peri-urban landscape, where almost all China's protected areas are located, hosting most of its biodiversity and cultural diversity. This study is built on a long-term action research in the Wolong National Nature Reserve and the surrounding Sichuan Giant Panda Sanctuary World Natural Heritage since 2004, as well as secondary information from as early as the early 1900s. Applying a complex adaptive social-ecological systems framework, we systematically investigated the ecological, socioeconomic and demographic transitions in the area over the past 100 years. Focusing on the past four decades since the Reserve was established in 1975 and later designated as China's first Special Administrative Region for nature conservation, we carefully analyzed a series of land-use plans, strategic plans and sectoral regional concepts (e.g. tourism plans) at local and regional scales in addressing the green, blue and grey environment issues. We identified various internal and external driving forces and examined carefully the evolution in the multi-level governance structure of the Reserve and the World Heritage. We discuss the experience and lessons of strategic plan making in Wolong's history and the strong implication for the ongoing process of strategic and specific plan making in Wolong and the new Giant Panda National Park, as well as the National Park planning else where and sustainable development in rural and peri-urban China.

Keywords: Strategic planning, Protected area, Territorial governance, Multi-level governance, China

Identifying key nodes of ecological restoration using complex network theory

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The principles of mountain-river-forest-farmland-lake-grass system were put forward under new historical condition and provided new strategic insights into ecological conservation and restoration in China, which took mountain-river-forest-farmland-lake-grass system (MRFFLGS) as a whole based on landscape processes and patterns to address ecological environmental issues. The establishment of an ecological network can well follow the principles of MRFFLGS and enhance the comprehensive and sustainable ability of the ecosystem at least cost but few studies focused on network stability. The study took the Beijing-Tianjin-Hebei metropolitan region as the research area and built an ecological network based on circuit theory to extract ecological sources, corridors and nodes. The theory of complex network was employed to assess the ecological network stability and identify obstacle points and key nodes. Under the condition of randomly or selectively removing network nodes, the stability of system was calculated using related indicators and the correlation between them was studied to locate obstacle points and key nodes. This study aims to construct ecological network and identify obstacle points and key nodes that the priority should be given in ecological conservation and restoration practice under the guidance of principles of MRFFLGS.

Keywords: mountain-river-forest-farmland-lake-grass system, ecological protection and restoration, ecological network, complex network, Beijing-Tianjin-Hebei Province

T_0993a

Worldwide human-wildlife conflicts: insights on why parrots forage in agricultural lands and its outcomes

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Expanding crop production and infrastructure are increasing human-wildlife interactions, including the use of agricultural lands by vertebrates and consequently attacks toward them by humans. However, there is an important lack of information on why vertebrates undertake the risks of feeding on crops. Here, we examined the species traits (size and cerebral volume) and macroecological factors that may promote parrots to forage on crops and the consequent persecution by humans. We focused our study on Psittaciformes (398 species) because the large number of endangered species, high plasticity to feed on different plant structures, and high behavioral variability. Within the range map of each species (BirdLife Datazone), we calculated climate variables, ecosystem productivity, and landscape modification, using thousands of gridded global datasets (e.g., Landsat, MODIS, Forest Watch, Human Modification, CHIRPS). Then, we modeled the effects of these variables on the likelihood of parrot species to feed on crops and to generate conflicts with humans (IUCN Red List). A higher number of parrot species forage on crops where seasonality of ecosystem primary productivity and temperature are higher, biota diversity is lower, human modification of habitats is higher, and when animal behavioral plasticity is higher, suggesting an association between natural food availability, landscape degradation and species traits. Bigger animals are frequently persecuted where landscapes show higher human modification and lower environmental protection level. These factors were determinant on their level of extinction risk. The continuous expansion and intensification of crop production combined with particular ecosystem conditions and animal traits are likely to enhance the frequency of human-wildlife interactions and its deadly outcomes. As demonstrated, multispecific and multisource information may be crucial to a better management plan of endangered species linked to conflicts with humans.

Keywords: Species risk of extinction, global human-wildlife conflicts, ecosystem functioning, species traits, agriculture

T0508

Wind power planning with a multicriteria approach - integrating biodiversity and ecosystem services in the Wind-GIS tool in Västernorrland, Sweden

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Wind power is one of the renewable energy solutions to meet the challenges of climate change. However, it comes with potential conflicts with other sustainability goals, such as biodiversity and ecosystem services. These challenges need to be addressed in regional planning, taking multiple sustainability aspects into account. This project aim to develop methods and the related Wind-GIS tool for integrating biodiversity and ecosystem services in wind power planning on regional level, targeting to meet multiple sustainability goals and to support municipal planning. It was conducted in cooperation with the County of Västernorrland. We used spatial multi-criteria analysis (SMCA) methods and developed a tool to find and evaluate suitable areas for wind farm development. We integrated expert knowledge, such as green infrastructure applied on county level, and structured the decision problem in cooperation with stakeholders. Main factors were wind resources and relevant infrastructure, biodiversity with subfactors representing sensitive birds, forest and wetland ecosystems, cultural ecosystem services related to residential areas as well as outdoor recreation, reindeer hearding, and other land use and claims. After aggregating and weighing the factors in cooperation with stakeholders, we designed scenarios using offensive and defensive approaches. Finally 7 sites of 10 km2 were selected for evaluation regarding potential energy output and suitability from wind power developer, social and ecological perspectives. In this way, synergies and trade-offs could be quantified and visualised, and main conflicting factors could be localised and discussed during the process. The methodology and the Wind-GIS tool has potential to be useful for transparent landscape planning on regional and municipal scales.

Keywords: Landscape planning, Biodiversity, Green infrastructure, Spatial multicriteria analysis, Decision support tool

T0272

Land management for climate change mitigation: afforestation vs. bioenergy plantations

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The recently published IPCC special report on 1.5 °C clearly states the need and urgency to rely on land resources to mitigate climate change via carbon dioxide removal techniques such as afforestation and bioenergy, especially when combined with carbon capture and storage. A large-scale deployment of land-based climate change mitigation options should minimize competition with food production and prevent damage to ecosystem services. The use of existing marginal and semi-degraded land that is currently not used for agricultural production is a promising option. However, which of the two major mitigation options will deliver the major benefits is still an open question. Afforestation generally increases storage of carbon in vegetation and soils and promote a variety of benefits for ecosystem services. Bioenergy crops can be used to avoid emissions of fossil fuels, and in case of perennial grasses they increase soil carbon and many ecosystem services relative to cropland.

This study will compare the potential for climate change mitigation from afforestation and bioenergy plantations on global marginal land that is currently unproductive or not forested. Satellite data will be analyzed to provide historical trends of land use changes. On the identified available land, crop yield models and forest growth models will be used. Regional climate models, together with expected changes in crop yields from climate scenarios from the IPCC, will provide a basis for considering the effects of future climate changes on crop and forest yields. The analysis will be performed over a long time period (e.g., until 2100) to understand the temporal evolution of the two systems. Climate change mitigation benefits will be quantified in terms of negative emissions. Spatial differences in the results will be explored. New knowledge describing future land management for climate change mitigation will be generated to assist decision makers achieving more assertive land management strategies.

Keywords: Climate change mitigation, Land management, Afforestation, Bioenergy

P0025

Sustainable future scenarios for environmentally sustainable livelihoods in the Zanzibar Archipelago

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Climate change, population increase, and socio-economic development are continually reshaping multifunctional landscape systems within small developing islands. The shocks and stresses arising from these drivers of change potentially threaten the sustainability of local rural livelihoods and subsequently compromise poverty alleviation efforts. Environmentally sustainable livelihoods are important for poverty alleviation as well as the protection and maintenance of vital ecosystem services. In the context of change, approaches to identifying sustainable pathways need to be flexible and dynamic in nature whilst also accounting for uncertainty and therefore require an integrated approach which recognises interlinkages across different sectors. This study aims develop alternative scenario pathways to support environmentally sustainable livelihoods by using situated knowledge's about how current perturbations are shaping the provisioning of water, energy and food resources across different spaces using Zanzibar as a case study. To gain a baseline understanding of how people are currently responding to perturbations ethnographic case studies will be used – these will then form the basis of strategic planning workshops which will merge participatory mapping techniques with participatory scenarios planning methods. As such this study stands to provide greater insights into how the drivers of change impact upon the sustainability of livelihoods in small developing islands and as a result better inform future policies which work towards reducing poverty and effectively responding to climate change.

Keywords: climate change, poverty , ecosystems , degradation , infrastructure

T0063

The role of land-use and environmental policies in a landscape of forest persistence and tourism-induced urban growth

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Land-use and environmental planning are key activities through which planners promote efficient urban growth and nature conservation. In Brazil, a number of land-use and environmental policies, together with spatial strategies, have been developed by the end of XX's and early XXI's. The 2004 Ecological-Economic Zoning (EEZ) for the Northern Coast of São Paulo State (NCSP) is one of the main instruments supporting land-use and environmental policy in NCSP. This study aims to better understand the role of the land-use and environmental policies in terms of spatial patterns from 2000 to 2015. We identified the main drivers of land-use and land-cover changes, and evaluated the efficiency of EEZ in terms of observed land changes and forest conservation. We used Partial Least Squares - Path Modelling to model the relation between drivers and the most frequently trajectory, i.e. urban/peri-urban increase, and forest persistence, before and after the implementation of the EEZ. Political factors (i.e EEZ and basic sanitation services) were the most important drivers of all changes during the investigated period. The EEZ zones regulating nature conservation were strongly correlated with forest persistence. Zones regulating urban use were correlated with dense urban growth, but not with peri-urban uses. The increase of urban use was correlated with an increase in basic service provision, but the peri-urban increase wasn't related with any basic services. The absence of correlation between population growth and urban growth suggests that urban zones were not built for resident housing, but mostly for touristic uses. Overall, the analysis indicates that the land-use and environmental policies and strategies have been important drivers of the contrasting development in urban growth and forest persistence. These findings are expected to be useful to reform EEZ and other planning instruments, regarding the improvement in housing programs and in better equality of public policies.

Keywords: Land-use and environmental planning, Drivers of land change, Urbanization, Ecological-Economic Zoning

Coproducing a local Landscape Character Assessment to guide strategic planning for Wilmslow, Cheshire

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Landscape Character Assessment is an established tool in England for applying the principles of the European Landscape Convention to guide landscape protection, management and planning. Assessments are often carried out for whole counties or districts to support Local Plan policy development. A layer of strategic spatial planning was removed in England when Regional Spatial Strategies were abolished in the 2011 Localism Act. The regional strategies were replaced with a "duty to cooperate" between local planning authorities when preparing their Local Plans. The same act also established a new ability for local communities to prepare a statutory Neighbourhood Plan to guide future developments in the area in which they live. The plans are prepared through an established process including extensive community engagement and a local referendum before a plan is adopted.

The town of Wilmslow lies in the Borough of Cheshire East approximately 22 kilometres south of Manchester. The parish of Wilmslow includes a large proportion of rural landscape, including farmland, mossland and incised river valleys. A local Landscape Character Assessment was prepared to support the Wilmslow Neighbourhood Plan. Much of the practical work was carried out by members of the local community, while Countryscape provided technical support. An initial training programme was followed by support in using spatial data and composing landscape profiles. The final landscape profiles included the sections covering: key characteristics; landscape character; landscape ecology; landscape history; spirit of place; celebrated landscape; changing landscape; and landscape opportunities. The work ensured that landscape had a strong focus in the Wilmslow Neighbourhood Plan that was submitted to Cheshire East Council in February 2019 for formal consultation and examination. The solid understanding of landscape has given the local community a powerful voice in discussions of strategic planning at broader scales.

Keywords: Landscape Character Assessment, Strategic landscape planning, European Landscape Convention, Coproduction, Landscape governance

P0050

Landscape planning of the region

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The theoretical foundations of landscape planning are based on the system-synergetic worldview, the concept of sustainable development and the adaptive paradigm of environmental management.
The authors define landscape planning as a scientific and practical activity, providing landscape organization of the territory for the purposes of its sustainable development. Under the landscape organization of the territory we understand the structure of natural landscapes and types of environmental management, which provides ecological stabilization of the territory.
The landscape organization of the region is based on evaluation system: the degree of landscape transformation; its ecological condition; landscape functions; landscape stability to a specific type of load; the quantity and quality of environment-forming geosystems; ecological network; the degree of adaptability of the types of economic use of the territory with the properties of natural landscapes.
The authors suggest a method of assessing the degree of adaptability (compatibility) of the types of economic use of the territory with the properties of natural landscapes. On the basis of the obtained estimates, zones of landscape-ecological restrictions are developed; nature management types that are compatible with the properties of the natural landscape are planned; an ecological network is being developed. Landscape planning is based on landscape data: properties of landscape components, holistic properties are planned (recording of various spatial landscape models: morphological, positional-dynamic, positional-genetic, biocentrical-network, basin-landscape ones).
The method of landscape planning depends on the level of planning, sectoral task of using the territory and the approach to environmental management: administrative, basin, regional.

Keywords: landscape planning, landscape organization, region

T0907

Spatial planning and territorial sustainability: Advances and challenges of strategic environmental assessment.

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Spatial planning is a key instrument for supporting decision-making at different scales, which regulates the spatial dynamic of social, economic and environmental activities, and in consequence future changes in land-use. However, the spatial planning process might also generate trade-offs on a range of ecosystems as well as on the goods and services they provide to society. In this context, including the principles of sustainability in the elaboration of policies, plans and programs is a critical aspect to move towards countries' growth but also development and well-being. In Chile, strategic environmental assessment (SEA) is, by law, the most important instrument for integrating sustainability objectives and criteria at policy and plans level. The aim of this work is to explore the current state of progress in the integration of the sustainable development goals (SDG), within the spatial planning instruments in Chile. For this, we collected all the available SEA reports at national level during the period 2011-2018 at regional, inter-municipal and municipal scale. Afterward, the reports were classified based on their level of progress (e.g. starting the SEA, advanced, finished, etc). In order to evaluate the relation between each SEA and one or more SDG, we included in the analysis only the reports that included environmental objectives in an explicit way. Additionally, we explored for patterns of relationships between specific SDG and different scales of spatial planning and geographical contexts. This research is still under development; however, the results will allow identifying the level of integration of the SDG in the Chilean spatial planning, scale and context relationships. The results will allow elaborating a diagnosis of the current state of implementation of SEA, including challenges and opportunities for a broader audience. This work has been developed with the support of the FONDECYT project 1181954.

Keywords: sustainable development goals, spatial planning, strategic environmental assessment

T0657

Ecosystem service assessment as basis for regional development planning, steering concept and educational activities

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Despite the broad attention that research on ecosystem services has received in recent years, the integration of the ecosystem service concept into decision-making and strategic planning is still limited. The European Alps provide a wide range of ecosystem services such as water provision, climate regulation as well as aesthetic and recreational values. Especially cultural ecosystem services and namely recreational opportunities are highly appreciated by the 14 million inhabitants and more than 120 million annual visitors of the European Alps. In recent years, space and time influenced by outdoor recreational activities increased strongly and hence effects on ecosystems and their capacity to deliver recreational as well as other services. Kleinwalsertal is a high valley in the northern eastern Alps in Austria, and with more than 1.7 million overnight stays a top tourist destination in the Alps. To proactively address and prevent conflicts arising between different types of recreational activities but also between recreationists and farmers, landowners, hunters, forestry, nature conservation, or others, the regional administration initiated the project "Natur bewusst erleben (Consciously experiencing nature)". The project aims to sensitize all involved stakeholders and to guarantee a sustainable use of the natural environment. For this, an ecosystem service assessment is used together with a stakeholder survey to develop a steering strategy for recreational activities and land use. This approach is complemented with a communication and educational concept providing suggestions for innovative knowledge transfer based on the assessment results and the steering strategy. Due to its innovative character and the transdisciplinary approach, this project can serve as a flagship project for strategic regional planning and management.

Keywords: ecosystem services, sustainabilty, tourism, Socio-ecological-system, regional planing

T0482

Assessing the extent of willife vehicle collissions (WVCs) on Cyprus road network

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Roads, although an integral part of an area's economic development, may cause irreversible changes to habitats and species. Wildlife Vehicle Collisions (WVCs) contribute directly to biodiversity loss with additional indirect environmental and social impacts even within Natura 2000 sites. In Cyprus an ever expanding road network has led to a decrease of Roadless areas, now covering only 4.5% of the island, in patches of less than 1 km2. Many of the WVCs involve species of EU concern, protected under Annex II of the Habitats Directive Therefore for the island's already impoverished fauna understanding the extent of the phenomenon and mitigating effects becomes of utmost importance. The paper reports on the first systematic and coordinated effort which started a year ago by the Open University of Cyprus to record WVC on the island. We compare data resulting from CyROS observations with data surveys from Department of Public Worksrecords available for the main highways of the island for the period 2013-2017. We used the KDE+ software to identify clusters of road-kills and hotspots. We compared roadkill incidents in and around Natura 2000. There were 630 WVC records reported by volunteers all over Cyprus since May 2017 and 1000 WVC records reported from 2013-2017 for the main highways The trends are similar from both sources of roadkills records indicating that foxes, hedgehogs and snakes are the most frequent WVCs. There were 21 hotspots identified, two of which in existing N2K. The number of observations recorded so far show no difference between roads which cross Natura 2000 and those which do not.

Keywords: roadkills, islands, KDE+, Natura 2000, citizen science

Mapping cultural ecosystem services capacity and demand to enhance the understanding of interactions among socio-ecological system

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Cultural ecosystem services (CES) bridge the natural environment and human well-beings, and provide the base for sustainable landscape management, decision-making and policy development. While existing frameworks for CES do not sufficiently consider and operationalize the dynamic interactions between humans and ecosystems through embodied scientific realism. This paper aimed to assess interactions among social-ecological system, adopting a multistep approach. We advanced a framework mapping and assessing CES capacity and demand with a focus on the identification of unsatisfied demand to influence the understanding and management of social-ecological system. The framework was tested in an agricultural landscape of central and western China, considering geographical mapping of ecological and social factors. The results show the trade-offs and synergies varied greatly for capacity and demand. Our assessment also reveals that the distance between the capacity-demand equilibrium point and the built-up area reflects the overall capacity and demand situation of the administrative region. Mapping of CES capacity and demand can provide a comprehensive picture of the CES delivery process, which can improve the usefulness of CES mapping as a decision-support tool by informing planners and policy-makers.

Keywords: Cultural ecosystem services, Socio-ecological system, Regional planning, Landscape sustainability, coupling human and nature system

T0012

Biodiversity Offsets - European Perspectives on No Net Loss of Biodiversity and Ecosystem Services

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This presentation deals with the new concept of biodiversity offsets. The aim of offsetting schemes is to achieve no let loss or even net gain of biodiversity. Offsets obey a mitigation hierarchy and reflect the precautionary and polluter-pays principle in regard to project impacts. This presentation points on a new book publication and offers insights into current debates on biodiversity policies in Europe, with outlining theoretical principles and the latest research findings. At the same time the focus is on practical application and case studies regarding biodiversity offsets. Today there is a lively international discussion among practitioners and scientists on the optimal legal framework, metrics and design of habitat banks to ensure the success of biodiversity offsets and to minimise the risks of failure or misuse. Contributing to the debate, this talk presents the activities and practices of biodiversity offsetting already implemented in selected EU member states, and the lessons that can be learnt from them. The audience may be surprised at how much experience already exists in these countries.

Keywords: Biodiversity Offsets, No Net Loss, Net Gain, Planning, Decision Making

A National Strategic Plan for Ecological Security for China

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China's rapid industrialization and fast built-up area expansion in the past four decades have been increasingly threatening the integrity of the country's ecosystems, and the prospect for even further development renders the threats graver. With existing local ecological planning covering only a fraction of the country's ecosystems and also lacking a consistent, scientific methodological basis, a master national plan is called for. In this paper, we propose a strategic plan for ecosystem preservation and restoration for the country's entire territory. The plan is consist of three specific spatial patterns: (1) An ecological security pattern – a spatial bottom-line ensuring the functioning of the essential ecological processes, including water cycles, geological processes, habitat and land cover dynamics, and also cultural landscape preservation, for the provision of vital ecosystem services at the minimum level, and also for the basic security of human's livelihood free from exposure of natural disasters; (2) An "ideal" spatial pattern of the country's ecosystems, which would provide ecosystem services at an optimal level, under the assumption of reasonable human interference; and (3) Scenarios of human-inflicted future landscape change under assumptions of various possibilities of socio-economic development, and also the influence of macro environment factors such as global climate change. The synthesis of the three patterns does not only designate the bottom-line for ecosystem preservation, but also shows the directions for restoration by identifying key vulnerable regions under ecological degradation threats with indication of specific threats factors involved, which future action plans can be built upon. Finally, we discuss the potential impacts for various stakeholder groups, and conclude the paper with policy suggestions alongside the spatial schemes which together constitute a comprehensive National Strategic Plan for Ecological Security for China.

Keywords: National Strategic Plan, Ecological Security, Optimal Landscape, Ecological Restoration, China

T0554

Ecosystem services as an integral support tool for green infrastructure and landscape planning: a case of agro-industrial landscapes in Latvia

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Landscape and spatial planning can help create alternative landscape patterns and increase landscape quality by the assessment and planning of green infrastructure (GI). 'Green Infrastructure and Landscape Quality in the Zemgale plain (Latvia)' is an applied research project, launched in 2018, that aims at elaborating a spatial strategic plan for green infrastructure and landscape quality improvement in the agro-industrial landscape region, using ecosystem services (ES) as a support tool. The project's area comprises lowland agro-landscapes with dense river patterns that during the last century were gradually converted into monofunctional production units with scattered pockets of semi-natural vegetation, and historical sites of cultural and ecological value. One of the project's objectives is to link the assessment of ES with existing and potential GI and landscape quality indicators at the regional scale. Thus the methodological approach to GI and landscape integrated planning includes mapping and assessment of existing ecological and landscape values, and ES supply potential, assessment of GI condition and identification of problem areas, development and assessment of scenarios for GI improvement. In this paper, we focus on the linkage between the existing and potential GI of agricultural matrix and landscape elements of cultural and ecological value, thus integrating ES and landscape factors to guide GI planning in the spatial context of subregional landscape units. The resulting data sets will be used to support the further identification of landscape quality objectives via the participation of stakeholders. We will discuss the challenges and opportunities of using ES as an integral support tool in the strategic landscape planning framework at the regional level.

Keywords: landscape planning, green infrastructure, ecosystem services, agro-industrial landscape

Identification of good-practice patterns in urban design for improved temperature regulation in warming climates

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Growing urbanisation calls for the need of widely-implemented planning activities that take into account aspects of human well-being in newly created urban fabric. One of the major challenges in urban design is the creation of spaces that are resilient to climate change, which frequently manifests as the increasing occurrence of hot waves during summer. As much as new solutions in green- grey- and blue infrastructure are necessary to mitigate these negative effects, it is equally important to identify and implement existing examples of good practice that can help alleviate them.

In this work we focus on three British towns collectively characterised with a variety of urban form that are representative of temperate climate cities susceptible to heat waves, and set out to identify instances of spatial configuration of urban patterns that are associated with cooler temperatures during the summer. We intend to use cluster analysis to find patterns within four major urban land cover classes: grass, trees, buildings and paved, that are associated with cooler temperatures on a regular summer day, and track their performance as the summer progresses into a heat wave. We inform our analysis by very high resolution (2 to 4m) spatial datasets that include land surface temperature (LST) maps downscaled from Landsat 8 satellite imagery and spatial configuration metrics. Our initial results indicate that our chosen set of indicators combined with Random Forest regression can be successfully used to predict LST on a regular summer day with R2 of 0.9-0.92 depending on land cover and that blocks of 80 to 200m in size should be considered in the planning process. Upon completion, this research intends to supply tangible recommendations to urban planners for urban form design contributing to heat-wave mitigation, and in further outlook – to link areas fulfilling these criteria to other ecosystem services to determine the potential for multifunctional character of these spaces.

Keywords: urban, land surface temperature, spatial configuration, landscape metrics, ecosystem services

Symposium 14

Linking natural and anthropogenic forces: landscape pattern and processes in global urbanized deltas and lowlands

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One of the major driving force influencing Earth is Homo sapiens. Humans could alter both the ecological conditions and the structure and function of ecosystems converting the undeveloped land into anthropogenic habitats. Compared to inland and mountainous areas, deltas and coastal lowlands generally offer a gentler terrain and fertile soil, are richer in freshwater and offer more transportation and human activities. Large deltas or lowlands in the world are often heavily urbanized and populated as people were initially attracted by the agricultural productivity of such areas. The urbanization is changing or even damaging the original natural landscapes in unexpected and unpredicted ways. Habitat loss and fragmentation processes strongly affect biodiversity conservation in landscapes undergoing anthropogenic land use changes.

This session focuses on landscape pattern and processes at the across global deltas and lowlands with high intensity human activity background. It includes but is not limited to : (i) agglomeration effects of anthropogenic dynamics on ecosystems in deltas and lowland area; (ii) landscape ecological solutions for coastal problems (flooding, pollution, biodiversity loss etc.); (iii) landscape management and conservation for sustainable development in delta and lowland areas; (iv) integration of physical processes (hydrological, geographical and ecological procedures) for human settlement in deltas and coastal lowlands.

T0536

Eco-hydro-morphological degradation of Israel lowland streams: The result of flood protection regulation

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By 2050 Israel is expected to double its current total population of 8 million people and to become one of the most populated developed countries in world with more than 700 people per 1 km^2. This trend will accelerate already existing anthropogenic pressure on the environment in large, and specifically on lowland rivers and floodplains where majority of the urban areas and agricultural land are. As a result, flood protection regulation is applied into the national statutory physical planning system such that lowland streams are designed and engineered to discharge floods with peak discharges above the natural bank full discharge. The modification of lowland streams, i.e. increasing discharge capacity, leads to river incising, excessive removal of bed material, loos of ecosystem services and overall degradation of the aquatic environment. This study describes the process and suggest designing flood protection policy based on nature-based solutions which will improve the eco-hydrology functioning of lowland rivers.

Keywords: Lowland Rivers, Floodplain, Mediterranean, River Restoration, Flood protection

T0490

When the hydrology drives the ecological subsidy: impact of climate change on floodplain contribution to fish productivity

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Climate changes are predicted to alter the subsidy patterns between ecosystems. Projections for temperate rivers are for reductions in flooding magnitude and duration, and should therefore impact floodplain productivity, an important subsidy to the main river. This study examines the impact of hydrology on the export and assimilation of planktonic prey produced in the floodplain by the littoral fish community of Lake Saint-Pierre, a large (≈ 300 km2) and shallow (≈ 3 m) widening of the St. Lawrence River (Québec, Canada). We hypothesised that floodplain subsidy contribution to fish diet would increase as a function of the magnitude and duration of the flood. We analysed the carbon stable isotope ratios (δ13C) of invertebrates and 31 fish species captured during 4 hydrologically different years. Floodplain contribution was estimated at the species and individual fish level, using a stable isotopic mixing model (SIAR) and a linear mixed model selection (AIC). Our results showed that fish captured during years of important flooding have a higher trophic dependence to the floodplain subsidy for a longer period than in years with shorter flooding periods. All five species (yellow perch, pumpkinseed, bridle shiner, golden shiner, banded killifish) captured every year showed a similar temporal trend in the assimilation of the floodplain subsidy. Our study revealed that climate changes will affect the pattern of assimilation of an important subsidy of a large temperate river by altering its hydrology and productivity, consequently impacting negatively on the food web of the recipient ecosystem.

Keywords: Climate changes, Floodplain subsidy, Hydrology, St. Lawrence River, Stable isotope analysis

Identifying upstream locations critical for downstream floods

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The hydrological processes in a watershed co-depend upon spatial land cover and land use configurations. River flood hazards can thus be mitigated by preserving or developing resilient landscapes, which incorporate ecosystems with high water retention, storage and infiltration capacities. These systems should be spatially configured in the landscape to maximally trap surface runoff upstream, thus minimizing peak discharge downstream. To identify where these ecosystems would have the highest impact in downstream areas, a simple raster-based rainfall-runoff- (RR-) model was developed, based on the Curve Number method. This model was integrated in an iterative approach to rank each of the grid cells covering a watershed according to its contribution to the accumulated runoff at the basin outlet for a given rainfall event, taking the previously ranked cells into account. The combination of the RR-model and our resulting iteration tool produced a decision support system (DSS) for off-site spatial decisions extendable to include on-site criteria (e.g. maximize carbon sequestration) and constraints, such as the minimum required residential area.
This DSS was applied to a middle-sized river basin in Flanders, Belgium for three conditions: the initial land use configuration, an afforestation scenario and a soil sealing scenario. The results respectively pinpoint the critical locations in the watershed contributing most to peak discharge, the most appropriate locations for afforestation and the locations to be most avoided for soil sealing with a view to flood hazard mitigation downstream.

Keywords: flood hazard mitigation, landscape configuration, rainfall-runoff model, decision support system

Characterizing the impact of urban morphology heterogeneity on land surface temperature in Guangzhou, China

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Urbanization has rapidly developed in recent decades. The World Urbanization Prospects 2014 Revision report stated that 54% of the world's population resided in urban regions in 2014 and was projected to grow to 66% in 2050. The resulted expansion of urban areas and impervious surfaces are likely to aggravate urban heat island (UHI), which are defined by the higher temperature in urban core areas relative to the surrounding rural areas.Recently, many urban authorities have recognized the importance of pedestrian thermal comfort and required mechanisms to control UHI during urban planning.The urban morphology is regarded as one of the main reasons for urban heat island (UHI). However, its effect on UHI in city-scale urban areas has seldom been examined. This study examines both the linear and nonlinear relationship between land surface temperature (LST) and urban morphology represented by building height, building density and sky view factor (SVF) with use of rule-based regression model across different dates in 2005. It was found that an urban morphology of medium building height and lower density significantly yielded higher LST variation levels, whereas the lowest LST variation levels occurred in high-rise and high-density building areas. Compared to building height, building density had stronger influence on LST. Medium SVF values produced the lowest LST, whereas the largest and smallest SVF values produce the highest LST. Results also show how rule-based regression model offer great performance in detecting the nonlinear mechanisms of LST as well.

Keywords: Urban heat island (UHI), Land surface temperature (LST), Urban morphology

T8789

Managing changes in the Dutch Delta for future generations

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Like most urbanized Deltas, the landscape in the Netherlands is predominantly men-made. The ecology is completely intertwined with the omnipresent cultural elements in the landscape. Especially in the lower parts of the country this landscape is result of a centuries long need for agricultural products and energy (peat) combined with the necessity to cope with land subsidence and the risks of flooding. It was constantly adapted to the needs of the moment forming an unique "tissue" of patters and elements like the characteristic over 800 year old elongated holdings, polders, thousands Kilometers of embankments and hundreds of wind mills and pumping stations for drainage. With change as its most prominent feature, the increasing urbanization and the modernization of agriculture since WW 2, its remarkable how much of that tissue is still left. However, the coming years the ongoing urbanization, land subsidence, sea level rising, the energy transition and te ongoing economies of scale in the agriculture will surely increase the pressure on the characteristic Dutch lowlands, It will be a challenge to conserve this landscape for future generations.
In this paper we will present how information about the cultural heritage values in a landscape can be used in challenging the given issues. We will show that the existing - sometimes centuries old - structures in a landscape can be a solution and not a problem in the face of the given significant environmental and social changes

Keywords: heritage and, Land subsidence, agriculture , circulair agrofood systems, participation

T0068

Ecological restoration and resources utilization of Yangtze Estuarine Wetlands - Project Introduction

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The saltmarsh at the Yangtze Estuary has been under declination and degradation due to reduced sediment input, land reclamation and invasion of Spartina alterniflora in the last decades. This project will develop technics to foster establishment and dispersion of native wetland communities under strong hydro-sediment- morphological dynamics, and to control exotic species with environment friendly measures. In the meantime, we will develop series of technologies to turn the abundant biomass into fodder ingredients, fertilizers, or bio-charcoals, as a part of control strategy for Spartina and other undesirable species to provide more favorable habitat for wild animals. Eventually, the estuarine wetland will become an ecological buffer to protect the coastal line from Typhoons in summer, and to provide habitat for migratory birds in winter with high economic benefit for the harvested material. Meticulous management strategies will be formulated for the wide application of this model in the world.

Keywords: salt marsh, restoration, Spartina alterniflora, biomass utilization

Cooling effect of water body in the Pearl River Delta: Patch size threshold

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The rapid urbanization process at the expense of natural land caused severe urban heat island effect (UHI). Urban water body mitigates the UHI through humidification and cooling effect, which is known as the urban cold island (UCI). However, research on the cooling effect of water body is insufficient. The patch size thresholds of water body and cross-city comparison need further exploration. In this paper, Landsat images were applied to analyze the cooling effect of water body of nine cities in the Pearl River Delta (PRD) using spatial and statistical analysis. Our results include the followings: (1) The cooling effect and the landscape indexes of water body of different cities were calculated through the spatial analysis. (2) The patch size thresholds of cooling effect were recognized through piecewise regression model. (3) Furthermore, all-subsets regression model was implemented to distinguish the influencing factors of the thresholds of nine cities. This study aims to recognize the patch size thresholds and reveal the differences between water body cooling effect of different cities in the PRD, so as to provide a scientific basis for alleviating UHI and urban ecological civilization construction.

Keywords: urban heat island, urban water body cooling effect, patch size threshold, landscape indexes, the Pearl River Delta

Analysis of Urban Residential Density Based on Low Altitude UAV Tilt Photogrammetry

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As a new technical method, tilt photogrammetry has broad prospects in many fields. Combine with the data obtained by low altitude UAV tilted photogrammetry technology, this paper analyzes the urban residential density by using edge extraction and classification methods.. Taking the partial area of Wuchuan City in Guangdong Province as an example, this paper uses tilt photography to obtain 3D color point cloud data with position information, and optimizes the point cloud data to obtain digital orthophoto map (DOM) and digital surface model (DSM). The extraction and recognition of buildings in DOM images are mainly realized by edge extraction algorithm and classification algorithm, and the urban residential density is calculated by combining the building height information obtained in DSM. The research results show that proposed model can be effectively applied to building extraction and residential density analysis.

Keywords: Urbanisation, Residential Density, tilt photogrammetry, buildings extraction, classification

T0480

Artificial water management in Italian lowlands – impacts and challenges by natural and anthropogenic forces

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Transformations of wetlands into agricultural areas by artificial drainage have allowed the creation of highly productive lowlands around the world. In Europe, the Po Valley (northern Italy) is one of the largest lowland zones that has become a focal point in demographic and economic activities. Hydrologic hazards such as floods and droughts pose a challenge to the Italian catchment. As a consequence of the non-natural water management, constant action is required to maintain a favourable hydrologic state, such as adequate water drainage during wet periods or water addition during dry summer periods. A vast network of hydraulic structures and pumping stations is responsible for safeguarding this, but its capacity is increasingly tested by natural and anthropogenic forces such as changes in land use and climate.

In this study, historical and future trends in urbanisation, water management practices and rainfall patterns were reconstructed for the years 1951-2060. Hydrologic modelling by rainfall-runoff model WALRUS (Wageningen Lowland Runoff Simulator) shows that agriculture-urban transformation and removal of drainage ditches causes more water excess. This increases the discharge requirements from the pumping station, and will continue to do so in the future with the given scenario. Climatic forcing is responsible for stronger seasonality: drier summers are increasingly common and will require more external water supply; while autumn and winter rainfall is growing in amount and aggressiveness. These results emphasise how common trends in lowlands are responsible for a growing pressure on the artificial water management system, thereby inducing water-related hazards for society. Land planners should take into account the hydrologic and hydraulic impacts of land use transformations, while water managers and engineers have an important task in safeguarding future safety.

Keywords: lowlands, hydrology, land use change, climate change, modelling

T0760

Analysing fragmentation patterns of interdunal wetlands along Medinipur Coastal Plain, India using landscape matrices

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The coastal wetlands, interspersed along the swales of relict sand dunes, are extensive repositories of numerous ecosystem functions and services throughout the tropical regions. In the Medinipur coastal plain of the Indian state of West Bengal, peasants along with traditional fishermen have established an intricate 'genre de vie' based on these wetlands through intensive subsistence farming, freshwater aquaculture, and seasonal extraction of non-timber products of the wetlands since time immemorial. However, many of these wetlands are degrading at an alarming rate at present due to extensive land use conversions in the form of expanding settlements, beach tourism infrastructure and shrimp aquaculture farms. However, no comprehensive analysis on the impacts of anthropogenic stressors and consequent landscape modifications with respect to interdunal wetlands of this region had been performed till date. Accordingly; this study had been conducted with a primarily focus on the spatio-temporal dynamics of interdunal wetlands and attempted to quantify its patterns of transformation within the regional land use and land cover mosaic for the last three decades using geospatial landscape matrices. Three successive Landsat images of 1988, 2003 and 2018 with similar spatial resolution were used for this purpose. Results of the study clearly demonstrated that large patches of wetlands had been fragmented, shrunken, and eventually isolated during this timeframe primarily as a result of continuous land engulfment by peri-urban residential units and real estates along with aquaculture farms. These actually led to notable habitat degradation and losses for wetland biota and consequent obliteration of its existing sustainable agroecosystems. Based on the findings, few necessary management guidelines had also been formulated towards restoration of these highly productive coastal agroecosystems and attainment of sustainable livelihood for the economically marginal coastal populace.

Keywords: Built-up, Coastal wetland agroecosystem, Land encroachment, Landscape metrics, Remote sensing

T0712

Evaluating the anthropic impact on Indonesian Peatlands using the Airborne Electromagnetic method

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Peatlands are the largest stock of carbon on Earth surface, storing more carbon than the terrestrial vegetation globally and almost the same amount present in the atmosphere. Despite their importance, the anthropic impact on peatlands is devastating and releases enormous amount of carbon dioxide and other greenhouse gasses every year. The protection and conservation of peatlands is one of the major actions foreseen by IPCC to mitigate climate change. This action necessarily needs a precise assessment of the potential avoided emissions linked to conservation strategies, which is in turn strictly related to the precise quantification of peat deposits at local to global scale. Unfortunately, the available estimates of the peat volume over large territories are affected by large uncertainties due to the difficulties in measuring the peat thickness. This is particularly true for peat deposits located in the tropics due to their limited accessibility and fast degradation that deeply changes the peat volume over time. In Indonesia the reclamation of large forested wetlands for intensive agriculture combined with severe drought events have greatly increased the vulnerability of peatlands to subsidence and deep burn fires, posing the problem of mapping the amount of the stored peat and its change over time. In this study we use Airborne Electromagnetics (AEM) collected over two large contiguous peatlands in Indonesia, to determine both the topography and the peat bottom surface, i.e. the separation surface between peat and the mineral substrate. The results obtained with the AEM method combined with our results on the correlation between peat thickness and surface elevation allow us to study the effects of the reclamation that has deeply affected one of the two peatlands. This work has implications for demonstrating the potential of AEM to rapidly infer peat thickness at regional scales and its applicability in characterizing the anthropic impact on Indonesian peatlands.

Keywords: Organic carbon, Peatlands, Airborne electomagnetics, Climate change

Landscape management in the Polesine lowland (northern Italy): consequences on flooding and population exposure

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Human activities are taking an increasing toll on environment and bringing negative effects on the whole ecosystem. Unfortunately, many of these effects are not apparent in complex systems subject to intense human pressure, due to mutual interaction (or conflict) of many different needs and processes. Management and planning of complex and fragile environments, such as anthropogenic lowland landscapes, require comprehensive and multidisciplinar analyses. Historical, social, hydraulic and political factors have been combined in this study to assess the effects of landscape management in one of the largest floodplains in Europe, the Polesine Region (Po River Valley in northern Italy). After the big flood occurred in 1951, hydrocarbon exploitation and several human interventions aimed at enhancing navigation and transportation occurred in the last 60 years have led to a sensible worsening of hydraulic hazard for similar flood events. In the same period, the Polesine Region has reorganized significantly in terms of population and urbanization. Massive migration caused a decrease in population (–30%), which never recovered; nevertheless, the number of houses has increased by 36% in 60 years. Quite surprisingly, the increase of houses was greater, and the reduction of population smaller, in areas where the hydraulic hazard has increased, suggesting that population and urban settlements reallocated for reasons other than safety from floods. By looking at the Polesine as a coupled human-environment system, such a behaviour can be seen as a serious non-optimality, which denotes a shortcoming in the feedback-based mechanism that should drive landscape management and urban development. We attribute the unsuccessful reduction of hydraulic risk in the Polesine lowland to an inadequate perception of flood-related issues, by both people and public authorities, and claim for a political agenda that includes resilience and security from floods as utmost priorities.

Keywords: Anthropogenic lowlands, Landscape management, Flood exposure, Flood risk

Correlation between urbanization and vegetation activities in the Pearl River Delta: Scale contrast

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Understanding the quantitative relationship between urban sprawls and vegetation activities could provide scientific support for sustainable development of cities. The interactions between vegetation dynamics and urban sprawls appear to be complex at different scales, but there is a knowledge gap in current research. Based on Leaf Area Index (LAI) and DMSP/OLS nighttime stable light data, we explored the correlation relationship between urban expansion and vegetation dynamics in different scales. Grid(1km,10km,50km), watershed(level 05,07,10) and administrative unit(town, county , city) are considered scales in the Pearl River Delta (PRD) in this study. The results show that from 2000 to 2012, the average LAI in the north is higher than it in the south and increased slowly at a rate of 0.02 km2/km2·yr. Meanwhile, the urban area is increasing with a growth rate of 0.39/yr and gradually expanded from the northwest to the southeast. The relationship between urbanization and vegetation activity is negative on all scales. And with scaling-up, the relationship varied remarkably in grid and watershed but it is similar in administrative unit. The study reveals that it is of great significance to reduce the negative impacts of urbanization on ecosystem at different scales by urban landscape planning.

Keywords: Pearl River Delta, LAI, vegetation, DMSP/OLS, urbanization

Coastal Delta in the Context of Urbanization and Global Change: Challenges and Sustainable Development

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Coastal delta is the origin of human civilization and the modern mega city agglomeration area. With 5% of world surface area and 1/14 of global population, costal delta cultivates important service, including agriculture, fisheries, and distribution center for global commerce and service. Its prosperity lies in the combination of adequate water resource, nutrient-rich sediment and the low-lying terrain.

Being the intersection of terrestrial and marine landscapes, coastal delta is highly susceptible to the coupled interference of global change and social-economic development. IPCC4 report a continuous sinking beneath sea level of coastal delta and a 50% increase in flood risk area at the turn of century. A range of crisis constrain the development of coastal delta, like landscape degradation, wetland loss, shoreline retreats, extensive flood, hurricane attack, salinization, etc.. Expensive engineering solutions have been applied to defend the immediate threaten in deltas in developed region. However, such short-term policies are inherently unsustainable.

In order to design sustainable solution to handle these crisis, we need to identify how urbanization and climate change have co-evolved with the natural process in coastal deltas, to set up integrated model simulating the effects of driving forces on the delta, to explore the deltaic response to threatens under multi temporal and spatial scales, and to equally address the precise strategy for single delta, as well as the global general strategy alleviating climate change. The ultimate purpose of the research is to protect and restore the environment, while maintain the sustainable development of the social-natural system of the coastal delta. Our research yield both scientific and policy-related insights. The mechanism of coastal delta response to multi-interference will be discussed. Practically, the conclusion will support policy decisions and facilitate the sustainable development of the coastal deltas.

Keywords: Coastal delta, adaption strategy, sustainable development, urbanization and global change

T0107

Island ecosystem management based on ecological vulnerability simulation and prediction: a case study of Zhujiajian Island

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In the past decade, more and more sea-cross bridges and tunnels were constructed to improve the accessibility of islands, which results in a rapid increase of tourists and economic income. Meanwhile the islands become more vulnerable after the construction of sea-cross bridge. It is urgent to formulate ecosystem management strategy based on ecological vulnerability assessment and simulation. The Zhujiajian Island is connected with mainland in 2009. The island area is about 68 km2 which attract over 5 million tourists in 2015. Island Ecological Vulnerability Index (IEVI) is used to evaluate the ecological vulnerability. Land use and tourists change in the next 20 years is simulated to estimate the change of island ecological vulnerability. The main results are: 1) The ecosystem of Zhujiajian Island is in good condition now; 2) Based on the prediction of ecological vulnerability, the threshold of tourists in Zhujiajian Island is about 16 million per year. The upper limit of built up area is 2500 ha, which means 90% is already used. 3) According to the vulnerability assessment and sensitivity analysis, the Zhujiajian island can be divided into prohibited development zones, restricted development zones and conditional development zones with different ecosystem management strategies. The island ecosystem management zoning based on ecological vulnerability assessment can provide scientific support for the fine management of island ecosystems.

Keywords: Island Ecological Vulnerability, anthropogenic disturbance, sensitivity analysis, ecosystem management, Zhujiajian Island

T0190

Identification on effects of land use on antibiotics in soils in typical peri-urban area of Yangtze River Delta, China

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Antibiotics are increasing recognized as anthropogenic contaminants in soils, and the can persist through a complex vicious cycle of transformation and bioaccumulation in urban, peri-urban, and rural ecosystems. Identifying the affection of land use on antibiotics in soils can help understanding the distribution, dynamics and determinants of antibiotics in environment. This is especially important for peri-urban areas, where had complex land use pattern and high antibiotic concentrations. In our study, soil samples in depth of 0-40 cm from rural ecosystem to urban ecosystem in a typical peri-urban area of Eastern China were collected. The composition, concentration and dynamics of 4 main groups of antibiotics (tetracyclines, quinolones, macrolides, and sulfonamides) in soils were analyzed. Results showed that the antibiotic concentrations in soils were mainly determined by land use. The antibiotic concentrations in cropland (0.05-395.55 μg/kg) were significantly higher than that of orchard and forestland in different seasons. The antibiotic concentrations in orchard (0.05-26.43 μg/kg) and forestland (0.07-3.65 μg/kg) had no significant differences in summer but significant differences in winter. The composition and concentration of soil antibiotics varied in different seasons, and winter had higher values than summer. The tetracyclines, quinolones, and sulfonamides in soils were significantly affected by intensity of human activities. Analysis showed that anthropogenic effects on the distribution of antibiotics in soils in winter were so strong that dwarfed the effects of environmental factors. In summer, human activities and their interactions with environmental factors were the dominant contributors to the variations in soil antibiotics. Results also indicated that surrounding land use pattern in buffer zones with radius of 350 m determined the concentrations and dynamics of antibiotics in peri-urban soils.

Keywords: Land use, Soil security, Spatial distribution, Dynamics, Antibiotics

Urban transformation of river landscapes in mainland China over the past 60 years

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Over the past 60 years considerable progress has been made in understanding the impacts of urban development on river processes and forms over the world. Such advances have occurred as fast urban population growth has accelerated in China. This study Used a compilation of research results from more than 100 Chinese cities conducted in a range of areas to describe how urbanization has transformed river landscapes across mainland China, emphasizing the distribution of impacts in a fast urbanization context. In China, urban development induces an initial phase of sediment mobilization, characterized by increased sediment production (on the order of 2–10 times) and deposition within channels, followed by eventual decline that couples with erosion from increased runoff to enlarge channels. Data from humid south China and temperate middle China indicate that channels generally enlarge to 2–3 times and as much as 15 times the original size. Results in south China indicate a tendency for channel reduction resulting from strong sediment erosion and deposition responses because of intense precipitation and highly weathered soils. Results in arid northwest China further suggest variable river responses to urbanization that are characterized by rapid morphological change over short distances. Regardless of location, the persistence of the sediment production phase varies from months to several years, whereas several decades are likely needed for enlarging channels to stabilize and potentially reach a new equilibrium. Urbanizing streams pose particular challenges for management given an inherent changing nature. Successful management requires a clear understanding of the temporal and spatial variations in adjustment processes.

Keywords: urbanization, river landscape, sedimentation, river management

Symposium 15

Toward a landscape-scale management of large carnivores in human-dominated areas

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In the last centuries, global biodiversity has been declining at an unprecedented rate as a result of a complex response to multiple human-induced environmental changes. Specifically, habitat degradation, loss and fragmentation due to land use changes are recognized as some of the most serious threats to the persistence of wildlife populations. Worldwide, the intensity and spread of these phenomena have transformed most of the landscapes into mosaics of human settlements, farmlands and scattered patches of natural habitat. Mainly due to their large home ranges and habitat selection, large carnivores have provided some of the most dramatic examples of the negative effects of fragmentation on the survival of wildlife in multi-use landscapes. The abundance and distribution of large carnivores has been historically reduced, in many cases up to the extinction threshold. Nevertheless, in the last decades, concurrently with the global biodiversity decline, an unexpected large-scale recovery of the previously lost carnivore populations has occurred in some of the most anthropised geographic contexts, such as Europe and North America. The recovery of large carnivores in these areas has been triggered by reintroduction projects and, above all, by natural expansions enhanced mainly by the legal protection of carnivores and by the recovery of their prey populations. Although developing countries may lack some of the institutional and legal tools that have allowed large carnivore recovery in Europe and North America, there are other examples of large carnivore recovering in human-dominated and urbanized landscapes, such as in India and South America. In particular, large carnivores are currently expanding to areas where until a few years ago the scientific community had ruled out that they could return, such as in fragmented landscapes consisting of forest-farmland mosaics or even in heavily exploited agroecosystems. This phenomenon is probably taking place because large carnivores have saturated areas characterized by optimal habitats and are moving towards much more anthropised contexts, exploiting unexpected ecological corridors. The ability of these species to recolonize novel ecosystems encourages optimism for the conservation of larger and, above all, more connected large carnivore populations. On the other hand, the colonization of highly anthropised areas, where carnivores compete with humans for the remaining semi-natural space and resources, increases opportunities of direct and indirect conflict between humans and predators, making the management of large carnivores in the Anthropocene particularly challenging.

The objective of the symposium is to collect insights deriving from multiple studies focused on the recolonization by large carnivores of human-dominated landscapes, with particular attention to the spatially explicit dynamics governing this phenomenon. Specifically, we aim to link the results of studies concerning the identification of environmental characteristics that facilitate and/or hinder the return of large carnivores in human-dominated contexts, the habitat and food habits of predators in novel ecosystems, comparing them to those observed in areas of historical presence, and the prediction of large carnivore expansion to new areas, which is essential to identifying future hotspots of conflict. Of particular interest are also studies that identify the characteristics of ecological corridors used by large carnivores in human-dominated areas, studies that develop or apply novel methods to identifying these corridors and that address the issue of identification/implementation of ecological networks for large carnivores in the Anthropocene.

The final goal is to provide novel insights to start thinking about how to move towards an effective management of large carnivores in highly populated areas following a landscape-scale approach.

T0846

Understanding spatial patterns of livestock depredation risk by wolves in a human-dominated landscape of northern Apennines, Italy

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Human-carnivore conflict is a major obstacle to co-existence of people and large carnivores in human-dominated landscapes. For large carnivores, conflict is mostly in form of depredation on livestock, which may cause substantial losses to local communities and result in the retaliatory killing of culprit species. Therefore, better understanding the factors influencing human-carnivore conflict is required to promote human-carnivore co-existence. We focused on wolf in the Italian Apennines, where the species has undergone a recent remarkable comeback and is posing a severe risk to free-grazing livestock. Our aim was to evaluate if the occurrence of depredation events was influenced by landscape-scale features of pastures, the existing conflict prevention measures, or by the level of wolf and wild prey distribution. We built a spatial depredation risk model in a generalized linear model framework, using locations of past attacks of wolves on livestock obtained through interview survey. We also developed spatial distribution models for wolf and wild ungulates in the study area.

Our results show that depredation risk is higher in fragmented landscapes with a higher proportion of pasture/forest interface, and in rugged terrain. Wolf habitat suitability was determined by low human presence in terms of building density, and distance from protected areas. However, this variable did not influence the probabilities of livestock depredation. Instead, there was a significant increase in the depredation risk where wild ungulates were scarce.

Our results highlight the importance of wild prey occurrence in human-wolf conflict intensities, hence an increase in wild ungulate population may reduce the trophic shift of wolves from wild to domestic prey. Moreover, we recommend the application of spatial risk models to target conflict mitigation efforts, and the application of preventive measures such as night corrals and high-quality fences in the identified depredation hotspots.

Keywords: Human-wildlife conflicts, Large carnivores, Predation risk, Livestock husbandry system, Canis lupus

T0082

Change of woody cover affects ocelot recovery in South Texas, USA

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The Rio Grande Delta of South Texas has become one of the fastest urbanizing regions in the United States. Since the early twentieth century, conversion of woody cover for agriculture and development has become one of the main drivers of the decline of ocelots (Leopardus pardalis) in Texas. We classified LANDSAT imagery from 1987 to 2016 to quantify different rates of land cover change and used housing density scenarios to project woody cover change until 2050 based on five landscape metrics. Since 1987, woody cover increased 3.3% along with patch and edge density, whereas mean patch area, patch size and Euclidean distance to nearest patch decreased. Closer inspection revealed that woody cover increases were due to increase in small patches (<1 ha) by a magnitude of four, with an observed significant skewness and kurtosis in the frequency distribution of patch size across years. Urbanization will have the largest impact on woody cover, thereby affecting ocelot recovery in South Texas over the next three decades. By 2050, the largest patches of woody cover will be located on private lands >60 km north of the United States-Mexico border. These results provide important information for predicting the impact of fragmentation on ocelot recovery.

Keywords: Land Cover Change, Landscape Metrics, Leopardus pardalis, Rio Grande Delta, Urbanization

T0195

Striped hyenas - human-wildlife conflict in a highly populated area

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The Striped hyena (Hyaena hyaena) is one of Israel's largest carnivores, found in various habitats. In the early 20th century, hyenas were near extinction, mainly due poaching and poisoning. Despite recovery and growth trends in hyena populations, it remains locally endangered (EN) and protected by law. Nowadays, the 21,000 km2 country of Israel, populated by 9 million residents with growth rate of approximately 2% per year, creates an increasing challenge for conservation biology, and ongoing human-hyena conflicts.
In 1998, an ecological corridors scheme was suggested by INPA, in order to insure connectivity between protected areas and valuable open spaces. During 2017, the INPA initiated a regional planning program in central Israel, the most populated area of the country, aiming to establish a statutory plan which will determine the outlines of the ecological corridors in local and regional scales, to be accepted by governmental planning committees. The ecological corridors defined three levels of land use: core area; "open" agriculture and bottleneck. A set of planning guidelines was made for each level.
GPS collared hyenas showed remarkable use of ecological corridors, exploiting core areas, open agriculture, bottlenecks, and wildlife crossings, both above and beneath highways, while generally avoiding human settlements. Yet, few individuals do enter human settlements, and in rare cases actually dwell and forage in them. Suchlike hyena-human occurrences usually raise anxiety levels among nearby communities, mainly derived from ancient fear accompanied by superstitions regarding hyena's behavior and diet. These events put hyenas in urban environments at high risk. Relocation is an applicable solution usually taken, with limited success. In other cases, hyenas will find there death in roadkill events before relocation attempts take place, undoubtedly suggesting the need for a strategic human-wildlife conflict mitigation plan.

Keywords: human carnivore conflict, landscape use, ecological corridors

T0933

How Iberian lynx interact with humanized landscapes? Insights from a Portuguese study

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The Iberian lynx (Lynx pardinus) is one of the most threatened carnivores of the world. After being almost extinct in the wild, a concerted conservation program allowed a steady growth of the population in Portugal. The specimens born in captivity and released in southern Portugal are being monitored by GSM tracking under the project LIFE Iberlince.These daily data revealed a natural expansion from the original release area and highlighted the need for assessing the potential of southern landscapes as new breeding areas and connection corridors in an Iberian context. However, the Portuguese region where Iberian lynx is consolidating its home range is historically humanized. As so, along with urban settlements, there are as roads, artificial lakes, forests and agriculture with different intensification. To understand how released lynxes interact with this landscape is paramount for the selection of new areas where conservation efforts should be implemented. Models developed in MODELYNX project gave new insights on lynx landscape use for cover and feeding activities. For example, landscape features like urban settlements or roads weights differently in the daily routines of this species; data corroborate a pattern of avoidance of the former up to an estimated topographic distance of 1500 m, whereas roads may be dangerously attractive as hunting grounds on their favorite prey, rabbits. Furthermore, recent stone pine forests (Pinus pinea L.) are being used by territorial lynxes more often than expected. Frequently, these young pine stands share similarities, in terms of structure with scrublands patches, which are one of the most important habitats for lynxes. The study outputs are used to discuss management measures towards the promotion of landscapes compatible with a sustainable Iberian lynx population. Study supported by MODELYNX (POSEUR-03-2215-FC-000040) with the data contribution from the Portuguese partnership in the Iberlince project (LIFE + program).

Keywords: Lynx pardinus, Selection indices, Urban proximity, Pine stands, Tracking

T0192

Integrating ecology and social science to understand dynamics of human-black bear (Ursus americanus) interactions across an exurban landscape

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Ecological and social challenges exist for recovering carnivore populations in areas occupied by humans. The American black bear (Ursus americanus) has been recolonizing the state of Connecticut (United States), a predominantly exurban landscape, during the past three decades. Our objective was to integrate ecology and social science to understand relationships that exist among attitudes toward black bears, human-black bear conflict, and support for potential management scenarios across the landscape. Mail survey data (n = 1,326; 41.4% response rate) were used to evaluate resident attitudes toward black bears across nine Connecticut towns experiencing human-black bear conflict. We calculated the known human-black bear conflict density using a statewide database of reported human-black bear interactions. Then, respondents were grouped based on attitudes toward black bears and known conflict density, and regression analysis was used to compare groups. Respondents who live in areas of greater conflict density tended to have less favorable attitudes toward black bears. Social carrying capacity was assessed for each group of respondents in relation to eight potential conflict management scenarios. Spatial analysis allowed for linkages between characteristics of respondents, attitudes toward bears, support for management scenarios, and landscape characteristics.

Keywords: American black bear, human dimensions, human-wildlife conflict, socio-ecological systems, Ursus americanus

T0648

Should I stay or should I go? Different strategies of recolonization of a lowland ecological corridor by wolf

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After 150 years the Italian wolf (Canis lupus italicus) unexpectedly reappeared in a highly fragmented lowland landscape in northern Italy previously considered unsuitable for the species. Here, wolves recolonized a wooded corridor connecting Apennines to Alps. The aim of the study was to investigate for the very first time the distribution and resource use by wolf within the corridor.
To collect wolf presence signs, 30 linear transects were walked once per season (2017-2018). The influence of environmental variables on wolf presence was assessed by a use vs availability approach, running separate GLMs for presence signs falling inside or outside possible core areas identified through a Kernel analysis. Variable selection was performed through dredge and model averaging. We investigated trophic ecology on 28 scats collected inside and outside the core areas.
The Kernel analysis showed a 5 km2 core area in the central part of the corridor. The averaged model on presence signs inside the core area had an explained variance of 67%. Presence probability was significantly favored by a high roe deer (Capreolus capreolus) density and from the proximity to the corridor inner part. The averaged model on presence signs outside the core area had no significant variable and a very low explained variance (8%). Wolf diet breadth was quite lower inside the core area, with a higher preference for wild ungulates, than outside. Conversely, considering wild ungulate species only, diet breadth was significantly higher inside the core area than outside.
The results suggest that the corridor is simultaneously occupied by passing dispersal wolves and by sedentary wolves carrying out a strong resource selection. These insights are crucial for targeting different conservation actions along the Apennines-Alps corridor that, for its geographic location, could significantly promote the viability of the isolated Italian wolf population by facilitating its connection with the Balkan population.

Keywords: Large carnivores, Human-dominated landscapes

T0475

Using Systematic Conservation Planning to identify habitat conservation priorities for brown bears in the Romanian Carpathians

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Recovery of large carnivores in the European human-dominated landscapes has sparked a debate regarding the optimal landscape conditions in which carnivores can coexist with humans. We use brown bears (Ursus arctos) in the Romanian Carpathians to test and develop a framework for identifying habitat conservation priorities based on a novel integration of resource selection functions, home-range data and systematic conservation planning. We used a GPS telemetry dataset from 18 individuals to (1) calculate seasonal home ranges and (2) characterize population-level habitat selection. We then used systematic conservation planning software Zonation to identify contiguous areas of high conservation value for males and females using Manly's habitat selection ratios as weights, and home-range data as a parameter for habitat connectivity. Home ranges were smallest during winter (median [IQR] for Nov–February: 28.2 km2 [9.8–42.4]), and largest during the intense-feeding season (September–November: 127.3 km2 [62.2–288.5]), with males having larger home ranges across all seasons. Females consistently selected for mixed forest habitat during all seasons. Males selected mixed forest during winter; then switched to a rather generalist approach, selecting regenerating forest and mixed and coniferous forests during low-feeding/reproduction and wild berries seasons. We identified large tracts of forest habitat (~14% of the landscape) that was selected across all seasons as key habitats for brown bear conservation . Spatially, high-value winter habitat was the most dissimilar for both males and females, suggesting that conservation actions should focus on protecting contiguous denning habitat. These key findings can inform the management and conservation of the brown bear population in the Romanian Carpathians by identifying critical intervention areas for maintaining landscape connectivity, enable transboundary management and contribute to maintaining Favourable Conservation Status.

Keywords: conservation planning, landscape connectivity, resources selection functions, Zonation software, home ranges

T0406

Evaluating impact of major developments in Myanmar on clouded leopard connectivity and population dynamics

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Changes in land use/cover are the main drivers of global biodiversity loss, and thus tools to evaluate effects of landscape change on biodiversity are crucial. However, landscape-level approaches are not widely implemented by planning agencies, mainly due to lack of extensive species-specific data, complexity of ecological guidelines and lack of integrated protocols which would increase their usability. In this study we integrated spatial statistics, landscape ecology and landscape genetics into a GIS-based methodological framework, to evaluate impact of potential major developments in Myanmar on landscape connectivity and population dynamics of clouded leopard in Myanmar. The framework was based on a clouded leopard multi-scale habitat suitability model developed from an extensive dataset of 44 camera trap grids located in 8 countries in Southeast Asia. Using cumulative resistant kernel and factorial least cost path approaches together with individual-based spatial population genetics models, we quantified and mapped the impacts of five development scenarios: construction of 53 dams, the Chinese One-Belt-One Road initiative, a pipeline/railway spanning the country, the Indian Highway, and the growth and establishment of economic and touristic zones. We found that all investigated scenarios have negative effects on clouded leopard population dynamics and landscape connectivity, often disconnecting the most important clouded core habitats in the whole SE Asia. However, growth of cities and establishment of new economic zones caused disproportionally the highest loss and extensive fragmentation of clouded leopard habitat (23.5% decrease in the sum of cumulative kernel values representing strength of landscape connectivity and 62% decrease in the area-weighted extent of the clouded leopard core habitats). Our study was based on clouded leopard in Myanmar, however, the developed here framework can be applied to any landscapes, ecosystems and species/set of species.

Keywords: landscape connectivity, population dynamics, core areas, corridors, cumulative resistant kernels

Symposium 16

Data Science in environmental research, planning and evaluation – for a scalable multi-source environmental monitoring network

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Ecosystems fulfill a whole host of ecosystem functions that are essential for life on our planet. However, an unprecedented level of anthropogenic influences is reducing the resilience and stability of our ecosystems as well as their ecosystem functions. The relationships between drivers, stress and ecosystem functions in ecosystems are complex, multi- faceted and often non-linear and yet environmental managers, decision makers and politicians need to be able to make rapid decisions that are data-driven and based on short- and long-term monitoring information, complex modeling and analysis approaches. A huge number of long-standing and standardized ecosystem health approaches like the essential variables already exist and are increasingly integrating remote-sensing based monitoring approaches. Unfortunately, these approaches in monitoring, data storage, analysis, prognosis and assessment still do not satisfy the future requirements of information and digital knowledge processing of the 21st century. This presentation therefore discusses the requirements for using Data Science as a bridge between complex and multidimensional Big Data for environmental health.

It became apparent that no existing monitoring approach, technique, model or platform is sufficient on its own to monitor, model, forecast or assess vegetation health and its resilience. In order to advance the development of a multi-source ecosystem health monitoring network, we argue that in order to gain a better understanding of ecosystem health in our complex world it would be conducive to implement the concepts of Data Science with the components: (i) digitalization, (ii) standardization with metadata management adhering to the FAIR (Findability, Accessibility, Interoperability, and Reusability) principles, (iii) Semantic Web, (iv) proof, trust and uncertainties, (v) complex tools for Data Science analysis and (vi) easy tools for scientists, data managers and stakeholders for decision-making support [1].

T_9012

Data Science in environmental research, planning and evaluation – for a scalable multi-source environmental monitoring network

Lausch Angela[1]

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Ecosystems fulfill a whole host of ecosystem functions that are essential for life on our planet. However, an unprecedented level of anthropogenic influences is reducing the resilience and stability of our ecosystems as well as their ecosystem functions. The relationships between drivers, stress and ecosystem functions in ecosystems are complex, multi- faceted and often non-linear and yet environmental managers, decision makers and politicians need to be able to make rapid decisions that are data-driven and based on short- and long-term monitoring information, complex modeling and analysis approaches. A huge number of long-standing and standardized ecosystem health approaches like the essential variables already exist and are increasingly integrating remote-sensing based monitoring approaches. Unfortunately, these approaches in monitoring, data storage, analysis, prognosis and assessment still do not satisfy the future requirements of information and digital knowledge processing of the 21st century. This presentation therefore discusses the requirements for using Data Science as a bridge between complex and multidimensional Big Data for environmental health.

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Keywords: Ecosystem health, Data Science, Semantic Web, Ecosystem Integrity, Traits

T0812

Widening the perspective in landscape monitoring by integrating ground-based repeat photographs as a quantitative data source

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The use of terrestrial photographs for documenting landscape dynamics has a long tradition in landscape research. With the technological advances in aerial and satellite remote sensing, ground-based photographs have lost most of their importance as data source in modern landscape monitoring. Still, these photographs bear useful information that cannot be captured from the birds-eye-view. Repeat photography is the retaking of landscape photographs from exactly the same position at different points in time and thus, provides valuable insights on how the landscape has changed. These "then and now" images have proven to be quite effective in communicating landscape changes to policy makers and public. Photographs are easy to interpret and close to the human's natural perception of landscapes. However, perspective distortion, varying illumination and scale as well as the lack of spatial reference make it difficult to extract geospatial information from them. In order to use photographs as a quantitative data source in landscape monitoring, we need to find ways to overcome these limitations. The aim of our research is to test the potential of ground-based repeat photographs for quantitative landscape research and monitoring. We present a method for taking high-quality repeat photographs in the field and show two solutions to retrieve quantitative information from them. First, we demonstrate the application of machine learning for an automated analysis of photographs. For this purpose, we trained a Convolutional Neural Network (CNN) to detect woody regrowth vegetation in repeat photographs. Second, we relate the landscape photographs to a spatial reference system in order to link them to other geospatial data such as aerial and satellite imagery. By combining data from the ground perspective and the birds-eye-perspective, we are not only able to take advantage of both systems; we can also gain a more holistic view of ecosystems and landscape dynamics.

Keywords: repeat photography, photo monitoring, landscape monitoring, image analysis, monophotogrametry

P0152

The Democratization of Technology in Geoscientific Research

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Here we present a summary of 'do-it-yourself' (DIY) physical computing technologies that have been used in geosciences and where the output is relevant, related disciplines. The 'democratization of technology' refers to the improved access and understanding of technology by the user and this review focuses specifically on how greater education, understanding and utilisation of physical computing in geoscience and associated disciplines has already and could in the future be beneficial to researchers and the advancement of knowledge.

The existing technological outputs we have observed are consistently innovative and seek to overcome similar methodological issues, ranging from the expense of existing equipment to the required equipment not existing at all. Studies we review also pose a number of important methodological questions related not to the creation of a computing product but to the conceptual development of the product. Past work in this field has discussed a continuum between evolutionary research (improving on process or understanding) and revolutionary research (creating a new process or understanding), suggesting that revolutionary research is more likely to appear at the interface between disciplines. We argue that the democratization of technology to researchers may be one way of producing revolutionary research in geoscience and related disciplines.

Keywords: Technology, Arduino, Raspberry Pi, Methodologies, Geoscience

T0940

Quantum Landscape: Understanding landscape heterogeneity as a response of the spectral variability observed by remote sensing

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Landscape ecology is a discipline that study the interaction between ecological processes and spatial patterns considering the dynamic of the spatial heterogeneity and it consequences on biotic and abiotic components.
The most usual approach to study landscape processes considers the landscape as a set of discrete elements (land use/land cover) inter-connected by its borders. Landscape composition and spatial configuration are the most important properties used to describe change under this approach.
Digital images obtained from remote sensing and supervise classification methods (including human interpretation) are the most usually tools for the landscape discretization in terms of land use/land cover. Despite the strong mathematical and statistical bases presents in these approaches a high level of uncertain is present due the spatial complexity associated with the spatial and spectral configuration of the sensors.
The aims of this work was to explore the description of the landscape heterogeneity considering the landscape as a continuous surface of spectral information captured by and observer (sensor) under different conditions of observation (spatial and spectral configuration). Metrics based on information theory such spatial self-organization, complexity and emergence were used to describe the landscape based on its spectral response. Results show that the spatial heterogeneity change if we consider the landscape as a continuous process. Finally a quantum landscape are composed by a mosaic of spectral information where self- organization, complexity and the emergence are present.

Keywords: Landscape heterogeneity, Spectral variability, Texture and information metrics, Remote sensing

T0225

Individual and Interactive Influences of Anthropogenic and Ecological Factors on Forest PM2.5 Concentrations at an Urban Scale

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Integration of Landsat images and multi-source data using spatial statistical analysis and geographical detector models can reveal the individual and interactive influences of anthropogenic activities and ecological factors on concentrations of atmospheric particulate matter less than 2.5 microns in diameter (PM2.5). The approach has rarely been used to comprehensively analyze the individual and interactive influences of anthropogenic factors (e.g., population density, impervious surface percentage) and ecological factors (e.g., canopy density, stand age, and elevation) on PM2.5 concentrations. To do this, we used Landsat8 images and meteorological data to retrieve quantitative data on the concentrations of particulates (PM2.5), then integrated a forest management planning inventory (FMPI), population density distribution data, meteorological data, and topographic data in a GIS database, and applied a spatial statistical analysis model to identify aggregated areas (hot spots and cold spots) of particulates in the urban area of Jinjiang city, China. A geographical detector model was used to analyze the individual and interactive influences of anthropogenic and ecological factors on PM2.5 concentrations. A combination of human activities (e.g., population density, impervious surface percentage) and multiple ecological factors caused the dominant interactive effects, resulting in increased PM2.5 concentrations. Our study suggests that human activities and multiple ecological factors PM2.5 concentrations both individually and interactively. We conclude that in order to reveal the direct and indirect effects of human activities and multiple factors on PM2.5 concentrations in urban forests, quantification of fusion satellite data and spatial statistical methods should be conducted in urban areas.

Keywords: multi-source data fusion, aerosol retrieval, vegetation dust-retention, urban scale, multiple ecological factors

T0655

Design and Implementation of an Integrated Platform for Forest Landscape Visualization

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In this paper, a 3D model of forest landscape was developed to present different effects of disturbances and management scenarios. Inputs comprise DTM and associated aerial imagery, spatial data for trees and forests, road and building information. Multiple functionalities of the interactive model for the case study area have been designed and tested among participants such as: 'drag-and-drop' features. It allows audiences to choose where they would like to position elements based on a series of 3D icons. At the same time, a new method for forest data collection is proposed by use of mobile devices. It is implemented through ODK (an open-source set of tools) and integrated with the created 3D model which allows data of ecosystem services and data collected on the ground to be viewed with their locations.

This model was used in the VR Theater, Google Earth and Google Maps for knowledge exchange programme to elicit public preferences regarding forest landscape use and monitoring. Feedback on the use of interactive landscape visualization for scenario exploration through a virtual reality environment was strongly positive. Over 80% reported it was effective for capturing views on priorities for future forest landscape uses including the role of climate change in modifying existing options. The findings through mobile data collection, analysis and aggregation have potential implications for the monitoring and assessment of woodland to increase the effectiveness of their use, and contribution to wider forest management. This has the potential to significantly change forest monitoring system which can provide local communities with information on indicators of forest loss, changing land-use practices and socioeconomic realities.

Keywords: Forest Landscape, Forest Monitoring, Ecosystem Services, GIS, Forest Management

P0038

Hybrid Method for Landscape Quality assessment blending with Street Views and Artificial Intelligence Technology in Computer Vision-the case of the linear road landscape between Beijing and Tianjin in

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In the era of big data, the emergence and collection of data have undergone tremendous changes. Street Views is one of possible dataset could be systematically analyzed and assessed with the development of artificial intelligence technology. In this study, it selected the 103 National Highway, which is the most important linear road linking Beijing and Tianjin, as the study object. Data of Land use, street views and human perception were combined, and serving for a hybrid landscape quality assessment process with the help of ArcGIS, Frag stats and semantic segmentation technology in the field of computer vision. Eight typical evaluating indicators including coherence, disturbance, historicity, visual scale, imageability, complexity, naturalness, ephemera are used for the establishment of a comprehensive evaluation system. Specifically, 9,000 street views of 1,800 selected points along the road were crawled by python and were analyzed through semantic segmentation into 10 items, such as sky, foliage, field, road and building. The research results include two parts, firstly, the quality and changing characteristics of road landscape between these two big cities are revealed, secondly, three analyzing approaches in this hybrid method are compared and reflected.

Keywords: Street Views, Artificial Intelligence Technology, and semantic segmentation

A portable indoor air detection box

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The purpose of this paper was to shorten the product update cycles of the household electrical appliances in the environment detection function. It integrated the required environmental detection sensors into a sensor box and managed it by a single chip microcomputer. The sensor box was transplanted into the existing household appliances and the data communication was carried out by the serial port. By integrating a variety of sensor boxes integrated into the existing air purifier to carry out the product update experiment, the manufacturer could save the time for the redevelopment of the air purifier and shorten the entire product upgrade period from the original 2 months to 3 weeks. This method could promote the research and development of similar household appliances.

Keywords: PM2.5 laser sensor, indoor air purifier, gas sensor, air monitoring

Symposium 17

Metropolitan Landscapes. Resilient articulation of the interface between city, agriculture and nature promoting the quality of dwelling and ensure the human well-being within the metropolis

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The necessity of a comprehensive and multidisciplinary approach to the study and the practice of metropolis became a common ground for our academic exchange in the past years. The Metropolitan Discipline supports the construction of the metropolitan spatial structure with an organizational, technical expertise, proposing the big project of urbanity based on the physical and virtual network between the new city shape, the interfaces among built capital and natural capital, and the new forms of conviviality.
The rapid urbanisation in the past few decades changed the scene of urban life on a global scale radically. Many critical issues have risen within the physical and spatial transformations of the metropolitan regions. Social and economic inequality, the fragility of environmental systems caused by the global climate change, the emergence of the political idea of the metropolitan dwellers as global citizens, preservation of cultural heritage, and the governance and policy issues are only a few of the issues that frame what we call 'the Metropolitan Complexity'. These issues cannot be addressed with a single, static, and traditional disciplinary approach, but rather require a comprehensive and multidisciplinary vision to understand them.
According to some scholars (e.g. Monte-Mor Roberto Luìs, 2014) we need to develop a different way of conceptualizing the new territorialities that are shaping the continent starting from an environmental perspective (the environmental question in its urban and metropolitan dimensions), to evaluate the relationship between city and countryside, the links between the metropolis and the region, as well as the settlement patterns in contemporary metropolises. One of the main objectives of the symposium is to open a dialogue amongst the participants to discuss approaches, tools, and case studies focused on the coexistence of urbanity and ecology.
The concept of Practice of Metropolitan Discipline is absolutely new. The specificity of the new discipline is in its field of action, where the starting point is higher than the local case. The idea is to bring the local case to an absolute generalization because the level of awareness of the local policy makers and civil servants has to be raised to the complexity of the metropolitan phenomenon.

P0145

The impact of composition and configuration of urban green space on its cooling effect

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Fortunately, urban greeneries besides their aesthetic values have been considered as an effective element to mitigate UHI through the cooling function. This study, in three phases, has focused on the cooling effect of composition and configuration of green space patterns in Olympic Forest Park of Beijing, china, by using field observation data, remote sensing images and GIS and statistical analysis. Firstly, we studied the effect of different composition of greeneries in green spaces. We found that trees, especially in combination with grasses or flowers on their beneath cover, could provide highest cooling effect than other greeneries. Secondly, the relation between green spaces configuration and land surface temperature (LST) has been studied. The result, in general, indicated a tight correlation between LST and land cover type. Urban water bodies and greeneries showed the lowest LST, while impervious surfaces such residential areas and roads showed the highest level.. Furthermore it was shown that surrounding area of the park was affected by the cooling function of the park and land cover type. In general, the cooling effect of the park had a negative correlation with increasing distance from the park. However, availability of greenery or water bodies could provide cooler LST for the remote area comparison with the area with the same distance and lesser greenery. Thirdly, we examined the spatial patterns of the ambient air temperature (AAT) distribution in the surrounding areas of the park, and its relation with distance to the park and urban greenery coverage. We found that AAT in the surrounding environment of the park are linked to the distance from the park and the green coverage. It is suggested that there is a correlation between air and surface temperature. This study provides important insights into urban planning and green space design to mitigate UHI through urban design and greeneries.

Keywords: Cooling Effect, Urban Green Space, Urban Heat Islands

P0144

How landscape planning can benefit from computational algorithm; introduction of process mining approach

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Landscape planning is a holistic discipline, in which practitioners simultaneously consider a variety of complex processes while designing their products. Among others, they consider the relationships with natural systems, the resilience to climate change and disasters, the adaptability to unplanned uses and unexpected evolution of society and culture, the adaptability to economic crises. In doing so, they rely on experience and on the literature of good practices, which support the prototyping of new context-sensitive approaches and forms for each site of intervention. The introduction of algorithmic tools could reveal information on emergent phenomena, previously observed empirically at a small scale, supporting practitioners in understanding site conditions and people's behaviour.
For bridging the respective domains, we propose the process mining algorithms as a tool to analyze and map behavioral patterns in the urban context. Process mining methodology extracts event logs through the dynamic behaviour of the process. The data gathered in this way could close the feedback loop to describe the performance of urban settlements in relationship to both natural systems and cultural phenomena.
Even acknowledging the limitations implicit in the use of Big Data to describe the urban environment,
the behavioural pattern/map concept is playing a key role in cross-designing approaches. For this reason, this research is focusing on possible ways of gathering information to design based on events as they take place and come about. The potential of learning from event gives a broad overview of the process to have improved planning.

Keywords: Process mining, Landscape planning, data gathering, learning from processes

Dynamic characterize of resilience in metropolitan city

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Nowadays, resilience has been a very popular term in academic or in public. It seems that resilience made more relationship with system dynamic change than sustainability instead. But how can we describe the resilience of a complex system? We suppose the relationship between quantity of local residents and different environmental elements can show the dynamic characterize of resilience.

We have chosen 10 variables from environment, social and economic, to represent a social-ecological system (SES). Environmental data were collected from Landsat data and MODIS data; social and economic data were collected from official Shanghai statistical yearbooks. Firstly, we modified a framework of evaluation model based on "Resilience Alliance' model", to combine these 10 variables together. Also, we used spatial autocorrelation analysis approach to examine pairwise correlations between them through each five years, from 2000 to 2015, in Shanghai, China.

We found that local residents have a strong cluster with other variables after year 2010, but the quantity of floating people did not show strong cluster with environmental variables. Especially, in 2015, the quantity of floating people decreased by 100 thousands in Shanghai, that means these people did not affect this metropolitan city as we have imagined. Either over-population or the pollution was already a serious problem in Shanghai, but the system can make an adaptive with such changes.

Our study proved that using spatial autocorrelation analysis of variables at a single point in time to help our understanding of resilience characterize.

Keywords: urban landscape ecology, resilience, pattern, effect, Shanghai

Landscape structure: a fundamental criterion to be considered when planning metropolitan areas

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The increasing global population enhanced the pressure over the world's urban areas, determining cities to constantly expand and merge into metropolitan areas in need of unbuilt land. As urban landscape became home for most of the people around the world, the urge for providing sustainable and liveable metropolitan areas is emphasized and promoted by scholars and policy makers. To achieve the expected quality of life levels in metropolitan areas, undisturbed and equally access to public and private services throughout the metropolitan areas should be provided to the citizens. Thus, the establishment of metropolitan areas must consider three fundamental criteria such as landscape structure, environmental and socio-economic aspects. In this paper we address the landscape structure as a fundamental topic in establishing metropolitan areas.

Since 2007 cities in Romania have declared metropolitan areas with neighbouring towns and villages. Until today there are 9 acknowledged metropolitan areas and 6 others in planning process, including Bucharest. The criteria on which the existing metropolitan areas where established were manly political and aspects regarding their functionality, liveability or sustainability where not considered priorities at that time.

In this paper we propose an assessment framework to determine if the existing metropolitan areas are meeting the landscape structure criteria. We compiled 9 indicators for the existing metropolitan areas to determine their functionality from a landscape structure perspective. The results showed that neither of the metropolitan areas fulfil the ideal landscape structure criterion. However, future researches aim in assessing the degree on which the metropolitan areas achieve the other two criteria (environmental aspects and socio-economic aspects) in order to establish if they are sustainable or not.

Keywords: accesibilty, urban planning, landscape indicators, Romania

Urban Betterment and Ecological Restoration: Urban Periphery Area Green Space Transformation- Case Study of the Heizhuanghu Area

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Since the reform and opening, China's urban construction has developed rapidly. After the city enters the stock planning, due to the lack of long-term planning awareness, many "metropolitan diseases" are left to be solved. To 1990s mid and late parts, "Periphery Area" has then become a highly contradictory area in the process of urbanization in China, as well as a lot of problems which produce along with it in aspects of society, economy, environment and so on also day by day become the chronic disease which affect the health harmonious development of city.

Periphery Area was the most sensitive to environmental change in urban spatial expansion, has witnessed the urban expansion and the problems brought by it. Green spaces in urban periphery area are the concentrated reflection of the relationship between human and land in this region. To this end, based on the "urban betterment and ecological restoration" strategy, the paper conducts research on urban green space transformation from the perspective of ecological exchange construction and optimization of human settlements.

The paper takes the Heizhuanghu in Beijing, which is in the process of "demotion and reform" as example, analyzes the possibility of urban green space development as a "participant", and establishes a spatial framework of the urban park groups. The study explores the guiding role of green space in integrating the space, inspiring the site and the future urban space in the process of high-speed urbanization. The study puts forward the basis of green space planning for urban Periphery Area, conducts multidimensional analysis in the context of social economy, industrial and land use planning, which reflects the super-scale and particularity of urbanization process in China. The spatial quantitative analysis method is used to establish the correlation between digital information and site spatial planning, and to further define the Urban Periphery Area landscape.

Keywords: Periphery Area, Urban metabolism, Landscape architecture, Urban betterment, Ecological restoration

Critical cartographies and datascapes for emerging metropolitan areas: testing 'Tell_me' research methodology for social cohesion and equity.

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In a non-large term, in many parts of the world, cities will face the challenge of leaving behind their identity as a community related to history and urban form. The growth, or the necessity for cooperation or administrative reasons, impel changes in what is considered one of the most immovable endeavours in the imaginaries: the feeling of belonging. In the development of a European Project Erasmus Plus K2 (TELL_me Training for Education, Learning and Leadership. Towards a new MEtropolitan discipline), our team focused the study of emerging new regions towards evaluating the goal of equity (instead of welfare) and social cohesion drew from the identification of dynamics. Using critical cartographies, a kind of representation of operational landscapes in the sense of Neil Brenner, upgrading a way inaugurated by Harley in the 80's with a political bias, we discuss the characteristics presented by 6 studies in the world (Tunis, Gulf of Öresund, Greater Bristol, Northern California Megaregion-San Francisco, Cádiz Bay and Valparaiso). In all of them, landscape plays a fundamental role that we can represent preliminarily as urban metabolism organizations, complex overlapping analysis and datascapes. The fieldwork, digital registration, processed treatment, public domain and powerful computation tools, as well as the shared results for comparisons, resilient strategies and homeostatic settlements, provide qualified information to insert in our protocol for entrusting how people assume this feeling of belonging to a new territoriality, new dimensions, uses in public spaces, mobility, heritage, conservation of natural areas, etc.
Equity as a goal divides its implementation into 5 principles in our protocol: Public realm (The Commons), Metropolitan Identity, Forms of Living, Environmental Justice and Communitas/Inmmunitas (Landscape, Right to the city, inclusion, emigration, etc.). Our paper will explain for discussing in the Symposium the achievements we got hitherto.

Keywords: Critical cartographies, Operational Landscapes, Metropolitan Areas, Urban Form, Social cohesion and equity

T0507

GIS Software modeling for localization strategies in planning activities

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The world population and urbanism are growing fast, often neglecting basic general planning rules. The 90% of the predicted growth in the next 3 decades will concern developing countries, in which the population of bigger cities will significantly increase, causing cumulative problems in the management of informal settlements and slums. These issues will also determine the intensification of inequality instances in different social classes. City managers need to focus on improving correct localization choices and spreading basic principles about safe health conditions of the built environment: mitigating natural and artificial risks related to settlements and housing will be one of the most important challenges in the next years.
The correct planning of urban contexts can help moderating some of the most important risks for human health, even in the built environment. The poor localization choices of settlements can even trigger multiple risks, causing significant effects and deaths reasons, that can be easily prevented by correctly teaching urban managers and citizens how to deal with these issues. The goal is to highlight a new planning and design approach for developing countries, using modern technological tools to drive conscious localization choices, even in highly fragmented urban contexts, where self-constructed housing is the standard.
Using modern choice tools means collecting highly specialized data, which are mostly unavailable in developing countries. Appropriate and accurate maps are necessary and structured databases are crucial to understand the specific needs of complex functions, according to specific elements in architectural/urban projects, referring to the local scale. The problem can be efficiently faced or improved using remote sensing imagery (at a suitable spatial resolution), specific software for classification and feature extraction, mapping tools, and geographic information systems (GIS).

Keywords: Developing Countries, Software modeling, GIS and remote sensing, Localization strategies, Planning rules

T0056

The role of urban form to achieve greener and more permeable matrixes in high-density cities

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In most of high-density and heavily built cities, formal greenspaces (eg. urban parks) has been shown to be not enough to provide proper area and connectivity to enhance urban biodiversity and ecosystem services. Besides, creating new urban greenspaces are difficult due to the lack of available lands for this purpose. Then, a matrix compound of many small residential greenspaces well-connected could be the key to improve the permeability for urban biodiversity, especially for birds. Even though, such strategy is challenging since studies worldwide have shown a negative relationship between urban density and green spaces. Our objective was assessed greenspaces from several kinds of urban residential matrixes built by different morphological design patterns across three high-density cities: São Paulo, Brasília, in Brazil and Berlin, in Germany. We evaluated the composition and configuration of the residential greenspaces through landscape metrics: land cover, average patch size, degree of aggregation and Euclidian nearest neighbor as a proxy of connectivity. Our findings revealed the significant role of urban form on the large variation of vegetation, mainly tree canopy cover. Considering urban matrixes at similar housing density level, we found out variations up to 88% in tree land cover percentage, 89% in average patch size (m^2), 65% in connectivity (average distance between trees in meters) and 22% in aggregation level. Our previous bird data surveyed in the same cities and morphological patterns (144 sampling points, 3 months of survey) corroborates that greener urban matrix also harbor higher bird richness. The results showed novel findings on how urban form influences the permeability of urban matrix, integrating the practices of urban planning and landscape ecology. They could also help decision makers in setting public policies and design guidelines for regenerated or new high-density urban developments to achieve more resilience and sustainability.

Keywords: greenspaces, landscape metrics, urban morphology, urban density, biodiversity

P0209

Transformations of the Corumbé stream: an analysis through the concept of Hemerobia

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The work has as its main scope to present an initial research about metrics that can aid the ecological planning of the urban landscape. In order to do so, it uses the concept of Hemerobia to investigate the transformations that took place over almost 80 years in the basin of Corumbé stream, located in the districts of Brasilândia, São Paulo/Brazil, in order to select the priority areas for a green infrastructure plan. The use of a case study was of fundamental importance to deepen the concept and made possible to broaden the understanding of the dynamics inherent to the urban landscape. Some caveats to the application of Hemerobia were observed. However, the benefits with its application are greater than its limitations, justifying its use as an auxiliary tool of analysis.

Keywords: Hemerobia, Green Infrastructure, Nature-City relationship, Corumbé Stream

Tropical Botanical Urban Landscapes Schools: lessons from Roberto Burle Marx's Botanical Garden in Maracaibo, Venezuela.

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This research begins at the Botanical Garden of Maracaibo (JBM), Venezuela, which was conceived in 1983 as a Garden School for the preservation of the Tropical Dry Forest and is the First School of Horticulture in Latin America, by Roberto Burle Marx and Leandro Aristeguieta.

Having achieved the reopening of the garden in 2013 after 20 years of closure, the first part of this article discusses how the tropical botanical garden defines its future. The goal is not to reach the recovery of an impossible past, but rather to guarantee the expansion and transformation of its pedagogical mission and key principals to the larger urban scale. Therefore, instead of considering historically significant landscapes as artifacts fixed in time and space, the quest shifts towards the processes that can sustain a transformative programmatic, botanic and aesthetic equilibrium in the long term.

The second part presents the 5 de Julio Landscape Master Plan as an example of how a hypothetical expansion of the JBM could work, based on 3 key principals:

a) The garden's phytogeographical structure which transforms into an urban learning adventure that takes citizens from the most arid life zones at the top of the avenue, through the different native forests and towards the waterfront.

b) The continuous water armature becomes a living support system and a substantial experiential device to connect the native forests;

c) The network of botanical centralities or urban moments of illusion and imagination, where the water armatures take more space and function as an oasis or as outdoor classrooms.

Finally the article goes back to the preservation of the JBM as transformation beyond the garden's wall. In this sense, the JBM has the potential to serve in similar situations by delivering a message of resilience and adaptation; one that emerges from a garden-school that builds itself, where 'practice is research' and where endurance is the celebration of the constantly transforming landscape.

Keywords: Tropical Urban Landscape, Modern Landscape, Cultural Landscape, Landscape of learning, Botanical Garden

P0044

China needs more re-habitats than US-Japan developed countries in mega-cities

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Chinese urbanization, one of the most important poles during global urbanization proceedings, is exerting profound influences. The people urbanization rate reached 58.52%, just beyond the world levels in 2017. However, a mass of impervious covers of buildings and grey infrastructures bring about multiple ecological problems and restrain urban sustainable development. It is necessary to rebuild biotic habitats by artificial recovery approaches, such as roof garden, vertical greening, and street & square planting, instead of the impervious areas so as for ecological restoration for biodiversity. The construction norms of urban greenspace system in China have made references from Western developed countries, but without simple copy. What are the special differences between China and US-Japan to revegetated habitats? This study took Shanghai, New York and Tokyo as metropolis cases to analyze the eco-socio-economic differences. The specificities of Shanghai include serious ecological environment problems and deficit green infrastructures; low per capita eco resources and few spaces for improvement; and higher wishes for nearby greening and street & square planting. The causes of specificities are the low stage of development; massive population size; special policy of population migration and census register; high building density and large impervious area; decades of statutory birth control; special urban planning and land policy; and inherent defect of ecological resources. In conclusion, the high-density centralized housing mode strictly confined within built-up area is a typical and dominant form for Chinese urban inhabitants, so that far higher population density and lower per capita greenspace resources in China than that in developed countries. To reduce the eco deficit, Chinese cities should rebuild more habitats. The international comparison is significant for Chinese urbanization to find optimal China models to build a resilient city.

Keywords: urbanization, rebuilding habitat, resilient city, ecology, Shanghai

Mixed Urban-Rural Landscape: Focusing on the Housing-Farmland Interfaces in Tokyo Suburbs

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Although a clear separation of urban and rural has been the key of modern urban planning, re-introducing agriculture as an essential element for the city is becoming to be a world-wide movement. However, Asian cities have historically been characterized by landscapes with urban-rural mixture. As the mixture patterns are diverse interfaces between farmland patches and houses surrounding them may also be diverse. Such a diversity in the interface is a clear reflection of dynamic interactions between urban and rural communities. This paper aims to discuss rational urban-rural mixture patterns by investigating spatial characteristics of housing-farmland interfaces by having the suburbs of Tokyo as case studies.

Seven sites, 1km diameter circle each, in Tokyo Metropolis were set by considering farmland types. Facade design of houses and the boundary shape of farmland patches were identified by conducting field surveys. Relationships between farmland types and the openness of house facade and boundary shape were analyzed, and rational urban-rural land use mixture patterns were discussed.

The openness of houses towards farmlands was determined by the farmland types: 68% of houses with orchards and vegetable farms on their southern neighborhood had terraces, and the number increased to 74% when facing to nurseries while decreased to 54% when facing to greenhouses. Perceiving from the openness of farmlands, orchards were significantly closed as 54% of them were surrounded by walls or nets taller than 2m, while merely 10% of vegetable farms, 6% of nurseries, and 8% of greenhouses were surrounded by such barriers. These results show that the interfaces of greenhouses and orchards reflect the conflicts between urban and rural communities, compared with those of vegetable farms and nurseries. In order to mitigate the conflicts and lead the rational urban-rural mixture, it is important to consider the design of housing-farmland interfaces by installing buffer zone for example.

Keywords: interface design, urban farming, facade, mixed landscape, Tokyo

On continuity: the landscape unit and eco-centrality

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As cities expanded by far-reaching their grasp on the territory, the boundary between built and unbuilt, once existed as a single line of a wall, became broader with greater ambiguity. Rapid urbanisation produced spaces that cannot be explained or described with the traditional definitions of built/unbuilt or urban/rural and failing to identify the post-modern marginal space resulted in neglecting these space from the metropolitan narrative. The research aims to identify these in-between spaces and study the perceptive, social, economic, and environmental values of them through case studies and define the landscape unit that recognises the building block of a metropolitan region. In particular, the paper attempts to explore the landscape unit in the extended metropolis of Chennai and Kolkata metropolitan regions in India. Starting from the concept of Canadian geographer Terry McGee's desakota pattern, the landscape unit of green-grey infrastructural continuity is identified using the metropolitan storyboard and semantic package. By introducing the model of the circular economy, a pilot project connecting the family agricultural industry in the desakota area to the global fair-trade market is proposed with a wetland reconstruction project as a new public eco-centrality. By focusing on the continuity of green-grey infrastructure and the metropolitan landscape unit, the pilot project demonstrates a new kind of public space that is productive and experimental and yet ecologically resilient in the era of climate change.

Keywords: landscape unit, metropolitan project, green-grey infrastructure

The effect of configuration on urban heat through edge effects between patches: Multiple-scale assessment through high resolution thermal imaging

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While an effect of urban vegetation configuration on land surface temperature (LST) has been identified worldwide, the mechanism underlying configuration-LST relationships remains unclear as most urban LST data only resolve to neighborhood scales. We evaluated how configuration causes neighborhood scale cooling through a multiple scale analysis spanning from within individual patches to among neighborhoods using high resolution thermal data (7m) in the Phoenix metropolitan area, Arizona, USA. Here we ask: does urban vegetation provide more cooling arranged in fewer and larger patches or more numerous but smaller patches? We hypothesized the combination of energy exchanges between adjacent patches and microclimate cooling induced by vegetation is a key factor determining how configuration affects LST. We found tree cover is the dominant factor influencing urban cooling and that configuration also substantially effects cooling. The effects of vegetation cover and configuration on LST were scale-dependent and reflect differences from individual patch to among neighborhoods. Nevertheless, our findings suggest more edge area strengthens energy exchanges between vegetation and surroundings and more vegetation core area leads to greater cooling within individual patches. Greater edge density and shape complexities of vegetation patches cool the landscape but warm individual vegetation patches. Conversely, increasing individual vegetation patch size and reducing shape complexity led to cooler vegetation patches but a hotter landscape. Through applications of high resolution thermal remote sensing, we are able to more directly connect effects of land cover composition and configuration to LST distributions that can help cities plan and evaluate local climate distributions.

Keywords: Urban green infrastracture, landscape configurations, urgan heat island

Symposium 18

Temporal dynamics in landscape science: New applications and opportunities in social-ecological systems

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One of the greatest challenges in the Anthropocene is the design and implementation of development strategies that enable human progress while ensuring the sustainability of Earth's systems and biodiversity. Solutions will require an understanding of the spatial, temporal, and social dynamics within complex landscapes. However, landscape ecology has primarily focused on the spatial dynamics of landscapes with limited consideration of the temporal dimension. Given the rise of climatic and human impacts on landscape function, there is a critical need to identify and predict temporal processes and their impact on social-ecological systems. Improving our understanding of temporal drivers and characteristics of landscape pattern and process will require theoretical and technological advancements. These findings will enable new spatiotemporal design and management opportunities that can better address dynamic social and ecological needs.

This symposium will present and discuss novel approaches that investigate the role of temporal dimensions in social-ecological landscapes and implications for planning and management. We welcome contributions that:

• Develop novel methods and ideas to incorporate temporal dimensions into landscape and conservation planning.

• Analyze how landscape change affects the spatial distribution of resources and ecosystem services over time.

• Explore the role of social-ecological dynamics and land use legacies into current and future landscape trajectories.

Transformation of land use in an agricultural landscape on landscape structure and soil based ecosystem services over the last 250 years

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Landscape structure and ecosystem services (ES) in the agrarian ecosystems have changed fundamentally over the last 250 years. The landscape structure analysis of a typical agricultural landscape near Leipzig (Germany) shows that arable land area increased from 73.4% (1750) to 87.2 % (2005) and grassland decreased from 22.1 % to 4.2 %. ES provision change analysis is based on the indicators crop production, natural soil production capacity, soil degradation caused by erosion hazards and biodiversity. ES analysis resulted e.g. in a significant increase of winter wheat production since 1750. However, natural soil production capacity has degraded and the actual erosion risk hazard strongly increased. Between 1750 and 1850 a high biodiversity level is found, followed by a slight decrease in the second half of the 19th century. Landscape transformation since 1960 by vegetation structure destruction has brought habitat degradation and a dramatic biodiversity loss. Driving forces analysis clarifies the impact of land use changes by Prussian agrarian reforms, industrialization, technology and land management innovations, Kolkhoz system and Common Agricultural Policy. The land use change and ES analysis uses digitized historical GIS-data, serial cadastral maps, historical soil assessment maps (1864, 1937) and documents in time steps 1750, 1850, 1950 and 2005.

The study combines digital map data, landscape ecological modeling of landscape related risks, ecosystem services analysis, landscape structure analysis, driving forces analysis based on drivers' and historical data entrances for a better understanding and interpretation of landscape and land use transformations in a complex world. Ecological, social, governance and economic dimensions are faced to clarify long term changes and the main causes of landscape transformation.

Keywords: Long-term degradation of ecosystem services, cadastral map analysis, historical soil assessment, landscape structure change, land use change

The Connected Nature of Landscape Transformation: A case study of Asian Carp

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Growth machine theory has provided an influential foundation for thinking about the political economy of landscape transformation. It remains silent, however, on how Anthropocene dynamics can connect landscape transformations in multiple places, disrupting political, scientific, cultural, economic and other social processes en route. I address this gap by advancing a modified "incorporated comparison" of the Asian carp invasion, an invasive species event generated by several landscape transformation in previously separate places that generated significant social turmoil in the American Midwest. Empirics draw from document analysis and 71 semi-structured interviews. Results illuminate how local place-making and landscape transformations can connect in contingent ways to render nature a powerful force in subsequent battles over both social and landscape change.

Keywords: Growth Machine Theory, Methodological Cityism, Environmental History, Invasive species

T0641

The tragedy of the parks: lessons for protecting nature in post-conflict Colombia

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Peace in post-conflict areas produces diverse and complex impacts on natural resources, in some cases leading to reckless development at the expense of nature. This has led to a mystifying underground narrative among some conservation circles and news platforms that unintentionally links peace to conservation tragedy. We use the emblematic case of Colombian protected areas (PAs) in the postconflict to illuminate such points, and to provide lessons to other countries that we hope will themselves be entering their own post-conflict world. We studied trends in deforestation before and after the year of the peace agreement with the FARC army, using Hansen et al. Global Forest Change dataset. We found that in the Colombian parks deforestation extent increased from the last years of the conflict (2014-2015) to the two years of postconflict (2016-2017) by 114%, numbers that further increase in parks' buffer areas. Deforestation in Colombian parks has accelerated with the onset of peace, being that several historical deforestation factors are now magnified by the exit of the FARC army. To counteract these alarming dynamics several steps should be urgently taken : i) a coordinated strategy among the relevant State institutions to make law application effective, ii) the urgent re-establishment of a physical and legal presence inside PAs, iii) the definition of a policy of formalization of land property outside the protected areas, and iv) the promotion of community-based local sustainable economies.

Keywords: conservation, Colombia, landscape fragmentation, postconflict, biodiversity

T0828

Pines stand still, vines move: Century-scale dynamics of a mountainous mediterranean landscape

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The study traces the dynamics of a mountainous mediterranean landscape of Cyprus, consisting mainly of pine woods and agricultural fields. The area is known for its wine production for ages. Our hypothesis was that the preservation of the identity of the social-ecological system formed around wine production would be reflected in the landscape as continuity in its structure.

This hypothesis was tested by means of two maps providing information on land cover, published in 1885 and 1969, agricultural census data (some dating back to the 16th century), the EU CORINE and LUCAS databases as well as by visually inspecting remote sensing images of selected parts of the study area.

The main finding was that different landscape elements have evolved in distinct ways. Pine woods exhibited remarkably little change throughout the study period, considering the time frame and that mediterranean pines are relatively opportunistic short-lived trees with great dispersal ability. Vineyards constitute a significant part of the landscape; they have migrated from terraced slopes to level fields from which they were practically absent in the 19th century. Terraced fields on slopping ground, previously massively cultivated with vines, were abandoned altogether. The second half of the 20th century seems to have been a tipping point; more extensive change can be traced between 1969 and the present date than between 1885 and 1969. Thus, the hypothesis of landscape stability was confirmed with respect to woodland but not with respect to agricultural land.

The local social ecological system has successfully adapted during the time of agricultural intensification that occurred during the second half of the 20th century by reorganising the space used for agricultural production. On the contrary, forested areas exhibited continuity in time and space, probably reflecting the protection policies enforced by the British administration and that of the Republic of Cyprus that succeeded it.

Keywords: Mediterranean landscape, pine woods, vineyards, historic maps, landscape dynamics

T0010

Examining socio-ecological connectivity through urban garden networks across varying cityscapes

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Connectivity of socioecological systems across urban landscapes can promote the resilience of communities and ecosystems to change. Community gardens are socio-ecological systems where residents cultivate food and interact with one another, and associated biodiversity is supported. Despite their importance as hubs of socio-ecological processes and socio-ecological connectivity, these systems are often temporary in the landscape. This research uses gardens as a model system to investigate how socio-ecological systems may facilitate landscape-scale socioecological connectivity and ecosystem service flows over time and space in relation to landscape heterogeneity. In three US cities (Baltimore, Chicago, New York), we show that the biophysical and social features of the landscapes control the strength and direction of ecosystem service flows. Baltimore and Chicago are largely driven by biophysical connectivity but New York has high contributions of social connectivity; this drives differences in connectivity directionality. Though NYC had the highest amounts of connectivity in areas with gardens, it also has the lowest in some neighborhoods, indicating that there are many areas in the city that have no gardens, and a high variation in connectivity across the city in relation to garden nodes. We highlight how such analyses can be applied to enhance landscape connectivity over time and space.

Keywords: connectivity, social-ecological systems, community gardens, ecosystem services, urban landscapes

T0862

Land systems on the move: A new spatiotemporal data-driven approach on land system modelling applied to the Mediterranean basin.

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Land system science is a widely recognized framework for modelling complex social-ecological systems. A full integration of the spatiotemporal dimension at the heart of land system modelling however remains a major methodological challenge, especially when large scales are involved. The difficulty of this task lies in the need to simultaneously take into account the statistical relationships between a set of heterogeneous data within each spatial unit, the ways these units interact at several spatial scales, and how they vary through time. In this line of thought, we propose an innovative and reproducible exploratory spatial data analysis method to model land system spatiotemporal trajectories, from micro to macro scales. In this approach, each spatial unit is described at the same time by its own inner characteristics and by those of its neighborhood at several scales. These characteristics consist in a set of land use, agricultural, environmental and socio-economic variables indicating the structure of this unit and of its neighborhood at time t, as well as the nature and the intensity of the changes they experienced between t and t+1. This set of indicators is then classified through data mining algorithms adapted to processing very large datasets, and spatial statistics. The output is an original typology of land system spatiotemporal trajectories that can be mapped at a fine resolution and interpreted thanks to its substantial number of multidimensional variables.

This approach is applied to the whole Mediterranean basin at a 2 kilometers resolution in order to highlight the spatiotemporal patterns of the ongoing changes in land use, agricultural systems and management practices. We propose to show its aptitude to analyze Mediterranean land systems' spatiotemporal trajectories in a more dynamic and integrated way than classical models, and to describe subtle spatiotemporal phenomena usually not visible at such a large scale.

Keywords: land systems, spatiotemporal trajectories, exploratory spatiotemporal data analysis, Mediterranean basin, data mining

P0095

Evaluating temporal changes in landscape connectivity for Alouatta caraya (Primates: Atelidae) among forest fragments in Pampa biome, south Brazil

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The black-and-gold howler monkey (Alouatta caraya) is widely distributed in Brazil, Bolivia, Paraguay, and northeastern Argentina. Despite its wide distribution, it is locally threatened in some parts of its range due to forest loss and fragmentation, and yellow fever outbreaks. In southern Brazil, A. caraya is highly associated with the Pampa biome, a steppe savanna physiographic region, characterized by grassland landscapes with trees concentrated along riparian forests, small valleys and slopes. The predominant economic activities are agriculture and extensive cattle raising. Only about 3% of the Pampa is protected, the smallest proportion of all Brazilian biomes. Our study analyzed the changes in habitat connectivity for A. caraya through a time series of land use/land cover maps (2002, 2009 and 2015). We used maximum entropy (Maxent) to model the species distribution and to determine the location and size of suitable habitat. For connectivity analyses, we created a resistance raster using five layers: land use/land cover, slope, and distances to roads, rivers and urban areas. The relative values of each class inside the layers and the relative weight of each layer were determined by specialists (n=29). A least-cost-corridor analysis for the focal species in each year was performed using Linkage Mapper 2.0 ArcGIS tool. We considered as nodes all native forest patches with an area higher than 100ha. Graph-based connectivity metrics were estimated using the software Conefor Sensinode 2.6. The results indicated a progressive increased in habitat connectivity between 2002 and 2015. However, the Probability of Connectivity (PC) was very low in all analyzed years. This context requires attention in regional landscape planning and howler monkeys conservation programs, especially in relation to the preservation and restoration of riparian forests, which are essential to maintain species habitat and connectivity among its populations in the Pampa biome.

Keywords: howler monkeys, funcional connectivity, CONEFOR, least-cost models, habitat fragmentation

T0049

Designing spatiotemporal multifunctional landscapes to support dynamic wildlife conservation

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Society is faced with the challenge of managing limited spaces for multiple social and environmental needs. Identifying opportunities to align social and environmental needs is thus a transdisciplinary design challenge. To meet this task, we present the concept of spatiotemporal multifunctionality (i.e., the provisioning of more than one social or environmental function in a given place at different times) and demonstrate how integrating principles of landscape ecology, social-ecological systems, and land system architecture enables a dynamic approach to landscape design and planning. Such an integration is capable of providing conservation tools for diverse social-ecological systems to maximize spatiotemporal multifunctionality. We use migratory birds as a working example to present a dynamic conservation opportunity and related challenges. By adding a temporal component to land-use classification in areas of high human use, we demonstrate the potential to enhance land-system sustainability and promote human-wildlife coexistence in a changing world.

Keywords: coexistence, social-ecological systems

Socio-ecological systems: Identification and spatial mapping in the Central Himalayas

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The Himalayas are complex socio-ecological systems (SESs) characterized by high natural disaster risks and extremely high vulnerability of local communities. The region is characterized by a wide diversity of altitude, climate, land form, biodiversity, ethnicity, culture, and farming system resulting in complex relationships between its social and ecological sub-systems. Understanding the systemic interactions and its adaptation capacities are crucial for integrating and formulating effective programs and policies to ensure human well-being and protect nature. The aim of the presented research is to identify and map SESs and their boundaries and addresses the questions which major types of SES can be delineated and what are characteristic properties of these systems. The study region for which initial results are presented is situated in the state of Uttarakhand, India. The presented mapping and delineation approach for the SES merges socio-economic and ecological data and includes a validation of the system boundaries. Initial outcomes to be presented are an advanced method for the delineation of the SES boundaries as a means for informing later on policy, planning and decision making. The latter addresses particularly site-specific adaptation strategies to reduce the risks from changing climate. The outcomes will help in recognizing local needs and gaps in existing policies and institutional arrangements. To be able to understand different socio-ecological units, a further meta-analysis of the units is recommended.

Keywords: Socio-ecological systems (SESs), SES boundaries, Policy, planning and decision making, Multivariate analysis

T0206

Spatiotemporal overlap of pesticide use and species richness in California, USA

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The consequences of agricultural pesticide use for ecological and environmental health are partially determined by the alignment of pesticide use, in space and time, with ecologically important areas. Yet, data limitations have inhibited understanding where and when high levels of pesticide use occur, and when and where high use overlaps speciose areas. Combining detailed, daily pesticide use data (2.6km2 spatial resolution) from the diverse agricultural regions of California with species richness data for several taxa including birds, mammals, amphibians and reptiles, we evaluate the location and persistence of pesticide use hotspots, and where and when they align with high richness areas. Hotspots of pesticide use were generally located in agricultural valleys, as anticipated, yet were surprisingly ephemeral. Between 0-5% of species richness hotspots intersected annual pesticide use hotspots depending on the focal taxa, whether or not richness was determined from range maps alone or from habitat suitability and range maps. The level of overlap also varied over the growing season, peaking for most taxa in May through July. Considering the spatial and temporal heterogeneity in both pesticide use and biodiversity is important to focusing monitoring and mitigation efforts to reduce the ecological impacts of pesticide use when and where they actually occur.

Keywords: agrochemicals, agrobiodiversity, hotspot analysis, temporal heterogeneity

T0250

Designign Soil in the Antropocene era - Territorial upgrade through the reinterpretation of “soil consumption” in the framework of landscape resilience

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The millennial transformations of the territory have modified soils structure and composition, threating some ecosystem service functions essential for the support of the human habitat. It drives to a rethinking of the territorial management which is translated into a revision of the planning practice with the aim to protect the soil resource.
EU introduced "zero net soil consumption" as a target for 2050. EU member States follow the directive in urban and territorial planning policies.
In Italy the concept of soil consumption is defined "as a variation from a non-artificial cover to an artificial cover of the ground". The approach is extremely prescriptive and lacks of a systemic vision.
There are conceptual and operative limits in translating the objectives into effective planning and design tools.
It’s suggested a critical reinterpretation of soil consumption, starting from the investigation of different spatialities (soil, subsoil, surface) instead of just limiting the concept of artificial cover. The attempt is to combine the relationship between pattern and process in land-use change on several horizon, with territorial and urban planning practice. To promote the contribution of soils to ecosystem services, it has to become design element. This way the transformation of soil becomes the starting point for territorial planning, instead of being the mere result.
As verification tool we refer to the methodology of Scenario Evaluation by Design, through the comparison of the traditional and the proposed approach.
The result will be the design of renewed and highly contextualized landscapes, as result of conscious and sophisticated actions.
This interdisciplinary approach allows a territorial upgrade to contemporary objective and needed, increasing the level of compatibility between the evolution of the human habitat and the natural environment.
Soil studies could be used in local and national policy development and program on natural resource use and management.

Keywords: soil, scenario planning, renewed landscape, ecosystem services, design

T0934

Integrating different time scales in the analysis and cartography of cultural landscape units in the mountain systems of Northwestern Portugal: Arga Hill as a case-study.

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An interdisciplinary analysis of the evolution of the cultural landscape of Arga Mountain (Northwestern Portugal) revealed the influence of geological time-scale processes and historical dynamics on the shaping of present landscape character.

The adopted methodology, bringing together geomorphologic and historical approaches in landscape analysis and cartography, deepens the understanding of the interaction between geomorphological features and processes with historical events in the shaping of cultural landscapes.

Nowadays landscape reflects an evolving legacy that resulted from locative options, settlement patterns, agrarian structure, defensive strategies, development of communication networks and exploitation of natural resources, which imprinted its marks throughout different historical periods. The main stages, drivers and processes of cultural landscape evolution were identified. The Neolithic revolution, the Hillforts Culture, the Romanization, the Middle Ages, with the implementation of the manorial system, the deforestation triggered by naval industry of the 16th century and the denominated "corn revolution" of the 17th century stand out as the crucial periods of landscape's evolution in the mountain of North-western Portugal, before the acceleration of landscape transformations that started to change the face of rural areas in the second half of the XX century.

Therefore, the cartography of cultural landscapes unities, was grounded on the crossing of several georeferenced data layers such as soil map, elevation, slope and soil use, including the correlation of the geomorphological outline with the cartography of historical and archaeological remains, in order to assess how did geomorphology played an important role on the strategic occupation of the territory by human communities.

This research work underlines the importance of addressing time dimension in landscape characterization, classification and management.

Keywords: cultural landscape, time-scales, landscape shaping, history, geomorphology

P0154

Land-use change in oil palm dominated tropical landscapes - An agent-based model to explore ecological and socio-economic trade-offs

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Land-use changes have dramatically transformed many tropical landscapes from forest-dominated to agricultural landscapes. Agricultural land uses, such as rubber and oil palm plantations, increase economic benefit at the cost of reduced ecological functions. Our study area is located in Jambi, Indonesia, where land-use decisions are mainly driven by smallholder farmers, creating a spatio-temporal landscape mosaic. Here, we investigate the spatio-temporal interactions, feedbacks and trade-offs between economic and ecological functions of the landscape mosaic. Based on field data from the EFForTS project (www.uni-goettingen.de/efforts), we develop the integrated, agent-based model EFForTS-ABM to analyze how land-use change affects ecosystem functions.

The economic module simulates smallholder land-use management decisions based on a profit maximization assumption. Heterogeneous farming efficiencies and learning dynamics incorporate the heterogeneity of households in knowledge and experience. The ecological module currently includes a simple account of carbon sequestration in above- and below-ground vegetation. To better understand the importance of heterogeneous farming efficiencies and learning under different output prices, we contrast realistic assumptions on farming efficiencies and learning with model scenarios where all households perform optimally.

Land-use change towards the more profitable crop was mainly driven by the output prices for rubber and palm oil. However, heterogeneity of farming efficiency created inertia of land-use change and asynchronous behavior of smallholder households. In general, model scenarios with higher inertia resulted in more stable landscape mosaics and carbon stock dynamics. The interactions between economic and ecological functions are not trivially straightforward, underlining the need of exploratory tools like EFForTS-ABM, which help to gain an understanding of such complex dynamics.

Keywords: land-use change, agent-based model, smallholder agriculture, Indonesia, Oil palm

T0241

Change in aesthetic value of landscapes over the last 150 years

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During the last century, a major landscape change initiated in many parts of the European Alps due to significant socio-economic developments. Before 1950, the landscape was mainly used by agriculture and forestry, whereas after 1950, the landscape was increasingly used for touristic purposes. Nowadays, in many Alpine regions, income from tourism has become highly important, which has led to an expansion of the tourist infrastructure. A similar development can be observed in many mountain regions worldwide. These changes have wide-ranging effects on ecosystem services provided by mountain environments, including aesthetic values that are an important factor for attracting visitors. On the example of the municipality of Sölden (Austria), this study evaluates the historic development of aesthetic values from a today's perspective considering the changes in the road and path infrastructure. Our results indicate that increased accessibility resulted in a general increase in the supply of aesthetic values until 1950, as many new roads and paths were constructed in higher elevated areas, particularly in aesthetically attractive landscapes. Although the accessibility to high-elevation areas continued to increase until 2017, aesthetic values rather decreased because of altered landscape patterns, resulting from the forest increase and decline of glaciers. In the future, the supply of aesthetic values is likely to be affected even more severely due to further landscape changes and reduced access to landscapes of high aesthetic values due to difficulties in the maintenance of hiking trails. As similar developments occur in other mountain regions worldwide, our results can serve to highlight general implications of increasing tourism and declining agricultural activities.

Keywords: Spatio-temporal dynamics, Cultural ecosystem services, Landscape pattern, Accessibility, Landscape change

T0547

Conceptual approach for analyzing the landscape dynamics in agricultural areas

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The dynamics of the landscapes can be analyzed in terms of changes in their condition within a certain temporal range. This study examines the seasonal dynamics of alterations in the vertical structure of the landscapes in agricultural areas. The agro-landscapes are characterized by intense dynamics in terms of changes in their vertical structure within one year, i.e. one seasonal cycle. A conceptual approach is proposed in the analysis of the transformations of the vertical landscape structure. For the purposes of this study, exemplary patterns of different types of agro-landscapes are reproduced. The specifics in the seasonal dynamics of the landscape units are defined and the main differences between them are differentiated. The analysis is based on the landscape-ecological approach. Methods of field investigations such as landscape mapping, route-expedition descriptive methods, and cartographic methods for spatial analysis in GIS environment are applied. Conceptual approaches have been synthesized in the analysis of the landscape dynamics on the basis of tracking the changes in the condition of each of the geocomponents constituent for the systems. Inter-system relations and inter-system interactions and the role of complex system-forming and system-supporting processes in determining the specific peculiarities of the dynamic seasonal transformations, taking place in the landscapes, are analyzed. The main results of the investigation represent the analysis of the condition of the landscape components during the different seasons, taking into account the specifics of the agricultural activity. The relationship between the types of agricultural activity and the nature and the degree of transformation of the structure of the agro-landscapes is established. The present research can serve as a representative conceptual foundation in the analysis of most of the types of agro-landscapes existing in temperate natural conditions with four annual seasons.

Keyword: landscape dynamics

T_9005

Social and ecological factors and consequences of the rural settlement pattern transformation in North-West Russia on the turn of the Middle Ages and New time

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Despite a high variability of the natural environment within the forest zone of Europe the initial distribution of plowing agriculture in the forest zone resulted in an amazing uniformity of agriculture and monotony of economics. The difference can be found only in peculiarities of selective spatial agricultural land use, which stands in close relation with spatial settlement pattern.

The area of North-West Russia had been under the last Valday (Würm) glaciation and, thus, was characterized with very contrast and varied geology and topography, young poor developed and usually bogged river valleys. In the course of agricultural development of Valday highland and up to the 16th century little villages (1-3 households) surrounded by arable lands at a short distance looked like little patches scattered here and there within moraine loam sandy hills out of boggy river valleys. Nevertheless, during the 16th-17th centuries cadasters recorded sharp diminishing of a number of settlements within North-West Russia. Many social disasters generally called “Troubles” were the reason. As a result, a number of settlements became 5-10 times less. After the end of Troubles, economic renewal took place, but the previous settlement and spatial agricultural patterns were never restored. Instead of numerous little settlements peasants lived in rather large but rare villages at first near fortresses, where they were protected from enemies and numerous “evil people” appeared during Troubles. Besides, the government needed soldiers, and it gave them land and peasants as a service award. These new landlords had to protect and control their peasants and large villages were more suitable for this task. The change of the settlement pattern led to the abandonment of previously cultivated agricultural land, which was far from a new network of settlements. Subsequently, this led to an excessive load on the land near the settlements, while the remote lands left the agricultural circulation.

Keywords: Rural settlement pattern, agricultural land use, plowing agriculture, Troubles

P_9073

Ecological footprint of country houses and their role in changes in suburbanized landscapes in central Russia

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The last decades in many regions of Russia have been marked by active expansion of a city into the suburbs. Seasonally-returnable dezurbanization – life in two houses, in the city and in the country, – has become most prevalent. This leads to excessive anthropogenic pressure and a number of environmental problems associated with water use, waste management, etc., to changes in the suburban landscape itself.

The purpose of the work was to assess the anthropogenic impact of modern country and summer houses in the suburban area of Vladimir city in central Russia.

The dynamics of changes in the boundaries of settlements of the peri-urban area was investigated. Since 1987, the total area of settlements within the 20 km zone around Vladimir has increased in 2.5 times. Agricultural and forest lands are transformed into residential and recreational areas. Most of the urban dwellers in the region own country real estate, summer or country houses, actually doubling their living space. As a result, there is an additional anthropogenic load on the ecosystems.

Assessment of Ecological Footprint (EF) of various types of households in the region has been done on the basis of statistical data and the results of surveys and interviews. The method of EF calculating complies with the standards of the Global Footprint Network. The EF analysis allowed us to estimate the anthropogenic impact of the "household-dacha" system and identify the role of the second, country house in the formation of the household's integral EF.

A comparative EF analysis of households of different types showed that life "in two houses" is the most burdensome to nature, since it requires the greatest expenditure of natural resources. The maintenance of second residences increases the Carbon footprint, the demand for forests and pastures.

Keywords: peri-urbanization, ecological footprint, second houses, landscape's changes

T0164

Combining paleoecological knowledge and trait-based ecology for the sustainable management of agroecosystems

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Agricultural ecosystems have evolved over thousands of years and have existed in many forms, with different degrees of success. Nowadays, agricultural land covers almost 40 percent of global land surface and therefore greatly impacts the environment, both ecologically and socially. To manage sustainable agricultural ecosystems in the face of current climatic, socio-economic and environmental changes, it is important to learn how humans alter the ecological functions of agricultural ecosystems, such as water regulation and nutrient retention. Several studies have suggested that the use of functional traits, instead of species nomenclature, allows for a more mechanistic understanding of ecosystem functioning. Modern trait-based studies allow for 'high resolution' study of ecosystems, but are not able to study the consequences of changes in functional composition over longer timescales. Paleostudies provide a rich amount of records on past plant composition as well as proxies on past ecosystem functioning. This enables the study of long-term ecosystem functioning and resilience. The trait-based approach has rarely been applied in paleostudies. This study evaluates the application of functional traits in paleostudies to increase the understanding of the effect of agricultural management on ecosystem functions on long time scales.

Keywords: paleoecology, plant functional traits, agricultural ecosystems

Symposium 19

Promoting Ecosystem Services for Sustainable Development Goals

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The pursuit of human well-being is one of the primary objectives for sustainable development. It is therefore unsurprising if well-being becomes a main focus of public policies and interventions, including those on the United Nations 2030 agenda, such as the 17 Sustainable Development Goals (SDGs). The SDGs represent an agenda to increase human well-being by, for example, ending poverty (SDG 1), while protecting the environment from degradation (SDG 14 and 15). Although the empirical relationships between environment and human well-being are not yet well understood, in the recent years, natural environment and human wellbeing have been increasingly linked with the provisioning of ecosystem services, defined as benefits that humans gain from the well-functioning ecosystems. Ecosystem services bridge the natural environment and human well-being, and provide the base for sustainable development. These services include for example the provisioning of clean air and water, fertile soil for crop production, pollination, and flood control. In the environment and sustainability literatures, many of the SDGs, such as Zero Hunger are likely underpinned by the delivery of one or more ecosystem services. To ensure the availability of food, we depend on ecosystem services such as food provisioning, moderation of extreme events, maintenance of soil fertility, biological control and pollination. Yet linking between different ecosystem services is complex because there must be interactions and trade-offs between different ecosystem services. Such complexity is added by the fact that much of human economic and social development has come through unsustainable use of ecosystems and their services. With complex environmental problems, sound environmental management which based on sustainability principles is required to restore, sustain and enhance the flows of ecosystem services to humanity. In this session, we invite multi-disciplinary research to improve our understanding on how human, through their contribution on sustainable practices can improve different ecosystem services using cost-effective interventions. Such research will be essential for planning synergistic actions to achieve multiple development targets of SDGs particularly in the developing countries where environmental costs often become a barrier to meet the development of sustainable practices. Research that contributes to a sound understanding on how interactions between ecosystem services can contribute to individual or multiple SDG targets will also become the priority. Preference will be given to studies that focus on biodiversity and ecosystem conservation, which form the basis of two SDG goals (14 and 15). These two SDGs become our priority because all SDG goals will likely benefit to some degree from ecosystem protection, restoration and sustainable use. They also contribute to human well-being and underpin the achievement of all other goals. Considering our environment is the constituent of our well-being, the outcomes of these studies can be used by policy makers to embrace planning and development approach where the environment is managed to achieve sustainability objective.

The effect of climate and land use change on global soil erosion

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Soil erosion by water is a great environmental threat at global scale. The changes of climate and land use have been found as two primary factors to accelerate soil erosion. The objective of this study is to estimate the effects of climate and land use change on soil erosion at global scale. The global soil erosion is simulated based on RUSLE (The Revised Universal Soil Loss Equation) for every 10 years from 1980-2017. The global soil erosion rates tends to decrease during the last four decades, but the trends vary among continents and land use types. The soil erosion rates in South America are considerably high and the values are low in Europe and Oceania. And croplands have the highest soil erosion rates while forest lands have the lowest. The results show that both climate change and land use change affect the soil erosion at global scale. It is an effective approach to improve the vegetation cover fraction in areas where soil erosion is severe.

Keywords: soil erosion estimation, global soil erosion, climate change, land use change

The spatial relationship between landscape recreation service demand and urbanization

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In the traditional ecosystem service evaluation, non-material services such as culture and recreation services are difficult to accurately quantify due to lack of a powerful evaluation model. Compared with ecosystem services, landscape services emphasize all the tangible and intangible services that landscape ecosystems provide to humans in the spatial pattern. Social media photos can be used for perceived services demand evaluation on the landscape scale. The study of spatial relationship between recreation service demand (RSD) and urbanization complements the integrity of the landscape service supply and demand relationship framework.

Firstly, this paper analyzes the spatial autocorrelation of landscape recreation service demand through Global Moran's I. There is a highly significant spatial agglomeration and certain seasonal differences in landscape recreation service demand. Secondly, the bi-variate Global Moran's I is used to analyze spatial correlation between landscape recreation service demand and urbanization, The result shows that there is a positive spatial correlation between urbanization indicators and landscape recreation service demand in different seasons. Thirdly, the bivariate LISA method is used to show the spatial agglomeration relationship between landscape recreation service demand and urbanization indicators. Finally, it is verified that the spatial lag model and the spatial error model are more suitable for measuring the dependence than the linear regression least squares (OLS). At the same time, population density (PD) has a positive impact on landscape recreation service demand in different seasons, while landscape recreation service demand in autumn is also positively affected by non-urbanization factors and negative impact of GDP, which also proves space spillover effect between landscape recreation service demand and urbanization. The above conclusions can be used as important information for urban landscape planning and decision-making.

Keywords: Landscape services, recreation services demand, spatial dependence, spatial correlation, urbanization

Spatial and temporal dynamics of ecosystem services in the Sanjiangyuan National Park, China

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The Sanjiangyuan National Park is located in the hinterland of the Qinghai-Tibet Plateau, which covers an area of 123,100 km2. The establishment of the Sanjiangyuan National Park is beneficial to the strictest ecological protection in the Three-River-Source region, strengthening sustainable protection on the "Chinese water tower", and enhancing the national ecological security barrier. Understanding the ecological background and change trend is crucially important for the ecological restoration and scientific management of national park. We comprehensively investigated the spatial distribution of ecosystem which was interpreted from medium and high-resolution remote sensing images (Landsat TM/ETM+/OLI and HJ-1A/1B). Then we simulated the ecosystem services of water regulation, erosion control and sediment retention in 2000-2015 by water balance model, RUSLE (Revised Universal Soil Loss Equation) and RWEQ (Revised Wind Erosion Equation) respectively. Finally we identified the extremely important area in the Sanjiangyuan National Park by the quality of ecosystem services and analyzed the spatial and temporal dynamics of ecosystem services. The results showed that (1) Grassland, desert, and wetland were the dominant ecosystems in the Sanjiangyuan National Park, accounting for 56.2%, 35.2%, and 8.4% of the total area, respectively. (2) In 2000-2015, the average annual water regulation volume was 6.54 billion m3/yr, the average annual soil retention against water erosion and wind erosion was 152 million t/yr and 480 million t/yr respectively. Over this period, the water regulation service and the erosion control service of water erosion prevention had improved in large part of the national park, whereas the erosion control service of wind erosion prevention showed decline trend. (3) 47.1% of the total area in the Sanjiangyuan National Park was the extremely important area which can provide valuable ecosystem services. (4) Climate warming and humidification and the implem

Keywords: ecosystem service, Sanjiangyuan National Park, ecological restoration

P0019

Assessing urban expansion and its effects on dune recreational value. An insight into the Mediterranean coast

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In the Mediterranean sandy coasts, urban expansion mainly occurs to support sea-side tourism, causing a drastic loss of natural coastal dune habitats and the associated ecosystem services.
We investigated on a representative tract of the Mediterranean coast to which extent land conversion into urban areas affected natural dune ecosystems and the related recreational value (RVES) supply over the last thirty years.
Using empirical data derived from 592 questionnaires of beach users we quantified the RVES provided by the main dune habitat types of the Adriatic coast (Beach with Pioneer annual Vegetation, Herbaceous Dune Vegetation and Mediterranean Macchia). On the basis of detailed multi-temporal land cover maps (years 1986 and 2006), we quantified the conversion of natural dune habitats into urban areas over time, by means of transition matrices. By combining the results of the assessment of RVES and the transition matrices we measured how the natural dune habitats' loss reduced the related RVES supply.
Results show that, although natural dune habitats have an important role as RVES suppliers, urban sprawl eroded them with specific rates, causing a total percent loss of 12% in the RVES.
Our work underlines the fragility of natural coastal dunes, which during the last decades have become a privileged destination for touristic and recreational activities, thus been progressively replaced by urban areas, with an unwanted direct impact on their RVES supply. By combining multi-temporal mapping techniques with ecosystem services measurements, we enhanced our understanding of transformation processes on coastal dunes, offering as well new insights for dune management. According to our results, an effective dune management shall favor both natural dune zonation and RVES supply, by welcoming sustainable sea-side recreational activities as the only acceptable form of coastal tourism.

Keywords: coastal dunes, recreational value, coastal ecosystem services, Adriatic coast, transition matrices

T8783

The Ecosystem Services of wetlands: a diachronic analysis of landscape changes in six Italian Ramsar Sites

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Wetlands are among the most diverse and productive ecosystems. They provide essential ecosystem services and supply of water. However, they continue to be degraded due to anthropic pressures, land modifications and climate change.This study seeks to explore if and how the establishment of international protection regimes, such as the Convention on Wetlands or Ramsar Convention (1971) implemented in Italy in 1976, has protected these ecosystems and the ecosystem services they provide.
Starting from ISPRA national activity of land use/ land cover monitoring and on the functional quantification of ES regulation and supply, this study intends to highlight the supply changes of water related ecosystem services (WES) (Brouwer and Hassan, 2013) due to land use/ land cover transformations. The analysis regards six Italian Ramsar Wetlands and their Functional Ecological Unities (catchment basin or sub-basin). The study is conducted through a diachronic analysis of the variations in land use/ land cover before and after the establishment of the Ramsar wetlands. The study is based on Corine Land Cover dataset for 1990, 2000, 2006, 2012 and 2018, in relationship with the ES supply capacity valued for each Functional Ecological unit, in order to analyze and assess the effectiveness of the Ramsar site protection. What emerge is the importance of the ESs evaluation at the landscape scale in order to understand how landscape modifications could lead the ESs changes at the Ramsar site scale, and to prevent wetland ecosystems and linked ESs degradation. In addition, the ESs evaluation highlights how the complex system of synergies of multiple ESs (especially of regulation) is the base for the supply of other ESs. The ultimate goal of this study is to contribute to the protection, the restoration and promotion of sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss (15 SDG goal)

Keywords: Wetlands, Ramsar Convention, Landscape, Ecosistem services

P0039

En route towards zero hunger in Africa: Optimizing the benefits of intercropping grain legumes to cereals

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Achieving zero hunger is challenging particularly in Africa due to high yield gap, low soil quality, pest, weed and disease outbreaks as well as climate adversities. Since increasing agricultural production greatly relies on agricultural intensification, we would like to re-visit intercropping grain legumes to cereals, that has long been used to mitigate the risk of crop failure, safeguard household income and provide diverse dietary sources. Despite its historical use, there have significant knowledge gap on multiple aspects of the farming system, including on the most commonly measured parameter (LER or land equivalent ratio), in which partial LER (pLER) is rarely explored to obtain a full picture of the competitive effect or facilitative advantage of certain legume species against its cereal combination. Using meta-analysis technique, our results suggested that intercropping legumes to cereals resulted in elevated LER (i.e., 1.31), regardless of species combination. A significantly greater LER than the overall LER ($P<0.05$) was observed with the combination of maize-pigeon pea (LER=1.57) and maize-groundnut (LER=1.52). Both combinations also had pLER=1 which suggested that the facilitative advantages of intercropping of these species were greater than the competition. Increasing LER with intercropping was consistent across rainfall variability, as well as the use or the absence of N fertilizer, which became the hallmark properties of intercropping in resource-deprived Africa. In terms of sustainable agricultural production, intercropping could increase soil erosion control, pest and weed control, carbon sequestration as well as biodiversity conservation without jeopardizing yield quantity and quality and eventually the economic profitability. Overall, we suggest a positive diversity–productivity effect of intercropping through improvement of plant-soil and trophic interactions which can be optimized to achieve zero hunger in Africa.

Keywords: ecosystem service, sustainable agriculture

Significant Green Tree Retention in the Southern United States Contributes to Biodiversity

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Biodiversity conservation is integrated into intensively managed pine forests (IMPF) of the southern United States. In this region, IMPF are harvested commercially by a process of clearcutting with green tree retention. We quantified the operational range of green tree retention and the associated bird community to understand effects on biodiversity of green tree retention during harvesting. We classified land cover on 1,187 management units ("MUs"; totaling 51246 ha), defined as contiguous, forested areas containing one or more IMPF patches, harvested and established as a cohort, plus associated green tree retention areas. Green tree retention cover averaged 18.6% of land cover and consisted mostly of streamside management zones (SMZs; mean 14.0 % of land cover) buffering perennial and intermittent streams, and stringers (mean 3.4% of land cover) buffering ephemeral streams. We compared species diversity of breeding bird species and avian guilds in three-year-old regenerating clear cuts (RCCs) and their associated SMZs and stringers on 60 IMPF management units. We detected 5617 individuals of 60 species; 8 species were considered common birds in steep decline. SMZs and stringers comprised an average of 17.4% of management unit area, but 27% of species were detected solely in retention cover types. There was an 84% species overlap between SMZs and stringers. Stringers augmented SMZ contributions to site avian diversity by hosting forest specialist guilds. Diversity of early-successional specialists was similar between stringers and RCCs, suggesting stringers enhanced RCC contributions to site bird diversity. Furthermore, we detected several species only within stringers. Green tree retention land cover represented a substantial proportion of the IMPF landscape and contributed to avian diversity disproportionately to its area, and in particular, stringer cover appeared to enhance the value to avifaunal species diversity of IMPFs.

Keywords: biodiversity, managed forests, green tree retention, landscape planning, avian

T0055

Effects of vegetation exposure on the well-being of urban inhabitants

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Experiences with nature in cities are getting scarcer, especially for cities that are environmentally unequal where accessibility to nature is only available for small amount of the urban dwellers. This is especially the case of Latin American cities, where unplanned growth has led to areas of the city depleted of nature. Understanding the relationship that people have with nature under an urban context is crucial to justify the inclusion of urban forests into planning resilient cities. We assessed the exposure of people to green spaces, and how that is related to their perceived happiness, psychological and physical health. For this we conducted a survey in Chile that was disseminate through social media and existing peoples' databases. This survey included questions on time expended, type of activity and frequency of visitation to a green space. We used a happiness scale, visitation to the doctor and intake of medication and questions on self-perceived mental health to evaluate people's well-being. Statistical analysis was done to detect the relationship existing between self-perceived health and nature exposure. Demographic variables were used to test if the relation could be generalized to all age and income groups. We found that people appreciate more the ecosystem services related to clean air, recreation and microclimate regulation. The exposure and use of green spaces were variable and related to age and level of education. Younger and more educated people tend to spend more time in green spaces, use them mainly for recreation and appreciate an ampler set of ecosystem services. People that disclose to be happier and in good psychological health tend to have contact with nature more often and for longer periods. Associating exposure to nature to health and happiness can support ongoing investments and public policies for conserving and a strategy to promote the livability of those

Keywords: urban ecology, well-being, ecosystem services, urban vegetation, health

T0893

Detecting critical scales and fragmentation thresholds for chimpanzee habitat connectivity in Liberia

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Liberia is home to the second largest population of West African chimpanzees and is a priority for species conservation. The western chimpanzee was recently reclassified as "Critically Endangered" on the IUCN's red list as the population has declined approximately 80% since 1990. The Liberian population is one of the most viable, and Liberia has some of the most suitable environmental conditions for chimpanzees in West Africa. Yet, the population is threatened by habitat fragmentation, among other causes. Assessing habitat fragmentation and connectivity is a priority for researchers and conservationists, but, until recently, the task was hindered by the lack of accurate land cover data for Liberia. A detailed land cover map was recently produced by the U.S. National Aeronautics and Space Administration (NASA) and Conservation International for Liberia that is specific to the ecosystems within the country and relevant for the conservation of species. Using this new land cover dataset along with other previously established indicators, we map chimpanzee habitat suitability across Liberia to produce a movement resistance surface. We then use Circuitscape to model habitat connectivity in this heterogeneous landscape. By completing this analysis at multiple scales, we are able to detect critical scales of fragmentation for chimpanzees and identify priority areas for conservation.

Keywords: fragmentation, habitat suitability, conservation, connectivity, scale

T0799

Plant-associated microorganisms may contribute to air pollution reduction in Milan urban area (northern Italy)

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Air pollution in urban areas is a global concern due to its detrimental effects on human health and ecosystem functioning. Plants have been suggested to effectively contribute to the enhancement of ecosystem services, including air pollution reduction and greenhouse gas emission offsetting. Moreover, they host many microorganisms, especially bacteria, on leaf surface (the phyllosphere). Both plants and phyllosphere microorganisms may effectively contribute to reducing air pollution in cities through the adsorption and biodegradation of pollutants onto leaves. To investigate that, we assessed the temporal variability of bacterial and fungal communities hosted by leaves of southern magnolia Magnolia grandiflora and deodar cedar Cedrus deodara, two evergreen plant species widespread in Milan urban area. Bacterial and fungal communities were characterized by Illumina high throughput sequencing of V5-V6 regions of 16S rRNA gene and of the ITS1 region, respectively, and by shotgun metagenomics. The presence of naphthalene dioxygenase genes was assessed by qPCR. Polycyclic Aromatic Hydrocarbons (PAHs) accumulated on leaves were also quantified. Taxonomic and functional profiles of microbial communities differed between host plant species and, to a lesser extent, between seasons. Higher PAH concentrations on leaves were observed in winter, and naphthalene was generally the most abundant PAH. Microbial communities harboured genes involved in the degradation of hydrocarbons. Particularly, the gene coding for naphthalene 1,2-dioxygenase was found at significantly higher abundance on magnolia samples in cold seasons than in warmer ones. Evidence collected in this work thus suggests that the abundance of hydrocarbon-degrading microorganisms on leaves increases with the concentration of hydrocarbons when atmospheric pollutants are deposited at high concentration on leaves, and that the phyllospheric biodegradation can contribute to the removal of naphthalene from the urban air.

Keywords: Ecosystem services, Plant-bacteria interactions, Urban green, Evergreen plants, Bioremediation

Supply and demand assessment of urban park cultural services: A case study in Shenzhen

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Park landscape is a crucial source of urban ecosystem services, providing multiple benefits for residents. Urban green infrastructure construction attaches great importance to landscape service abilities and the assessment of supply and demand of urban park landscape services is the key problem for the process from theory to application in urban landscape ecology research. Taking Shenzhen's communities as basic research unit, we evaluate park service supply according to recreation potential and accessibility of parks and park service demand according to population distribution and land exploitation. Four types of communities are classified based on the supply and demand of park services: High Supply-High Demand(HS-HD), High Supply-Low Demand (HS-LD), Low Supply-Low Demand(LS-LD) and Low Supply-High Demand (LS-HD). The results show that: supply of park services is highly clustered on community scale, and the high supply areas distribute mainly in central urban area like Nanshan, Futian and Western Luohu and decrease from urban areas to outskirts. For demand of park services, besides urban areas, there are several high demand areas distributed in suburban area like Banan, Longhua and Longgang. HS-HD communities, amounting 194, are mainly found in Nanshan, Futian and Western Luohu with a proportion of 85% and 204 of the 233 LS-LD communities are distributed in the remaining seven districts, indicating that balanced supply and demand areas distribute all over the city but strongly vary in high and low value between downtown and suburbs. The amount of the HS-LD communities is 143 and they mainly distribute in the forests in outer space of central city. LS-HD communities represent potential hot spots for park construction and are mainly found in Longgang, Baoan, Longhua and Guangming. The identification of hot spots of park construction could provide scientific basis for park planning and construction in Shenzhen.

Keywords: urban park, cultural services, supply and demand, spatial variation, Shenzhen

T0230

Impacts of land management and land cover change on albedo - a global assessment

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Widespread anthropogenic land-use activities are transforming a large proportion of the planet's land cover. This large scale transformation of the terrestrial biosphere is leading to environmental impacts at the local, regional and global scale, ranging from changes in atmospheric composition to changes of the Earth's ecosystems. One of the challenge we are facing today is to manage the trade-offs between the short-term human needs and preserve the capacity of the biosphere to provide goods and ecosystem services in the long term. Land cover conversion can alter climate via both biogeochemical processes like carbon cycling and biophysical processes like albedo, evapotranspiration, and surface roughness. The net climate effect of land cover change depends on the magnitude of these processes and can vary regionally. Therefore, mapping characteristics of ecosystems represent an important step. Projects like the ones aiming for reducing emissions from deforestation and forest degradation (REDD+) are contributing to monitoring the forest carbon stock. In this paper we offer a similar approach, by mapping the global albedo impacts and the associated top-of-atmosphere radiative forcing (RF) due to global land use changes. We use the 17 land use classes from the International Geosphere–Biosphere Programme (IGBP), free available albedo look-up maps (LUMs) based on Moderate Resolution Imaging Spectroradiometer (MODIS) and radiative kernels.

The albedo effects have been generally overlooked in traditional life cycle assessments (LCA). Results from this work fill in an important environmental analysis gap and offer a broader picture of the climate impacts of products and services requiring land use changes. Outcomes of this work provide insights for sustainable land use management which is critical for achieving a variety of Sustainable Development Goals.

Keywords: land use change, albedo, life cycle assessments, radiative forcing

P0069

Meta-analysis approach to assess the effectiveness of contour tillage in reducing water erosion in China

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Contour tillage is a widely practiced conservation tillage in China. The beneficial effects of contour tillage in controlling water erosion have been recognized, while further researches are needed to quantify the effectiveness of contour tillage in reducing water erosion and identify the influencing factors in China. We conducted a nationwide meta-analysis based on 229 runoff and 290 sediment paired observations from 47 published papers. Compared with traditional tillage, the benefits of contour tillage in China with respect to runoff and sediment reduction were 35.86% and 49.02%, respectively. Sediment yield reduction by contour tillage was greater under simulated rainfall than under natural rainfall. Runoff reduction by contour tillage decreased with the increasing mean annual precipitation and temperature, while sediment yield reduction was not affected by climate. Contour in loamy soils and soils with > 1 soil organic carbon content demonstrated the greatest benefits in reducing sediment yield (64.26% and 52.52%, respectively). The greatest runoff and sediment yield reduction (61.04% and 67.24%, respectively) occurred at slope length > 20 m. The greatest runoff reduction by contour tillage was found for tillage duration > 10 years (44.08%), while the greatest sediment yield reduction occurred at tillage duration ≤ 5 years (52.89%). Contour tillage The effectiveness of contour tillage under cereals provided better runoff and sediment yield reductions than under legumes and rotation due to the higher biomass quantities and lower mineralization rate of cereal straw. Our results conclude that contour tillage is an effective measure for soil and water conservation, and its benefits in reducing runoff and sediment yield are different at different levels of influencing factors.

Keywords: Contour tillage, runoff, sediment yield, meta-analysis, China

P0063

Resilience through synergies between agriculture and tourism for two contrasting trajectories in the Tyrolean Alps

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The transformation of agriculture towards multi-functionality brings many opportunities for integration into the tourism sector. The two villages of Obergurgl and Vent, both districts of the municipality of Sölden in the Tyrolean Alps, provide an empirical case and offer a unique opportunity to study the interactions between agriculture and tourism over a longer period of time based on the following characteristics: (1) both villages have a long history of tourism; (2) they have chosen two different development paths, one of which focuses on winter tourism with skiing, while the other is profiled as a mountaineering village; (3) both villages were part of a 'Man and Biosphere (MAB)' project between 1973 and 1979, which examined the structural change from agriculture to tourism. Hence, long-term changes and effects can be analyzed. The study presented here applies sociological and ecological perspectives on resilience and examines whether and how the provision of ecosystem services (ES) has changed. Modeling the provision of ES covers a wide range of methodological approaches and is based on sociological and / or ecological indicators. This allows the spatial mapping of historical ES offers as well as the assessment of the resilience of the socio-ecological system in a future environmental setting. Therefore, the study provides deeper scientific knowledge about the links between agriculture and tourism. The combination of the different forms of integration of the two sectors with different community development paths, identified over a 35-year period, provides a comprehensive picture of the factors that affect social-ecological resilience and shows indicators that are monitored to ensure future provision of relevant ES.

Keywords: social-ecological system, landscape, trajectories

An Integrated Land Use based Framework Matching Local Demand and Supply of Urban Ecosystem Services and Directing to the Implementation Actions in Fengxian District, Shanghai

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Countless plans of Urban Green Infrastructure have been made to increase Urban Ecosystem Services (UES) in Chinese cities nowadays. However, few benefits actually delivered to local citizens mostly due to poor implementations or mismatch of provisions. Integrated methods and explicit spatial mappings of UES play vital roles in related planning process, but how to link these plans with pragmatic actions and adaptive local measurements is the emerging key theme for high quality practices.

In this study, a comprehensive framework, comprising land use subdivision, supply-demand balance, priority weighting of actions and local measurements databank, was developed and applied in the case study on Fengxian District, Shanghai, China, combining with model estimation, expert judgment and policy interpretation. Land use subdivision which integrated quantitative and qualitative information derived from field investigations and land use managements was the core component linking the plan with measurements. The balance of supply and demand was made at three levels to catch the characteristics of different UES provision.

The results revealed the overoptimistic of current master plans and proposed an alternative and pragmatic approach under similar final goals. Most UES showed shortfalls in demand-supply budget except food provisioning. Key action areas not only lie in the high-density settlement, but also in the east agricultural zones which were used to be ignored. This study provided empirical experiences of UES provision from a local and practical perspective. Land use based framework is an adaptive approach that can bridge certain gaps between UES assessment and implementation and bring progressive solutions to increase the efficiency of accessible benefits for local citizens.

Keywords: Urban Ecosystem Services, Urban Green Infrastructure, Land Use Subdivision, Expert Judgment, Implementation Actions

T0493

Mapping and Assessment of Ecosystem Services in Cyprus

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Compared to most EU countries, in Cyprus work on mapping and assessment of ecosystem services (ES) at the national level is still in its infancy. The paper reports on the first attempt to map and evaluate the services of terrestrial ecosystems on the island as a step to assist with the country's first national assessment, meeting thus its obligations to the EU. The aim of this study is to demonstrate the benefits to society of Cyprus's terrestrial and marine ecosystems and to assist with developing a national ES policy agenda. The main broad ecosystem types were identified, based on CORINE land cover, namely: agro-ecosystems, forests, shrublands, wetlands and rivers, marine and coastal. We used CICES classification to identify the types and range of services provided by these ecosystems. We identified indicators for all services and all ecosystems based on literature review and experts opinion at the national level. This was followed by the collection and evaluation of existing data for mapping these indicators, following criteria used at the EU but also additional criteria proposed at the national level. We ranked indicators using a traffic-light system on the basis of their suitability for every service and ecosystem as well as data availability at the national or subnational level. We provide with a priority list of indicators which are appropriate, mappable and representative of ecosystems and their services in Cyprus and which can be readily used by planners and policy makers. This is the first study on the island-wide scale which a) identifies gaps in the harmonization of national environmental policy with the other EU Member States (design, implementation, integration) b) proposes concrete steps for assessing a large number of indicators on the basis of the most widely employed methodologies for ES mapping.

Keywords: island, indicators, Mediterrranean, CICES

Different household livelihood strategies and influencing factors in Inner Mongolia's typical steppe

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Household livelihood strategies can affect grassland ecosystem services and herdsmen's well-being. Understanding different household livelihood strategies and influencing factors are the foundation for sustainable development in pastoral areas. We have derived the data from a questionnaire survey of 243 households in eight counties of Xilinhot, China in 2017. An income-based cluster analysis is conducted to identify different livelihood strategy clusters and structural equation models are performed to determine the influencing factors of household livelihood strategies. Our results show that: (i) Household livelihood strategies can be classified into five clusters: 1) households who breed small livestock, 2) the households who breed both small and large livestock, mainly small, 3) the households who breed both small and large livestock, mainly large, 4) the households who breed large livestock, and 5) the households who don't breed livestock. (ii) Households' mean annual total incomes are significantly different among five clusters, and capital variables have significant effects on households' mean annual total income. (iii) Manufactured capitals significantly influence household livelihood strategy choices. Among them, the number of livestock has the greatest contribution. Our results imply that if only economic factors are taken into account, livelihood strategies of a mix of small and large livestock, mainly large, will be more beneficial for sustainable development in Inner Mongolia's typical steppe.

Keywords: household, livelihood strategies, cluster analysis, structural equation model, capitals

T0470

Mapping critical natural capital for identification and conservation of ecological functional areas: Insights from the Tibetan Plateau

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The Tibetan Plateau (TP) is the roof of the world, the water tower of Asia and the third pole of the earth. However, the fragile ecosystem of the TP is a sensitive and threatened area of global change. Climate change, land use change and grazing disturbance have exerted great influence on the ecological environment, social and economic development of TP, and directly affected the spatial and temporal distribution of natural capital in the region. Spatially explicit mapping of ecosystem services is an essential step in drawing up policies and practices designed to improve human well-being by ensuring the sustainable provision of ecosystem services. Therefore, it is necessary to propose strategies for natural capital protection and sustainable management based on quantitative assessment of ecosystem services in TP. In this study, regional survey, remote sensing inversion and model simulation were used to quantify the typical ecosystem services in TP, reveal the spatial pattern and temporal change characteristics of natural capital, and identify the key driving factors. By establishing the comprehensive evaluation index of ecological services, the key ecological functional areas are identified to put forward targeted strategies for improving the ecosystem services and protecting natural capital in key regions. This study can provide methodological and theoretical support for regional natural capital assessment and management.

Keywords: natural capital, ecological functional area, ecosystem service, spatio-temporal change, Tibetan Plateau

T0414

Half century change of interactions among ecosystem services driven by ecological restoration: Quantification and policy implications at a watershed scale in the Chinese Loess Plateau

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The concept of Ecosystem Service (ES) has provided an underpinning framework for ecological restoration research and applications. Ecological restoration is a corrective intervention that aims to reverse land degradation and to contribute to the 2030 Global Sustainable Development goal of Land Degradation Neutrality. It is critical to investigate the long-term effects of ecological restoration and land use change on ESs and ES interactions (synergies or trade-offs) to better understand the mechanisms supporting this goal. This paper describes an analysis of land use and ESs using historical data for a typical watershed in Chinese Loess Plateau, which has experienced series of restoration activities since the 1950s. Six important ESs (food provisioning, soil retention, hydrological regulation, carbon sequestration, water purification and habitat provisioning for biodiversity) were quantified at eight intervals between 1958 and 2015. The interactions between ESs were evaluated by correlation analysis. The results show that soil retention, carbon sequestration, water purification and habitat provisioning for biodiversity increased significantly across the different land use types over several decades but not hydrological regulation. The relationship between ESs was found to be variable over different time periods and a transition point between 1990 and 1995 was identified. Grassland was found to maintain greater water yield than woodland with high values of other ESs. The results suggest that trade-offs between ESs can be mitigated by adjusting the proportion of some important land use types (such as woodland and grassland).

Keywords: Ecosystem service, Land-use change, Ecological restoration, Temporal scale, Watershed management

P0163

Mitigating the Conflicts Between Environmental, Economic and Social Benefits - Examining Ecosystem Services from an Ecological Wisdom Perspective

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Ecological wisdom - "a philosophy of ecological harmony or equilibrium" (Naess, 1973, p.99) - is regaining broader recognition, and being proposed for use in socio-ecosystem planning and management for achieving urban resilience and sustainability (Liao & Chan, 2016; Xiang, 2014). According to Xiang (2014), a project possessing ecological wisdom should do real and permanent good, as exemplified by the Dujiangyan irrigation system in China, which project has been protecting millions of residents from deluge and drought and offering abundant living and flourishing opportunities ever since 256 BC. The beauty of Dujiangyan and other ecological wisdom practices lies in their "endurance overtime, efficacy in practice, and ability to predict project performance" (Yang &Li 2016, p.22).

However, there might be inherent or unavoidable conflicts among the different aspects of project performance, as demonstrated in a previous study by Luo and Li (2014). These conflicts can cause compromises and weaken the real and permanent good to be fully provided. Through the perspective of ecological wisdom, this study examines 148 published Landscape Architecture Foundation (LAF)'s landscape performance case studies, arguably the largest case portfolio that systematically quantifies and documents exemplary ecological practices in North America and other parts of the world.

Using the framework proposed by Luo and Li (2014), this study (1) examines the LAF cases in order to identify potential converging and conflicting relationships among their environmental, economic, and social benefits, and (2) explore the possibilities and pathways toward minimizing conflicting interests among these benefits. The 148 cases are analyzed according to their project type, size, location, and land use before construction to explore the respective influences on project benefits and their relationships. This study expects to offer a better understanding of the performance of ecological practices.

Keywords: benefit relationships, ecological service, landscape performance, ecological wisdom, conflicting and converging

T0341

The introduction of an ecosystem services concept to Central Asia: practical experiences to-date

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Central Asia is a diverse region recognised internationally for its species richness. Whilst several of its ecosystems play key roles in supporting activities at national (economic) to local (livelihoods) scales, many of these landscapes are identified as under threat. As a 'business as usual' approach is not sustainable, interest in alternative strategies has been growing within the region. One initiative looking to tackle this challenge is the research led by the Regional Environmental Centre for Central Asia (CAREC) into the applicability of an ecosystem approach (EA) within the region.

This paper provides the results of an independent review of five CAREC EA programmes (two in Kazakhstan, two in Kyrgyzstan and one in Tajikistan). Involving a combination of field visits, stakeholder interviews and desk-based review of all project documents, results indicate the potential for an EA to support Central Asia's transition to a more sustainable development pathway. A series of notable successes (the novel use of PES and best practice in stakeholder engagement) and areas for further development (need for greater clarity over ecosystem and ES mapping methodologies) are highlighted, and a comprehensive set of recommendations to enhance the delivery of an EA within a Central Asia context developed. Key recommendations include development of common Central Asian ecosystem and ES typologies and scoring systems to support their consistent application throughout the region. A further major recommendation relates to facilitating an EA in practice; the need to map ES terminology to the Central Asian policy sphere, development of policy briefings on the 'what, why and where' of integrating ES knowledge within a range of legislative areas such as national Water Codes, ecosystem monitoring programmes, biodiversity strategies and land use planning frameworks as well highlighting its role in contributing towards achievement of several UN Sustainable Development Goals.

Keywords: SDG, Ecosystem services, Ecosystems, Regional studies, Review

T_0982

The impact urban expansion on the environment in Harare, Zimbabwe

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Africa is facing rapid urbanisation which is a challenge in attaining sustainable development goals (SDG's). The unprecedented urbanisation often leads to consumption of pristine agriculture and forest land as well as affecting ecosystem services (ES). Harare, in Zimbabwe is a major epicentres of urban growth has been sprawling significantly thereby expanding its ecological footprint. Accordingly, the aim of the study to determine the environmental impacts and ecosystems services assessment as a result of urban sprawl in Harare. Multiple satellite imagery from 2000 to 2017 was collected and superevised pixel-based classification conducted to determine the growth of Harare. A questionnaire was also distributed to residents and experts on the perception of the impact of growth on ecosystem services in Harare. The results from the satellite imagery indicate huge haphazard and often improperly planned urban expansion in Harare causing landscape change, consumption of rural, pristine agricultural and forest land resources. Consequently, the resident's perception is a decline in the quality and quantity of ecosystem services such as urban parks, quality of water, vegetation, landscape and visual aesthetics. Similarly, the urban expansion has also negatively affected sustainable livelihoods in Harare. A major reason for this is the poor planning and the policy of the fast-track land resettlement programme (FTLRP) of the year 2000 which saw the haphazard parcelling out of land. The combination of urban expansion and poor planning is a serious threat to the attainment of SDG's provisioning of ES and sustainable livelihoods. This calls for a revamp of policy and planning in Harare, Zimbabwe.

Keywords: Ecosystem services, urban growth, SDG's, Harare

T0991

Linking microbial structure to ecosystem function for improved prediction of ecosystem processes

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A fundamental challenge of biogeochemistry is to discover unifying links between soil microbes and nutrient cycling. Similarly, a fundamental goal of soil ecology is to understand how soil microbial communities change under external pressures, such as land use and land change. Improved understanding of these links between microbial structure and ecosystem function will improve prediction of ecosystem models. We sampled top 5-cm soil along a land use gradient (6 sites from pristine forest to degraded land) in the highlands of Malaysian Borneo to assess the links between soil microbes (quantified by next generation sequencing) and ecosystem function (carbon decomposition rate and carbon efflux), and understand how it changes due to external pressure of land use and land change.

Our results suggest no significant difference in organic matter decomposition rate among land uses, while organic matter stabilization is significantly higher in pristine forests, providing evidence that land use can impact the capacity of tropical forests to sequester carbon in the form of soil organic matter. Microbial community composition, based on shifts in relative abundance of dominant bacterial phyla, is strongly correlated to soil pH. Carbon efflux shows a strong relationship between temperature and different patterns in pristine forested versus agriculture sites. Our results highlight the links between land use and land change with physical and biological soil properties and how it translates into ecosystem function.

Keywords: Sustainable agroforestry, Microbiome, Land use change, Tropical forests

T0914

The role of urban green spaces in care facilities for elderly people. Case study Romania

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Urbanization and ageing are the two processes which define the current social environment worldwide. In this context social equity and sustainable urban development represent one of the priority directions of the Sustainable Development Goals which aim at creating inclusive, safe, resilient and sustainable human settlements. This study highlights the role green spaces have in care facilities for elderly people and analysis their relation with other urban green infrastructures.

The analysis was based on a database containing all care facilities for elderly people in Romania, along with their spatial distribution, characteristics and services. A questionnaire regarding the presence and use of green spaces was applied to administrators of care facilities for elderly people with a response rate of 17%. We used statistical analysis to underline the characteristics and use of green spaces inside care facilities and spatial analysis to assess their relation with urban green infrastructures which could provide an alternative space for recreation.

The results showed that many care facilities for elderly people have gardens but they usually lack specific designed elements for elderly people because of the costs they imply. In many cases the health of the residents limits their capacity of using the garden, but the administrators are aware of the benefits green areas can provide. The large range of cultural ecosystem services this category of green area provide to a vulnerable group of population makes it a very valuable part of the urban green infrastructure. Moreover the study showed that care facilities residents mainly have contact with nature in this areas, only rarely using other categories of green infrastructures, usually in their families company. This study, through the applied questionnaire, also tried to raise awareness in relation with the importance of green spaces inside care facilities for elderly people.

Keywords: green spaces, care facilities for elderly people, cultural ecosystem services, quality of life

T0280

Worldwide patterns of ecosystem services and environmental conservation based on the Human Development Index

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Most countries' growth models are currently unsustainable, which jeopardizes the provision of ecosystem services worldwide. Disentangling the relationship between the development status of countries and their particular threats to nature is important to recognize trends and set specific conservation agendas for country groups.
In this novel study, we identify global patterns using structural equation models and worldwide economic, social and environmental data at the country level while controlling for the type of biome.
Results show clear relationships between the human development index (HDI) and conservation variables. Countries with lower HDI currently provide most ecosystem services at planetary scale; however, they have been losing natural landscapes and increasing farmland areas at high rates. In addition, low HDI countries commit less territory to protected areas. By comparison, high HDI countries emit more greenhouse gases, cause more water pollution and have fewer natural areas.
Major threats to ecosystem services at the global scale are the consumption model in high HDI countries and the rapid conversion of natural areas into agricultural lands in low HDI countries. Therefore, we encourage a drastic change in consumption models and international assistance in low HDI countries (e.g. money for ecosystem services), as a solution to this urgent need.

Keywords: Ecosystem services, land use change, HDI, policies, global patterns

T0521

The role of Landscape sustainability science within the framework of forest Biodiversity and global change impacts

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Moving landscapes towards sustainability often requires fundamental transformations or transitions, including changes in how forested landscapes are valued, newly established relations between societal actors, new rules as well as supportive rather than controlling roles of governments. This demands a holistic vision towards forests as key ecosystems for the maintenance of biodiversity and the sustainable provision of ecosystem services. We should aim to address up to what extent and how the status of any particular forest ecosystem and its temporal dynamics should be included in the overall assessment of ecosystems and their services at multiple scales. Such understanding is essential to adaptive management and to the assessment of land use changes that might increase or decrease forest areas, including transitional states, and the availability of ecosystem services. Within this framework, I aim at stressing the importance of an integrative landscape level perspective to support sustainability towards a forest balanced management integrating multiple objectives including biodiversity and conservation targets in the light of the Sustainable Development Goals (SDGs) targets.

Keywords: Forests, SDG's, Adaptive management, Sustainable landscapes, ecosystem services

T0873

The path towards MAES Estonia

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Estonia has recently started the process towards achieving the targets set by the Action 5 of the EU Biodiversity Strategy to 2020. Beyond mapping and assessing the state of ecosystems and their services, the MAES process in Estonia aims at providing relevant input to ongoing and future sectoral planning and policy processes such as Green Network planning, Environmental Impact Assessment, biodiversity monitoring and assessment of the effects of climate change in biodiversity. In this presentation, we outline the steps, datasets and methodologies that will be used in the implementation of MAES.

The conceptual framework used in this project is the "Integrated Ecosystem Service Assessment Framework (IESA)" built and tested within the H2020 ESMERALDA project. IESA drives the workflow of MAES Estonia and is closely aligned with the Common Assessment framework from MAES EU level.

Four priority ecosystems have been selected for assessment: Forests, grasslands, wetlands and agricultural land. The first step of the process is the creation of a consolidated basemap. A wide array of data sources will be overlayed on top of the Estonian Base Map, allowing for a complete and more accurate representation of the ecosystems under study. The National LiDAR survey plays a critical role in the creation of the consolidated basemap, as it will reshape outdated spatial datasets.

Methodologically, MAES Estonia follows the Tiered Framework developed in the H2020 ESMERALDA project. The Tiered Framework provides a flexible mapping and assessment approach that will address the multiple spatial scales envisioned in the project: Base levels of ecosystem services supply at the national scale and ecosystem services supply and supply change at pilot areas. Four main methodologies will be tested in the project: Direct/primary data, spatial proxies and modelling.

Keywords: MAES, ecosystem services, biodiversity, Estonia

T0033

Linking catchment characteristics with stream water isotopes over multiple spatial scales in a humid area

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Linking the catchment characteristics with stream water isotopes is important for understanding of dominant factors regulating streamflow across multiple spatial scales. In this study, we investigated the relationship between catchment characteristics and water isotopic compositions (δD and δ18O) in streamflow induced by three summer rainfall events (28.2–88.8 mm) of eight catchments (0.28–22.90 km2) in the Zhangxi catchment in eastern China. The catchment characteristics include size, soil properties, topography, land use, and landscape metrics for nine catchments (including a catchment with dam overflow). The correlation, linear regression, redundancy analysis, and mixing model were employed to detect the relationship. The results showed that no statistically significant correlation was found between stream water isotopes and catchment size, average slope, and topographic wetness index. The stream water isotopic composition exhibited significant relationships with agricultural land percentage, patch cohesion index, and Shannon's evenness index (δD: $R2 > 0.55$, $P < 0.01$; δ18O: $R2 > 0.45$, $P < 0.01$). Agricultural land had great influence on stream water isotopes, though covered less than 3.1% of the catchment area. Compared with catchment size and topography, the land use and related landscape have predominant role in regulating isotopic compositions of streamflow in the humid catchments with fractured rocks underlain by shallow soils, within the area range of 0.28–22.90 km2. Our results suggest that, for the range of studied catchment scales, the land use and landscape had significant role in regulating the rainfall-induced stream water isotopes. This study provides more insights for land use and landscape effect on stream water isotopes, and enhance our understanding about the linkage between catchment characteristics and stream water isotopes in the humid area.

Keywords: land use, landscape metrics, stream water isotopes, multiple spatial scales

T0457

Mapping and promoting cultural ecosystem services using public participation for Sustainable Development Goals in Central-Hungary

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Several researches highlight the importance of public participation in the process of strategy building. International conventions aim to establish procedures for the participation of the general public. In spite of these initiatives in Central-Europe the public participation methods are not common tools in practice.

In the frames of our research we applied ppGIS method (Public Participation GIS), which aims to foster the integration of the public into the process of planning and decision making using GIS technology (e.g. mapping of cultural ecosystem services). We applied the method in Budapest Metropolitan Region. 5 cultural ecosystem services (CES) were defined: aesthetic, recreational, spiritual, historic, educational values. During the survey 200 maps were collecting representing the opinion of locals. The data was digitized and processed using QGIS software. We had the following research questions:

• Are the mapped cultural ecosystem types concentrated or more dispersed in the study area? Which ecosystem services have similar spatial distribution?

• Which landscape elements, settlements are marked mostly with local significance?

• Do the commuting or travel routes influence the significance of landscape elements for the society?

• Is there any correlation between hiking trails, cycling routes and the location of marked elements?

Our results reflect the importance of certain landscape elements considering ecosystem services. Our results show that most of the regionally known values are in the historic center of the micro-region, but some settlement-groups may have separate local identity. Similar spatial distribution can be identified between recreational, aesthetic furthermore the spiritual and historic values. It turned out that there is correlation between bike and hiking routes and CES in the region. In spite of huge number of commuting residents the most important daily routes did not influence priorities locally.

Keywords: cultural ecosystem services, ppGIS, public participation, metropolitan region, Hungary

Establishment and Application of Ecological Suitability Evaluation System for Highway Line Selection

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Subtropical mountains area Landsat8 satellite Tm images were used as information sources, RS technology was used to extract vegetation coverage, soil erosion and land use type for the evaluation of ecological background condition, and the GIS software was utilized to extract indices of terrain slope and water environment. Based on the indicators above, with GIS analysis techniques, comprehensive evaluation and analysis of the ecological background of the ecological background of the subtropical mountains area were conducted, subtropical mountains ecological background conditions could be classified as excellent, good, fair, poor and very poor level. Based on the overall distribution and evaluation route corridors with relatively some feasible routes, and possible route options were compared to ultimately determine the best route with environmental coordination. The results show that the method overcomes the limitations of traditional line selection method which is too dependent on designers experience and subjective judgments.

Keywords: Highway line selection, Ecological suitability, Evaluation system, Ecological sensitivity

T0332

Pathways from payments for ecosystem services to positive socioeconomic outcomes

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Payment for ecosystem services (PES) is a widely accepted policy tool for achieving environmental conservation and socioeconomic development goals. However, the mechanisms through which PES programs affect socioeconomic outcomes remain elusive. Here, we use a framework which integrates links between PES programs, livelihood activities, and socioeconomic outcomes, to determine how China's Grain-to-Green Program (GTGP) has affected the incomes of participating households in the Loess Plateau. The results show that the GTGP has significantly positive effects on household income. The main positive effect is from the pathway in which the GTGP increases participation in local non-farm jobs, which leads to increased income. Based on our findings, we suggest several ways of improving the socioeconomic outcomes of the GTGP. Our study provides a template for revealing the underlying pathways to socioeconomic outcomes of PES programs — crucial knowledge if we are to design and implement better PES programs and achieve the desired environmental conservation and poverty reduction goals.

Keywords: Payment for ecosystem services, Path analysis, Grain-to-Green Program, Loess Plateau, Sustainable Development Goals

T0126

Spatiotemporal patterns, relationships, and drivers of China's agricultural ecosystem services from 1980 to 2010: A multiscale analysis

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During the past three decades, China's agroecosystem had undergone dramatic changes due to changes in climatic and management factors. However, how did climatic and management factors affect agricultural ecosystem services (AES) were not fully investigated. We adopted the GIS-based Environmental Policy Integrated Climate (EPIC) model to simulate the five critical AES: food production, soil organic carbon (SOC), nitrate leaching, water erosion, and wind erosion from 1980 to 2010 and used a partial least square regression model to quantify the contributions of the divers to the variation of the AES at the main grain-producing area (MGPA), climatic zone, and national scales. At the MGPA scale, SOC had no obvious change, food production increased, while the negative environmental effects largely increased. The MGPA is important to ensure China's food supply. At the climatic zone scale, food production and SOC increased, water erosion in the tropical-subtropical monsoonal zone, water and wind erosion in the temperate monsoonal zone decreased, while N leaching, water erosion, and wind erosion increased in other climate zones. At the national scale, food production, SOC, N leaching, and wind erosion increased, whereas water erosion decreased. Crop cultivated area played a major role in impacting food production and SOC. The dominant factors for N leaching, water erosion, and wind erosion varied with crop types and study scales. Adjustment of agricultural management measures is vital and possible to minimize the tradeoffs, increase the synergies among agroecosystem services, and promote adaptation to the changing climate.

Keywords: Agricultural ecosystem services, Land use/cover change, Climate change, Landscape sustainability

T0423

Are there enough soil available water for vegetation sustainability in Loess Plateau of China?

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The soil available water content (AWC) has a strong ability to indicate the soil water conditions under different land cover types. Although the AWC has long been calculated, soil water characteristic curve estimation models and the distribution of AWC, as well as the impact factors, have rarely been evaluated in the Loess Plateau of China. In this study, four typical land cover types were selected: introduced shrubland, introduced grassland, natural restored shrubland and natural restored grassland. Four widely used models were compared with the van Genuchten (VG) model, including the Arya and Paris (AP) model, Mohammadi and Vanclooster (MV) model, Tyler and Wheatcraft (TW) model, and linear fitting (LF) model to estimate the wilting point. The distribution of AWC and the relationships with environmental factors were measured and analyzed. The results showed the following: (1) the MV model was the most suitable model to estimate the soil water characteristic curve in the Loess Plateau; (2) the factors impacting the AWC varied under different precipitation gradients, and the area with a mean annual precipitation of 440-510 mm was the most sensitive zone to environmental and vegetation factors; and (3) the soil water deficit was more severe when considering AWC than when considering soil water content (SWC), and the water deficits were different under introduced grassland and introduced shrubland. Consequently, the construction of vegetation restoration should be more cautious and consider the trade-off between soil conservation and water conservation. During restoration, policy makers should focus on the AWC in addition to the SWC to better assess the soil moisture status.

Keywords: water deficits, soil available water, shrub, grass, Loess Plateau

P0060

Ecological Effects and Potential Risks of the Water Diversion Project in the Heihe River Basin

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To curb the severe ecological deterioration in the lower Heihe River Basin (HRB) in northwest China, a water diversion project was initiated in 2000. A comprehensive analysis of the ecological effects and potential risks associated with the project is needed. We assessed the hydrological and ecological achievements, and also analyzed the potential problems after the project was completed. We found that since the project began the hydrological regime has changed, with more than 57.82% of the upstream water being discharged to the lower reaches on average. As a result, the groundwater level in the lower reaches has risen; the terminal lake has gradually expanded to a maximum area in excess of 50 km2 since 2010, and there has been a significant recovery of vegetation in the riparian zone and the Ejin core oases, which represents the initial rehabilitation of the degraded downstream environment. Additionally, the economy of Ejin has developed spectacularly, with an annual growth rate of 28.06%. However, in the middle reaches, the average groundwater level has continuously declined by a total of 5.8 m and significant degradation of the vegetation has occurred along the river course. The discrepancy in the water allocation between the middle and lower reaches has intensified. This highlights the inability of the current water diversion scheme to realize further ecological restoration and achieve sustainable development throughout the whole basin. In future water management programs, we recommend that water allocation is coordinated by considering the basin as an integrated entity and to scientifically determine the size of the midstream farmland and downstream oasis; restrict non-ecological water use in the lower reaches, and jointly dispatch the surface water and groundwater.

Keywords: Ecological effects, Heihe River Basin, Water diversion project

T0042

Linking ecosystem services with Sustainable Development Goals based on expert knowledge

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The Sustainable Development Goals (SDGs) aim to embrace potential synergies between the environment and human wellbeing. Meanwhile, sound ecological management could identify the pathway on sustaining flows of ecosystem services to humanity. Understanding the relationships between SDGs and ESs (ecosystem services) provides explicit demand of ecological management to support to realization of SDGs. An expert survey on the relationships between 18 ecosystem services and SDGs and the prioritized degrees of SDGs has been processed. Our survey found that SDG2 (Zero Hunger) was the most prioritized worldwide goal and the top cited goals contained aspects of human survival such as SDG6, SDG1, SDG3, SDG4 as well as aspects of natural environment such as SDG13, SDG15 and SDG14. In addition, although continental differences existed in SDG priorities, SDG2, SDG1, SDG3, SDG6 had most priorities in each continent. According expert judgements, the SDG15 (Life on land) had the strongest correlations with ESs on global scale, and several ESs including education, fresh water, climate regulation, food, water purification, biodiversity and air purification should be paid more focuses for promoting sustainable development. SDGs which concerning public good (SDG2, SDG6, SDG4) in Latin America & the Caribbean and Africa had higher correlations with ESs than other continents. When combined SDG priorities and SDG-ES relationships to derived ES important degrees, water purification could be the most important ES on global and continental scales, and aesthetic value, wood fiber and genetic resources were the less focused ESs. The front concerned ESs in each continent contained all categories of ESs while the slight discrepancies existed by the sequences. This study triggers understanding prioritized SDGs and relationships between SDGs and ES for further analyze the promoting role of ecosystem services to SDGs.

Keywords: Sustainable Development Goals, Ecosystem services, Relationships, Priority

Niche Evolution of China's Provincial Social–Economic–Natural Complex Ecosystems, 2005–2015

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The ecological niche of a complex regional ecosystem reflects the fit of various human activities and the advantages and disadvantages of the environment in the region. This study examined China's comprehensive niches of the compound social–economic–natural ecological system during the "11th Five-Year" and "12th Five-Year" periods using a Full Permutation Polygon Synthetic Indicator method. The results showed that before the 11th Five-Year period, the levels of comprehensive niches in the country were generally low, and, by the end of the 11th Five-Year period, the comprehensive niche levels in Beijing, Tianjin, and the eastern coastal regions each exceeded 0.40. During the 12th Five-Year period, after the ecological civilization construction plans were implemented, the average national comprehensive ecological level reached 0.57, the comprehensive ecological niche levels in eastern coastal areas reached more than 0.84, those in southern regions and some developed middle and western regions were greater than 0.72, and, in central regions, the levels were between 0.50–0.70. This shows that the concept of compound sustainable natural–societal–economic ecosystem development was incorporated into planning and used to guide local policies and assessment criteria for regional development. This paper compares the advantages and disadvantages of regional development plans through time, and can be used to promote coordinated and sustainable regional development.

Keywords: compound ecosystem, ecological niche, ecological civilization, sustainable development

P_0236

Impacts of mining on net primary productivity of the vegetation: a case study of Shengli Coalfield

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The exploitation of the mining area has an important influence on the vegetation growth in the surrounding areas. Analyzing the dynamic changes of NDVI (Normalized Difference Vegetation Index) and NPP (Net Primary Productivity) on different spatial scales helps to assess the ecological environment in the mining area and serve the protection and management of the regional environment. Based on Landsat and MODIS data, the NDVI average value in the growing season and annual NPP average value were used as indicators. Buffer analysis and correlation analysis were used to identify the influence range of the Shengli coalfield in Inner Mongolia on the surrounding areas. The changes of vegetation and the correlation analysis between NDVI and NPP were represented between 2000 and 2017, and the linear regression and exponential regression model were discussed compared at different spatial resolutions. The main results are: (1) first defines the scope of the study area for the mining area and the surrounding region of 10 km, and identifies the mining area ecosystem function contribution rate threshold to be 25.9~32.3% where can be used as the boundary of research region. (2) Both the NDVI and NPP in the mining area and the surrounding area were showed a fluctuating upward trend during the study period, indicating that the mining land reclamation and vegetation reconstruction have a significant positive effect. (3) The dynamic change of NDVI and NPP is dependent on the spatial scale. There is a significant correlation between NDVI and NPP in the study area. And the power function regression model was superior to the linear model for 250 m and 1000 m spatial resolutions over the years. Based on the above results, it has important theoretical and practical influence on the evaluation, planning and management of the ecological environment in open-pit coal mining areas.

Keywords: impact scope, ecological assessment, NDVI, NPP, Shengli Coalfield

T0491

Application and challenge of big data in ecosystem service evaluation

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With the advent of the era of big data, the growth of user-generated content data provides large-scale data sources and new research ideas for landscape ecosystem evaluation. Text data generated by users can not only identify the differences in park ecosystem service types, but also evaluate the supply status of different services. Based on the textual user comment data of Beijing park on DA ZHONG DIAN PING website, this study attempts to construct the framework of the evaluation system of park ecosystem services based on textual big data by integrating the basic emotion theory of psychology and text information mining technology. The framework consists of the following three modules:
(1) Textual data acquisition module: the comment text of the park can be acquired through the web crawler technology to provide data support for the research.
(2) Ecosystem service identification module: identify the park ecosystem services involved in the text based on the keywords and extended dictionary of four types of ecosystem services and combined with the machine learning mechanism.
(3) Ecosystem service evaluation module: on the basis of module 2, the whole evaluation system is supported by the algorithm based on rules, and the satisfaction score is output for text content item by item.
Through case study, it is found that the framework can realize the quantitative evaluation of park ecosystem services and has the advantage of real-time update, which provides a new approach for the evaluation of park ecosystem services. Through the operation of textual comment data of Beijing park of DA ZHONG DIAN PING from 2008 to 2018, it is found that it has poor recognition performance of supporting service, supply service and regulating service, but good recognition of cultural service. In addition, different elements in the park can greatly influence tourists' perception of ecosystem services.Further research needs to use the traditional survey data for inspection and correction.

Keywords: big data, ecosystem services, user-generated content

Symposium 20

Challenges of Arid and Semi-Arid Landscapes in the Anthropocene: Searching for New approaches for Adaptation, Conservation, Planning and Management

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The arid and semiarid lands of the world occupy an area of a third of the global terrain. These lands have abundant resources and vast developing landscapes, but rapid landscape change through human activities has taken place in many semi-arid regions recently. In addition, these areas face interactive effects of climate change, land use changes, and habitat loss. In the face of global change and the threat it may pose to the integrity of ecosystems, the new research frontier is the forecasting of how landscapes, and the ecosystems & species within them, will evolve under future scenarios of change. This symposium, will help to advance landscape ecology research in the semi-arid areas and promote interdisciplinary research and communication among scientists, planners, and other professionals to find new approaches toward resiliency at arid and semi-arid landscapes in the Anthropecene.

T0367

Synergies between Ecological Restoration and Energy Production- A Case of Bioenergy and Climate Change Mitigation Potential of Arid Wastelands in Northern Nigeria

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The Sahel region of Sub-Saharan Africa is increasingly under severe ecological threat, having been overtaken by increasing aridity and progressive sand dune developments. Even though some previous research, public opinion and international bodies have attributed this largely to climate change, more recent studies have found that human activities also play a big role in shaping this unpleasant trend. Reversing this trend is however more complex than it seems. As important and laudable as the goal of ecological restoration is within this context, there is also need to co-address very pressing and emerging regional needs occasioned by human population increase within the local biome/ecosystem under consideration. These other emerging regional needs include food supply, sustainable rural livelihood, income generation and wealth creation, grazing pressures, energy provision and more recently climate change mitigation. This study advocates an optimum solution that does not narrowly address ecological restoration as the sole objective but also cater in part for other emerging regional needs especially energy provision and climate change mitigation functions. This study assessed the energy and climate change mitigation potential of cultivating grass and tree species (e.g. Gliricidia sepium, Panicum maximum etc.) for ecological restoration and energy production on arid wastelands in the Sahel region of Sub-Saharan Africa, using arid lands created by wind deposition in Northern Nigeria as a case study. Preliminary results suggests that the energy and climate change mitigation potential of a combination of trees and grasses will not only contribute immensely to Nigeria's energy provision and climate change mitigation targets, it will also enhance and not conflict with other sustainability objectives such as ecological restoration, sustainable rural livelihood, income generation/wealth creation, meeting increasing grazing pressure demands, as well as future food supply needs.

Keywords: Ecological restoration, Arid Landscapes, Bioenergy, Grazing, Sustainability

T0152

Impacts of landscape changes on regional climate: The case of vegetation restoration in the Loess Plateau of China

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The Grain to Green (GTG) program launched in 1999 by the Chinese government is one of the largest ecological restoration programs ever implemented in the world. Although the GTG program has been demonstrated to affect different ecosystem services in the revegetated areas, its impacts on climate regulation are seldom reported and poorly understood. Therefore, our study examined the impacts of revegetation owing to the GTG program on summer climate in the Loess Plateau, by incorporating near real-time remotely sensed land use/land cover data and vegetation characteristics of 2001 and 2010 into a coupled land-atmosphere model. From 2001 to 2010, a considerable portion of croplands was converted to forests and grasslands, with vegetation fraction and LAI increasing while surface albedo decreasing throughout the Loess Plateau. Compared with those from 2001, simulation results from 2010 indicated lowered 2-m air temperature, with the magnitude of reduction in nighttime minimum (as high as 0.8 – 1.0 ℃) greater than that in daytime maximum (generally restricted to 0.4 ℃). The concurrent decrease in 2-m specific humidity further led to widespread reduction of near-surface heat content (i.e., moist enthalpy). Summer precipitation decreased in northern Shanxi province and western Loess Plateau (up to 1.0 – 1.4 mm/day) while increasing in southeastern Loess Plateau (between 1.0 – 2.0 mm/day). Our findings underscore that vegetation restoration has exerted strong influences on regional climate in the Loess Plateau, and provide useful information for the sustainable management of the GTG program in arid and semiarid areas.

Keywords: climate regulation, afforestation, vegetation characteristics, land use/land cover, semiarid landscape

T0394

Quantifying desertification trend using the hexagonal network, gradian analysis and landscape metrices in Chaharmahal Va Bakhtiari province, Iran

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Desertification rate rises in the world scale is one of the main environmental problem which has changed to a noteworthy challenge during the 21 centuries. The Zagros Mountains forests and pastures have environmental and socio-economic distinct importance in the region that their elimination can cause desertification expansion in the region in not a very far future making vast catastrophic complications to Iran. Forests and pastures of the Chaharmahal va Bakhtiari province are disturbed so they are exposed to eradication risk. One of the main factors which influences the phenomena at the province, is the abnormal mis-benefiting of the existing natural land uses. So, the aim of the present study was carried out to study the changes trend of forest and pastures land uses in the province. The first step was to work out the land use/ land cover map of the province through LANDSAT data image processing for 1994 and 2015. Then, two transects were erected and analyzed with employing few metrices and mosaic analyses. Also the gradient analysis were applied on the class and landscape levels. To study the forests and pastures disturbances, the erected transects were blocked in 10km by 10km directed north to south and east to west of the province. In this manner, hexagonal network was planned for forest and pasture land uses to study the amount of disturbances in a homogeneous unites. The produced maps with hexagonal network method present, during 1994 the lands with no vegetation cover class was abundant and dominated at the east and north east of the study region. While during the 2015, this land use class was extended and widespread to the all province.

Keywords: Transect, LANDSAT, Land use changes

T0447

Soil and gas exchange under historically farmed and pristine Acacia karoo patches in the Tankwa Karoo National Park, South Africa

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The succulent Karoo biome in South Africa is widely reputed to house Earth's greatest diversity of succulent plants. It is also famous for spectacular displays of annual flowers after good rains. The area experiences winter rainfall, which seldom exceeds 100 mm in any year. Hence, irrigated agriculture was never an option when European farmers began colonizing the land from the indigenous San hunter-gatherers. The land underwent extreme transformation in the last 200 years following the invasion, which resulted in homogenization of the landscape and extinction of many succulents and annuals, thus reducing biodiversity. The major change to the landscape was the introduction of large herds of livestock which need feed and therefore farmers started growing Lucerne extensive because it does relatively well under arid and semi-arid conditions. Large parts if the Tankwa Karoo National park used be under this land tenure, which is diametrically opposed to its status as a biodiversity conservation resource. Management of the park hence required data on the impact of these abandoned homesteads on ecosystem functioning in the park. Thus followed the impetus of this study where we set out to investigate the ramifications of farming on soil properties, microbial community composition and plant physiology. We used the natively occurring Acacia karoo as an indicator of plant physiological performance, practically the only tree in the landscape, seen along riparian corridors adjacent to the usually dry riverbeds. Conventional soil surveys and plants physiognomic status were undertaken. The two realms differed markedly in soil properties like pH, EC, C, N, texture etc., the cultivated patches were more nutrient-rich, generally. Plants in the pristine sites had greater stature. In gas exchange properties, plants in the cultivated sites were less efficient in C assimilation, WUE and transpiration. Finally, microbial community profiling suggested a decrease in their biodiversity.

Keywords: arid, microbiology, africa, conservation, plants

T0618

Valuation of tradeoffs between agricultural production and ecosystem services for adaptive water resources management in the Heihe River Basin

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Ecosystem services are faced with multiple stress from complex driving factors, such as climate change and human interventions. The Heihe River Basin (HRB), as the second largest inland river basin in China, is a typical semi-arid and arid region with fragile and sensitive ecological environment. For the past decades, agricultural production activities in the basin has affected ecosystem services in different degrees, leading to complex relations among "water-land-climate-ecology-human", in which hydrological process and water resource management is the key. In this context, managing trade-offs among water uses in the river basin to sustain multiple ecosystem services is crucial for healthy ecosystem and sustainable socioeconomic development. In this study, we analyze the trade-offs between different water uses in agricultural production and key ecosystem services in the HRB by applying production frontier analysis, with the aim to explore the potential for managing them. This method traces out joint production frontiers showing the combinations of ecosystem services and agricultural production that can be generated in a given area, and it deals with the economic problem of the allocation of scarce water resources under presumed objective, which aims to highlight synergies and reduce trade-offs between alternative water uses. Thus, management schemes that targets to both sustain agricultural production and increase the provision of key ecosystem services have to consider not only the technological or biological nature of interrelationships, but also the economic interdependencies among them.

Keywords: Trade-off, Ecosystem services, Agricultural production, Water management, Arid river basin

P0132

Grazing and fire on the reversibility and management of woody shrub encroachment: A modeling approach

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Grazing and fire have been widely used to manage woody shrub proliferation in many arid and semiarid grassland systems. The actual intensity of grazing and fire, along with the timing of the interventions, however, are difficult to determine in practice. In this study, we developed a cellular automata model to evaluate landscape dynamics in response to scenarios of grazing, fire, time of intervention, and initial coverage of grasses and shrubs. For a grassland to shrubland transition system located in the northern Chihuahuan Desert, New Mexico, USA, the modeling results show that, with current grazing intensity and fire suppression, the landscape may shift to a shrubland-dominated landscape in 100-150 years. This study highlighted that the introduction of fire not only directly removes shrubs but also reallocates the soil water and resources among different microsites, which may accelerate grass recovery and prevent shrub regrowth, thereby synergistically inhibits the plants' replacement and neutralizes the shrub invasion process. Reduced grazing slows down the grass decline rate, thereby prolonging the time needed for a landscape to shift to shrubland. An appropriately combined grazing and fire management could help maintain over 50% of grass cover and reduce the shrub cover to less than 2%, keeping the landscape highly reversible. Even using 1% grazing intensity and periodic fire once a year, the management tools should be implemented in 60 years, otherwise they may lose effectiveness and the vegetation transition tend to be irreversible to grass dominance.

Keywords: cellular automata model, arid and semiarid

A rapid method for quantifying landscape-scale vegetation disturbances by surface coal mining in arid and semiarid regions

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Context Quantifying landscape-scale vegetation disturbances by surface coal mining (SCM) is crucial for assessing and mitigating its negative impacts on the environment. Methods for detecting such disturbances in woody ecosystems exist, but these methods do not work well for deserts and grasslands in arid and semiarid regions because of their sensitive responses to precipitation variations.

Objectives The objective of this study was to develop a new index to reliably detect the locations and spatial extents of SCM-induced vegetation disturbances in dryland regions in the face of fluctuating precipitation.

Methods We have developed a vegetation disturbance index (VDI) that combines MODIS EVI data with precipitation data to detect vegetation disturbances by SCM on the Mongolian Plateau during 2000-2015. The VDI is computed by comparing vegetation production per unit precipitation for a given year with a multi-year mean, and by considering distances from coal-mining areas.

Results Our results show that the VDI was able to adequately distinguish vegetation disturbances by SCM from climate-driven vegetation changes in five selected sites across the Mongolian Plateau.

Conclusions The VDI provides an effective tool for quantifying the locations, spatial extents, and severity of vegetation disturbances by SCM in arid and semiarid regions.

Keywords: Vegetation disturbance, Surface coal mining, MODIS EVI, Precipitation, Mongolian Plateau

T0529

Tree Rings as Bio-indicator of Riverscape Changes in Central Iran

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Zayandehrud River, the only permanent river located in Central Iran, has been under both natural and anthropogenic pressures- such as climatic and land use changes- which are dramatically changing the face of the river basin. Different water levels along the 400-km-length of the river have divided the river and the adjacent riparian ecosystems into three distinct zones: upstream (from the river origin to the Zayandehrud Dam, with a new water body), midstream (between the dam and city water treatment facility, with a high water fluctuation), and downstream (from the city water treatment facility to the wetland, where the river experiences dry periods). Recent climate change has caused the river water to fluctuate more increasingly, bringing new environmental conditions to the ecosystem. It seems that riparian trees are one of the early-affected victims of river water fluctuation whose annual growth serve as a suitable indicator of the past changes in Zayandehrud River landscape. To do this, we sampled the annual growth ring of 90 trees (30 samples in each zone) to evaluate the effect of riverscape changes on vegetation. Firstly, we evaluate the fine scale changes in water discharge, physiochemical condition (i.e. temperature, BOD, COD, CO, EC, pH, sediment characteristics, etc.), biological parameters (i.e. diversity of zooplankton and benthos) as well as course scale changes such as vegetation cover, NDVI, Land Surface Temperature (LST), and land use change over the past recent decades. Secondly, we analyze the correlation between the annual tree growth and changes in river ecosystem changes over time. We conclude that the annual growth of trees significantly ties with the past ecosystem changes.

Keywords: Dendrochronology, River landscape, climate change, landuse change

Desertification classification framework and its application within the Northern Kulunda Steppe in Western Siberia

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A framework for classification of the complex changes underpinning the degradation of the landscape system caused by desertification has been developed during the last ten years and applied within the Northern Kulunda Steppe in West Siberia. In a region typified by very cold winters, hot summers and low precipitation rates, desertification is induced by climatic and anthropogenic driving forces. Therefore a set of indicators to determine bio-physical (biological, morpho-dynamical, pedological, hydrological and hydro-geological) and socio-economic processes is developed to support a systematic assessment of these factors. Based on thresholds of change detection, 34 indicators were analysed and assessed to systematically and robustly describe the regional desertification process. Each indicator has been benchmarked using literature, statistics and field data, classified in indicator groups and interpreted to the changes due to describe the desertification process. The analysis of the regional land use system indicated two major systems changes as causes of desertification: First the steppe conversation from natural steppe into arable land in the 1950ties and second the result of a combination of causing driving forces of climate (climate change), society (collapse of Soviet Union) and land use (management changes) influencing both the bio-physical and socio-economic sub-systems.
The presentation gives insights into planning and management perspectives by a special focus on complex land-use problems in a changing world. The presentation clarifies the applicability of landscape ecological knowledge as based in the framework on multiple causal chains integrated from pattern to functions into a structured indicator assessment. This framework is important for clarifying the analysis of SDG goals (e.g. land degradation neutrality) and its assessment based on landscape ecological systems knowledge to land degradation and desertification.

Keywords: Indicators framework, Driving forces, complex monitoring, Central Asia, land degradation neutrality

P0054

Habitat Quality Modeling of Wild Sheep (Ovis orientalis) in Central parts of IRAN Using InVEST and MaxEnt Models

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Biodiversity is declining as an ecosystem service, due to climate change, land use change and habitat loss. These changes are particularly noticeable in arid and semi-arid areas such as Iran. Sustainable goods and services to humans can be achieved through the conservation of biodiversity, habitats and ecosystem functions and services. Mapping and evaluating ecosystems and their services are considered as an essential strategy for biodiversity conservation. The main goal of this study was to map and evaluate habitat quality of Wild Sheep (Ovis orientalis) using InVEST model as an indicator for biodiversity. This biodiversity model is a habitat-based model that combines land cover and land use data with information on biodiversity threats to produce a quality habitat map. Our study area is around 32752 km2 which is among the most important habitats for Wild Sheep. In this regard, after determining the quantities of varieties of land cover and land use, the degree of degradation and quality of habitat was modeled. The results of this model showed that southwest and central parts of the study area were highly qualified for this species. Then, we tested the reliability of the model by comparing the estimated habitat quality values with habitat suitability map of Wild Sheep obtained by maximum entropy distribution model (Maxent), which used the presences and occurrence data of species distribution and related them to environmental data and predict habitat suitability distribution of species. The results of these two models indicated that conservation measures and planning, including the design of migration corridors for interstate areas of protected areas, which have high quality habitats, are necessary. Based on the results of this study, using these two models together can be useful for evaluating and distribution modeling of habitat quality and habitat degradation of important species of conservation concern.

Keywords: Habitat Quality, Maximum Entropy Distribution Model, Ecosystem Services, Biodiversity

T0632

Development of a system of systems framework to better understanding feedback loops and multi-scale interactions in social-ecological systems in Sub-Saharan Africa

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In Sub-Saharan Africa, food and water security are directly linked through the management of agricultural landscapes. Population growth, climate change or land degradation cause increasing stress on natural resources and threaten the local livelihood. It is quiet challenging to capture these complex non-linear social-ecological system dynamics in order to develop adaptive strategies for a sustainable food and water management. While no single modelling approach addresses all social, economic and ecological interdependencies, we suggest to implement a multi-disciplinary framework across spatial and temporal scales.
This talk presents a novel system of systems framework to include local land management in modelling regional land-use changes by combining the models ECOSERV (France), GISCAME (Germany) and MOWASIA (Burkina Faso). We will give an overview about preliminary scenario results of this on-going study reflecting the complexity of drivers, existing agricultural practices and human-nature interactions in different agro-ecosystems. According to nested social-ecological feedback loops, this approach incorporates different qualitative and quantitative knowledge sources such as local experts, stakeholder perception or already existing results provided by previous projects. Finally, we will discuss how stakeholders and local experts assessed the pre-developed scenarios to identify major trajectories in agricultural system. Such knowledge is essential in developing sustainable scenarios to strengthen food and water security.

Keywords: Land-use change, Land management, Landscape modelling, Social-ecological system

T0051

Effects of Land preparation and Reforestation on Eco-hydrological Services in the Loess Plateau of China

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In many drylands of the world, human disturbances greatly affect land cover, landform and related bio-geophysical processes and services. Such behaviors may bring positive or negative effects to local ecosystems and security, depending on what kind of disturbances are. In this study, we mainly took the degraded Chinese Loess Plateau as a case-study region, and the coupled roles of planted vegetation and land preparations on eco-hydrological responses from hill-slope and small watershed were monitored and analyzed. The key findings are stressed as follows. Diverse land preparation measures, including fish-scale pits, level ditches, level benches, broad-bench terraces as well as zig terraces, all play important roles in soil and water conservation (73% runoff retention and 42% sediment reduction in general), soil nutrient improvement, soil moisture recharge (0.87-37.71% increase) and vegetation growth enhancements. Vegetation plantation coupled with land preparation greatly benefits erosion control, but unfortunately increase the complexity of ecological response (e.g., exhausting deep soil moisture), which may further hamper the process of ecological restoration. More basic researches regarding plant selection (e.g., the low-water-consumption ones), reasonable site density and arrangement patterns should be launched in details in further steps, aiming at fighting against severe water erosion and land degradation in such regions.

Keywords: ecohydrology, terracing, ecosystem restoration, land degradation, drylands

T0552

Modeling Spatiotemporal Dynamics of Ecosystem Services in Zayandehroud Basin for the Last Decade (2008-2018)

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The concept of Ecosystem Services (ES) focuses on the linkages between ecosystems and human well-being, referring to all the benefits, direct and indirect, people gain from ecosystems. Evaluating and mapping ecosystem services in arid and semi-arid environments are of high importance since these ecosystems have witnessed an unprecedented rate of area decline during the last decades. The main goal of this research is to investigate and compare changes in landscape patterns in Zayandehroud basin, one of the most important rivers of the central plateau of Iran and then evaluating how ecosystem services are affected through these spatial landscape changes. Towards this aim, first, two satellite images were selected for the whole study area with temporal intervals of nearly 10 years. After that, images were processed to delineate the land use/land cover (LU/LC) map of the region based on CORINE land cover classes. Spatial changes were then estimated by comparing the values of five landscape metrics: CA, PLAND, ED, LPI, and TE measured from different-year LU/LC maps. As a last step according to extensive literature review and experts' opinions the important type of ecosystem services with significant impact on human wellbeing were identified and mapped. The existing research indicates declining in vegetation cover (21% to 19%) and decreasing in urban surface (3% to 12%) that is associated with a wide spectrum of adverse impacts on ecosystem services, processes and functions. Furthermore, these past changes are used to devise the future of environmental conditions and also how ecosystems will be influenced by the on-going environmental changes.

Keywords: Arid land, Zayandehroud Basin, Landscape Metrics, Land Use Change, Ecosystem Services

T0600

The impact of historic land-clearing on the fire-response of an endangered bird species

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Land-clearing for agriculture often focusses on fertile parts of the landscape, with many nature reserves confined to less fertile areas. It is well known that this bias in land-clearing has caused widespread declines in many bird species. Whilst this consequence of biased land-clearing is well studied, the idea that legacy of land-clearing can alter our perception of species' fire-responses is new to landscape ecology. In Australia, widespread land-clearing during the 20th century removed fertile areas that were important for many bird species. I present data on the endangered mallee emu-wren Stipiturus mallee, which is a fire-specialist species. I show that across most of its range today, the mallee emu-wren is a "mid-successional specialist", meaning that it prefers vegetation with 40-70 years since fire. However, in a small number of fertile areas that were never cleared, the mallee emu-wren occupies a much broader range of fire-ages (25-120 years since fire). I show that prior to land-clearing, these fertile areas were common and would have supported over half of the global mallee emu-wren population. By favouring fertile areas during historic clearing, we have pushed the mallee emu-wren towards a novel fire-response characterised by mallee emu-wrens occupying a site for only 30 years, rather than for 100 or more years. This discovery explains why a dispersal-limited species like the mallee emu-wren has a fire-response that requires frequent dispersal to access new habitat with an appropriate fire-age. Historically this species would have had much lower dispersal requirements due to the longevity of habitat. Given the poor dispersal of this species, I conclude that the mallee emu-wren is not adapted to its modern fire-age preferences because it evolved with different fire-age preferences. I ask how many species globally have fire-responses today that are the result of modern landscape transformations rather than a continuation of their historic fire-responses.

Keywords: fire ecology, bird conservation, land-clearing bias, fire management, drought refuge

P0159

Investigate the impact of road traffic for bird monitoring in an urban park in central Iran

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Soundscape ecology is an emergent and potentially transformative scientific discipline that focuses on the study of the effects of the acoustic environment on the physical and behavioural characteristics of those organisms living within it. The majority of research within the field focused on quantifying the characteristics and dynamics of soundscapes and examining their effect on non-human biota. Empirical evidence has suggested that biological and non-biological sounds could have a relevant role in animal population aggregation, community composition, and more in general in environmental dynamics.
The aim of this study is to detect and understand changes in soundscape composition in response to human disturbance. The study area is the central urban park of Isfahan city, Iran. It is characterized by the presence of city dwellers and it is close to a highway that is a source of traffic noise. These two disturbances overlaps and mixes with other natural sounds, represented mainly by bird songs and geophonies. We take repeated recordings of soundscape in eight point at equally spaced locations with low cost audio-recorders in March 2019. The intensity values and frequency bin occurrences of soundscapes, the total number of bird vocalizations and the Acoustic Complexity Index (ACI) were processed by using the software Wavesurfer 1.8.5. Changes in ACI indexes were compered for different places, different day time and during the season. This index offers new opportunities for the monitoring of song bird communities faced with the challenge of human-induced disturbances.

Keywords: soundscape, urban park, ACI, birds, road traffic

Symposium 22

Land-use legacies and forest change: understanding the past to forecast the future

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The ecological importance of land-use legacy effects has become widely recognized, and there are many examples where reconstruction of historical land use has proved instrumental for developing an in-depth understanding of contemporary landscape dynamics. However, it remains challenging to assess the implications of historical land-use processes for how a given landscape may response to future environmental change. In the case of forest landscapes, for example, it is often not well understood under what conditions particular types of historical land-use will reduce or increase sensitivity to global climate change drivers. Our era has been defined as the Anthropocene because it is strongly determined by a significant human impact on the Earth's ecosystems and even geology. The legacy of human impact on forest landscapes can persist over long time scales (decades to centuries). Management for forest landscapes that are resilient to global environmental change requires a nuanced approach incorporating land use history effects in studies of landscape dynamics, including projections of future forest landscape change.

Our symposium will focus on how forest landscape history, arising from past land use, constrains and shapes the future forest response to disturbance, management, and global change. The symposium will be structured with a mix of talks from around the world, to fill a diverse session that encompasses both modeling and empirical approaches to understanding how landscape change in future is strongly dependent upon historical land-use legacies. Although our session will have a focus on forests, we also encourage talks that explore the implications of land-use legacy for non-forested systems, as well as for landscape mosaics that incorporate multiple vegetation types. Finally, we hope to include talks that consider land-use legacies over a range of time spans, including from prehistoric times using paleoecological approaches, as well as from historical times.

T0070

Relations between nature conservation and land-use legacies in the Białowieża Forest (Poland): the influence on a landscape and its evolution

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The work examines the influence of land-use legacy on the state and continuity of a landscape of the Białowieża Forest (Poland). Nature conservation, which stems from unique ecological values of the area, and which should play a key role in its management is under special consideration.

A complex method of research is employed. The study analyses land-use legacy of the Forest from historical times (16th c) up to present. Investigation of landscape evolution and forest history was linked with comparative studies,analyses of scientific reports and policy documents (forest management plans, conserv. strategies), additionally, with an insight into discussion about the future of the area.

The Białowieża Forest represents the last primary deciduous and mixed forest in the European Lowland. Nowadays, a part of it constitutes a World Heritage Site and a Biosphere Reserve. Importantly, high protection values can be seen as a legacy of centuries, since the area was designated to perform the function of a royal reserve. Nevertheless, as the study reveals, the relations between the legacy of land-use and conservation not always are explicit. Firstly, the 20th c brought important changes of land management and many forms of landscape disturbance with it, and secondly, contemporary conservation implies an increase in general and specific requirements. Although there is a strong need to enhance a protection regime, this aim is difficult to achieve, mainly owing to character of present land-use and forest management practice.

The study shows that land-use legacy belongs to the most important factors affecting structure and protection of the Forest. Furthermore, the relations between this legacy and conservation are decisive about the future. However, the research highlights the significance of interpretation of the legacy. It is shown that landscape history narrative may be used to justify an increasing pressure on ecosystems, adding thus to processes of landscape deterioration.

Keywords: landscape change, value protection, historical ecology, forest, Central Europe

P0012

Commune land use planning in Cambodia: Concept, methodology and approaches

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The commune land use planning refers to the planning of land uses for all land in the commune, including state land and private land of private persons. The purposes of the commune land use planning include: Provide competency to commune councils in preparing effective land and natural resources use and management. Support equitable and sustainable socio-economic development. Contribute to the people poverty reduction. Help to achieve high productivity of land use in the commune based on the actual conditions and natural potential of the land. Respond to the land need of authorities and commune residents. Help prevent degradation and inappropriate use of land and natural resources. Facilitate better fulfillment of commune council role as state representatives in determining and managing state land in the commune. And seek supplementary technical support from various institutions and units as well as from private sector for preparation of commune development plan and investment program.

In generally, the commune land use planning is an importance tool for commune council as well as stakeholders at sub-national level to contribute in management and using the natural resources in sustainable and equitable manner. Truly, land issues are the core factors for economic development and livelihood. Thus, if land use plan existed, local authorities at all levels will get a wide angle of perspective and, integrate land use plan into the socio-economic development plan at local level through district integration planning, then get approval at provincial level, as same as the usual procedure in socio-economic development planning, which all stakeholders involve in decision making. To make easier for implementing at local level, the Ministry of Land Management, Urban Planning and Construction has been prepared this CLUP Implementing Manual, in order to support the Commune Development Planning (5 years planning) and Commune Investment Planning (1-year program).

Keywords: Land use planning, socio-economic , Investment , land use change, Commune development plan

Two centuries of extinction debt: landscape heterogeneity in the 18th and 19th centuries influences contemporary woodland ground beetle distribution

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Extinction debt, arising from time-lags in response to landscape change, has been identified in an increasing number of taxa. However, studies often focus on a single period of change and use a patch-matrix paradigm rather than addressing change across the landscape mosaic. In order to better explore the dynamic nature of landscape change and its effects on biodiversity, we used historical landscape character assessments to reconstruct land use data for four time points. In particular, we considered the effects of 240 years of landscape change on woodland ground beetle communities. Ground beetles were sampled in 36 woodland patches and land use maps were constructed for a 1 km radius circle around each collection point. The response of carabid communities to contemporary and historical (c. 1770, c. 1850 and 1930s) landscape heterogeneity was assessed using ordination analyses. Variation partitioning unpicked the unique explanatory contribution of each time period. Models for landscape heterogeneity c. 1770 performed better than those for all other time points. Shade-affiliated species, especially those that disperse poorly, were negatively correlated with the number of grassland patches c. 1770 and c. 1850 and positively correlated with woodland patch size c. 1850, but not with contemporary woodland patch size. Urbanisation through the 20th century further impacted large-bodied, flightless species, whilst favouring smaller-bodied and generalist species. Variation partitioning showed that historical landscape heterogeneity made a larger contribution to carabid community composition than contemporary landscape heterogeneity. All four time points made a unique contribution to explaining variation in ground beetle communities, demonstrating the value of incorporating multiple time steps and underlining the importance of considering historical land use when planning landscape conservation strategies.

Keywords: landscape change, landscape mosaics, landscape history, extinction debt, ground beetles

T0054

Land use history legacies on forest landscape dynamics in the Alps and the Apennines

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Millennia of human activities and natural processes have shaped forest landscapes of the Alps and Apennines (Italy). Land cover changes and landscape pattern modifications were investigated over a 60-year time interval, comparing areas at different slope exposures and elevation. We selected 20 study landscapes located along the Alps and the Apennines, applying an object-based classification to aerial images from 1954 and 2012. We obtained 40 land cover maps (2 time periods x 20 landscapes) with a classification accuracy (K statistic) range of 0.61 - 0.91. Landscape changes were assessed through transition matrices and landscape patterns were computed by means of landscape metrics at different spatial scales. The main environmental (topography and climate) and anthropogenic (distance from human infrastructures) drivers affecting post-agricultural forest dynamics were assessed with a modelling approach (GLM). Forest cover increased everywhere in Italy, with a higher rate (34%) on the Apennines than on the Alps (23%). Landscape mosaics at lower elevation lost structural complexity due to forest recolonization in abandoned grasslands, whereas at higher elevation they became more complex due to occurrence of woody vegetation patches in former grasslands above the historical treeline. Forest expansion was faster at lower elevations, on steeper slopes, and closer to existing forests. Our research provides a fine-scale dataset useful for modeling land-cover change and forecasting future mountain forest dynamics throughout Italy.

Keywords: land use change, mountain landscape, new forests, socio-economic drivers, historical ecology

The transition of the relationship between human and nature in Satoyama landscape in Japan. -Project management for collaborative restoration of regional social-ecological system-

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The management of abandoned Satoyama landscape is the important issue for biodiversity conservation in Japan. The Satoyama landscape is the socio-ecological production landscape which has been formed and maintained through appropriate use of natural resources in each region. In recent studies, how to maintain the Satoyama landscape as a Green Infrastructure (GI) becomes important subject. In order to restore the regional ecosystem in Satoyama landscape, how to enhance the social system that sustain people's interaction with the regional landscape should be considered. The aim of this study is to recreate a social system for regional ecosystem restoration in Satoyama landscape focusing on ecosystem services (ES). The study site, Mt.Omine is located in Fukutsu city, the southern part of Japan. The study site is an important environment for biodiversity conservation in the region. The collaborative forest management project have been implemented since 2017. The project team consist of different specialties and participate in the forest management to obtain provisioning and cultural ecosystem services. The interview survey to local residents was conducted for evaluating the past and present ES. The ecological characteristics were analyzed by GIS. According to the interview survey, the Satoyama landscape became underuse in association with lifestyle changes and construction of infrastructures. As the result, provisioning and cultural ecosystem services declined. At abandoned Satoyama landscape, the Moso Bamboo (Phyllostachys edulis) expand 0.21ha to 5.17ha in 62 years. The expansion of Moso Bamboo affected the species diversity of the forest floor vegetation. The project focuses on effective use of Moso Bamboo and other underused materials which promote biodiversity conservation and sustainable forest management. Thus, reflecting the past and present ES on the forest management would be important to create social system for regional ecosystem restoration.

Keywords: Ecosystem services, Social-Ecological system, Biodiversity conservation, Project management, Green Infrastructure

T0985

Identifying anthropogenic burning via paleoecology and paleolandscape modeling

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People have used fire to alter landscapes across North America for millennia, and though ethnographic records indicate regular fire use by Native Californians, the records do not specify the frequency, extent, or quantity of that fire use as a land management tool. Previous paleoecological work done at Holey Meadow (HLY) and Trout Meadow (TRT) in Sequoia National Forest, California (Klimaszewski-Patterson and Mensing 2016, Klimaszewski-Patterson 2016) indicated two periods of forest composition (1550-1050 and 750-100 cal yr BP) that were inconsistent with climatic expectations over the last 2000 years. The authors suggested that because of a disconnect between expected climatic forest response and the observed pollen record, these periods exhibited qualitative signals of anthropogenic fires set by Native Californians. We use the forest succession landscape model LANDIS-II to independently investigate the type of fire regimes present at TRT over the last 1600 years, building on previous modeling efforts done at HLY (Klimaszewski-Patterson et. al 2018). We test whether climatic fires alone can explain changes in the observed paleoecologic record at TRT, or if the addition of Native American-set surface fires better approximates the record. Simulated vegetation outputs from LANDS-II were compared to the pollen record at TRT. Modeled scenarios of climatic fires alone did not appear to fully explain changes observed in the paleorecord, especially during the Little Ice Age (750-100 cal yr BP). Modeled scenarios at TRT show greater statistical correlation and consistency with the observed pollen record when Native American-set surface fires are applied.

Keywords: paleoecology, landscape modeling, California, Native Americans, Anthropogenic impacts

The legacy effect of invasive pinewood nematode as a threat to ecocultural identity in Korea

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Threat to ecoculturally significant tree species is not new: Chestnut in the U.S., Bornean ironwood in Indonesia, and Pau Brasil in Brazil, to name a few. In this study, we review the case of pine trees in Korea threatened by invasive pinewood nematode (Bursaphelenchus xylophilus, PWD). We present the unique value of pine trees in shaping Korea's ecocultural identity and the challenges it is facing. We provide insights to better tackle similar problems, which will undeniably increase with globalization and climate change. Since its first case in 1988, invasive PWD has spread throughout Korea with mortality reaching 100% across most native pine species, devastating the forest ecosystem. There has been tremendous effort and public pressure to 'eradicate the disease', due to the cultural significance of pine trees. While debatable, the concept of cultural keystone species has been used for species with significant role in defining cultural groups. Much like an ecological keystone species would define an ecological community, a cultural keystone species plays a dominant function or displays profound presence in a cultural group through its usage or symbolic importance. In essence, such species is be deeply involved in defining the group's cultural identity, such as pine trees in Korea. Review of literatures and search trends showed that for over a millennium, village groves (maeul-soop) of pine trees have been established, maintained, owned, and conserved cooperatively by villagers in Korea. The ecocultural significance of pine tree has been traditionally prevalent throughout Korean's life. And despite the weakening cultural functions and management, strong communal practices and mindset still persists in both rural and urban communities. Furthermore, the millennium-long cultivated pine village groves may be genotype pools with greater resistance. We call for better education and communal effort are important to protect and to build new ecocultural identities.

Keywords: Village grove (maeulsoop), cultural keystone species, Bursaphelenchus xylophilus, communal forest

P0079

Collateral Values: The Natural Capital Created by Landscapes of War

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Warfare and related military activities have intensive, long-term, negative impacts on the environment. But sites of past human conflict also present potential opportunities for conservation and restoration. We provide an approach to valuing military landscapes based on the ecosystem services that they provide. These services are often underappreciated because the benefits gained from the functioning of the ecosystems are not the primary reason for the protection of the sites. We describe these services as collateral values, drawing on the military concept of collateral damages. Examples are provided from across the globe, reflecting conflicts stretching over hundreds of years. Landscapes considered include military battlefields, demilitarized borderlands, and potential peace parks. Specific conflicts include the American Revolutionary and Civil Wars, the Great European Wars, and recent engagements in Cuba, Afghanistan, and the Korean Peninsula. Examples are set within the conceptual framework of warfare ecology with a focus on post-war activities. They address conservation issues including land preservation, protection of biodiversity and water resources, and sustainable tourism. Where possible and appropriate, lessons learned from historical landscape trajectories are discussed in the context of their potential application to the future management of ecosystems still engaged in conflict. We suggest that the increased recognition of the multiple values of these unique landscapes should lead to their increased protection and careful management to preserve and promote the diverse services that they provide.

Keywords: Battlefields, Borderlands, Conservation, Ecosystem Services, Landscape Planning

P0181

The influence of land abandonment on disturbance regimes of forest ecosystems: a review

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Land-use and climate change are important drivers of regime shifts for several disturbances across landscape and global spatial scales. The role of land abandonment on disturbance regimes in human dominated landscapes has been recognized for some types of disturbances, nevertheless it is still somewhat overlooked compared to climate change. During the 20th century, many areas of the world experienced a progressive abandonment mainly due to socio-economical changes with an indirect effect on disturbances regime characteristics. The aim of this literature review based on worldwide studies is to explore the effects of abandonment upon the regime of different forest disturbances, emphasizing its interaction with each of them. To achieve this goal a bibliographical search was performed by using the query 'TITLE-ABS-KEY(land use AND abandonment AND disturbance AND forest*)' within the Scopus database. The natural disturbances considered in this research were wildfire, wind-throw, storm, flooding, landslide, avalanche, herbivore, and insect outbreaks. We found a total amount of 321 papers, which were grouped by using several descriptive attributes such as type of disturbance, study area location and size, scientific approach. We also gave a rating to each paper according to its relevance for the aims of the review. The highest rate was given to those papers that clearly measured the interaction between abandonment dynamics and disturbance regime characteristics. Our preliminary results showed an ascending trend in the number of the published studies (> 10 per year) during recent years (2010-2018). European regions were the most frequently studied as they are widely interested by land abandonment. We observed that land abandonment can either exacerbate disturbances, as in the case of wildfires, or can have inhibiting effects on them, as for avalanches.

Keywords: land use change, new forests, natural disturbances, historical ecology, disturbance interaction

T0159

Forest use legacies in protected nature reserve (Kaluga region, Central Russia)

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The modern forest structure and its spatial pattern are determined by various natural and socio-economic factors and legacies of previous forest management. Our study area - Kaluzhsky Zaseki Natural Reserve - is situated in Central Russia. First nature conservation activities started here at the end of the 16th century due to defense needs at southern border of Russian State. Our aim was to reconstruct the dynamics of various types of forests since 18th century on a local scale. We utilized Landsat-5, 7 and 8 images for the period from 1986 to 2018 to make supervised classifications of land cover using random forest method. They were verified according to the state forest survey data and field observations. We obtain natural factors (such as landscape features, topography, soil nutrient and moisture supply levels, etc.) from digital elevation model and landscape map to describe spatial distribution of forest types. We also used socio-economic features (such as distance from settlements, road network, administrative boundaries, population density, etc.) that were calculated in SAGA-GIS from historical maps and satellite images. According to historical data and literature, periods of forest management regimes were compiled, including time and spatial area of the reserve, cutting and planting of different types of forests. We applied ensemble modeling (combination of random forest, NNET, logistic regression) to identify the contribution of natural and socio-economic factors to spatial distribution of forest types. This allows us to reconstruct long-term forest change for earlier periods up to the 18th century. The results showed that typical deciduous forests preserved here from the beginning of the 18th century. The share of oak increased due to planting in the middle of the 18th century, and the share of aspen and spruce increased during the Soviet period. Traces of earlier impacts are now can be seen only in the soils.

Keywords: land cover change, GIS, modelling, long-term, old maps

T0171

Historical legacies on the forest landscapes of central Italy

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We present a 2700 yr pollen record of forest history from central Italy and interpret forest change in relation to climate and human land use reconstructed from historical documents and archaeology. The Rieti Basin in the Apennine foothills 80 km north of Rome, has been continuously occupied for 2300 yrs. At the beginning of the Roman period, a rich deciduous forest dominated hillslopes, and floodplain forest filled the valley. The Romans partially drained the wetland and cleared some floodplain forest, but hillslopes remained largely unimpacted. The Lombards (600 - 750 AD) created the first major impacts, reducing the diversity of desirable hardwood species. Following the conquest by Charlemagne in 750 AD, new laws and land use led to regrowth of secondary oak woodland, but with continued changes in land ownership and expanding populations, extensive forest loss occurred during the Medieval period (900 – 1350 AD). Depopulation after the Black Death, and a shift to cooler wetter climate with the Little Ice Age led to widespread land abandonment and rapid forest regrowth. After 200 years of abandonment, by 1600 AD, the forest was beginning to approach a composition comparable to the Roman period; however, new hydrologic technology led to draining of the valley, resurgence of agriculture and grazing , and forest loss. Management over the last two centuries has maintained a less diverse forest of oak and hop hornbeam. Reduction in livestock grazing has allowed invasion of juniper, not seen in the previous 2700 yrs. Agriculture has removed nearly all floodplain forest. To restore the forest, some agricultural land would need to be returned to floodplain forest, and grazing would need to be reestablished to control juniper and conserve historical land uses. Under a warmer future climate there is still potential for a return of diverse hardwood and beech forests, an important step for the achievement of the Paris (climate mitigation) and Aichi (biodiversity) conventions.

Keywords: pollen, historical archives, forest history, Medieval, Italy

T0399

The fast-paced expansion of dust source areas: A major threat changing the face of iranian southeastern arid landscapes

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Northern coasts of the Gulf of Oman are environmentally sensitive arid landscapes where upstream flows blocking by dams and irrigation with saline waters have resulted in the expansion of dust source areas (DSAs). Taking Gowatr region-Iran as the study area, this research aimed to identify the ecological and spectral reflectance characteristics of these sources. Secondly, the extent and expansion rate of DSAs were delineated employing remote sensing techniques. Two mosaicked Landsat tiles acquired in 1986 (TM) and 2016 (OLI) were classified to identify main land use classes including natural vegetation cover and DSAs with an acceptable accuracy. Results showed a significant increase in the area of dust sources from 1062.41 to 2281.22 km2 (annual rate of ~3465 km2) and a decrease in the area (from 784.41 to 422.65 km2) and biomass (from mean NDVI of 0.11 to 0.08) of natural vegetation cover during 1986-2016. Spatially, DSAs have expanded through an edge growth pattern towards the coastline northern highlands where decreased vegetation coverage and biomass indicate the risk of further land conversion to DSAs. Facilitating the water flow through the region in addition to limited use of saline water for agriculture were our suggestions to curb the extensive DSA expansion.

Keywords: Dust source areas, remote sensing, Landsat, change detection, Iran

P0215

Effects of historical land use and land pattern changes on the landscape structure and its functioning – case studies from the middle-taiga upland plains of the southern Arkhangelsk region

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Effective land management requires studying the landscape structure of a territory, its genesis and evolution. This study is devoted to the formation of the landscape patterns of the middle-taiga upland moraine-erosion plains of the southern Arkhangelsk region located in Zayachya river basin. Tectonic framework of the region determines the landscape fragmentation in to the landscapes of the tectonic micro-blocks and the landscapes of the fracture zones. Erosion forms arranged in agreement with the tectonic fault zones. Carbonate sediments of the Permian time, lying close to the surface, are responsible for the formation of the Ca-dominated landscapes, which are highly untypical for the Taiga. These factors determine the slope variations of the territory and the speed of the erosion, spatial distribution of the redox conditions, and consequently soil forming processes.

Main aim of the current investigation is the estimation of the impact of the land use pattern on the landscape pattern of the region and changes in its inner structure properties (relief, lithology and neotectonic framework, vegetation, soil types, geochemical peculiarities, etc.) and their functioning.

Materials used include the map of the landscape structure of the region, Landsat data, topographic maps of the region, general survey plans of 18, 19 and 20 centuries. All the collected data were compiled into a geo-database by means of the ArcGis suit. Comparison of the modern landscape structure with historical survey plans allowed to track changes of the woodland's areas, arable and pasture lands areas, evolution of wetlands and hydrographic network, growth of the settlements. Performed analysis allows to estimate impact of the land use on the functioning of landscapes, soils hidromorthism changes, estimation of the inner structure properties of Zayachya river basin. Results of the current work will be used to predict evolution of the landscape patterns of the studied region.

Keywords: landscape structure , land use change, landscape evolution, functioning of landscapes, middle taiga

T0803

Spatial structure of forest plantations in the Araucanía region, Chile by means of landscape metrics, factor analysis and principal components

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The forestry industry is one of the main economic activities in Chile, which contributes approximately 3% of the country's GDP. This has been possible through a considerable increase in the area occupied by forest plantations located mainly in the centre-south of the country. In this line the study of the structure of the spatial occupation of forest plantations has not been widely studied. Although studding its spatial structure can reveal underlying processes in its establishment, which can contribute to the planning of this important activity. In this sense, the ecology of the landscape allows us to study the structure of the landscape by quantifying the components and the relationships that exist between them as part of a dynamic territorial system. For this, a great diversity of metrics have been developed that allow us to analyse the structure and the spatial relationships of the landscape components. However, such diversity of metrics implies the choice of a reduced set of metrics, which allows to explain with greater capacity the particular characteristics of a region. This work aims to describe the structure of the occupation of forest plantations in the Araucanía region, Chile. For this purpose, a factorial and principal components analysis will be carried out in order to select the set of metrics that best characterize the spatial structure of the current occupation of forest plantations (FONDECYT 1181954). For this, the distribution of forest plantations has been extracted from the forest inventory of 2013 (CONAF). Additionally, a set of landscape metrics was calculated at the patch, class and landscape level using the Fragstat software. The factorial analysis and main components will be carried out in R. The results obtained will allow to contribute to the understanding of the pattern of occupation of territory by forest plantations as a basis for future regional territorial planning in the region.

Keywords: landscape metrics, principal component analysis , forest plantation

P0142

Historical floras: a cultural heritage and a data source to detect past landscape features. A case study from late 19th century (Bologna, northern Italy)

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Historical floras, i.e. lists of plant species recorded in a given geographical area, are not usually considered for capturing past landscape features. Maps are a key source of information for reconstructing past landscapes, however they usually do not give detailed information on plant composition of the habitats. In this study, we tested the usefulness of the simultaneous use of historical floristic data and a coeval topographic map to evaluate the potential of such data in change detection. We analysed the flora of the Bologna province by Girolamo Cocconi (*1824 - †1904), published in a single volume in 1883. This work is one of the first examples in northern Italy of local flora directed to young (pre-university) students and common citizens, which aims at encouraging them to study (or at least to start to know) the flora of their territory, as it was common in the European cultural and scientific climate of that epoch, in which Cocconi's work is fully inserted.
As floristic data are characterised by the absence of an explicit and well-defined geographical framework, we firstly georeferenced Cocconi's data. This meant to make the toponyms used in the flora coincident with those present in a topographic map. The species list for each toponym was used as a proxy of the exploration effort. Habitat composition of late 19th century was reconstructed by using plant species as environmental indicators of habitat. Finally, these results were coupled to a coeval topographic map and used to estimate past vegetation composition.
This research allowed to:
- detect the spatially biased exploration patterns, based on accessibility and/or better attractivity for field work (i.e. the anisotropies in the floristic exploration of the study site);
- give a quality to the coeval land cover map, by means of the passage from species to habitats;
- assess to what extent past floristic data allow to determine the main vegetation features of a past landscape.

Keywords: toponyms, landscape history, floristic investigation, habitat, topographic maps

T0997

Endangered socio-ecological habitats. The case study of chestnut orchards in the Bolognese Apennine

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Chestnut orchards represent a key element of the cultural landscape in the Apennines and a socio-ecological habitat of great interest. Since the early Middle Ages, they provided staple food and represented a civilization that shaped the landscape and the lifestyle of mountain people. A first decline of the cultivation started in 18th century, but massive abandonment occurred after World War II. In addition, pest and pathogens heavily impacted perceptions and attitudes of growers towards the cultivation. Consequently, most of the stands were coppiced or just abandoned, thus evolving toward mixed woods. At present, chestnut groves may locally still assure incomes, especially when related to "maroon" market. Furthermore, the UE has recognized it as a habitat worthy for biodiversity conservation. This work aims at retrospectively reconstruct the historical role of the chestnut orchards connecting past legacies with present state so as to better understanding their present significance. Our study focuses on Bologna Apennine where a great amount of historical data on chestnut culture are available for the 18th century. In this study we combined historical maps and written sources with present monitoring data and structured interviews. Our approach allows to confirm how the long cultivation history makes the chestnut an essential part of the cultural heritage well anchored in the local community. After great worries, diseases seem well manageable, while climate change has been starting to impact cultivation. Although the traditional management of chestnut orchards allows to preserve high level of biodiversity, there is still a high risk of abandonment of these activities, which are related to marketing possibilities of products on one side and to property condition on the other side, and in particular the aging of the growers and difficulties in granting a management succession. So, only a complex strategy can aim to conserve the multifunctional values of chestnut groves.

Keywords: Castanea sativa, Landscape history, Data integration, GIS

Land-use legacies: the evolution of British forestry in response to changing resource needs

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Forestry in Britain has been subject to a series of policy changes since the early 1900s. The low forest cover at the beginning of the last century continues to influence forestry today. This study examined the evolution of British forestry in response to changing resource needs over the last 100 years, using a comprehensive review of the scholarly literature and legal and policy documents. With origins in a largely ad hoc attitude towards forest expansion and management which dominated up to World War I, a productive stance based on intensive mono-culture plantations in order to reduce dependency on timber imports then held sway until the early 1970s. This has since been overlain with ideas about multi-functionality and sustainable forest management that continue to be important until today. However, although British forestry is increasingly influenced by international obligations, it continues to be influenced by its low forest cover.

Keywords: Forestry, Natural Resources, Policy, Landscape Change, Sustainable Forest Management

T9008

Patterns and drivers of habitat loss in a rural landscape over multiple time periods between 1930 and 2015

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Many studies evaluating biodiversity loss and altered ecosystem services have tended to examine changes over the last 40 years, despite the fact that land use change and its negative impacts have been occurring over a much longer period. Examining past land use change, particularly over multiple time periods is essential for understanding how the drivers of decline vary in significance overtime. We determined the habitat cover at over 3700 sites across Dorset, south England in 1930, 1950, 1980, 1990 and 2015, using a historical vegetation survey, re-surveys, historical ordnance survey maps and other contemporary spatial GIS layers. Considerable declines in semi-natural habitats occurred across Dorset between 1930 and 2015, with the majority being lost during the middle of the 20th century (1930-1980). The proportion of sites lost to agricultural intensification declined linearly over the 85 years, whereas afforestation and urbanisation declined monotonically, with indications of levelling off in the latter time periods. Despite this a number of semi-natural habitats were still being lost more recently within the last 25 years. This has important implications for future land management and ameliorative actions, such as restoration. The results also highlight the importance of statutory protection for retaining semi-natural habitats, suggesting the need for continued protection and additional notifications of important sites in Dorset and across Europe.

Keywords: Spatial, Temporal, Semi-natural habitats, Drivers of change

P0177

Relationship between historical land use and the current state of soils in agrosilvopastoral systems in Southwest Spain

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Past human activities have influenced present and future landscape dynamics. The agrosilvopastoral systems known as Dehesas, located in Southwest Spain, have been subject to land use and management changes during the last centuries. Nowadays, the soils of Dehesas present a poor state of conservation influenced by accelerated soil erosion, especially during the last decades. The goal of this study is to analyse how land use and vegetation cover changes generated by human activities along the last centuries have influenced the temporal variation of soil erosion rates in Dehesas. Results indicate a continuous increase of soil losses from the second half of the 19th century onwards and a further increase corresponds to the 20th century. In this way, three periods were differentiated: P1 (1636–1830), P2 (1831–1885) and P3 (1886-2014). During P1, soil erosion rates were very low (1.6 t ha-1 y-1), which could indicate that natural soil erosion predominated in the study areas and that the human activity did not influence the erosion processes. P2 was characterized by an increment of average soil erosion rates amounting to 5.5 t ha-1 y-1, coinciding with an increase of cultivated areas to tackle a continuous demand of food. P3 stood out with a strong increase of erosion rates, reaching a mean erosion rate of 27.2 t ha-1 y-1. The main causes were diverse: the expansion of cropped surfaces due to protectionism politic imposed by Europe at the end of 19th century; the introduction along the first half of the 20th century of new agricultural techniques like the moldboard plow; a further increment of the cultivated areas after the Civil War to alleviate poverty (1939–1980); and the increase of livestock density during the last decades (1980–2012). In conclusion, this study could contribute to a better understanding of landscape changes and the prediction of future changes.

Keywords: Historical land use, Land use change, Dehesas, Historical soil erosion

T0512

Landscape and forest legacies in the Czech Republic: how it was influenced by land use changes during the 20th century and protection for future

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Forests cover approximately one third of the area of the Czech Republic but their area changed in past and used to be less mainly at the end of the 19th century. Their regional distribution is uneven; more forests are in highlands and mountains in the borderland. Forests in lowlands are often connected with former land use, especially with hunting, or there are small and unstable forest patches.

The paper focuses on forests in lowlands and their legacy. On the model areas, stable and unstable forest patches will be identified. Stable and often bigger forest patches are mainly former game parks and pheasanteries, which represent landscape legacy connected with other cultural monuments (e.g. gardens, manors, gamekeepers´ lodges, follies). Small forest patches are remnants of former productive forests or they were created spontaneously on the areas less suitable for intensive agriculture and mechanization. Both, big and small forests play important role in nature conservation and ecosystem services and they could be also natural monuments.

Forests cover could be studied on the old maps that are available for the whole area of the former Habsburg monarchy from the end of the 18th century. Older maps from the early 18th century exist for important forests (especially for the game parks) but their analysis vis GIS could be difficult because of the spatial inaccuracy of these old maps. Land use and forests quality could be studied according land registers and qualitative archival sources. The paper also enhances different types of the sources, their advantages and disadvantages and methods how gain the information about forests cover and quality.

Keywords: land cover chages, forests, biocultural landscapes, Czech Republic

T0023

Historic land-use and fire exclusion influence oak regeneration and mesophytic expansion

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Across many landscapes, the processes that generated contemporary vegetation patterns are poorly understood due to insufficient historical data. The southern Appalachians in the southeastern United States exemplify this conundrum: Although the canopy is currently dominated by oaks, oak regeneration is limited. A clear understanding of the processes that generated the current oak canopy – and that limit oak regeneration today - is necessary for making decision about how to manage oaks into the future. We used a landscape simulation approach to generate a historic analog of the landscape beginning in 1500 CE and simulated forward to 2000 CE, and included estimates of critical processes and events: Native American burning up to ~1700; colonial settlement and burning from 1700-1900; the loss of chestnut (Castanea dentata), a keystone species, due to blight around 1940; and fire exclusion beginning in 1920. Our simulations suggest that although fire is necessary to maintain regeneration across the landscape, it was the sudden loss of chestnut that created a unique opportunity for oak dominance across the landscape. The extent of oak dominance today is likely a millennial maximum for the species. Future oak dominance at the current extent would require more fire than would be acceptable given human settlement patterns although local efforts at reintroducing prescribed fire can maintain this critical species.

Keywords: land use change, landscape history, prescribed fire, oak regeneration

T0163

Disentangling climate change and land use legacy effects on European forest disturbance dynamics

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Disturbances are important drivers of structural, biological and functional diversity in forest ecosystems, thus helping to maintain the important forest ecosystem services we as humanity rely on. There is, however, accumulating evidence of increasing disturbances worldwide, which might impact forest ecosystem services and erode forest resilience. Understanding the drivers of increasing forest disturbances is thus of upmost importance. For Europe, there are two hypotheses explaining observed increases in forest disturbances. On the one hand, past land use has largely homogenized forest diversity and structure, which led to a highly susceptible cohort of trees that is now affected by large-scale natural disturbances, and is also subject to increased forest harvesting activity. On the other hand, climate change is expected to increase the frequency and severity of natural disturbances, and might also increase forest harvest due to higher rate of biomass accumulation (e.g., as a result from CO2 fertilization). Our aim is to disentangle both effects for Europe's forests. To estimate recent (1984-2018) increases in forest disturbances consistently across Europe, we manually interpret more than 20,000 satellite time series plots, covering 35 countries and a total of 40 million hectares of forests. Initial results indicate a doubling in forest disturbance rates in Central Europe over the study period, but also high spatial variability is evident at continental scale. Subsequently, we compare the satellite-based disturbance estimates to national-level trends in climate and forest structure, as well as to model-based estimates of harvest dynamics. This analysis allows us to disentangle the effect of past land use and climate change effects on observed trends in forest disturbances.

Keywords: Disturbance, Europe, Landsat

The Transformation of the Cultural Landscape with Washi Paper Industry in Gokayama Area, Japan

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Washi is the traditional handmade paper that was first made in Japan, and was added to UNESCO's Intangible Cultural Heritage List in 2014. Gokayama washi paper is a long success story of over 1,200 years in Gokayama, Toyama Prefecture. In the villages belong to Gokayama listed as World Heritage Site in 1995, the conservation of natural resources and regional development which are related to washi paper industry, are very important. However, with the ups and downs of Gokayama washi paper industry due to different factors such as policies and the economy, the cultural landscape have experienced several changes. This study aims to clarify the transformation in land use and spatial patterns based on the history of Gokayama washi paper industry, and to discuss how to develop appropriate natural resource management and conservation effort from cultural landscape scale. The results indicated that: To get the raw material for paper-making, the change of plantation influenced the land use. The production changed the spatial patterns of people's living area inside villages. The management methods also changed from the spontaneous behaviors of local people to communities and associations based activities and policies have improved but it became more difficult to find enough managers. Therefore, this study can be a basic knowledge in order to inherit the traditional culture and conserve the unique regional landscape in the future.

Keyword: cultural landscape

Land-use history lessons for managing arid woodlands of the western US: the forgotten role of the carbonari migrant workers?

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Pinyon-juniper woodlands of the arid Great Basin (western US) are typically managed from the perspective that they have expanded since the late 1800s due to over-grazing and fire exclusion, such that restoration efforts emphasize large-scale removals of these native tree species (Pinus monophylla and Juniperus osteosperma). Yet not all post-settlement woodlands are the outcome of tree invasion processes; rather, many arise from slow reforestation following 19th Century harvest. From ca. 1865 – 1895, large areas of woodland were harvested to produce charcoal for the smelters and furnaces of the mining industry. Evidence of such practices, carried out by Italian, Swiss and Chinese immigrants, is noticeable today as charcoal kilns and pits. The land-use legacy of the carbonari has influenced the current distribution and stand structure of pinyon-juniper in ways that remain poorly known. Through mapping from high-resolution imagery and field visitation, we developed a novel data set of late 19th Century charcoal kiln, pit and wood-cutting sites, extending to over 20 mountain ranges across an 180,000 km2 area. We quantified the impacts of historical wood-cutting on woodlands in several ways, including cost-distance modeling of impacts around charcoal sites; analysis of spatial correspondence between highest and lowest sites with the current elevational limits of woodlands; and use of the sites to validate an existing, process-based spatial model of charcoal-related harvesting in the region. We then quantify the overlap between historical wood-cutting and areas of recent landscape restoration treatments. Our results show how land-use legacies influence woodland dynamics and constrain management options. In arid woodlands, historical harvesting has particularly long lasting effects because of slow and episodic tree establishment. Thus, second-growth regeneration can readily be mistaken for the novel expansion of trees into shrublands and grasslands.

Keywords: landscape history, land-use legacy, dryland ecosystems, pinyon-juniper

Symposium 24

Multiple roles for landscape ecology in future farming systems

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Agriculture is one of the oldest human uses for the land having transitioned through several revolutions to shape what it is today. Current farming systems face new pressures, with mounting social, environmental and economic challenges as we progress through the 21st century. Climate change will alter the prevalence and capacity of farming and forestry across regions; it is likely that flooding and drought events will increase in frequency and water quality and quantity will become increasingly problematic. Additionally biodiversity is declining; biosecurity threats abound; market influences are changing; and there are heightened concerns around the relationship between animal protein and human health contributing to a shift from pastoral economies to meat-free futures. There is also growing public intolerance for the cumulated environmental impacts from the agricultural sector requiring a need to adopt more of a social licence to operate into the future. This is all set in a framework where there is a need to feed a growing global population putting pressure on marginal and previously unproductive land to be considered for production or intensification. The future confronting agriculture is one in which the problems are not neatly defined or bounded, but rather they are multi-faceted, transdisciplinary and unpredictable. The implications for the landscapes in which current and future farming systems sit are equally uncertain as some face de-intensification whilst others further intensification. To minimise socio-economic and environmental impacts the necessary course of action is to adopt approaches to land management that enable future landscapes to support livelihoods and increase production whilst maintaining the valuable ecosystem goods and services required for sustainability. Recognising that the livelihoods supported and production carried out may be very different to what has occurred before and the resultant landscapes may take on a different form and appearance. To respond to the challenges transdisciplinary research is needed to imagine new futures and pathways for achieving new farm systems set within sustainable landscapes. This means new or adapted production systems being carried out in multi-functional landscapes designed for maximum environmental as well as economic outcomes and value and 'buy in' from rural communities to be part of the new systems. Landscape ecology to date has suggested improved management strategies to facilitate preservation of important landscape structure and function in agricultural landscapes. As an evolving discipline, it also has been increasingly focusing on the socio-economic aspects of landscapes. Given this, it would seem pertinent at a conference focusing on 'Nature and society facing the Anthropocene' to ask what can landscape ecology contribute in response to challenges facing agricultural change, and give further currency and credibility to its pursuit of being a science addressing landscape sustainability by contributing to new sustainable farming systems. Landscape ecology is strategically placed to be able to contribute significantly towards various aspects of the required landscape and societal transformation. It should be able to provide appropriate tools, approaches and frameworks that can facilitate the planning, design and advice required to help work towards the creation of future farming systems that meet societal needs, respond to the environmental challenges and that can sit within sustainable landscapes. The aim of this symposium is to explore this contribution and to flesh out the evolving roles for landscape ecology. The symposium will cover environmental impacts and considerations for a broad spectrum of landscapes ranging from ones under intensive farm production to those where development has yet to occur, and will explore how landscape ecology can assist in the transformative change required to the socio-economic systems of rural areas.

T0583

Accounting for environment in sustainability assessments: measuring and modelling bioeconomic impacts across agricultural landscapes

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Land use integrates human-environment relationships and is a foundation for provision of many ecosystem services used by individuals and society. Although environmental impacts of land use are well-known, there has been limited development of methods for measuring the geographic patterns of bioeconomic pressures from land use that can be used to understand impacts on natural capital. In this paper we generate spatially distributed measures of bioeconomic pressures from agricultural land uses across the UK.

Data used describe national-, regional- and farm-scale land use, production, economics, and energy use for the UK. The data are structured as a series of interconnected multi-scale and multi-dimensional accounts of the economic and energy dynamics of farming. Measures of bioeconomic pressure are derived as the flow-fund ratios of energy per hectare for different farm types. Maps are created for the bioeconomic pressures at different scales from data on the geographic distribution of farming types. These bioeconomic pressures are then related to geographic variability in environmental conditions, and, specifically, to changes in soil and biodiversity.

Energy input densities range from 1.5 GJ/ha for Specialist Sheep LFA in Scotland to 360 GJ/ha for Pigs and Poultry in England; crop and Mixed farms have energy inputs of 13-32 GJ/ha, while hill and upland livestock farms have energy inputs of 1.5-12 GJ/ha. Results demonstrate geographic patterns of bioeconomic pressure; influences of the geography of environmental variability on farming and associated pressures; impacts of bioeconomic pressures on natural capital; multi-scale inter-relationships of farming types and land management practices; and the differential outcomes of national and international policies and markets within regional landscapes. The approach has application to land management, food and environment security, climate change and the roles and contributions of land systems science to sustainability.

Keywords: land use, agriculture, natural capital, bioeconomic pressure, land systems

T0842

Sustainable soil management in arable landscapes and invertebrate prey availability to farmland birds

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Arable landscapes have been subject to a strong decline in invertebrates, a crucial source of protein during the early stages of development of most farmland birds. In recent years, agri-environment schemes have encouraged sustainable soil management to improve soil health and ecosystem functions. As soil health is known to influence the abundance of soil specialist invertebrates and the survival rates of larvae of terrestrial and aerial invertebrates, can soil management increase the availability of quality bird food in intensively managed landscapes? This study addressed the individual and combined effects of cover crops and green compost amendment on invertebrate abundance and availability to farmland birds during breeding season. Fieldwork took place at Grange Farm (Cambridgeshire, UK). Three split-plot experimental fields undergoing different combinations of soil management since 2015 were sampled along transects projecting from the field boundary to the field centre. Aboveground invertebrates were collected using pitfall trapping and suction sampling. Soil penetrability was assessed using a hand penetrometer and plant cover was measured with pin quadrats. Soil samples were taken to measure bulk density, water content and organic content. Some taxonomic groups responded positively to the treatments, showing increased biomass particularly with the combined effect of cover crop and compost amendment. However, our Chick Food Index showed no significant increase in palatable prey availability for juvenile birds, with preliminary results showing that its best predictor was field boundary quality.This study shows how sustainable infield management, albeit valuable for soil improvement and effective in supporting some invertebrate taxa, may not increase food availability to farmland birds. Sustainable landscape planning for biodiversity conservation should stress the importance of semi-natural habitats retention and promote the addition of quality linear features.

Keywords: sustainable agriculture, soil management, farmland birds, biodiversity conservation

P0092

Co-designing insect-friendly farming systems – the project concept of FInAL

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Protection of insects in agricultural systems is an urgent matter because insect biodiversity is heavily decreasing due to current agricultural practice, such as unbalanced orientation on efficiency and use of pesticides. At the same time there are several research gaps: a) lack of implemented insect-friendly farming systems; b) little knowledge about farmers' and other stakeholders' perspectives concerning their problem awareness, attitudes, current behaviour, or solutions; c) need for accepted solutions. The objective is to co-design innovative insect-friendly farming systems by involving agri-ecologists, entomologists, social scientists, and stakeholders (farmers, landowners, farmers associations, advisory services, decision-makers, etc.). To achieve this, we develop an integrative and collaborative process with iterative feedback-loops, which encompasses the following steps: stakeholder analysis, co-design workshops on joint framing of guiding principles, qualitative acceptability studies, etc. As main result we expect the identification of accepted and effective insect-friendly farming systems that can be implemented on landscape scale (landscape labs) and in different agricultural systems (intensive cropping, intensive and extensive grassland, small-scaled agriculture). The results are embedded in the broader challenge to contribute to the initiation of a system change beyond developing agri-environmental schemes that encourages a rethinking of current agricultural system and supports establishing an innovation niche.

Keywords: collaborative design, transdisciplinary research, insect biodiversity, transformation, innovation

T0454

Interplay of agroecology models in the study of landscape ecosystem services trade-offs

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Designing agricultural landscapes producing food and ecosystem services is a challenge. Farming systems are complex and depend on several factors such as land cover, land use or farming uses. Modelling has proven a fruitful approach to decipher the links between agricultural practices and ecosystem services, as well as highlighting strategies for softening trade-offs and enhancing synergies. However, existing models often specialize in a specific scale and have their own specific formalism to describe a landscape, providing focused, but disconnected insights.

The aim of our study is to explore the synergies and trade-offs between ecosystem services and farm production via interplay between several existing agroecology models that were selected to cover a large part of ecosystem services from crop protection to carbon storage and economic outcomes. We define a set of scenarios (e.g. the increase of wooded areas) that could be simulated in the models, providing a broader view on the resulting ecosystem services (in that case bioagressor dynamics, crop production...).

We present the technical and conceptual issues that we faced to combine the different models, while preserving model parsimony without losing important details and system interplays. With this integrated approach, we explore different levels of agroecological solutions outcomes.

Keywords: modelling, sustainable landscape, agricultural, multidisciplinary

Using landscape ecology to help take a more holistic approach to agribusiness: The Kakadu Plum industry in northern Australia as a case study.

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There are millions of people around the world that are classified as living in poverty, many reliant on customary or commercial use of natural resources. Many Aboriginal people in remote parts of northern Australia find themselves with limited livelihoods opportunities, often caught in poverty traps and dependent on welfare. This has resulted in numerous social problems and contributed to a drift of people away from their customary lands and into larger townships in search of work. Aboriginal people are actively seeking local livelihood opportunities, so they have the option of remaining on their country. They have abundant natural capital and exceptional customary knowledge of wildlife which offers many commercial livelihood opportunities. Kakadu Plum (Terminalia ferdinandiana) is a tree which is endemic to northern Australia and has been used for a variety of medicinal and nutritional purposes for millennia. It has the highest levels of ascorbic acid of any fruit in the world and a range of commercially important antioxidants such as anthocyanins and polyphenols. Since early 2000, Kakadu Plum has been wild harvested commercially and as market demand increases there is pressure to shift to more intensive production systems. As production intensifies it will be important that the ecological integrity and social and cultural values of these landscapes are taken into consideration and planned for. This will require an understanding of the values and priorities of local people who own the land as well as the economic feasibility of the different production systems and ecological impacts. Landscape Ecology offers the holistic, multi-disciplinary approach that is needed to be able to integrate these values and help plan landscapes for multiple use. This paper will outline the research and development work that is taking place in planning towards a Kakadu Plum agribusiness to ensure natural and cultural landscape values are managed as development occurs.

Keywords: Cultural, Integrated, Traditional, Aboriginal

T0785

Estimating effect of farming practices on sediments and nutrients loading using SWAT model

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Current farming practices represents source of water resources pollution by sediments loaded during erosion process and nutrients originated from applied fertilizers. Water bodies than suffers by high nutrients inflow and remobilization from sediments resulting in eutrophication often causing algal blooms. Water resources are then worse usable for drinking water, industrial purposes as well as for recreation. Sources of sediments and nutrients from agricultural land can be mitigated by using best management practices in farming system.

Aim of this study is to estimate effectivity of selected best management practices on sediments and nutrients loading into small water reservoir Olešná situated in the eastern part of Czech Republic. For purpose of the study SWAT (Soil and water assessment tool) was chosen for simulating effectivity of contour farming, no-tillage farming and planting winter cover crops. Appropriate input data about topography, soil properties and current management were collected. Developed model was then calibrated and validated against measured flow time series and then estimated sediments, nitrate nitrogen and total phosphorus from monthly samples. In calibrated and validated model producing realistic results were then changed selected parameters as expected after management practices implementation.

Results show possible effect of all practices on reducing sediment loads. In case of nutrients, most effective seems to be planting winter cover crops, other two by increasing infiltration also slight increase of nitrates leaching.

Model will be used for estimation of change in effectivity of management practices under possible climate change scenarios with changing temperature and precipitation conditions.

Keywords: SWAT model, sediments, nutrients, agricultural management practices

T0258

Beyond Margalef: Testing the links of landscape structure and energy and information flows driven by farming with biodiversity

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The aim of this paper is to test two methodologies, applicable to different spatial scales (from regional to local), to predict the capacity of agroecosystems to provide habitats for the species richness of butterflies and birds, based on the ways their socio-metabolic flows change the ecological functionality of bio-cultural landscapes. First, we use a more general Intermediate Disturbance–Complexity (IDC) model to assess how different levels of human appropriation of photosynthetic production affect the landscape functional structure that hosts biodiversity. Second, we apply a more detailed Energy–Landscape Integrated Analysis (ELIA) model that measures the energy storage carried out by the internal biomass loops, and the energy information held in the network of energy flows driven by farmers, in order to correlate both (the energy reinvested and redistributed) with the energy imprinted in the landscape patterns and processes that sustain biodiversity. The results obtained after applying both models in the province and the metropolitan region of Barcelona prove the Margalef's energy-information-structure hypothesis showing positive relations between butterflies' species richness, IDC and ELIA, and between birds' species richness and energy information. They make apparent the relationships between farming energy flows, agroecosystem functioning and biodiversity, and the importance of farmers' knowledge and labour to maintain bio-cultural landscapes.

Keywords: Landscape Agro-ecology, Land-sharing debate, Intermediate disturbance hypothesis, Human Appropriation of Net Primary Production, Energy Return on Energy Investment

What can landscape ecology contribute towards the challenges facing agriculture and the need for agricultural change in New Zealand?

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New Zealand (NZ) is renowned for its beef and lamb farming and it is the world's 8th largest producer of milk. Intensification of agriculture has been beneficial for the economy but for this famous tourist destination the environmental implications have been marked. The once clean green image of NZ is being challenged as contaminated waterways demonstrate the downside of intensive farming by substantially clearing native vegetation and draining 90% of the wetlands to make way for today's scale of production. To address its environmental challenges appropriate land use and land cover change needs to occur. Planning for a sustainable future must ensure multi-functional landscapes that enable biophysical, socio-cultural and economic processes to operate to allow important landscape process and services to be maintained. An effective approach to planning needs models and strategies that determine important landscape characteristics (those that need to be preserved and those that can be sustainably utilised), suggest features that can be reconstructed to assist in landscape sustainability, and incorporate key stakeholder involvement so as to ensure the design of future landscapes supports important functions and values. Approaches need to be driven by integrated problem-focussed transdisciplinary research. The paradigm of landscape ecology that incorporates value and design has an important role to assist with this. Process informed and value influenced planning and design within a theoretic framework of landscape ecology has yet to be fully explored in NZ but has the potential to enable decisions to be made that can help to reduce the detrimental environmental impacts of agricultural land utilisation. This paper discusses how such an approach could be applied and the important role that landscape ecology can play in helping to transform NZ landscapes so that the clean green image can once again prevail.

Keywords: multi-functional landscapes, planning, design, value, land use change

P0191

Farmland contributions to urban green infrastructure

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In 2013, the European Commission has adopted the Green Infrastructure (GI) Strategy, to promote the deployment of green infrastructure across the EU. It addresses one of the six main targets of the EU Biodiversity Strategy to 2020, to maintain, enhance, and restore ecosystems and their services.
In recent years, the understanding of Urban Green Infrastructure (UGI) has matured and developed to a spatial planning and design concept, contributing to human well-being in urban areas. Therefore, UGI helps to address major challenges of urbanization, such as conservation of biodiversity, climate change adaptation, increasing social cohesion, and promoting the transition to a green economy. However, the focus of research has been largely on green urban structures, such as parks, urban forest, building and street green. The contributions of agricultural landscapes are rarely considered. This poster presents a PhD thesis that aims to address these gaps and harnesses the question if agricultural landscapes can contribute to the basic conception of UGI.

Keywords: urban green infrastructure, peri-urban agricultural landscape, mutlifunctionality, benefits

Developing a comprehensive knowledge system to support the ecological optimization of agriculture in Switzerland

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In the mid-20th century, the intensification of agricultural production was the strong and sole driver for site-suitability mapping. Meanwhile, high-tech agriculture derives fertilizer dosages and the need for pesticide applications from remote sensing data and spatially explicit yield monitoring, sometimes neglecting soil characteristics and other site conditions. Biodiversity still plays a minor role in production schemes.

In Switzerland, over recent years a suite of maps were elaborated, indicating production constraints for different crop types and priority areas for biodiversity promotion, some of them in sub-parcel resolution. Regions of the potential distribution of target and indicator species listed in the Swiss government objectives for farmland biodiversity and nationwide mapped potential corridors for wetland species support the selection of priority areas to promote biodiversity. The climate suitability map delimits the production areas of crop types at a regional scale. The erosion risk map (two-metre resolution) indicates areas that require prevention measures and restrictions for crop management. The wetness potential map indicates where the cultivation of mesophilic crop types requires technical measures like artificial drainage systems. The inventory of organic soils shows agricultural areas relevant for greenhouse gas emissions.

These maps are put together to develop a comprehensive knowledge system aiming to make biodiversity an integral part of agricultural production and to support the ecological optimization of production systems. The knowledge system provides a high-resolution framework that addresses the local site qualities important to small-scale production systems and serves to close the gap between the local knowledge of farmers, the high-tech information delivered by the agricultural industries, and the knowledge base that policy makers use to develop direct payment schemes.

Keywords: Ecological optimization, biodiversity promotion, site suitability, agricultural production, sustainable agriculture

P_0239

Social agriculture turns eco-social – case studies from the Southern Alps

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Global change and socio-economic transformations pose particular challenges to mountain areas. For example, biodiversity loss, abandonment of remote mountain regions, the increase of natural hazards, intensification of agriculture in the valleys, and changes in the landscape water balance call for innovative approaches of land use. The integration of social services, resource protection, and the conservation of nature as well as the traditional cultural landscape could be a strategy to face these transformations. Accordingly, we explore within an interdisciplinary project that bridges the social and the natural sciences the capacity of social agriculture to promote human wellbeing and health as well as environmental protection and the maintenance and increase of ecosystem services. Our approach comprises a literature review and the analysis of case studies with a regional focus on the Southern Alps. Our leading hypothesis is that social agriculture has the capacity to become eco-social. Thus, we develop a matrix based on ecological criteria in order to analyze the environmental impact generated by social agriculture. With our case studies, we explore initiatives in order to identify best practices. For this, we perform semi-structured interviews with various actors and stakeholders on farms.

Keywords: Social farming, Green care, environmental education, landscape conservation, environmental sustainability

Symposium 26

Application of novel remote sensing data and techniques to habitat and biological assessments

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The rapid advancement of remote sensing technologies and increasing availability of open access data provides many opportunities to better understand landscape-species interactions and address complex questions which were previously not possible or very costly. In recent years satellite missions providing worldwide high spatial (<1-20m) and high temporal (daily) resolution have been launched, such as Worldview 4, Sentinel 2, PlanetLabs CubeSats, etc. Some of these missions (e.g. the European Space Agency's Sentinel missions) also offer the data free of charge through an open-access portal. In addition, there have been continued advancements in capture of laser scanning data, and very high resolution (spatial and spectral) aerial and terrestrial data including from unmanned vehicles. This wealth of new remotely sensed data remains under-utilised for spatially dynamic biological applications and within Landscape Ecology. These new advances and data sources are considered a game changer for the application of remote sensing data to address ecological questions. There are now are possibilities to consider, for example, the three dimensional structure of vegetation and buildings over large spatial extents, to investigate the intensity of landscape management or disturbances, to determine the seasonal dynamics of vegetation. The high spatial and temporal resolution of remote sensing products allows for more continuous monitoring of indicators of land-use intensity and landscape function such as phenology, primary productivity, vegetation structure and fragmentation. This allows researchers to move beyond static 2D views of landscapes or small case study areas and consider the implications of structure, temporal dynamics and continuity at fine spatial resolution and wide extents for ecosystem function and the behaviour of species within a landscape. There are now excellent opportunities to gather data remotely in areas which have previously been understudied due to their remote or difficult to access locations.

There are greater opportunities for monitoring of temporal landscape dynamics, particularly within-season which was not previously possible. Open access data affords opportunities for more research in areas/by researchers with limited funding. This symposium will bring together experts from ecology and remote sensing to discuss and share experiences and ideas on how to best take advantage of modern remote sensing in assessment of habitats, species movement, and landscape-species interactions. We will also consider how utilising remote sensing data will help to achieve aims related to landscape management, ecosystem function and landscape protection and conservation goals particularly within dynamic and anthropogenic dominated landscapes. The symposium focuses on recent advances in remote sensing and the specific advantages of high resolution (spectral, spatial, temporal, vertical) data for addressing landscape ecology questions.

T0275

Mapping compositional diversity in mediterranean sparse forests using sentinel-2 imagery

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Eventhough Mediterranean vegetation (MV) covers 2.2% of the world's terrestrial ecosystems, it has exceptional biodiversity value in terms of rarity and endemism. Therefore, mapping the distribution of MV is crucial for understanding the current disturbance regimes, community interrelations and developing conservation strategies especially for desertification and wildfires.

Previous approaches to mapping MV were based on the spectral discrimination of plants using remote sensing. These were carried out by a classification typology, which was in accordance with the density and height of different vegetation types like forests, maquis, garrigues and grasslands. Classifications on the species level was mainly based on the field spectroradiometer.

In this study we used time series data from the Copernicus Sentinel-2 satellites (S2) together with topo-climatic information to calibrate a Random Forest algorithm for classifying Mediterranean sparse forests of different maquis formations. As reference data we collected seven dominant maquis species, i.e. Arbutus andrachne, Erica sp., Genista acanthoclada, Olea europaea, Phillyrea latifolia, Quercus coccifera and Quercus infectoria of the heterogeneous vegetation patches.

To calibrate the models we computed (using Google Earth Engine (GEE)) statistical variance of the spectral bands, vegetation indices, topographic and climatic variables. Overall accuracy was almost 0.7. P. latifolia and Quercus where the species that demonstrated poor spectral discrimination while others were classified successfully. The presented approach has great potential for mapping the compositional diversity of MV at species level in an effective manner. The open source platform GEE and the free archive of S2 present a great opportunity for replicating the study in other regions. Our species maps can be used for conservation and monitoring purposes especially required for biodiversity degradation, fire prevention and species succession.

Keywords: Maquis, Compositional diversity, Sentinel-2, Random Forest, Google Earth Engine

T0690

Retrieving early indicators of high impact of an invasive ecosystem engineer from remote sensing data

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High impact invaders, such as the N-fixing Acacia longifolia, are a major threat to ecosystems worldwide. While local impact of A. longifolia on ecosystem structure and functioning in Mediterranean dune ecosystems is well understood, there is a lack of methods for early detection of its impact at larger scales. Thus, we aimed at upscaling impact models from leaf to landscape scale using sensor-based techniques focusing on three questions: Can differences in traits, e.g. N content, between A. longifolia and native species be mapped using hyperspectral sensors? Can A. longifolia‘s spatial impact on N cycling be tracked at stand level using functional tracers? Finally, how can A. longifolia‘s modifications of ecosystem structure and functioning be detected and monitored at landscape scale?

First, we show that the invader differs in its biochemical and biophysical traits from the native species, particularly regarding leaf N content. This dissimilarity may provide an indicator for invaders with a high impact on N cycling, and can be retrieved from hyperspectral data, which emphasizes potential for mapping.

Second, we traced the impact of the invader on N cycling at the stand scale joining a functional tracer of N-fixation, δ15N, with airborne laserscanning (LiDAR) data. Foliar δ15N of the non-fixing, native shrub Corema album increased in vicinity of invader stands over and above the influence of environmental heterogeneity derived from LiDAR indicating an uptake of N previously fixed by the invader.

Third, we mapped A. longifolia at landscape level by integrating airborne hyperspectral imagery with LiDAR data. A clear increase of Gross Primary Production (GPP) after invasion was detected even at early stages of invasion when A. longifolia cover was below 10%. Thus, early indicators of high impact can be retrieved from earth observation data, which offers promising possibilities for monitoring invasions of ecosystem engineers in sensitive and biodiverse ecosystems.

Keywords: remote sensing, invasive species, impact , stable isotopes, ecosystem functioning

Tropical reservoirs as hourglasses of dam-related ecosystem changes

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Dams serve as traps for floating vegetation and provide improved habitat conditions for plants such as invasive water hyacinths (Eichhornia crassipes) by slowing down flow speed. We used invaded reservoirs and river systems as gauges for water quality in tropical and subtropical river catchments. Based on LANDSAT satellite imagery we followed the development of floating vegetation cover from 1990 to 2018 at 12 locations on four continents and linked these observations with global climate and land cover change data. For the Kafue river in Zambia, we contextualized these observations with flow observations from two dams. We found that floating vegetation coverage increased over time at most of the studied locations. At the same time, all invaded reservoirs are located in watersheds with rapid growth of urban areas. We show that floating vegetation cover shows strong seasonal variation, with annual peaks typically being aligned with temperature peaks. The example of the Kafue flats wetland system shows how the peak occurrence of floating vegetation follows the rainy season and ends once the flood gates are opened at a downstream dam. Our observations show that floating vegetation can serve as a potential vector to transport nutrients from the water to the land during periods of high flows and floods. Based on our results, we predict that climate change will potentially favor floating invasions due to higher temperatures and warmer winters. For most of the studied locations, some form of mechanical, chemical or biological weeds control is in place. Our long-term observations show that the effect of these interventions is limited in time and extent, as long as sufficient nutrients and stagnant water are available.

Keywords: Invasive species, water quality, land-use change, ecosystem management, remote sensing

T_8857

Surrogate Method for Biodiversity Assessment and Conservation Prioritization in the Indian Himalayan Region

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Biodiversity assessment is a multidisciplinary endeavor and involves complex design, data collection methods and appropriate analytical tools, but is frequently compromised due to various challenges and inadequacies. Because conservation actions plan and inputs relate to spatially explicit biodiversity information at regional scale and that available methods are data intensive, it is necessary to devise a novel approach to biodiversity assessment at regional scale and therefore, the basis for conservation prioritization. We developed a bottom-up grid-based approach to assess biodiversity values based on surrogate habitat characteristics. We divided the Indian Himalayan Region (IHR) into 4x4 km grids and quantified structural attributes of topography, forest cover, land cover, productivity, temperature and human footprint. Derived values were standardized to 0-1 scale using a minimum-maximum approach and the results were synthesized to reflect biodiversity values across the region. The values were then pooled and categorized into spatially explicit low, medium and high biodiversity values across the IHR. The total area of IHR covered ca. 0.5 million sq.km. (ca. 16.2% of country's geographical area) and of the six states in the region, high biodiversity areas are dominated in the states of Uttarakhand (30%), Sikkim (22%) and Arunachal Pradesh (39%). A vast majority of these areas fall within the protected area coverage which indicate that the protected areas continue to support conservation goals by retaining key biodiversity areas. However, the high biodiversity areas outside the protected area network require landscape approach for sustainable management of natural systems and land allocation for development agenda. In the rapidly changing environmental conditions, this surrogate approach would be efficient for spatiotemporal monitoring and for understanding the effects of climatic and anthropogenic drivers in this globally important mountain region.

Keywords: Landscape approach, Spatial prioritization, Climate change, Indicator analysis, Environment management

P0020

Multitemporal NDVI classification of coastal dune habitats of central Italy with Sentinel 2 data

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Given the complex mosaic of plant communities coexisting in a relatively small space, coastal dune ecosystems have long represented a challenge for habitat mapping and multi-temporal monitoring applications. However, being one of the most threatened ecosystems on Earth, cost-effective ways to conduct recurrent observations over vast areas are urgently needed. In this context, the increasing high spatial and spectral resolution of open access, remotely sensed data is promising for monitoring.
We tested the habitat mapping strength of a multitemporal Sentinel 2 imagery dataset for a sector of the Tyrrhenian coast (Lazio) at two detail levels: i) main land cover types (woody vegetation, herbaceous vegetation and sparsely vegetated areas) and ii) complex of habitat types (EU Habitats sensu 92/43/EEC). Spectral analysis was based on the Normalized Difference Vegetation Index (NDVI) temporal variation, as proxy of vegetation phenological proprieties, and classification on random forests method. All the processing chain was carried out with the open source products of the European Space Agency (sen2cor processor, SNAP toolboxes). Then we assessed through aerial images or field floristic surveys.
We identified 3 land cover types with 80% general accuracy and over 60% producer accuracy, and 3 habitat complexes classes with 73% general accuracy and a weak (53%) to high (80%) producer accuracy, depending on the habitats complex.
In this study, multitemporal Sentinel classification resulted an effective instrument for mapping an highly fragmented coastal dune system. This is an encouraging perspective for extending the open source earth observation monitoring techniques (from wide areas) to the local scale of the Italian and Mediterranean sand dunes landscapes in highly fragmented territories.

Keywords: Coastal dune mapping, Sentinel 2, NDVI time series, Random Forest, Phenological classification

P0097

Influence of topography and vegetation dynamics on coffee sting bugs population across an altitudinal gradient in heterogeneous landscape

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Coffee is a source of livelihood to over 25 million smallholder farmers globally. Despite an increase in acreage under coffee, the recent trends have seen a gradual decline in coffee production globally. Coffee pests and diseases contribute largely to this decline, which is further aggravated by the impacts of climate change. This study seeks to identify key agro-ecological variables that influence the occurrence of two species of coffee sting bugs (Antestiopsis thunbergii and Antestiopsis facetoides) across an altitudinal gradient. A network of 30 coffee plots were selected for monthly assessment of the pest populations. 30m DEM was used to characterize the topography of the landscape whereas 250m NDVI and 3m PlanetScope images were used to extract phenology variables and vegetation indices respectively. A generalized linear model was used to identify key variables that influenced coffee sting bug populations, while variogram models were fitted to estimate the spatial connectedness of the observed pest densities. A. facetoides were three times higher at low elevation than A. thunbergii, which were more at higher elevation. Closed depressions, diurnal direction of the sun, landform type and wind direction influenced the population dynamics of both species. The rate of vegetation increase and decrease, the period of mid-season and the cumulative vegetation greenness in the first season were the most important seasonal characteristics. Perpendicular vegetation index, ratio vegetation index and edge analysis were the important vegetation indices. The observed pest populations fitted poorly on all the variogram models due to poor spatial autocorrelation. Plots with high pest populations were neighbouring plots with low pest populations and vice versa. These results indicate that local scale variability of topography and vegetation structure are key determinant of the sting bug populations.

Keywords: Coffee pests, Phenology, Topography, Modelling

T0681

Automated mapping and modelling of habitat types at the national extent for Switzerland – a first prototype

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Habitats are increasingly used to assess the status of biodiversity. The classification of environments into defined habitats provides a reference system for field data and can facilitate cross-comparisons between surveys. The habitat classification of Delarze & Gonseth (2015) is the most widely used in Switzerland. While there has been some regional modelling of this classification, a spatially explicit distribution map of habitats across Switzerland does not exist. We develop a methodology to model the habitat typology across Switzerland. Within the software eCognition, airborne ortho- imagery (1m resolution) is segmented into 'objects' on the basis of reflectance in the RGB and NIR bands, and values of the metrics NDVI and NDWI. The topographic landscape model (TLM) of Switzerland provides coarse land cover information to support segmentation. A rule-based approach is then used to assign habitat types to segments and form a high spatial resolution Swiss-wide map of habitat types. An extensive suite of existing data and models are employed as inputs to the rule-based process. High-resolution 3D information was used, for example, to differentiate shrubs and trees and identify buildings. Seasonal variation and annual standard deviation in NDVI, derived from high temporal resolution Sentinel-2 satellite imagery, represents phenological dynamics and allows differentiation of agricultural habitat types. Forest species distribution models, created in an ensemble modelling approach incorporating forest structure from LiDAR, topographic and climatic data inform rules for assigning forest habitat types. The approach is automated so that it can be re-applied with updates of the base data. This first prototype considers only existing spatial data and models covering the extent of Switzerland. We then identify information gaps for certain habitat types and methods for improvements. Validation data is sourced from plot data from large scale Swiss monitoring projects.

Keywords: remote sensing, segmentation, classification, typology, Sentinel

T0087

Harnessing the use of declassified historical satellite images in land use change research – case study from Latvia-Russia border area

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Novel sources of remote sensing data and processing approaches allowed us to study differences in trajectories of forest cover change the North-Eastern Europe before and after the collapse of the Soviet Union. Our goal was to analyze changes in forest cover from 1967 to 2015 in Latvian-Russian border area (22,209 km2) with similar biophysical conditions. This study utilized a unique data source - declassified Corona KH-4B spy satellite images from 1967, which we complemented with Landsat 5 and Landsat 8 images from 1989 and 2015. We used Structure-from-Motion photogrammetry, image segmentation and expert classification to extract forest cover from satellite images. Morphological Spatial Pattern Analysis allowed us to compare forest pattern dynamics in Latvian and Russian parts. Results show that from 1967 to 2015 forest cover increased by 28.5% in Latvia and 47.5% in Russia (Pskov district). Afforestation rates slowed considerably after 1989 in both countries. We explain these differences with population density, legacies of historical land management and the availability of farming subsidies in both countries. Detected changes have serious management implications for sustainable and multifunctional use of these areas.

Keywords: Land use change, Remote sensing, Latvia, Russia

P0115

Assessment of Monitoring of Coastal zone erosion by Airborne laser scanning system

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Monitoring of Environment is one of the crucial human task which must be done continuously. This purpose will be result in having green-clean and safe planet. Understanding, Detection, monitoring and managing of erosion in coastal zone help to predict the disaster management in urbanization nearby. Sediments transported by the sea water flow always been the priority concern point for Environmental Engineers. Airborne light detection and ranging (LIDAR) is an active remote sensing technology that is able to rapidly collect data from huge areas. Likewise, this is increasingly beneficial in a variety of ocean and coastal mapping applications. In this research, the assessment of the usage of Airborne Laser Scanning (ALS) system for Prediction of erosion in coastal zone will be discussed. Meanwhile, the possibility of different aspects of Using of point cloud processing of ALS for Investigation of Sediments transportation will be considered. This innovation of usage of Airborne laser scanning system in the case, can be the novel issue for interaction of environmental ocean coastal zone and implemented of remote sensing Technology.

Keywords: remote sensing, Environmental management, Airborne laser scanning (ALS), Erosion, Point Cloud

T0713

Landscape analysis of light pollution in Korean national parks using VIIRS DNB nighttime images

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Light pollution refers to damage caused by excessive light from artificial sources. Light pollution has detrimental effects to both diurnal and nocturnal wild animals by disturbing circadian rhythms and hunting success rate. In this paper, I examined four landscape factors that affected the levels of light pollution in nineteen Korean national parks (excluding three ocean and coastal national parks) using monthly composite nighttime images collected by the Visible Infrared Imaging Radiometer Suite (VIIRS) day and night band (DNB). I used four monthly nighttime images in October 2017, and January, April and August 2018, that represented different ecological and touristic characteristics.

Multivariate regression analyses showed that, of the four landscape-scale variables, the total floor area of buildings in 1-km buffer regions surrounding the national park had greatest impacts on the levels of light pollutions in the parks. This variable had statistically significant effects at $\alpha=0.05$ in all four months. The effect of this factor was even greater than the total floor area of buildings in the park that was statistically significant at $\alpha=0.05$ in two of the study months (except August and October). The greater impact surrounding than inside of the parks indicates that artificial light in the park was minimum due to strict land development restriction in the park and trespassing of light from outside of the park. Statistically significant impacts of perimeter-area ratio of the park further illustrated the effects of trespassing light from surroundings on the levels of light pollution in the parks. The longer perimeter, the larger area to be polluted by trespassing light. These results suggest that light pollution can be seen as a type of ecological edge effect in protected areas where land development is strictly prohibited, and need to regulate artificial lights in buffer zones to protect wildlife from light pollution.

Keywords: trespassing of light, buffer zone management, artificial light, protected area

Rapid Assessment Study of Typhoon Disaster in the Urban Agglomerations Along Western Taiwan Straits Region Based on Remote Sensing Data of Night Lighting

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The traditional post-disaster information survey and statistics of natural disasters adopt the method of manual field work, which requires a large amount of manpower and material resources.Optical remote sensing technology still has low resolution and inconsistent scale due to the objectivity and dynamics of its data.In recent years, more and more monthly and annual data of new night light composite images have been used to assess the socio-economic situation, but the use of npp-viirs night light image day-night band (DNB) data to detect and assess short-term catastrophic events is limited.In this study, the rapid assessment and application of npp-viirs DNB data in the severe typhoon disaster of haixi urban agglomeration was discussed, with the focus on the rapid identification and extraction method of night light remote sensing image change area after the disaster.Then the damage area of typhoon is counted and the recovery status is evaluated.Secondly, it discusses the mathematical relationship between the changing region and the typhoon damage scope and the affected population, and constructs the model of the night light image and the population and GDP.Based on the above model, the spatial and temporal distribution analysis and evolution degree determination of the macro scale of typhoon disaster are realized.The results obtained from the inversion are in good agreement with the actual situation and have high accuracy.The analysis results of this study show that the npp-viirs DNB daily night light image data is effective for detecting the damaged area of typhoon and the affected population. The findings of this study can provide auxiliary reference and decision support for the government's disaster resistance and disaster emergency rescue plan.

Keywords: Night light remote sensing, NPP-VIIRS DNB, urban agglomerations along western taiwan straits region, typhoon, disaster statistics, rapid assessment

P0182

Analysis of land surface phenology using densified Landsat 8 OLI – Sentinel 2 MSI time series: a case study for Kanivs'kyj Nature Reserve area, Ukraine

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Being an important satellite remote sensing essential biodiversity variable (SRS-EBV), land surface phenology (LSP) is also a proxy for multiple landscape characteristics related to its functioning and spatiotemporal pattern (Liang and Schwartz, 2009; Pettorelli et al., 2016). Expected advances in LSP analysis are related to the combination of Landsat and Sentinel data, as their consolidated observations allow to map phenology at moderate resolution and to compensate for data gaps related to infrequent revisit cycle and cloud cover (Li and Roy, 2017). The general aim of this study is to map and analyse LSP using densified Landsat 8 – Sentinel 2 2016-2018 time series for Kanivs'kyj Nature Reserve area, Ukraine recently recognized as a Key Biodiversity Area and an Emerald site. The specific objective is to develop and test an analytical workflow that includes data preprocessing, datasets combination, generation of gap-filled time series, and quantification of LSP metrics. The overall number of scenes available for analysis from both satellites within the area of interest exceeded 800. For Sentinel data preprocessing included atmospheric correction, calculation of vegetation indices (VIs), masking of non-clear observations. For Landsat the data of surface reflectance-derived VIs are already available (Vermote, Justice, Claverie, and Franch, 2016), thus preprocessing only included the masking. Time series filtering and analysis were performed in the TIMESAT software package (Jönsson and Eklundh, 2004) that allowed to derive fitted time series accompanied by LSP metrics for 2 vegetation seasons. The comparison of the results with the available in situ phenological and meteorological observations have confirmed that the developed approach correctly fixates the timing of main phenological events. Moreover, at the given spatial resolution it also reflects landscape-scale patterns emerging due to land cover variation and microclimatic differences introduced by topography.

Keywords: land surface phenology, essential biodiversity variables, time series analysis, Sentinel, Landsat

Symposium 27

Working with Natural Processes: Co-benefits at the Landscape Scale

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[3]*University of Manchester*

Working with Natural Processes (WWNP) aims to protect, restore and emulate the natural functions of the landscape to reduce flood risk whilst delivering co-benefits to the wider environment. Measures include targeted woodland and hedgerow planting, upland gulley blocking, peat moorland restoration, changes to soil and land management practice, building woody dams and installing bunds and ponds amongst others. WWNP is most effective when landscape scale processes are considered and local communities and stakeholders are engaged in the choice and implementation of different measures. When this is achieved, WWNP not only reduces flood risk for society, but delivers benefits in areas such as biodiversity, agricultural productivity, climate change mitigation and human well-being. In this symposium we invite oral and poster presentations that address the current evidence, opportunities and challenges of WWNP at the landscape scale from research, policy and practice viewpoints. We welcome presentations that fall within the following themes:

• Application – examples of past, current and future WWNP projects being undertaken at any location worldwide.

• Co-benefits – looking at the wider benefits of WWNP beyond reducing flood risk e.g. resilience to climate change, supporting biodiversity, reducing soil erosion, community cohesion, health and wellbeing.

• Co-production – examples of where local communities and stakeholders have been involved in the design and implementation of WWNP measures and the challenges and opportunities that this can bring.

• Methods – different approaches for evaluating and validating the effectiveness of WWNP. For example, modelling techniques, use of observational and field data and participatory approaches. What do 'successful' WWNP interventions look like and how can you measure success?

• Scales, types and magnitude – evidence as to the effectiveness of WWNP measures across different scales and in different landscape types and for flood events covering a range of return periods.

• Landscape design and policy – examples of how evidence from WWNP may be used to inform future landscape design, conservation and management, as well as local and national planning policy. What are the best governance arrangements to underpin WWNP projects/programmes?

T0453

A multi-criteria approach for the Nature-Based Solutions (NBSs) assessment. The case-study of the Isar River (DE)

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Nature-based Solutions (NBSs) are usually applied for hindering hydro-meteorological events such as landslides, soil erosion, snow avalanches, flooding and drought, nowadays raising because of climate change. In contrast to traditional grey solutions, NBSs can strengthen the ecological and socio-economic resilience, fostering the development of ecosystem services and biodiversity conservation.
On this issue, the H2020 Innovation Action "PHUSICOS – According to Nature" (Grant Agreement nr. 776681) project aims at assessing the NBSs effectiveness to hinder extreme events in vulnerable areas such as rural mountain landscapes, showing their cost-effectiveness, replicability and scalability at regional scale.
The NBSs reliability is evaluated through a Multi-Criteria approach, assessing the design effectiveness from the technical, environmental and socio-economic viewpoint. The implementation of a hierarchic framework tool, based on the estimation of Performance Indicators (PI) belonging to 5 different Ambits (Risk Reduction, Technical Feasibility and Affordability, Environment & Ecosystem Services, Society and Local Economy), is currently ongoing. A participative multi-disciplinary approach, fostering the interaction between scientists, public and private organizations, stakeholders and end-users, is applied through the Living Labs (LLs) approach, leading to sustainable designing and to hazard and risk management with socio-economic resilience. The implemented methodology will be tested on 3 demonstration sites and 2 concept cases in Europe, involving local, technical and administrative stakeholders.
Herein, the preliminary results of the NBSs assessment tool – according to an ex-post analysis – to the Isar River (DE) concept-case are provided and discussed. At this site, during the last decades, several NBSs were designed to both reduce the flooding risk and the riverbed erosion rate, enhancing the recreational quality and the ecological status of the river course.

Keywords: Nature Based Solution (NBS), Ecosystem Services, Multi-Criteria Analysis, Performance Indicators, Isar River (DE)

P0011

Flowing Lives. Understanding landscape as a tool of social change and ecological coexistence.

Claudia de Sas Trujillo, Juanita Leal Ochoa

Running water as the most active landscape - transforming agent on the earth's surface. Understanding landscape, not as an empty canvas, but as a picture full of elements, ecological values and links between living organisms.
Topographical modifications to start. Water will flow, letting biodiversity to activate cycles. Flooding areas to clean. Natural barriers to embrace. Water, sun, wind and green, to take advantage of. Agriculture, recycling and composting to close cycles. Living entities will join natural cycles, conforming dynamic territories.
The main idea aims to strengthen this synergy. Facilitating exchange based on collaborative processes, through educational and cultural practices, making the invisible visible.The starting point requires non-specific spaces, any kind of settlements could work as a field. Social supporting networks will be conformed over time. Facilitating spaces of coexistence and assembly with landscape. A gradual revitalization, based on the feedback of local matters for planning challenges will allow an approach to strengthen social capital among territories. The strategy will be developed with a short-term commitment to realistic objectives and a long-term sustainable vision.
The initial and largest investment to start the project is the adaptation of common spaces suitable for generating coexistence and launching social initiatives in accordance with natural cycles. Further on, intuitively human beings will understand nature as a comrade. As a result, the environment will be a vibrant organ pumping energy in every pulsation.
The process will flow. This reintegration will be an active territory. Small changes will conclude into an inclusive community, taking advantage of a social and ecological gap. The street, the block, the neighborhood, the city, the territory in general, will become a living organism, where individual, partners, groups and networks, leans on dynamics and new bonds, adapting them to natural flows over time.

Keywords: territory, coexistence, synergies, cultural, resources

Incorporating farmer and local knowledge into the development of policies sympathetic to Working With Natural Processes

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The LANDWISE project is assessing the effectiveness of realistic and scalable land-based NFM measures to reduce the risk from flooding from surface runoff, rivers and groundwater in groundwater-fed lowland catchments. As part of the project a survey of farmers and land managers was undertaken to collect data on the impact of soil type, tillage practices and crop choice on soil functionality with a view to determining if there are options with realisable potential for reducing surface runoff and slowing down the movement of water to reduce peak levels in groundwater and rivers. Also within the LANDWISE study are of the West Thames there are 3 Defra funded Natural Flood Management projects where local communities and stakeholders have been involved in the design and implementation of WWNP measures. This paper will consider the findings and lessons from these 2 aspects and consider how WWNP may be used to inform future landscape design, conservation and management, as well as local and national planning policy.

Keywords: working with natural processes, natural flood management, agricultural land management, co-benefits, co-production

T0851

Exploring the acceptability and feasibility of different Natural Flood Management measures in the West Thames, UK, and the evidence needed to support decision-making.

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[1]*University of Reading*

Our workshop was designed to explore: a) the feasibility and acceptability of different Natural Flood Management (NFM) options within the West Thames area (UK); and b) the 'evidence' needs from different groups to support decision-making around NFM. The participants represented three sectors - Agriculture, Conservation, and Communities at Risk - and three different landscape types - Cotswold Limestone, Chalk Downs, and Clay Lowlands. In groups, the participants reflected on 11 NFM measures identified by Environment Agency Working with Natural Processes (WWNP) report, and individually scored each of the measures based on: a) how acceptable each measure is to them, and b) how feasible each measure is in terms of how easy it would be to implement for a certain landscape. In terms of acceptability and feasibility, the highest scoring measures included Soil and land-use management, Run-off pathway management, Leaky barriers, Riparian woodland, and Catchment woodland. Soil and land-use management was consistently ranked in the top 3 most acceptable and feasible measures across all landscape types and by all groups of expertise who took part in the activity. Headwater drainage and Floodplain woodlands scored among the least acceptable and feasible measures overall. Participants were then asked what type of evidence would be needed to help deliver each of the top NFM measures. Overall, Experiential, Relational, and Economic evidence scored highest, and Technical (models) scored lowest. However, the types of evidence needed varied by landscape type and NFM measure. Economic evidence scored high for Soil and land use management, whereas Relational and Technical (observed) evidence scored highest for Riparian woodland and Catchment woodland. For Leaky barriers and Run-off pathway management, Experiential and Technical (observed) evidence scored highest. Whilst this paper has an NFM focus, our findings will be of wider interest to those involved in geoscience communication.

Keywords: Natural Flood Management, Scenario development, NFM implementation

T0872

Co-production within Working With Natural Processes (WWNP) Projects: lessons from Natural Flood Management projects in the England and Italy

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Co-production is becoming a central factor within WWNP projects due the range of stakeholders involved and the need for local engagement in order for on-the-ground interventions to occur. This raises important issues regarding the type of engagement, how local knowledge is utilised and the long-term prospects for local representation. This paper will combine interim results from an England wide review and two in-depth case studies. One is the six-year project 'Stroud Rural Sustainable Drainage System (RSUDS), led since 2014 by the local government of Stroud, a town in South West England, which has implemented a co-production approach to WWNP. This is compared to an Italian case study which involved a participatory process implementing river restoration solutions to mitigate flood risk in North Italy. Both case studies originated from major flood events and subsequent local pressure for a different approach towards reducing flood risk mitigation measures. Conventional engineering solutions to the challenges were not acceptable so the bottom-up process resulted in implementing NFM consisting also of multiple interventions with different functions to assist in the reduction of flooding. In both case many different actors were involved contributing different kind of knowledges, which interacted at local level, driven by relationships between actors and between actors and water catchments. The different relationships resulted in bespoke NFM and different practices. This has been reflected in the growth of WWNP projects across England. In terms of lesson learnt, the interim findings suggest that local knowledge in flood risk management can refer to multiple functions of both NFM and WWNP and the challenges and opportunities that this results in. The paper will also reflect on the issue of scale, magnitude and co-benefits, which are all inter-related.

Keywords: Working with Natural Processes, Co-production, natural flood management, co-benefits, land management

T0833

Delivering Natural Flood Risk Management through restoration of upland peatlands – evidence from landscape scale restoration in the southern Pennines, UK

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The UK has 15% of the global blanket peat resource comprising a major part of upland land cover, but peatland degradation is widespread. These peatlands are significantly degraded due to a range of anthropogenic impacts so that bare peat and extensive gullying of the peatlands surface are common. Over the past 10 years landscape scale restoration of peatlands through re-vegetation and gully blocking has been occurring alongside significant natural regeneration as pollutant loads have fallen. The drivers for restoration work typically include enhanced biodiversity and restoring carbon sequestration. Recent work had also demonstrated significant impacts of restoration on runoff generation so that there is potential for useful Natural Flood-risk Management (NFM) benefit from upland restoration work. This paper reports data from monitoring work in the Peak District National park which compares runoff generation from bare peat sites, naturally revegetated gully systems and from different types of restored sites (re-vegetation with nurse crop, damming erosional gullies, and sphagnum planting). The data demonstrate substantial reductions in peak flow and lengthening of hydrograph lag times in response to natural and artificial re-vegetation and indicates that there is significant NFM potential through upland peat restoration.

Keywords: Blanket peat, Landscape restoration, NFM, Flood risk, Working with Natural Processes

Reduction of flood and sediment disaster risk using traditional knowledge of satoyama landscape on the west side of Lake Biwa, Japan

Katsue Fukamachi[1]

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In Japanese satoyama areas, traditional knowledge related to disaster response is still existent. It is based on the characteristics of the local ecosystem and on the local history of disasters. Such knowledge has been formed throughout centuries. This presentation is based on a study conducted in a satoyama landscape on the west side of Lake Biwa, Japan. Based on historical and ecological data analysis and interviews with local residents, it was clarified that this area is an actual example of traditional knowledge that is closely related to flood and sediment disaster risk reduction. In the history of each village, rules and organizations were established based on traditional knowledge that played a significant role in disaster preparedness. Traditional knowledge and techniques contributed to the implementation of appropriate risk management and efficient counter-measures when a natural disaster such as landslides or flooding occurred. Currently, new trend of local citizens to conserve and revitalize the local satoyama landscape is based on unique local characteristics of nature, culture, and history, and relies on ad hoc measures and skills. Positive local action in a landscape will not only enhance sustainable management, but will also increase disaster resilience.

Keywords: traditional knowledge, satoyama landscape, natural disaster

Sustainable development through Eco-DRR and WWNP in Aso region, Kyushu, Japan

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There are many kinds of natural disaster in Japan due to its climate and geographical condition, namely earthquake, tsunami, flooding, typhoon, storm surge, landslide, avalanche, tornado, forest fire, eruption and so on. The 2011 Tohoku earthquake and tsunami, and the accident of Fukushima Daiichi Power Plant damaged huge areas in the east part of Japan. Onagawa Town located in Miyagi Prefecture and few affected by radiation lost 37% of its population for four years because reconstruction in the rural areas took a long time and some people wanted to move from remote areas to more convenient ones. The population of most rural areas in Japan has decreased since the 1980s. A disaster in a rural area accelerates depopulation. In April 2016 two massive earthquakes caused by Kumamoto Prefecture and damaged rural areas again. Two hundred sixty-seven people died, and 8,673 buildings and houses were collapsed. Approximately 24 thousand people still live in temporally houses (statistics in September 2018).

Aso region, east part of Kumamoto, is located on the caldera of Mt. Aso. It is the largest active volcano in Japan and is among the largest in the world. Approximately 50,000 people live there. The region is one of the most popular national park in Japan, a global geopark and a site of Globally Important Agricultural Heritage Systems (GIAHS). The earthquakes in 2016 attacked the region, then the industries, especially agriculture and tourism, were heavily damaged. Also, there were massive floods and many landslides in July 2012 due to heavy rainfall. A new project starts from April 2019 which addresses the objective to develop a collaborative network of sustainable regions and an innovative post-disaster revitalization approach. We are focusing on Ecosystem-based Disaster Risk Reduction (Eco-DRR) and Working with Natural Processes (WWNP) to achieve it. I am one of the co-leaders of the project.

Keywords: disaster, flood, earthquake, rural area, depopulation

T0499

Green infrastructure planning for reduction of flood risks and improvement of ecosystem viability within lowland river landscapes in Latvia and Lithuania

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Success in implementation of the nature-based solutions (or Working with Natural Process projects) for reduction of flood risks in lowland river landscapes depends on comprehensive assessment and planning of green infrastructure, stakeholder engagement in development of solutions as well as integration of the results into local or regional spatial planning documents. Such approach is tested within the Latvian-Lithuanian cross-border cooperation project ENGRAVE, with aim to enhance river-based green infrastructure by integrating ecosystem and landscape concepts in to the planning and management of the lowland rivers at local and regional scale. The project involves collaboration between researchers, planning authorities and local municipalities in development of methodology for integrated landscape and green infrastructure planning and testing it within four planning cases (regional, river catchment and urban). The applied research study includes mapping and assessment of existing green infrastructure, based on ecological value and ecosystem service supply potential; 'hot spot' and 'cold spot' analysis to identify risk areas; as well as elaboration and assessment of green infrastructure improvement scenarios. The solutions for reduction of flood risks are targeted to revitalisation of rivers and floodplains to improve the natural water retention capacity at the same time providing co-benefits for biodiversity protection, climate regulation and recreational possibilities. The implementation of measures is related to spatial planning instruments for changing the land cover and use and habitat restoration activities.

Keywords: green infrastructure, nature based solutions, ecosystem services, flood risks, stakeholder engagement

P0013

Working with Natural Processes for flood control and nature restoration in Shiga, Japan

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Working with Natural Processes can contribute to safe and prosperous communities by allowing disturbance of natural environments in order to restore original natural variability. We focus on contemporary projects that aim to restore damaged or lost natural ecosystem while finding new uses for natural resources. For example, reed grows as natural vegetation on the lakeshore. They play an important role as flood control and waterside habitats for diverse bird and fish, and for numerous hydrophytes including endangered species. Wave control structures for reed community restoration were built using brushwood bundles made from local forest resources. The structures help to protect the ecologically vulnerable but valuable reed communities. An interesting movement has also been started by citizens who investigate the possibility of a legal framework for the conservation and revival of the traditional stone culture for reduction of natural disaster. Through such unique uses of local natural resources, new cultural diversity is created along with the restoration of nature.

Keywords: nature restoration, flood control, natural resources

Symposium 28

Forest disturbances as drivers of tree species range shifts under global change

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In order to survive in the changing climate, tree species need to either adapt to the new conditions or shift their distribution range. At the same time, the effects of abiotic (e.g. fire, wind, drought) and biotic (e.g. insects, pathogens) disturbance agents are increasing throughout many parts of the globe. Disturbance regimes influence forest dynamics and distributions in complex ways – the process of mortality and regeneration is likely to interact with those of migration or persistence processes. Together the new climate conditions and disturbances will result in latitudinal, longitudinal and elevational shifts in tree species distributions, strongly shaping the distribution and composition of future forested landscapes. Traditionally, the literature has focused on species range shifts driven most directly by climate. However, that is no longer the case as recognition of the importance of disturbance regimes in influencing species distributions grows. Disturbances can provide the opportunity for range shifts (contraction or expansion) by opening up new resources or removing seed sources. For example, broad scale, stand replacing disturbances such as wildfires can trigger range expansion opportunities for pioneering species whereas massive insect outbreaks can cause substantial range contraction. Compounding effects from disturbance interactions may lead to regeneration failures and even result in long-term changes to substrate conditions. In addition to the natural disturbances, global trade has increased the number of non-native biotic disturbance agents causing a novel threat for the health of forests. Agents such as emerald ash borer, sudden oak death or ash dieback may have unpredicted effects on tree species distribution and range shifts. The shifting and potentially intensifying role of disturbances in determining tree species range shift rates and directions is therefore a significant and important question for modern ecologists.

The proposed symposium will bring together experts from different continents working with the interaction of natural disturbances and tree species range shifts. The goal of the symposium is to discuss the current state-of-the art on the topic as well as to identify future research needs. The survival of tree species is crucial for how we will see the future forested landscapes and thus follows the Congress theme “Nature and society facing the Anthropocene: challenges and perspectives for landscape ecology”.

T0156

Anthropogenic disturbance is more important than climate change in explaining compositional changes in northern forests over the past century

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The relative importance of disturbance and climate change in driving long-term forest dynamics is poorly understood, presenting a major challenge for making predictions in an era of rapid global changes. Here we assembled a data-set of >100,000 tree species lists made in the 19th century across a broad region (>130,000km2) in temperate eastern Canada, as well as recent forest inventories, to test the effects of changes in anthropogenic disturbance, temperature and moisture on long-term forest dynamics. We evaluate changes in forest community composition using four indices that quantify the affinities of different co-occurring tree species with temperature, drought, light and disturbance. Land-use driven shifts favouring more disturbance-adapted tree species were far stronger than any effects ascribable to climate change. Climate change impacts were either undetectable, weak, or correlated with responses to change in disturbance regimes. Because species responses to disturbance are correlated with their responses to different aspects of climate change, ongoing changes in anthropogenic as well as natural disturbance could significantly influence the response of forest ecosystems to future changes in temperature and moisture regime.

Keywords: global change, land-use change, historical ecology, forest dynamics

T0481

Gaps accelerate temperate forest adaptation to global warming

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Climate change is known to increase temperatures and storm intensity. Storms are responsible for considerable damage in the forest but they also allow a resetting the vegetation dynamics cycle. The objective of our study was to investigate if the forest gaps formation favours the adaptation of the forest vegetation to the warmer climate, by shifting to warmer adapted floristic composition of forest plant communities.

We carried out 109 20m-diameter plots in gaps created in the French forest by the 1999 storms. Floristic inventories were conducted in these plots in 2002, 2005 and 2018. In 2018 109 additional plots were located under canopy close to studied gaps. A bioindicated temperature was assigned to each plot using independent species temperatures indicator values calculated with species distribution models carried out according temperature of 1961-1985 period. These bioindicated temperatures were compared to Mean Annual Temperature (MAT) calculated for 1961-1985 and 1994-2018 periods, using weather station interpolated temperatures. Ellenberg light index (LI) was also attributed to plots in order to control light evolution during forest succession.

We found that temperature bioindicated in the gaps was significantly higher than the MAT in 1961-1985 but lower than MAT in 1994-2018 periods. The bioindicated temperature increased between 2002 and 2018 and approached the MAT of the 1994 to 2018 period. Comparison of 2018 gap and canopy suggests that bioindicated temperatures in gaps tend to be higher than bioindicated temperatures under cover. While bioindicated temperature in gaps increase along time, the LI decreases between 2002 and 2018 meaning that heliophilous species are not responsible of the communities' thermophilization.

Observed increase of bioindicated temperature in forest gaps suggests that gaps favour the faster adaptation of the floristic composition to a warmer climate independently from floristic changes induced by the natural forest succession.

Keywords: Global warming, Windstorm, Forest gap, Plant succession, Thermophilization

T0663

Climate-induced slope processes favour widespread microrefugia for nival and alpine plant species across treelines

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In alpine areas, above and across the treeline ecotone, disturbance regime due to abiotic factors is foreseen to increase under the effect of climate change. Rising temperatures may alter magnitude and frequency of geomorphological processes acting along alpine slopes. We hypothesized that recent deglaciation and active processes may affect the distribution of treelines due to mechanical disturbance and in turn favour colonization areas for high alpine plant species at low elevation, across treelines.

In the Adamello group (Central Alps, Italy), the upper and lower treelines were mapped based on ESA Sentinel2 image classification and topographic variables derived from digital terrain modelling. We collected field data on the presence/absence of 14 high alpine species typical of the summit and recently deglaciated areas, within plots of 3x3 m selected with a random sampling, stratified according to the main active landforms and deposits on alpine slopes, across the treelines: channels, debris-flow, rock/debris-fall and snow avalanche. The relationships between the mean elevations of the investigated species growing on the alpine landforms and deposits and the treelines were analysed using linear mixed models. Results show that alpine species typically growing in deglaciated areas and on summits (about 3000 m asl) crossed upper and lower treelines (range 1900-2200 m asl) well over a thousand metres below their common distribution on the investigated geomorphological landforms and deposits.

Despite the general trend of increasing temperature induces glacier retreat and alpine species and treelines upward migration reducing alpine habitats, geomorphological processes and active landforms and deposits create widespread microrefugia for alpine plant species even at low elevation across treelines.

Keywords: climate change, treeline ecotone, cryptic refugia, glacier extinction, climate refugia

P0171

The effects of catastrophic wind disturbance and subsequent salvage logging on the species composition of seedlings, juveniles, and adults are still apparent more than 50 years after the event

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The risk of catastrophic natural disturbance in boreal forests is increasing as the climate changes. In developed countries, stands that have been affected by natural disturbances are often salvage-logged, primarily as a measure to prevent secondary disasters such as fire and insect outbreaks, and also for economic benefit. However, recent findings suggest that salvage-logging after natural disturbances inhibits the initial recovery of vegetation and may thereby change future forest structures. Most studies of forest structure following windthrow and subsequent salvage-logging have been restricted to time frames of ≤20 years. Long-term effects over >50 years have rarely been examined. Thus, we investigated forest stands in the eastern region of Mt. Daisetsu in northern Japan that had experienced catastrophic wind disturbance 63 years previously. The original forest was dominated by Picea jezoensis, Abies sachalinensis, and Picea glehnii. We investigated species composition, stem diameters at breast height (DBH), and the environment of the forest floor in three types of plots: (i) those that had experienced windthrow only (WT), (ii) those that had experienced windthrow and salvage-logging (WT + SL), and (iii) those that contained old growth stands (OG). We ordinated species compositions for each tree growth stage in the plots using detrended correspondence analysis (DCA). The species composition of the WT + SL plots differed from those of the WT and OG plots across the seedling, juvenile, and adult stages >50 years after the event. The relative dominance of broadleaf tree species was highest across all growth stages in the WT + SL plots. We also considered the less possibility that the future forest structures of WT + SL plots will shift to resemble those of the OG plots. As a preparatory measure for predicted increases in forest disturbance rates, forest management practices should be selected based on their potential long-term effects on future forest structures.

Keywords: owned logs, windthrow, nursery beds, mother trees, forest structure

T0100

Plant pathogens have their say: Impact of a novel Phytophthora species on plant composition and ecosystem functions of kauri forests

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Phytophthora agathidicida, a soil-borne oomycete, is a novel disturbance and threatens the survival of the culturally and ecologically significant kauri (Agathis australis) forests in New Zealand. Our aim was (1) to investigate the shifts in plant species composition in a P. agathidicida infected kauri stand and (2) to quantify canopy and forest floor water, carbon and nutrient fluxes to assess changes in ecosystem health and functions. The observed pattern of decreasing carbon and nitrogen fluxes with increasing soil Phytophthora infection may be driven by a reduction in leachable kauri leaf surface area, modification of the leaf chemistry, and a change in understory plant species composition and density, which likely enhanced nitrogen uptake. Direct effects of the root infecting P. agathidicida on ecosystem nitrogen and carbon dynamics are likely driven by alterations belowground (i.e., root dieback) and aboveground (i.e., yellowing of leaves, canopy thinning) of the host species kauri. Direct and 'secondary' effects (i.e., shift in understory plant composition) of P. agathidicida induced kauri dieback will change the landscape and ecosystem functions of these unique northern New Zealand forests.

Keywords: Ecosystem health, Disturbance , Biogeochemical indicators , Vegegation science, Monitoring

T0248

Do we need disturbances to project species distributions? Insights from Temperate and Mediterranean forests.

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One of the most acknowledged effects of climate change is the shift in species distributions, leading to a complete reshuffling of communities and ecosystems and the services these provide. The literature of range shifts have essentially focused on the climatic constrains of species using large-scale and often correlative models between species distributions and climate. In such approaches the effects of disturbances have been virtually ignored under the assumption that these disturbances are included in climate variables. Using a series of studies I show how disturbances – or lack thereof – may constraint several processes involved in range shifts. In a first study in the North-West United states, I show how disturbance could mediate distributional shifts under climate change when feedback mechanisms are present in forest communities. In a second study, in eastern US, I show that disturbance may not affect forest distributions largely even when harsh management scenarios are imposed in the simulation. Finally, I present a virtual species simulation study in which I show the importance of species traits and the spatial context in projecting range shifts under climate change.

Keywords: Climate change, Species range shifts, Disturbances, Landscape models, Forest

Symposium 29

Good anthropocene practices in contributing landscape ecology. Discourses and perspectives on governance process towards resilience and adaptation of complex systems

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The symposium aims to open a debate on the contribution of grassroots initiatives and transition initiatives, here named "good anthropocene practices" to the complex systems sustainability, resilience and ecological functionality enhancement. Since last decades academic and disciplinary debates and researches (societal transition models are examples) have increasingly paid attention to good anthropocene practices as spontaneous intervention and grassroots innovations and to their growth, pervasiveness (both in relation to geographical diffusion and issues of interest and action) and spread (it becomes a relevant worldwide phenomenon). Under the "good anthropocene practices" it is possible to include a large range of local based process led by citizens groups (NGOs) but also by private sectors and experts and acting on different set of issues from social innovation to sustainable local behaviour and social inclusion that could be addressed towards the sustainability goals. A large range of good anthropocene practices is acting on the landscape and ecological services improvement (Observatory of Resilience Practices, 2018).
A specific focus of symposium debate is the investigation of governance process and in which terms the good anthropocene practices can contribute in reaching long terms and regional/global issues (e.g. the 17 UN sustainable goals, the UN-habitat new urban agenda goals…).
At the same time, the governance of decision making process and implementation process emerges as one of main critical obstacle in implementation of both institutional-led and community-led initiatives addressed to nature based solution polices implementation. The renovation of the governance process has to embrace cross system interactions and multi-scales phenomena and dynamics (temporal/spatial) of complex systems (Ostrom 1990, 2005). The renovation of governance towards adaptive and more collaborative model is a common challenge for urban policies in order to integrate emerging phenomena of community-led and transition initiatives and climate change/environmental policies in the process of complex systems transformation (Colucci A. 2018).
During the symposium will be presented main outcomes (and critical aspects for the debate) from the research projects involved focusing on the "good anthropocene practices" networking and improvement (Observatory of Resilience Practices, DRIFT research projects).
During the symposium the main questions that will be addressed and discussed are:
• relevance of "ecological issues" in the good anthropocene practices and the contribution to ecological functionality improvement of complex system deriving from good anthropocene practices;
• perspectives and tools in order to orient the good anthropocene practices towards a more robust and effective positive impact on the landscape improvement and ecosystem services/green infrastructures improvement (capacity building, boosting the integration and mutual synergies among academic/scientific and operative knowledge…);
• perspectives for adaptive governance model implementation integrating good anthropocene practices in long term polices related to sustainability, climate issues and nature based solution polices;
• perspectives and tools for stabilization and up-scaling of good anthropocene practices.

T0366

Institutional barriers of the adaptation process of the cities and their reactions to the climate change

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Climate change is currently accepted by most of the scientific and general public. The modern planning approaches are nowadays based on the nature-based solutions (NUOs) supporting sustainable a resilient development. Nevertheless, the application of those adaptation measures in practice is still rare. To be able to understand the causes of this contradictions, we need to analyse the institutional governance barriers hampering the adaptation process. Our study aims to the specification and occurrence of barriers related to NUOs in the adaptation planning process on the level of four Czech cities (Brno, Ostrava, Plzeň, Olomouc). Based on this data we are able to predict the future scenarios of the adaptation process development.
The methodology is based on the analysis of environmental policy integration (EPI) and face-to-face meetings with the main city decision makers. The EPI analysis comes from the national climate strategy which specifies the main NUOs applicable to the city level. All of the strategic documents, primarily urban plans, shows a capacity to fully integrate the national environmental policy and implement certain types of NUOs. This capacity is further discussed with the main decision-makers and exposes the institutional reasons why the measures are hardly or not at all supported in the planning practice.
Results of this study show that greenery is the most popular nature-based solution, but its climatic function is still underestimated. The main institutional barriers do not relate surprisingly with the financial or technological issues but belong to institutional fragmentation, supported by missing communication strategy and political will.
The discovered typology of barriers shows a current planning phase of each of the cities and further offers different scenarios of the adaptation planning process perspectives if the barriers won't be respected. Based on that the specific tools for effective adaptation planning are provided.

Keywords: adaptation planning process, institutional barriers, nature-based solution, environmental policy integration

T0622

Good anthropocene practices: emerging trends and perspectives for the implementation of renovated adaptive governance models

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A large range of good anthropocene practices (GA practices "bloomed" worldwide in last decades has in the Nature Based Solutions (NBS) the core and lever of innovation process activation. The paper focuses on the community-led initiatives involved in the Resilience Practices Observatory (RPO) engaging more than 150 practices and acting in NBS/sustainability/ecology polices implementation.
The paper will present a characterisation of the practices focussing on landscape ecology. The proposed investigation aims to explore the contributions of good anthropocene practices in the improvement of landscape and ecosystem functionality. The characterisation will explore:
• the typologies/categories of instruments adopted/proposed by practices to reach the strategic visions and goals (NBS/ecosystem improvement);
• the categories of benefits to social, economical and environmental components of territorial complex systems;
• the possible innovation in the governance process;
• the existing level of awareness in relation to landscape ecology (and if the adoption of LE approach contributes to the achievement of improved environmental and social benefits).
The main aim is underline promising trends and emerging critical barriers (suggesting possible solutions) in order to improve the contribution of GA practices to the sustainability.
The proposed outcomes from RPO project will be integrated with the main emerging phenomena from the "worldwide panorama" of transition initiatives acting on urban climate change mitigation and adaptation issues.
The paper will underline:
• perspectives to orient the GA practices towards the improvement of ecosystem services (capacity building, boosting the integration and mutual synergies among academic/scientific and operative knowledge…);
• tools for stabilization and up-scaling (locally and in a global scale) of GA practices in the perspective of a renovation of governance towards adaptive and more collaborative model.

Keywords: good anthropocene practices , Nature based solutions, Resilience, social innovation, governance

P0190

An innovative governance practice to face the Anthropocene challenges in the Alpine area: the activity of EUSALP AG7 regarding the development of Green Infrastructure

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The Alpine areas are assuming a strategic role in facing different environmental, social and economic challenges of Anthropocene. To face these challenges, the European Commission issued the EU Strategy for the alpine Region (EUSALP) in 2013, among other macro regional strategies as EUSBSR, EUSDR, EUSAIR, to define and plan strategic topics and activities for promoting a shared and efficient territorial development.
In EUSALP Strategy, the work of Action Group 7 focuses on developing ecological connectivity and green infrastructure with intention to strengthen, improve and restore biodiversity and ecosystem services as well as to allow the benefits of ecological connectivity to emerge at ecosystem and social dimensions, also enhancing resilience to threats such as climate change. Further, this implies the exploitation of the potential of the Alpine Green Infrastructure in a multifunctional perspective. The AG 7 provides the framework for developing a strategically planned network of natural and semi-natural areas (green infrastructure), including features in rural and urban areas that together – functionally interconnected – ensure diverse advantages for nature and landscape as well as social benefits and economic prosperity for humans. With its broad representation of members from Alpine countries and regions as well as advisors with different institutional and sectoral backgrounds, AG 7 builds on a dialogue among stakeholders from all relevant sectors. Networking, sharing of experiences and awareness raising are of the core importance of AG7 activities.
The presentation would like to underline the AG7 governance practice as part of the implementation of macro regional strategy in order to contribute in reaching long terms alpine issues with a strong interaction between transnational/ national and local levels (both institutional and community). This innovative governance process will involve and create interaction between different sectors, phenomena and dynamics.

Keywords: EUSALP, ecological connectivity, green infrastructure, governance, resilience

T0115

Urban psychology: neuroscience, epigenetics and resilience as contributions for an ecological response to the Anthropocene

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It is now widely established that our psychophysical health is strictly influenced by the built environment in which we live. In fact, there is a strong conscious and unconscious link between our mind and the places where we live. Studies on perception and in the psychological and neuroscientific field confirm that our brain is conditioned by shape, colors and relationships of the spaces in which we live. In addition to this, recent studies show how emotions and feelings interact with both brain and body.
It is therefore currently possible to link neuroscience research to a deeper understanding of how human beings respond to the built environment in which they live. Reference is made to the most recent studies concerning the objective collection and analysis of data deriving from the relationship between neuroscience and urban planning, that is between the reactions of our body and our psyche and urban planning. Some results are presented in this regard, highlighting also innovative investigation techniques (Serious Games), recently applied to psychological studies, especially in the Central European area. Studies concerning the effects of traumatic events on individuals give a significant contribution to the understanding of out-of-control or inadequate urbanization's consequences on the population. An urban reality realized at the periphery of Milan (Nocetum) is taken as a positive experience: as an example of urban fulfillment on the psychic, concrete and spiritual levels.
Very important are the contributions of research on epigenetics, in relation to the future consequences of interventions in the concrete reality, and on the resilience of a territory not only after catastrophes, but also as positive unexpressed possibilities of that place. Public psychophysical health becomes indeed an integral and important part to tackle complex issues, concerning the sustainable governance of the territory.

Keywords: urban psychology, neuroscience, epigenetics, resilience, ecological response

Behavioural change towards sustainable and resilient communities: the role of community involvement, green co-design and gamification tools

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When applying the principles of landscape ecology to urban systems, a significant role is recognized to the participative practices, aimed at building collaborative communities aware of the value of natural and social assets. The necessary tools for expressing the community active contribution to design and adopt innovative and sustainable practices and lifestyles are key to increase the resilience of the communities themselves with regard to environmental and social changes, and also to economic stresses.
Specific tools can be used, aiming at sensitizing people, building awareness of the effects of their actions and choices and measuring the resulting change. These tools combine aspects of communication, active involvement and co-design, information and training as well as components of collaborative technology and ICT gamification.
Two experiences in the context of EU projects developed in Milano are presented: a path of co-designing, testing and implementing green community and collaborative services and activities (Climate-KIC Merezzate+ project) and an ICT tool using gamification as a trigger for the orientation towards sustainable behaviours (H2020 Sharing Cities project).
The first case works on a new community to be established in Merezzate, a social housing district in construction. The engagement activities, integrated with the already planned community start-up process, enrich and customize the process as regards the environment, in particular for nature-based solutions and circular and low-carbon economy actions.
The second project concerns an existing district in the Porta Romana-Vettabbia area, where an app (the digital social market SharingMi) is proposed to increase citizens' desire to contribute to their community sustainability, offering incentives through fun and personal rewards-provided by an ecosystem of stakeholders (eg. service providers and shops)-to influence their behaviours (eg. on mobility and transport, lifestyles and purchase choices).

Keywords: Sustainable and resilient communities, Community involvement, Co-design, Behavioural change, ICT gamification tools

T0722

From the past straight into the future: the Italian Commons revived as socio-ecological systems in an Ecosystem Service perspective.

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In Italy, wide areas of HNV farming landscape are still managed by ancient forms of common properties, called "Usi Civici". There are a wide variety of institutional settings resulting in very different management effectiveness, from the very organized northern Commons to still undetermined areas in the South. A common narrative states that these ancient forms of management actually preserved ecosystems from overexploitation, although the evidence shown in different settings is controversial. In an Ecosystem Service perspective, these human communities are an active part in ES provisioning. Furthermore, land under Commons management can be valued both as Natural Capital and as Cultural Heritage for its long standing history.

The identitarian dimension of Usi Civici is a key factor of the complexity. Even in the face of lack of appropriate support, as is the case of Central Apennines, the sense of belonging of local residents is still a most powerful driver for preservation of traditional land uses such as pastoralism: the survival of all pasture-related biodiversity is fundamentally relying on the stubborn willingness of native people to carry on an activity that has very little economic rewards, and for which the mere existence of Common pastures is a fundamental. Most Commons systems are very weak institutions, mostly concentrated on mountainous and marginal land, yet contributing to crucial ES provisioning. A recent law (n. 168/2017) sets for them a new legal setting with interesting ecological implication, especially if combined with a new forestry law (D.lgs. 3 aprile 2018, n. 34) and art. 72 L221/2015 for the Green community.

A comprehensive framework will be presented, to achieve a better understanding on the socio-ecological mechanisms by which Commons can relate to ecosystem dynamics and provide ecosystem services, hoping to strengthen these ancient institutions and ensure they acquire enough ecological know-how to carry on their ES provisioning role.

Keywords: Commons, Mountain, Seminatural ecosystems, Abandonment

T0322

Alignment of Social and Ecological Structures Increased the Ability of Trans-boundary River Management

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Large hydrologic basins involve multiple stakeholders, and coupled dynamic social and ecological processes. Managing such basins has long been a challenge. Balancing the demand for water from nature against that from humans is always difficult, particularly in arid watersheds. Here, we analyze potential institutional causes of ecological degradation and how it can be reversed by introducing new forms of governance. The framework and assumptions are illustrated using China's second-largest endorheic basin, where empirical evidence shows that the introduction of a new governing authority connecting midstream and downstream actors facilitated the establishment of a new governance regime that is better aligned with the biophysical scales of the watershed. A trans-regional water allocation project initiated by the new higher-level authority successfully rescued downstream oases and restored a dried terminal lake. These outcomes suggest that when social and ecological structures are better aligned our ability to manage the interplay between social and ecological processes increases. However, the lack of direct connection between the actors of the middle and lower reaches resulted in the paradox of an increase in water demand. We therefore suggest that measures to stimulate the emergence of horizontal social ties linking different critical groups of actors across the watershed could further the alignment of the institutional and biophysical structures — without these changes sustainable management of river basins and other common pool resources will remain problematic.

Keywords: Basin management

Delineation of county landscape governance units for WuSheng

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The delineation of county natural landscape management units is beneficial to manage and develop country in the context of urban-rural integration. Landscape unit and ecoregion delineation research usually involve more natural attributes and stay at the theoretical level, which is unable to provide practical suggestions for specific development. In this study, the delineation of landscape governance unit framework was proposed with geographic information systems and cluster analysis, which involves a sequence of natural and social factors. The definition can serve as the basic division of the territory for use in planning and land management efforts. Specifically, there are the following three aspects: ecological protection and control; Urban-rural integration as well as design characteristics and features. The results demonstrated that Wusheng county can be divided into three different management modes: single town, single village and complex village. At the same time, the development strategy of the seven built-up areas can be proposed based on unit characteristics. The delineation of county natural landscape management units provides a new perspective for the adjustment of the current administrative management system, and provides suggestions for rural development, which is of great significance for the protection and construction of diverse rural landscapes.

Keywords: landscape governance unit, Cluster analysis, Administrative system, Urban-rural integration

Symposium 30

Mapping and monitoring farmland biodiversity and ecosystem services

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Agriculture dominates global land use. Agricultural landscapes, which are land area that is either arable, under permanent crops, or under permanent pastures and rangelands, are therefore instrumental for biodiversity conservation. At the same time, farming is intimately connected to biodiversity by the ecosystem services it relies on such as pollination, crop production, pest control, water provision, soil fertility, etc. Agricultural practices depend on the provision of multiple ecosystem services and in turn also affect them by the choice of cropping or grazing patterns and by the use of external inputs such as fertilizers and pesticides. Those practices also act on the biodiversity conservation potential of agricultural landscapes.

The importance of agricultural practices for biodiversity and the provision of multiple ecosystem services is widely recognized. Still, surprisingly less attention has been paid for quantifying and monitoring impacts of those practices on biodiversity and consequently ecosystem functioning and services across different spatial scales. This symposium aims at presenting and discussing the recent developments and innovations in mapping and monitoring farmland biodiversity and ecosystem services. Specifically, the symposium will collate contributions on the following topics:

- Quantifying biodiversity and ecosystem services in agricultural lands at the farm to landscape scale
- Potential use of remote sensing and new technologies, such as drones, and next generation sequencing, together with new analytical approaches, such as Machine Learning, for monitoring farmland biodiversity and ecosystem services
- Development of new approaches, techniques and tools for mapping and monitoring biodiversity and ecosystem services in agricultural lands over time and space
- Assessing biodiversity and ecosystem services benefits of farming practices in different agricultural landscapes
- Resource mapping: Landscape and habitat mapping from the perspective of farmland species

T0834

Contrasting classification models in coastal landscapes: studying Golfo de Arauco, at south-central Chile

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The human pressure on the landscape has generated that the analysis of land use/land cover is increasing during the last years. Understanding and knowing the spatiotemporal changes of the landscape is critical, especially for the modeling of future scenarios in a climate change context.

In this context, diverse models of classification have risen in the last few years; some classifiers had major facilities to process images than others, while some classifiers are more complicated to use. Some of them are Cart, and Random Forest (RF), which are machine-learning methods based on decision trees that look for the best performance of training areas and generalization, Support Vector Machine (SV) was also based on statistics functions. In this study, we analyzed the behavior and results of these classification methods in coastal landscapes which are not only complex but also acquire vital importance in the climate change context. in this research we studied the Golfo de Arauco region, located in the coast of the Biobio region, at south-central Chile. Sentinel-2 images were classified using 14 land use categories (young forest plantation, forest plantation, bush, agriculture, intertidal, marsh, dunes, cloud, shadow, water, sediments, urban, bare soil, and clearcutting). Main results present high accuracy values: 91% for SVM, 93% for RF, and 88% for CART. Land use categories intertidal, marsh, scrublands and native forest, were the most complex during classification, showing lower accuracy values (< 90%).

The similarity could explain these issues in the spectral firm to other land use categories, and also by the low separability that has shown according to the JM-Distance indicator. These problems raise the need to increase additional information as textures and vegetation indexes, to increase the spectral separability and also to improve the ecosystem identifiers.

Keywords: Land use / land cover, Coastal landscapes, Remote sensing

The past present and future fragmentation in the Swedish landscape, as contribution to loss of biodiversity

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Abandonment of rural land and rationalization of remaining farmland are issues of concern in many countries. The fragmented rural biotopes and the movement toward monocultures in farming changes the prerequisites for biological diversity and increases the risk of losing many important ecosystem services. The National Inventory of Landscapes in Sweden, the NILS monitoring program, collects data of the "Everyday Landscape" nationwide. Data is being gathered in a multi-scale scheme, where statistics and remote-sensing data from satellites or laser scanners, earlier collected data/knowledge and modelling creating basis, where second-step 3D-interpretation of aerial photographs, in near-infrared is added to the landscape context, and subsequent field inventories – collecting the detailed data, including species, with the options of up to 253 variables and subclasses. While working and travelling over the land, the personnel also collects data for other programs or projects, thus increasing the overall capacity for different scientific analyses, as well as for national reporting of potential for biodiversity or the status of habitats. The context of historical depth is important and can be mapped in detail using older 3D aerial-photo coverage of the country, Sweden has at least two covers of the entire nation backwards, photographed by the Swedish Land Survey during the 1970/1980´ies and the 1950/1960´ies. An on-going analysis in the NILS program is the fragmentation of farmland and the rural areas in general, as they have been the carriers of much of the biological diversity in Sweden. Much of the land has been abandoned and either turned into active forestry, or just slowly passing through succession stages towards more natural forest. The older farms are either abandoned or turned in to summerhouses, depending on location. Peri-urban land is either abandoned due to closeness of swelling cities or turned into suburbs.

Keywords: Resource mapping and monitoring, Remote sensing, Agricultural landscapes, Policy-making, Planning

T0263

Classical land use maps or food resource maps – which one predicts predator abundance in crops better?

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To optimize agricultural landscapes for natural pest regulation, we need to understand the resource requirements of predators. Classical land use categories have been widely used to predict pest control services. However, the results are highly variable, indicating that broad categories such as forest, grassland and arable land are inadequate as general proxies for resource availability. There are numerous factors influencing predator abundance and ecosystem service provision, amongst which certainly are food resource requirements and distribution. Food resource needs vary greatly between predatory insect groups and resource occurrences may be more or less disconnected to classical land use categories. We assessed the potential of high-resolution food resource maps compared to classical land use maps to predict abundances of predators of crop pests in agricultural fields, and identified resources and habitats of particular importance driving predator abundances in crops.

Keywords: pest predators, landscape, food resources

High Nature Value Farmland Monitoring: A closer look uncovers different trends in German farmland biodiversity

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HNV farmland is defined as extensively used agricultural land with elevated biodiversity, semi-natural vegetation and/or elevated structural diversity. To measure the success of agri-environmental schemes, indicators like the HNV Farmland Indicator are implemented within the Common Agricultural Policy of the EU.
In Germany a targeted, random sample based monitoring programme was developed to fulfil the EU reporting obligations regarding HNV farmland and operates since 2009. It allows to identify state and trends in biodiversity within the agricultural landscape over time. Moreover the state and the changes concerning biodiversity of the different land use types like grassland, arable and set aside or landscape elements are assessed. Monitoring is conducted in a 4 year cycle and indicator values are reported regularly by calculating the gliding mean. HNV farmland quality is evaluated thus quality changes within HNV farmland can be detected.
Recent results provide new insights into the dynamics of the agricultural landscape. The two largest components of HNV farmland in Germany are HNV grassland (45% of total HNV farmland) and landscape elements (34%). The results show a sharp decline of overall HNV farmland from 13.1% of the UAA in 2009 to 11.4% in 2015 and subsequent stagnation up to 2018, with set aside and arable showing the largest proportional declines. The main decrease took place within the lowest quality level. That suggests stronger intensification pressure on land parcels that were hitherto used less intensively than usual.
To analyse different contexts of land use, we defined different reference areas in order to compare biodiversity trends. This way it is possible to use the HNV farmland monitoring as a new tool to evaluate the efficiacy of Natura 2000, of agri-environmental schemes and other factors influencing farmland biodiversity.
The findings can provide important contributions to the improvement of agri-environmental schemes and management plans.

Keywords: HNV farmland, farmland biodiversity, biodiversity monitoring, HNV farmland indicator

Multi-dimensional Assessment of Agrarian Cultural Landscape Values: A Case Study of Duman Agricultural Landscape of Barangay Sta. Monica

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The concept of Cultural Landscape emerged in the 1992 World Heritage Convention, becoming the first instrument in safeguarding and providing recognition to cultural landscapes, defined as cultural properties representing the combined works of nature and man (World Heritage Committee, 1992). Recent related literature reveal that most cultural landscapes are assessed according to their Outstanding Universal Values, which unfortunately results in the deprioritization of certain landscapes, including rural agrarian areas like those in the Philippines. Thus, the study focuses on the need to develop a comprehensive assessment tool, tailored specifically for the agrarian cultural landscape. Five evaluative dimensions—ecological, production, economic system, cultural, and social values—were adopted from analyzing cultural landscape assessment theories. Aiming to generate a visual and quantifiable measure of assessing its acceptability, the tool was applied to a specific site located in the Duman Agricultural Landscape of Barangay Santa Monica, Municipality of Santa Rita, Pampanga. The proposed Agrarian Cultural Landscape Values Assessment Tool was found to be effective not only in determining the full values of agrarian cultural landscapes, but also in assisting cultural agencies and related research fields in considering the different landscapes in the country.

Keywords: Cultural Landscape Values , Agrarian Cultural Landscapes, Cultural Landscape Assessment , Multi-dimensional Assessment

Progress in farmland biodiversity monitoring in Germany

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Agriculture is one of the main drivers of biodiversity loss. Yet, agriculture and biodiversity depend on each other: While agriculture needs ecosystem functions and services for a sustainable production, countless wild species depend on habitats in agricultural landscapes. Whether these landscapes provide habitat to support biodiversity highly depends on agricultural management practices. Management is, in turn, intimately linked to agricultural policy having considerable direct and indirect impacts on both farmers' land-use decisions and biodiversity.

To identify and survey effects of agricultural policy decisions on biodiversity, a comprehensive national database on biodiversity in agricultural landscapes is required. Here, we present a farmland biodiversity monitoring scheme for Germany, recently launched by the Thünen Institute, the Julius-Kühn Institute and the Federal Office for Agriculture and Food, funded by the German Federal Ministry of Food and Agriculture. The goal of the farmland biodiversity monitoring scheme is to provide scientifically sound data at high spatial and temporal resolution to assess the status and trends of farmland species and to provide recommendations on how to optimize agri-environmental measures and land-use practices. Based on a modular structure, the monitoring scheme encompasses a general trend monitoring on a national scale, which is based on existing stratified sampling units, and a more question-based monitoring at the scale of representative agricultural landscape units. The modular structure enables both, to gather long-term data (> 10 years) using conventional trend monitoring modules, and to adapt indicators to challenges and changes in agriculture through the adaptive nature of question-based monitoring modules. These modules are complemented by a citizen science approach to gain farm-related biodiversity data, and to raise farmers' awareness to the link between land-use, biodiversity and ecosystem service provision.

Keywords: agricultural landscapes, biodiversity conservation objectives, indicators

The influence of landscape alterations on changes in ground beetle (Carabidae) and spider (Araneae) functional groups between 1995 and 2013 in an urban fringe of China

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Urbanization is one of the main causes of landscape change over time, but knowledge of its effect on different functional groups of carabids and spiders in adjacent rural areas over time remains limited. We assessed whether landscape alterations (1993 versus 2013) drove changes in carabid and spider functional groups (1995 versus 2013) in an agricultural landscape located on the fringe of a rapidly growing city, Qianjiang, on the Yangtze floodplain of China. Although built-up land increased from 6.3% to 32% across the whole landscape, the overall species richness of carabids and spiders did not decline. In contrast to the reduction in species richness of large carabids, the species richness of small carabids increased. Species richness of both large and small spiders increased. The species composition of carabids and spiders significantly changed between 1995 and 2013. Species compositions of large, predatory carabids and large or ground-hunting spiders were more sensitive to the changes in built-up land than those of small, omnivorous carabids and small or web-building spiders. The amount of grassland (abandoned land covered by wild grass) also increased as farmers began to work in the city. The increased grassland significantly contributed to the increased species richness of predatory and macropterous carabids. However, increased landscape diversity did not affect species richness of either carabids or spiders. High landscape diversity was related to reduction in field size, resulting in a decrease in the mean body size of carabids. This indicates that evaluating the effect of landscape change on carabid and spider diversity should be based on their functional traits. Different taxa, even different functional groups, have different responses to landscape change. The increase in built-up land did not immediately reduce species richness at the urban fringe. Increasing wild grasslands and combining smaller fields may benefit farmland biodiversity in this region.

Keywords: Land use change, Temporal change, Abandoned land, Species composition, Species richness

T0461

Temporal dynamics of soil bacterial communities at a landscape scale: dependence to soil properties and agricultural practices

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Soil microbial communities play a major role in agricultural functions and are an efficient indicator to evaluate the impacts of agricultural practices on soils. Studies on wide scales ranging from landscape to countries demonstrated that soil microbial communities were heterogeneously distributed in space under the dependence of soil properties (e.g. pH, soil texture, Organic matter Content) and agricultural practices. However, temporal dynamics of soil microbial communities at a landscape scale still need to be documented in order to go further in evaluating the sustainability of agricultural practices. In this extensive monitoring study, we focused on landscape dynamics of soil bacterial communities in an agricultural landscape (13km2, Burgundy, France). Soil bacterial communities were characterized by means of high-throughput sequencing in 2011 and 2016 together with soil properties and land management for their abundance, diversity and composition. Soil microbial biomass, bacterial richness, evenness, Shannon index and bacterial community structure exhibited spatial patterns at the landscape scale either in 2011 or in 2016. Nevertheless, over this period, only bacterial evenness, Shannon index and bacterial community structure changed significantly together with their spatial patterns. These changes were mainly related to changes in land management and more slightly to changes in soil properties, which experimented small variations over this period. Altogether, these results are a first step toward the operational use of soil microbial communities in the management of farmlands at a landscape scale and will be reinforced by introducing climatic data in the analysis. Results of this study may be used in order to create a Decision Support Instrument (DSI) for stakeholders in the agricultural communities to help choosing practices that improve soil quality.

Keywords: soil microbial communities, monitoring, agriculture, next-generation sequençing, landscape

T0350

Using Sentinel satellite data to supplement monitoring of farmland landscapes

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The Norwegian Monitoring Programme for Agricultural Landscapes ("3Q") was established in 1998 to record changes in land use and indicate consequences for landscape composition, farmland biodiversity, cultural heritage and for people. 3Q is a sample-based programme involving detailed mapping from aerial photographs at five-year intervals. Supplementary fieldwork is carried out at ca. 10 % of the monitoring squares. Over the last two decades, new data sources, tools and methods have been introduced to improve the usefulness and cost-efficiency of the 3Q Programme, whilst at the same time ensuring the comparability of time series data. Europe's satellite program Copernicus now offers a new source of potentially valuable data. The Sentinel-2 satellites provide images with 10 x 10 metre pixel size and a frequency of about three days over Norway, far superior to previous satellite data. We will present our methods for using pixel-based time series to supplement the information we gather from aerial photographs. With typically 10 to 30 cloud-free observations of a pixel during the growing season, we are able to classify agricultural land as annual crops or permanent grassland. The satellite data can thus provide annual information about grassland management that we currently miss with the single time-shot of aerial photos and a five-year monitoring cycle. We are also interested in detecting autumn ploughing, forest felling and new buildings and are considering change detection methods based on radar data from Sentinel-1. The presentation will discuss how we envisage integrating satellite data into the 3Q Programme for improved future monitoring.

Keywords: Landscape monitoring, satellite images, Sentinel

P0168

A comparative landscape genetic approach to assessing landscape effects on agricultural native bees in Alberta, Canada

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Maintaining bee habitat and its connectivity across agricultural landscapes is important for promoting pollination as an ecosystem service provided by bee communities. However, connectivity is a species-specific concept, and the effect of landscape change on bee habitat connectivity may vary among species with different morphological traits or behavior. Through recent advances in next generation sequencing, researchers can cost-effectively collect high resolution genetic datasets for non-model organisms. Therefore, through comparative studies, we can more accurately assess how a landscape differentially affects the population genetic structure of multiple taxa. We illustrate this with a pilot study comparing the population genetic structure of two native bees, Bombus borealis and Andrena lupinorum, that were sampled at sites across the agricultural region of Alberta, Canada. We use ddRAD sequencing to identify and genotype neutral SNPs de novo, and we conduct analysis with conStruct to assess population genetic structure. We hypothesize that the smaller, solitary bee A. lupinorum shows more pronounced spatial genetic structure than the larger, eusocial B. borealis. This would suggest that A. lupinorum may be more susceptible to isolation effects through habitat loss, fragmentation, or agricultural intensification. Taxa with certain traits, such as lower dispersal capability, smaller body size, or solitary life history may be more vulnerable to loss of genetic diversity through anthropogenic landscape change. We can now compare multiple non-model species with higher genetic resolution and make more informed management decisions, which is especially valuable in the case of pollinators within an agricultural landscape.

Keywords: landscape genetics, agriculture, bees, population genetics, landscape ecology

T0038

Farmland biodiversity monitoring for improving agri-environmental policy

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The Swiss agricultural landscapes are very contrasting and range from intensively used lowlands dominated by arable crops, fruit and horticulture to marginal mountain grasslands. In a cross-compliance mechanism, farmers have managed at least seven percent of their land as ecological focus areas (EFA) since 1999. Those EFA, together with additional agri-environmental measures, should help to reach the government's environmental objectives for biodiversity, habitats and ecosystem services.
To evaluate if the objectives are reached, the monitoring program ALL-EMA maps the number and diversity of habitats, vascular plants, butterflies and birds on 170 1x1km landscape units distributed across Switzerland. First results illustrate the contribution of different EFA types and of agri-environmental measures for maintaining farmland biodiversity – as well as the limitations of the approach.
The presentation will summarize the results of ALL-EMA. It will focus on different approaches to the evaluation of habitat and species measures (diversity indicators, indicators for "ecological quality"). We will demonstrate how we approach the evaluation of policy targets for ecological quality, which involves expert judgement but should still be scientifically sound and reproducible. Moreover, we will discuss the challenge of operating a landscape and biodiversity monitoring program in the context of agricultural policy.

Keywords: Agricultural landscape, Habitat quality, Vascular plant

T0731

Assessing farmland ecosystem services in Canadian prairies: contributing knowledge to decision-making systems

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Robust, reliable and comparable data on the provision of ecosystem services (ES) are increasingly crucial for the effective conservation and management of farmland systems. However, for most of the geographic regions, more data is still needed to provide a diverse range of land management practices that may lead to trade-offs between agricultural production and the provision of multiple ES (e.g., water and carbon-related ES, and biodiversity). Using the systematically collected data by the Alberta Biodiversity Monitoring Institute (ABMI), on the status and trend of ecosystems, and human modification, we successfully developed spatially explicit models for consistent assessments of multiple ES across a diverse range of farmland systems in Alberta (661,190 km2), a western prairie province of Canada. We examined the impacts of recent climate change on the provision of carbon-related ES (i.e., soil carbon storage and aboveground biomass production) across Alberta's farmland landscapes. We also explored opportunities to protect and enhance the provision of these ES by simulating impacts of alternative land management scenarios at the farm to landscape scale and for a wide range of farmland systems. The information and knowledge developed provide a baseline to determine if alternative management strategies will lead to the resilience of socio-ecological systems in the Canadian prairie farmland. We are currently integrating our simulation results into decision support tools to develop credible and transparent market programs for protecting and enhancing multiple ES on Alberta's agricultural landscapes. We are also utilizing the knowledge and tools developed to help the beef and other relevant industries within the agricultural sector to understand climate change-induced challenges and to develop innovative approaches for their sustainable development in the future.

Keywords: Agriculture sector, Alberta, Climate change, Decision support tool, Land management

P0091

Identifying landscape structures to enhance wild bee diversity in agricultural areas

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Wild bees provide a major ecosystem service by pollinating crops and wild plants in agricultural landscapes. Agricultural intensification is known to be a major driver for the decline of wild bees. The project BINATS 2 (BIodiversity–NATure–Safety) assesses biodiversity of representative indicators (landscape structure, vascular plants, wild bees, grasshoppers, butterflies) in Austrian agrarian regions.
These indicators were sampled in 50 test areas in maize (2017) and 50 test areas in oilseed rape cultivation regions (2018). Within each of the 625m x 625m test areas the landscape structure was mapped. In ten randomly selected test circles (20m radius) in each test area, plant and animal indicators were recorded. Wild bees were sampled by a semi-quantitative method once in each test area, which represents a snapshot of the species inventory. Additionally, 34 of the 100 test areas were sampled three more times between April and August to evaluate the situation of wild bees in these Austrian agrarian areas. Wild bee diversity was analysed in the context of landscape structures in the test circles and test areas. In total 200 bee species were sampled during 2017. Preliminary results showed, that 76% of the species were recorded in semi-natural elements (e.g. fallows, hedges, extensive meadows) and 35% of the total species were present in field and road margins which represented only 1% of the total sampled area. Over half of the species were sampled in grassland which represented 16% of the total sampled area. In contrast, entomophilouse crops (8% of the total sampled area) such as sunflower, oilseed rape, hosted 23% of the species.
By combining our data from both survey years we will validate our preliminary findings on relevant landscape structures to enhance wild bee diversity in agro-environments. The effect of semi-natural elements on wild bee diversity on a wider spatial scale will be identified by including the mapped landscape structure within each test area.

Keywords: Apiformes, pollinators, agro-ecosystems

P0014

Effects of semi-natural habitats on the abundance and distribution of insect pollinators in sunflower fields in Hungary

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The decline of insect pollinators, especially in agricultural landscapes due to the degradation of semi-natural habitats (SNHs), is a sincere threat to the pollination service and a current hot topic in landscape ecology. In this study, we wanted to test if the presence and type of SNHs in the vicinity of sunflower fields has an influence on the abundance and distribution of insect pollinators visiting sunflower heads. The field experiments were carried out over two years in 36 sunflower fields, located in an agriculturally dominated region in the central part of Hungary. In each field, bee and non-bee pollinators visiting sunflower heads were detected and identified in distances of 5, 25, 50 and 75 meters from the field edge. The sampled fields were grouped according to the presence and type of SNHs within a distance of 150 m from the starting point of the transects. Based on the canopy cover of shrubs or trees, we differentiated between herbaceous SNHs (< 30%) and woody SNHs (> 30%). During the field experiments we counted ten times more honeybees than wild bees or other pollinators. In all cases, with exception of two fields, SNHs occurred within the threshold distance. The average number of wild bees was nearly twice as high in fields with nearby herbaceous SNHs compared to fields with nearby woody SNHs. This difference was, however, not significant due to two outliers. In case of the wild bees, we also found a decrease of their abundance with increasing distance from field edge, being significantly lower at 75 m than at the other distances. This effect was similarly found both in fields with nearby herbaceous and woody SNHs. In summary, the results indicate that the abundance of wild bee pollinators might be higher in the vicinity of herbaceous SNHs and that distance effects may also have an important influence on their flower-visiting frequencies.

Keywords: pollinators, sunflower, semi-natural habitats, distance effects

P0107

Creating a spatially and temporally-explicit model of floral resources for pollinators in the agricultural landscape of Central New York, USA

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Many pollinators rely on the availability of floral resources at broad scales across the landscape for survival. Floral resources, both nectar and pollen, are temporally variable, so the abundance and diversity of these resources in a landscape change over the growing season. Less diverse and non-vegetated land uses such as urban and agricultural areas may exacerbate availability by decreasing total available floral resources and removing critical plant species that flower outside of common flowering periods. Further, such land uses may alter dynamics of availability by introducing mass-flowering species, such as certain crops, or creating new floral habitats, such as roadside ditches. Using freely-available data from federal and state governmental agencies and non-governmental organizations, we created a spatially and temporally-explicit model of flowering land cover of the Central New York region of USA. This model incorporates remote sensing-derived natural habitat, crop, and land use data products with infrastructure GIS data to create a map of land cover relevant to floral resources at up to 1-m spatial resolution. Using phenological data (collected from fieldwork and literature) of the representative plant communities in each derived land use, we calculated spatially-explicit floral resource surfaces at 1-day time intervals over the year. The resulting dataset allows the quantification of flowering resources available within any area (e.g. 2 km radius around the location of a bee hive), as well as over any specified period in a year. This dataset would be of use to both researchers and practitioners, allowing them to estimate floral resource availability around planned field sites or hive placements. We present the methodology for the creation of this dataset, its use, and results from preliminary studies.

Keywords: pollinators, sunflower, semi-natural habitats, distance effects

T0099

Applying unmanned aerial vehicles (UAVs) to evaluate the impact of pastoral land uses on avian biodiversity in the Tibetan agricultural landscape

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With 67% of the land used for nomadism, the Qinghai-Tibetan Plateau (QTP) is the world's largest alpine agricultural landscape, where grazing disturbance regimes regulate the vegetation dynamics and biodiversity patterns. In farmland biodiversity studies of the QTP, however, it remains a challenge to quantify land use and land cover (LULC) impacts, as well as to identify the "scale of effect" when conducting meaningful LULC–biodiversity analysis. In this study, we evaluated the performance of small, unmanned aerial vehicles (UAVs) to derive a comprehensive set of LULC predictors for the eastern QTP. We conducted 39 flights and obtained 5500 images covering 45 km2. UAVs provided us with high-resolution (10-cm level) orthophotos and digital surface models. Combining data from ground bird surveys, we performed canonical correspondence analyses (CCAs) to analyze explained variance in the local avian community at incremental sample scales. Results showed that 3D-based predictors contributed strongly to the explanation (50 m: 45.44%, 100 m: 44.60%, 150 m: 49.21%, 200 m: 36.22%), followed by 2D-based predictors. The sample plot scale of 150–200 m radius led to the most comprehensive explanation of variance. As such, we demonstrate the great potential of UAVs in facilitating the evaluation and monitoring of farmland biodiversity.

Keywords: biodiversity monitoring, Tibetan Plateau, remote sensing, drone, bird

Mapping the Supply and Demand of Pollination Service for Pollination management: A Case Study in the Changping District of Beijing,China

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Pollination service is one of the most important services related to sustainability of human society. Unfortunately, the rapid development of urbanization and agricultural intensification has caused severe loss of both habitat and biodiversity, resulting in decline of pollination service. Recently, the land-use based ecosystem services mapping approach has raised wide attention but focused on the spatial pattern of the supply of the pollination service only, the evaluations on the spatial pattern of the demand of the pollination service and the supply-demand relationship of the pollination services were largely neglected. In this study, we investigated and mapped the levels of both supply and demand of the pollination service, as well as the relative levels of the supply-demand of pollination service at Changping The pollination supply was evaluated by using the InVEST Pollination model, which considered a series of parameters including the available nesting sites of habitats, the floral resources in the habitat, and the relative abundance of that pollinator species of habitats. High resolution remote sensing image- Gaofen remote sensing image was used for habitat classification by combining with intensive field survey and computer interpretation. Wild bee diversity, vegetation composition, soil compaction and other information in seven common habitats were carried to derive the parameters related to upon mentioned needed for pollination supply evaluation coupling with related literatures. The demand of pollination was evaluated based on the statistic data of the area of cultivated crops and the dependence of these crops on the animal pollination in each town. Finally, we generated a map of the relative levels of supply-demand by overlaying the maps of the levels of supply and demand of pollination service, and then put forward the management suggestions to improve the pollination service in the region.

Keywords: InVEST model, wild bees, ecological service mapping, ecological service supply, ecological service demand

T0727

Beyond the stand: Reviewing landscape fragmentation measures and dynamics on biodiversity and ecosystem services in Southeast Asia

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Forest and agriculture landscapes in SE Asia are highly diverse ranging from traditional swidden systems to intensive industrialised plantations and have fabricated distinct fragmented landscapes that could yield significantly varying impacts on biodiversity and ecosystem services (ES). Our systematic styled review synthesises evidence from industrial oil palm (IOP) and smallholder (SH) studies to assess how landscapes are measured in SE Asia and how this influences biodiversity (soil fauna, avifauna, and vegetation) and ES. Two literature searches were carried out capturing fragmentation studies in IOP and SH settings. After devising a selection criteria, we identified relevant studies, assessed the type of landscape metrics used, and synthesized research findings.

From 2301 results, 27 studies passed our selection criteria; isolation was the most popular landscape measure (n=13). 50% of studies focused on IOP in Malaysia and none focused on Indonesia despite being the world's largest oil palm producer. We found too few studies on interactions between ES and landscape dynamics to draw meaningful comparative findings. Studies on SH systems provided cases of well-connected and diverse forest-agriculture mosaics that successfully supported all biodiversity. In IOP landscapes, we found mixed effects, which depended on the dispersal range of species, their adaptive ability along habitat gradients, and how actors managed forest fragments.

Land use research is dominated by land use level comparisons, and rarely do studies measure landscape interactions. Most landscape metrics implemented were not measured at the landscape level, and did not account for lag time effects, which can form misleading findings. Nonetheless, some studies do use more sophisticated measures of landscape fragmentation that are more suited for complex landscapes, which could help support future research to accurately capture how fragmentation impacts biodiversity and ES in SE Asia.

Keywords: landscape metrics, Southeast Asia, landscape level, Forest fragmentation, Smallholder systems

T0307

Similarities of carabid assemblages in neighboring cereal and grassland fields in three intensive agricultural areas

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Ground beetles are important beneficial entomofauna and contribute to biological control of pests in crop production. Though grassland areas have decreased in Europe since 1950, their vicinity has been proved beneficial to maintain a high carabid diversity in arable fields. However, the nature and relationships between the carabid assemblages of these two agricultural habitats was studied little so far. We hypothesized that carabid communities would converge in neighboring cereal crops and grasslands, expecting more commonness of mobile and polyphagous taxa.

Our main objective was to seek for similarities of carabid biodiversity in neighboring pairs of grasslands and cereal fields. Carabids were sampled in 104 pairs of cereals-grasslands in three intensive agricultural areas of southeastern in France. Carabid biodiversity was measured through species richness and abundance, and sampled species were classified into life traits such as mobility and diet. We calculated evenness and tested the correlations between ecological similarities and spatial proximity. Further we quantified the relationships of carabid assemblages with exclusiveness or commonness of species between the two habitats.

Species richness was similar in the two habitats and was explained by study area. Communities were more evenly distributed in grasslands. Species richness and evenness could be explained uniquely by study area and habitat. There was a significant similarity of carabid assemblages between two habitats up to a distance of 5 km. Large, polyphagous and predatory taxa were more likely to be sampled in both habitats, potentially enhancing biological control of pests in farming.

Our analyses suggest that carabid assemblages are not only driven by cover types since the communities of the two habitats converged when closer. We highlight the importance of considering the beneficial importance of grasslands communities for conservation biological control in farmlands.

Keywords: Agroecology, Biodiversity, Ground beetles, Landscape agroecology, Landscape agronomy

T0675

Exploring long term monitoring data to establish agro-ecological patterns in grassland at landscape scales for comparison with innovative grassland farming practices.

Lisa Norton

Existing data from the GB Countryside Survey (CS) was used to provide a picture of the status of grassland (Improved and Neutral Grassland Broad Habitats) on a national (GB) scale, against which the ecological status of livestock production systems in which ruminant animals raised wholly on grazed and conserved pasture and forage (the Pasture for Life (PfL) certified approach) was evaluated. Land was compared on the basis of grassland types and on livestock use (as recorded in CS). Ecological measures included plant biodiversity, elements of soil biodiversity (bacteria, fungi and wider eukaryotes from eDNA assays) and the following 0-15cm soil properties: organic carbon, total N, mineralisable N (and C:N ratio), Olsen P, total P, bulk density and pH. Existing contextual information (such as hedge density, areas of different habitats) for the 1km square in which sampled fields were located also form part of the data. Multi-variate analysis was undertaken to; 1) explore the relationships between grassland variables in the CS dataset (for example soil biodiversity and above ground biodiversity) and their dependence on landscape context, both spatially and temporally (over repeat surveys) 2) assess the status of 56 PfL farms compared to grassland in the wider countryside (CS) to establish if and how the ecological measures (collected using CS methodologies) differ from those for grassland in the wider countryside. This paper will report on the findings from this analysis, highlighting the value of long term integrated monitoring of agricultural land and the links between measures of biodiversity and ecosystem function and ecosystem service production.

Keywords: monitoring , soil, vegetation, biodiversity, agro-ecology

T0442

Shattered agricultural landscapes: from diverse structure to uniformity and fragmentation: analyses of two data-sets of BINATS I and II

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Growing demand on crop production for food supply as well as renewable energy generates increased pressure on our farmland. Hence, habitat and species diversity conservation in agricultural landscapes poses a major challenge.
In the Austrian Biodiversity monitoring program BINATS (Biodiversity-Nature-Safety) - implemented in 2006 - surveys of habitats, vascular plants, butterflies, and grasshoppers were carried out after a time span of ten years for the second time (BINATS II). In the 100 BINATS test areas (625x625 m) in maize (2017) and in oilseed rape cultivation areas (2018) habitats were mapped area-wide. Presence/absence data were collected for vascular plants in ten test circles (r=20m) within each test area. For the animal indicators, their abundance was measured additionally. A fifth indicator - wild bees - was incorporated into the survey design for the first time in BINATS II.
In BINATS I, we recorded a total of 106 different habitat types, 900 vascular plant species, 41 butterfly and 57 grasshopper species in total for all 100 test areas. Positive correlations of species richness of plants, butterflies and grasshoppers with habitat diversity, landscape patch shape complexity as well as proportion of grassland habitats could be determined. In contrast, all three taxa were negatively correlated with the proportion of cultivated land. Concerning climatic gradients an unexpected correlation of plant species richness with decreasing mean annual temperatures was detected due to land use intensity increasing with favourable climatic conditions.
Data analyses of the two data sets of BINATS I and II are currently being carried out. We will identify changes concerning habitat diversity within the test areas, patch sizes, habitat quality as well as fragmentation. Land use change, farming practices as well as climate change will be analysed for their significance as drivers for biodiversity loss in the Austrian farmland on both, small and large scale.

Keywords: Austrian farmland, biodiversity monitoring, farmland species and habitats, farming practices, biodiversity change over a decade

T0813

Linking farmland bird species to land use data in a national landscape monitoring programme

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The decline in farmland birds observed throughout Europe during recent decades has attracted much attention. Agricultural intensification or land abandonment are commonly forwarded as key drivers. National bioeconomy strategies emphasize increased use of biological resources from agriculture and hence could have huge impact on land use. Here we report from a study of the relationship between land use and bird species in the agricultural landscape of Norway. The main objective is to monitor and investigate the effect of spatial heterogeneity and diversity of land use on total richness, abundance and distribution of farmland birds.

Monitoring the distribution and abundance of birds is part of the Norwegian monitoring programme for agricultural landscapes. The monitoring programme is based on 1 x 1 km monitoring squares distributed across the Norwegian agricultural landscape, mapped with a detailed land use classification system based on interpretation of aerial photographs. Within 130 monitoring squares permanent observation points have been established for recording breeding birds to assess the relationship between land use/cover and species richness, distribution and abundance of farmland birds.

We found that both spatial heterogeneity of land use and high land type diversity were a significant positive factor for farmland birds. We also found that between 2000 and 2017 several of the farmland bird species had declining populations as well as reduced distributions in the monitoring squares.

The results presented here highlight the importance of a spatial heterogeneous agricultural landscape with relatively high land type diversity interspersed with natural areas. Several of the national bioeconomy strategies, if implemented as planned, has the potential to reduce both heterogeneity and land type diversity and hence further reduce the already declining bird populations.

Keywords: landscape monitoring, agricultural landscapes, land use, spacial heterogeneity, farmland biodiversity

T0106

Could farming practices subsidized by the European agricultural policy lead to a better nature condition and fight against climate change?

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The European Common Agricultural Policy (CAP) has a huge impact on how our landscape look and nature's condition is. Also on how healthy is the food we eat, and how successful are the efforts against climate change. This paper describes the outcomes of a literature review to assess the impact of four farming practices currently applied and subsidized by the CAP to improve environmental sustainability. We review three practices applied in crop systems: fallow land, cover crops and four groups of landscape features (hedgerows and wooded strips, field margins, trees in groups and field copses, and isolated trees and trees in a line); and one practice used in livestock systems: manure management. We mainly base the crop systems literature review on six recent meta-reviews and the manure management on a new review. Cross-analysis among the practices helps to identify a common list of potential impacts that we use to summarise consistently the findings. We record the scientific evidence from the literature as (positive, negative or none) impact of the practices on 10 environmental issues: air quality, water quality, water quantity, greenhouse gas emissions, carbon sequestration, climate change adaptation, regulation of soil erosion and soil quality, biodiversity and pollination, and their linked ecosystem services. We also identify and analyse the range of factors that determine the extent of the impact, from which emerges that 'wisely designed' farm management is essential to achieve the desired environmental objectives of the practices. The factors identified include not only the management but also some bio-physical, climatic and landscape constraints. The paper builds the case for the role of good management practices (individually or combined) as a means of promoting positive impacts on ecosystem services and environmental outcomes, whilst minimising the negative.

Keywords: farming practices, biodiversity, ecosystem services, agricultural policy

T0234

Landscape effects on crop pest biocontrol are modulated by local pesticide use.

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Control of crop pests by their natural enemies provide a valuable but poorly quantified ecosystem service in farmland. Complex landscapes including semi-natural habitats are expected to favour natural enemies thereby enhancing natural pest biocontrol in crops. However, when considering a large number of situations, the response of natural biocontrol to landscape properties is globally inconsistent, a possible explanation being that local agricultural practices counteract landscape effects. Here, we report on survey conducted along a crossed gradient of pesticide use intensity and landscape simplification that analysed the interactive effects of landscape characteristics and local pesticide use intensity on natural biocontrol. In 80 commercial fields located in four contrasted regions in France, we estimated biocontrol during three consecutive years, using a set of sentinel prey (weed seeds, aphids and Lepidoptera eggs). In parallel, for each field and every year, pesticide use was monitored by farmer's survey and the 1km2 surrounding landscape described in the field. Our analysis shows that the predation rates of all sentinel prey types responded to interactions between landscape characteristics and local pesticide use intensity. Specifically, the landscape proportion of suitable habitats for crop pests decreased the predation of sentinel prey, irrespectively of the local pesticide use intensity for weed seeds and aphids, but only in fields with low pesticide use for Lepidoptera eggs. In addition, landscape complexity, proportion cover area of semi-natural habitats or length of interface between semi-natural habitats and crops had a positive effect on biocontrol if local pesticide use intensity low but had a negative effect elsewhere. These results suggest that pesticide pressure can strongly mediate landscape effects on biocontrol and that these two drivers should be considered alongside in future landscape biocontrol studies.

Keywords: Biocontrol, Pesticide pressure, Landscape simplification

T0936

Landscape agronomy: bibliometric insights on key issues and background concepts of a conceptual framework

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Landscapes are formed in the interactions between natural resources and heterogeneous land managers that expect/pursue an increasing variety of ecosystem services. Landscape ecology undoubtedly indicated the landscape as the best level to assess existing services and to support expected improvements. Where agriculture drives local dynamics, a contextual cross-scale analysis of farming activities and actors is needed to understand how and why landscapes are produced, eventually, re-designed. Inspired by landscape ecology, the landscape agronomy framework was proposed to extend the study of patterns and processes to agriculture, so calling to focus on the spatially explicit characterization of farmers' decision-making. In summary, landscape agronomy conceptual framework helps to describe and analyze the patterns determined by the interactions between agricultural practices and local resources (Benoit, Rizzo et al. 2012, Lands Ecol). This communication aims at providing insights into the key concepts underpinning the conceptual framework, such as the "cropping system" defined by agronomists, and the "force fields" applied in geography. A few years after the launch of this conceptual framework, we address the question: "who cares about landscape and agriculture?". To this aim, we will present the result of a bibliometric analysis using the CorText platform to explore research keywords, (inter)disciplinary bridges and emerging issues related to landscape agronomy. In the discussion, we will address some relevant applications, such as the challenges for agrifood system management of natural resources or to energy production by farmers (e.g., biofuel, biogas), and the landscape perspective on the deployment of smart farming and agtech. We will conclude on possible improvements to this conceptual framework. Altogether, this communication sets the scene for an upcoming multidisciplinary book about advances and challenges of a territorial approach to agricultural issues.

Keywords: landscape agronomy, conceptual framework, bibliometric analysis, cropping system

T0718

Developing a Semi-Automatic Classification tool to map habitats and GBI at European scale using OBIA method

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BIOGEA is an European project aims to examine how Green and Blue Infrastructures (GBI) can be better managed through Common Agriculture Policy measures and provide the greatest benefits for biodiversity and ecosystem services. Within the framework of this project, it is outlined the need to model the impact of the GBI on biodiversity. For this, the present study proposes to develop a Semi-Automatic Classification tool that allows to map different habitats at European scale for which biodiversity database are available. Object-Based Image Classification (OBIA) method has been used to classify orthoimages taking into account both, RGB bands composition and the shape of the objects to be classified. Google and Bing satellites resources were used to get images from different seasons (winter and summer) to tackle the seasonal variability of the agriculture landscapes. Training areas from different European countries (Portugal, Germany, UK, Spain, France, Czech Republic, Switzerland, Bulgaria, Greece, Austria, Sweden), representatives of the different landcover classes to be mapped (agroforestry, arable, grassland, water bodies, shrubland, track, forest, urban, grassy and woody strip) and bioregions, were used to extract spectral (e.g. mean, min., max., stddev., homogeneity, etc.) and morphological statistics of objects (e.g. area, compactness, shape index, rectangular and elliptic fit), as well as RGB indices (vegetation, water and urban indices). In addition, NDVI was calculated through the Sentinel 2A images bands in order to differentiate between vegetation covers. The statistics and indices values were used to establish the classification parameters. We present the methodology design, results for different agricultural landscapes and the accuracy tested by cross-validation with landscape mapped by field visits. While successive satellite images were adequate to map main land covers/uses, orthoimages were needed to map small landscape features.

Keywords: Resource mapping and monitoring, Remote Sensing, Habitats, Biodiversity, GBI

T0834

Contrasting classification models in coastal landscapes: studying Golfo de Arauco, at south-central Chile

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The human pressure on the landscape has generated that the analysis of land use/land cover is increasing during the last years. Understanding and knowing the spatiotemporal changes of the landscape is critical, especially for the modeling of future scenarios in a climate change context.

In this context, diverse models of classification have risen in the last few years; some classifiers had major facilities to process images than others, while some classifiers are more complicated to use. Some of them are Cart, and Random Forest (RF), which are machine-learning methods based on decision trees that look for the best performance of training areas and generalization, Support Vector Machine (SV) was also based on statistics functions. In this study, we analyzed the behavior and results of these classification methods in coastal landscapes which are not only complex but also acquire vital importance in the climate change context. in this research we studied the Golfo de Arauco region, located in the coast of the Biobio region, at south-central Chile. Sentinel-2 images were classified using 14 land use categories (young forest plantation, forest plantation, bush, agriculture, intertidal, marsh, dunes, cloud, shadow, water, sediments, urban, bare soil, and clearcutting). Main results present high accuracy values: 91% for SVM, 93% for RF, and 88% for CART. Land use categories intertidal, marsh, scrublands and native forest, were the most complex during classification, showing lower accuracy values (< 90%).

The similarity could explain these issues in the spectral firm to other land use categories, and also by the low separability that has shown according to the JM-Distance indicator. These problems raise the need to increase additional information as textures and vegetation indexes, to increase the spectral separability and also to improve the ecosystem identifiers.

Keywords: Land use / land cover, Coastal landscapes, Remote sensing

T0835

Combining remote sensing and field surveys in the Austrian farmland biodiversity monitoring "ÖBM Kulturlandschaft"

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The Austrian biodiversity monitoring ÖBM-Kulturlandschaft has a focus on habitat and species diversity in Austrian cultural landscapes (including alpine pastures). The stratified random selection of the sampling sites is based on the 1 km² grid of Statistics Austria with a minimum of 50% of agricultural area. 100 nested sampling plots are arranged hierarchically by (i) remote sensing based landscape survey: 3 x 3 km² - landscape plots, (ii) habitat mapping: 625 m x 625 m test areas; and (iii) organismic surveys in test areas: 10 test circles for vascular plants, grasshoppers and butterflies. A rolling survey is conducted: in the first year of the survey, half of the 100 sampling plots were covered, in the second survey year the remaining half. The repetition of surveys will take place every three to five years. Survey methods for organismic groups are closely aligned with those applied in the monitoring project BINATS that focusses on maize and oilseed rape cultivation areas (Pascher et al. 2011). The recording of habitat types is based on the Austrian red lists. Remote sensing analyses include phenological characterizations of the habitat types and detection of changes in ecosystem functions (e.g. NDVI) and ecosystem structure (e.g. land cover).
Here we report first results from the baseline survey, conducted in the years 2017/18, focussing on differences in species richness and phenological characterizations among habitat types. Preliminary results from 2017 are that 69 species of grasshoppers, 103 species of butterflies, and 1299 taxa of vascular plants were detected. Average species richness was 10.6±4.6 for grasshoppers and 10.5±4.7 for butterflies per test area, and 3.9±2.9 for grasshoppers and 2.8±2.2 for butterflies per test circle.

Keywords: biodiversity monitoring, cultural landscapes, habitat monitoring, plant monitoring, insect monitoring

T0335

Costs-effectiveness of wildlife-friendly practices for multiple taxa: a landscape scale approach

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Wildlife-friendly farming is a common tool to enhance biodiversity and ecosystem-services in agricultural landscapes, but it incurs costs to farmers, hence careful consideration of the cost-effectiveness of wildlife-friendly practices is key to promoting agro-ecological policies. While numerous studies assess the benefits of wildlife-friendly farming, few studies simultaneously evaluate the economic costs of these practices. We assessed costs and benefits of maintaining uncultivated field-margins compared to conserving large semi-natural patches, at a large spatial scale over multiple seasons and crops in Israel. We estimated economic costs in terms of increased production costs and revenue loss, and ecological benefits in terms of increased potential biological pest-control and above-ground biodiversity of plants, birds and arthropods. Uncultivated field-margins increased above-ground biodiversity by 64% compared to cultivated-land, and accounted for 78% of the biodiversity recorded in semi-natural patches. Yet, their ecological-effectiveness varied across seasons and taxa, and was lowest for bird and plant diversity, with 42-46% less species than semi-natural patches. Uncultivated field-margins increased potential biological pest-control, but benefits were not translated to higher yields; field-margins were associated with reduced yield in some irrigated crops, leading to low cost-effectiveness compared to sparing semi-natural patches. However, field-margins were more cost-effective in orchards and extensive rain-fed crops. This suggests that there is no ‘one-size-fits-all solution’; generally, restoring large semi-natural patches was more cost-effective than uncultivated field-margins. Yet for some crops, uncultivated field-margins mutually benefited farmers and biodiversity and can therefore be used to minimize costs for farmers, preferably where sparing semi-natural patches is not possible.

Keywords: biodiversity conservation, biological pest-control, Mediterranean, land-use policy, field-margins

T0430

Spatio-temporal analysis of the number of hunted animals for the assessment of the landscape quality and the provision of ecosystem services

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Since the middle of the last century, the increase of areas used for human settlements, production, and traffic as well as the intensification of agriculture have significantly affected the landscape and its quality. Some of these changes are claimed as important reasons for changes in biodiversity and the transformation of ecosystem services. Still, there are hardly any methods and indicators which can measure the multifunctionality of the landscape in its entirety and over a long period. Some animal species are known to inhabit very specific habitats. Changes in these systems can cause population increases or declines or in extreme cases disappearance. In this study, we aim to find animal species or species groups which can be used as indicators to measure, describe and assess changes in landscape structure and landscape quality in South Tyrol, Italy, over the last 150 years. Firstly, long-term shooting quota of 40 hunting grounds are compared to population counts to test on correlation between the number of hunted animals and the number of animals occurring in the areas. In a second step, all available numbers of hunted animals at the hunting ground level from 1870 onwards were digitized and evaluated. Species like the capercaillie (Tetrao urogallus) and the grey partridge (Perdix perdix) show strong population declines over the last 70 years. Hunting these species is nowadays restricted. By contrast, the total sum of shot red deer (Cervus elaphus) increased from 114 individuals between 1953 and 1964 up to 33.447 individuals between 2005 and 2014. In the next step, statistical analysis will be used to find a link between shooting quota and predictors as landscape structure, land use, temperature, use of pesticides and number of hunters in the area. Further, we will use this data to analyze and assess the changes in the provision of ecosystem services.

Keywords: shooting quota, landscape indicator, landscape change, landscape quality, ecosystem service

T0594

Beyond agricultural production: using remote sensing to map farmlands' biodiversity

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The main objective of agriculture all over the world is to supply multiple provisioning ecosystem services. However, the agriculture also plays a very important role in conservation of biodiversity in rural landscape. The main purpose of this study is to identify relationships between biodiversity and agriculture by analyzing internal structure of landscape. The spatial pattern of agricultural landscape in terms of the spatial distribution of arable lands, permanent crops, rangelands and pastures is relatively easy to assess using land cover databases. Analysis of its internal diversity needs, however, more detailed information. The launch of the constellation of Sentinel satellites has opened new opportunities in monitoring of agricultural areas as it provides images in regular basis with high spatial and temporal resolutions. The use of time series of radar and optical Sentinel images has increased substantially a number of recognised crop/land cover classes, as well as the accuracy of the classification. Exploring these possibilities, this study has three specific aims:
1) to map internal structure of agricultural areas and other land covers, using remote sensing data;
2) to analyse biodiversity of a given area using landscape metrics
3) to correlate landscape metrics calculated with farmland bird index, pollution data and protected areas data.
These two aims will be achieved using the case of two Polish regions (Greater Poland, Wielkopolska, and Warmian-Masurian, Warmia i Mazury). They differ in agriculture practices, air and water contamination, and nature and biodiversity protection. The results prove that there are strong relationships among agricultural landscape pattern, biodiversity, and state of the environment.

Keywords: Crop detection, satellite images time series, landscape metrics, biodiversity

T0586

Surface modelling of biodiversity and ecosystem services in China

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Satellite observations can frequently supply spatially continuous information about the Earth's surface, which is impossible from ground-based investigations, but remotely sensed data by satellites are not able to directly obtain process parameters. Ground observations are able to obtain highly accurate data with high temporal resolution at observation points, but these observation points are too sparse to satisfy some application requirements. The most effective method for Earth's surface modelling entails the integration of satellite observations with ground observations. However, the full integration was ignored in most of the methods. For finding a solution for this problem, we suggest an alternative method, high accuracy surface modeling (HASM), which takes global approximate information (e.g., satellite observation data or spatial models) as its driving field and local accurate information (e.g., ground observation data or spatial sampling) as its optimum control constraints. A Fundamental Theorem of Earth Surface Modelling (FTEM) is created along with HASM development and applications in recent 30 years. From FTEM, seven corollaries were deduced, corresponding to interpolation, spatial upscaling, spatial downscaling, data fusion and model-data assimilation respectively. In this paper, we present applications of HASM and FTEM into surface modelling of biodiversity and ecosystem services on multi-scales in China.

Keywords: HASM, surface modeling, biodiversity, ecosystem services

Symposium 31

Biocultural Seascapes of the Anthropocene

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Anthropogenic seascapes are today clearly visible on coastlines, with different functions and uses in the interface between land and sea. Many seascapes of the world retain a dual character: they combine cultural and natural functions, and form unique biocultural seascapes. Recent studies have pointed out the importance of the coupled human-nature dynamics, where man has cussed deep changes in marine systems, and where conversely seascape functions have affected human systems. The analysis of cultural-natural interactions in anthropogenic seascapes represents a challenge for the sustainability of our future marine and coastal landscapes.

In this context, the symposium aims to cover integrated environmental conservation and sustainable development of seascape, with ICZM, marine design, planning, policies and strategies. It addresses seascape ecology, littoral gradients and climate change related to cultural aspects of seascapes, including heritage and communities embedding socio-ecological and artistic functions. It aims also to cover seascape character assessment and historical seascape character assessment which consider tangible and intangible values. Finally, it deals with people of coasts and seas, with participatory marine and coastal design, planning and governance.

The symposium participants will provide an illustration of these issues, with a narrative on biocultural seascapes around the world for a better understanding of their evolution and possible solutions for their future.

P0139

Assessing the delivery of ecosystem services in a climate change context: using ecological reasonable indicators

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Every European Member State has been asked to deliver before 2021 an exhaustive Maritime Spatial Planning (MSP). The Ecosystem Based Approach (EBA) required by MSP can be achieved with the Ecosystem Service (ES) assessment. In this context, multiple ES in the 3-dimensional scale of the marine environment (sea surface, water column, seabed) should be modelled together taking into account side-effects and feedbacks. The pitfall not to consider these externalities can give a rather blurry picture of the reality of ecosystem functioning. Furthermore, ES assessment is developing fast and in an even more difficult scenario to define: climate change.
My phD project will focus on the marine coastal ES (up to 12miles from the shore) evaluation as support at the Italian MSP. A Petri net model (even if the decision of the model to use is still ongoing) has already been implemented in the Venice lagoon case-study as a dynamic operation tool for exploring how ES interacts among each-others and how they behave under different scenarios of Business-As-Usual (BAU), Climate Change (CC) and different management options up to the end of the 21st century. Geospatial ES within MSP context, allows stakeholders to identify priority area of conservation and suitable indices can summarize conflicts between uses and sustainability. The best alternatives in the management of natural resources, explored in the operational model above cited, at the sea can support environmental policies at the national level for natural capital conservation.

Keywords: Marine multiple ecosystem services, Marine Spatial Planning, Climate Change

P0157

Landscape Ecological Exhibition Experience Using Tidal-flat Biocultural Resources

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Recently, as the awareness of importance of cultural landscape and ecology has increased, interest and efforts for preservation and utilization are increasing. In this paper, we will develop exhibition experiences for conservation and utilization of landscapes and ecological resources of tidal flats, and propose a utilization plan. As the exhibition experience area, Muan Tidal-flat Center at Muan tidal-flat landscape, Southwestern part of Korea was selected. It has excellent ecological landscape resources with biocultural diversity. Although the number of eco-tourists is steadily increasing, there is not enough system to induce and manage eco-activities. The exhibitions of the Muan Ecological Tidal Flat Science Center are centered on models, making it difficult to learn and experience about the ecology and landscape of tidal-flat. The proposed tidal-flat ecological landscape exhibition experience is contents in which the viewer solves the mission in the contents using the smart pad downloaded or rented to the personal mobile device. The augmented reality technology was applied as a method for exhibition experience, contents and implementation method are as follows. The contents of the exhibition can be experienced in the ecological landscape of types and characteristics of tidal flat creatures, tidal-flat fishery and traditional tools, and habitats structure. The content implementation method explains the exhibition through image and ground recognition and actively utilizes animation elements that can induce educational contents and users' interest. The technology can realize interactive tidal-flat creature style and tidal-flat ecological scenery through the device through the object created 360 degrees by using the gyro-sensor. The above-mentioned tidal-flat ecological landscape exhibition experience provides experience and education for excellence and conservation efforts of tidal-flat, and provides effective exhibition viewing and learning.

Keywords: landscape education, tidal flat landscape, augmented reality technology, Landscape Ecological Exhibition

Island Biocultural Diversity - past, present and future

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At the World Conservation Congress (WCC) 2012 of the International Union for Conservation of Nature and Natural Resources (IUCN), the agendum of 'the bio-cultural diversity and the spreading of the traditional ecological knowledge of the coastal areas of the islands in the Asia-Pacific' was adopted as a resolution of the IUCN (IUCN Resolution 5.115). As a result, there is a need for the Ministry of Environment to organize an aggressive implementation program for the realization of the agendum by cooperating with the IUCN according to the above results. And, also, there is a need to actively respond by possessing the international leadership regarding the related subjects in the future. Together with the SIDS, the IUCN Resolution 5.115 widened the opportunities for the island countries in the surroundings of the Asia-Pacific to aggressively respond to the diverse issues regarding the preservation of the traditional, ecological knowledge of the biological culture, the preservation of the ecosystem, and the sustainable development by mutually cooperating. It is in this regard that the IUCN Resolution 5.115 has the purpose in overcoming such a viewpoint and intensively heightening the level of the international interest regarding the preservation of the biological resources of the islands and the culture and safety of the residents who use them and in expanding the support through a global network. An initiative regarding the bio-cultural diversity of the global islands for preserving the ecosystems and the biological diversities needed for the biological diversity, the governance, and the sustainability of the islands of the world, for the wise utilization of the ecological knowledge, for establishing an international network regarding the sustainability of the cultural diversity, and others of the like, and for playing the central role of developing, operating, and putting into practice the programs together with the IUCN is needed.

Keywords: biocultural diversity, islandscape, nature conservation, island residents, biological diversity

Sustainable biocultural diversity in Southwestern seascape of the Republic of Korea

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The Republic of Korea (i.e., South Korea) has about 3100 islands of which about 470 are inhabited. More than 60% of all the islands are located in the Southwest Sea. About 2000 islands are located in the adjoining province of Jeollanamdo, forming a seascape called Dadohae in Korea, which is generally known for its high biodiversity. In addition, people have lived here in close harmony with nature for a very long time. This paper examines how the people living in the inhabited islands relate to the surrounding uninhabited islands. In addition, the paper addresses how the uninhabited islands play a role, not only in terms of biodiversity, but also in terms of biocultural diversity. A survey was conducted of in total 80 uninhabited islands in Shinan County, which has the largest number of islands in Korea. The results of the study show that bigger islands and geologically well-developed rocky coastal islands are well-used by people from inhabited islands. Coastal rocky areas are very important as they provide excellent living conditions for various algae and snails. It is, however, not simply the existence of creatures that makes the uninhabited islands important to local islanders. They also play a very important role as cultivating areas for islanders. The islanders are applying sustainable resource management based on traditional ecological knowledge to continue to use such resources. Therefore, it would be an effective way to manage inhabited and uninhabited islands conjointly in order to support sustainable biocultural diversity.

Keywords: biocultural diversity, uninhabited islands, traditional ecological knowledge, Shinan County, Dadohae

Marine and coastal cultural ecosystem services: Current status and future prospect in Japan

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Marine and coastal ecosystems have provided us with cultural ecosystem services such as beach recreation, recreational fishing, and aesthetic or spiritual spots. Cultural ecosystem services have attracted attention in recent years from the viewpoint of improving psychological well-beings of residents as well as providing economic values through sightseeing and recreation. Seascape, particularly for coastal zone is likely to face intensive development for human use due to alluvial plain. However, quantitative evaluation of cultural ecosystem services provided by seascape is not enough.
In this research, I compared the relationship between the characteristics of the coastal landscape such as land use type around the coast and population density, and each cultural service type (ex. beach recreation, aesthetic sites). As a result, beach recreation sites had not only plain sandy landscapes but more accommodation facilities in the surroundings, whereas scenic spots were not necessarily located in environments with lots of accommodation facilities. In addition, the scenic spots tended to be the locations for endangered water species to inhabit. Each type of marine and coastal cultural services that people enjoy was related to different characteristics of seascape, suggesting the responses to environmental changes may be different among services.

Keywords: recreational use, tourism, landuse degradation, environment change, biodiversity

T0902

Anthropogenic seascapes

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Anthropogenic seascapes are the interface between land and sea. They are characterised by fundamental dualities expressed in the blend between natural and cultural elements, characters and functions developed in times. Many of these are a clear expression of biocultural seascapes. However, man has impacted their ecosystems, as well as their cultural heritage, and the interaction between natural and cultural forces has often become fragile. The research addresses fundamental concepts in seascape ecology and climate change related to cultural aspects of seascapes, including heritage and communities with their socio-ecological uses. Considering tangible and intangible values of seascape at global level, it focuses on the Mediterranean character and people, with participatory approach in integrated environmental conservation and sustainable development of seascapes.

Keywords: Biocultural seascape, Cultural heritage, Seascape ecology, Culture and nature

Symposium 32

Past, present, and future resilience of forest landscapes: Unpacking effects of multi-scale climate change

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The resilience of Earth's forests may be severely eroded by climate change during this century. In fact, growing evidence suggests that trends in mean decadal climate could fundementally alter forests at regional to global scales. Yet, these broadscale projections likely do not fully capture the potential effects of 21st century climate on forests. Beyond mean trends, key climate drivers all have their own dynamic patterns of shorter-term variability across multiple spatial scales, and future changes in climate variability, rather than mean trends, may be more influential on forests at landscape scales. However, limitations of past records and uncertainties about future dynamics currently constrain our understanding. We propose a session where speakers will unpack the relationship between multi-scale climate change and forest-landscape resilience: Specifically, we will address two questions:

1. How and why has climate change at multiple scales (from extreme events to long-term transient changes) influenced past and current resilience of forest landscapes?
2. How can we better anticipate 21st century changes in climate and potential consequences for forest landscapes?

Climate is and always has been defined by nonstationarity and variability across spatial scales of meters to continents and temporal scales of seasons to millennia. The relative importance of climate for shaping forest dynamics depends on scale. In subalpine forest landscapes of western North America, for example, mean temperature has varied substantially during the Holocene with little change in stand structure or species composition. However, early tree regeneration is critical to ensure forest recovery following wildfires, and spatial heterogeneity in soil moisture or the occurrence of an unusually severe seasonal drought can cause tree regeneration failure, shaping successional trajectories for decades. A key challenge is to untangle how and why spatial and temporal climate variability, versus mean climate trends, has shaped the resilience of past and current forest landscapes, and how the consequences of that finer scale variability aggregate to alter regional to global forest outcomes.

To better understand where and why forest resilience may erode in this century, we must begin to anticipate how climate is likely to change across spatial and temporal scales. However, decadal predictions of mean climate trends remain highly uncertain, let alone variability around the mean. Further, future effects of climate on ecosystems may be difficult to predict as climate and ecosystems become increasingly novel and not well represented in the historical record, or if reciprocal forest-atmosphere feedbacks develop. Thus, it will be essential to identify a suite of approaches that can better constrain projections of future climate, mechanistically determine how forest landscapes will respond, and assess whether forest responses could feedback to further alter climate patterns.

We will convene a diverse group of landscape ecologists and ecological climatologists who study forests on different continents and employ different methodological approaches to unpack the multi-scale effects of past, current, and future climate on the resilience of forest landscapes. Limitations exist with making inference from imperfect reconstructions of past dynamics and there is great uncertainty about the future. However, by simultaneously looking behind and ahead, we hope to provide a holistic and more complete perspective on climate change and forest resilience, shaping a new interdisciplinary research agenda.

T0098

Topographic complexity increases the climate resilience of mountain forests

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The mountain forests of the Alps are disproportionally affected by climate change, which may substantially alter their fundamental characteristics and functioning. At the same time, complex mountain topography could help mitigate these changes by buffering impacts and offering climate refugia. It is therefore important to better understand the effects of topographic complexity on mountain forest resilience.

We used the forest landscape model iLand to simulate the impact of climate change on an Alpine mountain forest landscape in western Austria. The landscape is characterized by strong topographical gradients (elevation range: 900-2200 m) and is currently dominated by conifers. We gradually exposed the landscape to increasingly extreme changes in temperature and precipitation (between +1°C and +6°C relative to the historic landscape mean, and between 0% and 30 % reduction in precipitation). Subsequently, we reversed the climate forcing (temperature again decreasing to +1°C relative to historic values) in order to assess resilience to climate change, here defined as the ability to recover the previous vegetation state. In addition, we investigated the effect of topography on climate resilience by comparing the complex mountain topography to an artificial landscape with uniform characteristics.

The change in temperature and precipitation had a profound impact on both forest composition and structure. There was a tipping point for warming levels >2°C, with the equilibrium vegetation shifting from a conifer-dominated forest with many large trees to a landscape dominated by small broadleaved trees. Topographic complexity buffered this critical transition and caused a more gradual change. Furthermore, climate refugia increased the reversibility of vegetation changes in the topographically complex landscape. However, the buffering capacity was limited, and the landscape eventually also shifted to the warm-adapted state at extreme warming levels regardless of topography.

Keywords: simulation modelling, forest resilience, climate change, topography, reversibility

Effects of climate variability on the resilience of tropical, temperate, and boreal forest landscapes

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Twenty-first century climate change could erode forest resilience in tropical-, temperate-, and boreal-forest biomes. However, it is difficult to predict where and why forest landscapes will be vulnerable, in part, because climate change is a complex multi-scaled process where dynamic patterns of interannual variability are layered upon long-term trends. Future climate variability, rather than mean trends, could be a particularly potent agent of change in forest landscapes during coming decades. We propose a spatio-temporal framework to anticipate where forests may be more or less vulnerable to future changes in climate variability and to characterize how forest landscapes might change in response. Landscapes where climate variability was pronounced in the past could prove resilient to future climate variability because they house greater diversity that can cope with a wide range of conditions. Conversely, these landscapes may be more vulnerable if extreme climate events occur that exceed their capacity to recover. Temporally, changes in climate variability could initiate fast, lagged, or slow forest responses that set the pace at which resilience will erode. Spatially, changes in climate variability may cause synchronous or heterogenous responses in forest landscapes that determine the nature of feedbacks to broader-scale processes.

Keyword: forest resilience

T0522

Ecological constraints on the pace of upslope range shifts by subalpine forests with warming

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Climate change is driving shifts in the distribution of species with numerous ecosystem consequences. Trees at the upper elevation limit of trees and forests are expected to migrate into alpine tundra with alleviation of cold limitation and die out at low elevations, but there are few studies of constraints on relevant processes or the pace at which shifts could occur. Further, widely distributed species exhibit ecotypic variation in functional traits along environmental gradients, a potential factor in species responses. We combined experimental climate manipulations of establishing seedlings with spatially explicit demographic models to quantify ecological constraints on the pace of subalpine tree range shifts in the Rocky Mountains, USA.

Across three subalpine species, warming exacerbated water limitation, counteracting temperature benefits above treeline and compounding water stress at low elevations. Low-elevation ecotypes consistently recruited more strongly than high-, but ecotypes had similar responses to warming and summer moisture addition. Species and ecotypic differences reflect distinct phenology, morphology and physiology, yielding differences in recruitment on par with those due to experimental climate change. Model simulations indicate centuries-long lags between the onset of climate changes and tree population establishment in the alpine due to low dispersal and recruitment. Population growth is also sensitive to summer soil moisture, suggesting that warming may not always result in upslope shifts. Because low-elevation ecotypes are further from alpine treeline, upslope range expansion will occur slowly until they have established reproductive populations at treeline. Finally, the dominant species rapidly declined at low elevation due to recruitment failure with warming. Our results highlight how interactions among environmental change, ecological strategies, and slow demographic rates determine the pace of range shifts by high elevation trees.

Keywords: species range shift, climate change, subalpine forest, demography, recruitment

T0660

Scale-dependent changes in the structure of naturally dynamic old-growth boreal forests on two continents

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Global change has altered boreal forests dynamics and structure. While changes in forest dynamics are well-studied, neglecting the scale-dependency in how forest structure changes hampers the understanding of forest development.

We studied scale-dependent changes in the structure of three 4 km² forest landscapes in Finland and two landscapes in Quebec, Canada. We visually interpreted canopy cover in each landscape at three time points between the years 1959 and 2011, using aerial photographs and a grid of 0.1-ha cells. We used field- and tree-ring data to calibrate the interpretation and to develop posterior distribution for the interpretation error. We quantified and mapped annual canopy cover changes between the time points, identified spatial scales at which the changes occurred, and analyzed the credibility of changes at these scales.

Canopy cover changed at three to four spatial scales, the exact number of scales depending on the studied landscape and time period. At large scales (15.4–321.7 ha), predominantly positive changes occurred in Finland, independent of the studied time period. In Quebec, the direction of the large-scale change varied between the studied time periods. At large scales, 36–100 % of the landscape area changed credibly, considering all landscapes and time periods. At small-scales, changes occurred at 1.3–5.0 ha, and at 0.1 ha scales. At these scales, both positive and negative changes occurred in all landscapes and time periods. The landscape area that changed credibly ranged between 12–35 % at 1.3–5.0 ha scale, and between 3–12 % at 0.1 ha scale.

The results indicated that boreal forest structure changed at different hierarchical scales, and the change direction and magnitude varied between the scales. Hence, this scale-dependency should be considered in forest change analysis. The eminent large-scale change suggests that currently top-down factors, not gap dynamics, change the structure of the studied old-growth forests.

Keywords: Forest ecology, Forest dynamics, Aerial photography, Tree-rings, Bayesian inference

T0597

Multiscale climate change impacts on the Amazon rainforest

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The Amazon rainforest is a hotspot of biodiversity and plays an important role in the global carbon- and water-cycle. The forest stores large amounts of carbon in its biomass, acting as a large terrestrial carbon sink. Global models predict that the Amazon rainforest will continue to act as a carbon sink in the coming decades due to rising atmospheric carbon dioxide concentration. At the same time, soil phosphorus impoverishment in most of the Amazon basin is assumed to limit productivity and growth. With increasing frequency and magnitude of drought events in the future, productivity and growth of the forest may additionally be negatively influenced. In the worst case, a large-scale loss of Amazon rainforest may be caused by climate change which may lead to substantial changes in ecosystem functioning and structure. Here, we present results from different empirical and modelling studies that we conducted in the Amazon region. We show that large uncertainties remain about the magnitude of impacts on the forest resulting from increasing atmospheric CO2 concentration and drought. In particular, we discuss how drought may be amplified by forest loss due to changes in moisture transport across the continent. We conclude, that climate change has the potential to significantly affect the Amazon rainforest that, combined with deforestation, may move the region beyond a tipping point.

Keyword: Amazon rainforest

T0488

Variability is more important than the mean: sensitivity of vegetation to rainfall in seasonally dry tropical forests

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Some research suggests that forest resilience to drought differs depending on historic mean annual precipitation (MAP). However, MAP may have limited explanatory power in ecosystems characterized by significant intra- and interannual variability. For example, across seasonally dry tropical forests (SDTF), where rainfall ranges from 500 to 2000 mm/year, the seasonal distribution of rainfall varies substantially. SDTF tree species cope with rainfall seasonality via a variety of physiological strategies, such as deciduous leaf habit. Across landscapes, these strategies translate into differences in how SDTF respond to precipitation. We investigated how variability at multiple time scales influences sensitivity of SDTF to rainfall as observed via satellite remote sensing. To characterize vegetation sensitivity to rainfall, we calculated the average correlation between monthly rainfall and vegetation condition in 0.25 degree grid cells covering all SDTF. This metric incorporates the relative abundance of deciduous and evergreen trees and the degree to which phenology of photosynthesis is coupled to rainfall. To characterize climate variability, we calculated long-term mean and standard deviation of total annual precipitation, a seasonality index, and measures of the timing and duration of rainfall. We found that rainfall seasonality better predicted vegetation sensitivity than MAP. Furthermore, interannual variability in seasonality, duration, and timing of rainfall explain more variability than long-term means. When interannual variability is high, physiological strategies that couple photosynthesis to rainfall may become riskier. High inter-annual variability might favor plant strategies that either tolerate dry conditions better, or that help plants access water uncoupled from precipitation (e.g. stem water storage, deep roots). Our results suggest that future shifts in interannual variability could have larger impacts on SDTF than changes in long-term means.

Keywords: tropical forest, climate variability, remote sensing

T0276

Forest resilience to climate change: An investigation across scales

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Climate change has the potential to fundamentally alter the processes and feedbacks governing forest ecosystems. These changes happen across multiple scales, from the tree scale to the global scale, and from the level of days to the centennial level. Focusing on processes at a single spatio-temporal scale holds the potential to underestimate the impacts of climate change, as it neglects feedbacks and interactions across scales. The aim of the current session is to investigate the climate resilience of forest ecosystems across scales. Here I will set the stage by highlighting (i) how climate influences tree mortality – a crucial process in the context of forest resilience – from the tree scale to the globe, and (ii) how these changes in climate and tree mortality result in fundamentally altered long-term landscape dynamics. Combining tree-level forest inventory data with global remote sensing information I will show that extreme climatic events are a key driver of tree mortality across scales. Furthermore, climatic extremes result in a synchronization of forest dynamics at the regional to sub-continental scale, with potential adverse effects on landscape resilience. Based on simulation results I will subsequently demonstrate that such climate effects have the potential to exceed the resilience of forest landscapes in the future, leading to fundamentally different landscape composition and structure. Tree mortality is a particular catalyst of forest change, yet the inertia of forest landscapes result in long lag times of ecosystem responses. This "resilience debt" requires a multi-scale consideration of climate effects on forests in order to understand and project future forest landscape change.

Keywords: landscape resilience, climate change, forest disturbance, climatic extremes

T0500

Evaluating savanna-forest stability from temporal trajectories of change

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A mechanistic understanding of biome distributions is a critical issue in modern ecology, especially in the context of predictive models of past and future climate change. While we can explain the current distribution of many biomes accurately, our predictions are less successful in dynamic systems where vegetation-environment feedbacks are significant. Over large parts of their tropical range, savannas may be one such system, persisting where climate can support forests, maintained by a positive feedback with fire. Past biome distributions may thus partially determine where savanna and forest occur today, and future transitions in response to changing climate may be abrupt and difficult to see coming. Current evidence for these dynamics rely on fire exclusion experiments and from snapshot analyses of tree cover distributions, using space-for-time substitutions to infer ecosystem stability. However, the evidence is incomplete, and debate continues.

Here, we present direct observations of ecosystems trajectories from time-series of remote sensing data. We use woody biomass estimates from across the dry tropics from calibrated radar remote sensing to evaluate the observed woody biomass trajectories in each region of the African dry tropics, evaluating directly the evidence for 1) savanna-forest bistability and 2) possible losses of savanna stability due to accelerating tree growth. We find direct temporal evidence for alternative stable states in ecosystem structure, but also evidence for substantial change -- providing further substantiation of the idea that positive feedbacks and bistability are widespread in the biosphere. Savanna and forest responses to global change are likely to be abrupt and difficult to predict without careful mechanistic prediction.

Keywords: savanna, forest, bistability, fire, feedback

Symposium 35

Planning and design for sustainable and healthy cities: mainstreaming urban ecological measures beyond demonstration projects

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Fostering adaptation to warming and increased urban pollution is a worldwide challenge of planning and design in order to reduce critical health impacts and to enhance social inclusion for city dwellers. Current urban infrastructure and management practice remains at stalemate of the past century using expansively today's limited resources and resists to changes. There is growing awareness of the critical need for strategic investments in long-term solutions for a sustainable and adaptive urban resource management, but institutional inertia in urban infrastructure systems is high and practice of sustainable urban resource management is limited to few demonstration projects. Beyond classical components of the urban blue green infrastructure, we focus on innovative urban ecological measures such as rainwater management measures (e.g. swales, rain gardens, ponds, green roofs, green façades) or urban productive green elements (e.g. garden, rooftop farming) and their provision of health relevant ecosystem services. The main goal of the session is 1) to review the state of the art of urban ecological measures and their associated ecosystem services and to analyse knowledge gaps and 2) to open the discussion on strategies for the planning of sustainable and healthy cities with an efficient network of urban multifunctional infrastructures.
The Symposium will be organized in the framework of two H2020 ‘Societal challenges’ projects started in 2018 and will involve the partnership.

Assessment of the structural connectivity of green spaces to identify stepping stones for garden city development of Quezon City, Philippines

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With the construction of MRT 7 in Quezon City, domino effect of the urban development is anticipated to grow exponentially, threatening the natural environment in the city. The removal of 1,858 trees to pave way for the MRT line can possibly lead to loss of natural habitats and further landscape fragmentation which will go against the goal of the city government in creating a garden city. The major challenge is how to create ecological network when La Mesa Nature Reserve which is 55% of the city's total area of green spaces is located only in the northernmost part of the city and is separated from other ecological cores by the MRT line and wide highways traversing the city.

Using aggregation metrics, the landscape texture of Quezon City is assessed to evaluate the connectivity between the ecological cores. With GIS tools, a resistance weight, a structural connectivity index and an ecological barrier effect index, the needed area for stepping stones to form greenways are identified. This study helps shorten the distance between urban green spaces and offer a spatial-planning strategy to increase the green space connectivity in Quezon City.

Though further analysis may be necessary, the results give indication on possible paths of stepping stones necessary for creating ecological connectivity.

Keywords: Urban Ecological Network, Ecological Connectivity, GIS, Stepping Stones, Biophilic City

Residential Greenery and Human Well-being: the Case Study of Berlin

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Policymakers are increasingly addressing the greening quality as part of citizen's health improvement. The aim of the research was to analyze the state-of-the-art of the residential greenery in Berlin and its health-related benefits. The study focused on socially disadvantaged and on high-load of environmental stressors districts, considering the Berlin Map of Environmental Justice. Eight sample areas, related to four building types of four historical periods, were selected. Four sample plots for each sample area (32 sample plots in total) were analyzed from April 2017 to August 2018. In each sample plot the plant species composition (trees and shrubs) and the structural elements (e.g. playgrounds, bike racks, benches) were surveyed. Moreover, a SWOT analysis was carried out in order to pointing out the benefits related to green areas. Results showed that residential greenery in Berlin is highly differentiated, indicating no common plant use or design scheme fashion. The tree species recorded provide moderate to high air filtering capacity. Nevertheless, more than 30% of all trees have a high allergenic potential. Bike racks, benches, lights and playgrounds are common elements. On the other hand, bioswales, fountains and ponds are rare elements. In conclusion the residential greenery plays a fundamental role in providing benefits for disadvantages districts and contributes to the overall quality of the urban ecosystem. Its proper design and management must be considered in the city planning policy.

Keywords: ecosystem services, well-being, urban, green space, health

Potential of new urban greenery areas in the context of present and future global challenges.

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The importance, position and development of city green areas, combined with present and future global challenges, is the main theme of the contribution. Bratislava as one of the largest cities in Slovakia is exposed to the need to address the concept of green development not only in terms of adaptive mechanisms for climate change but also due to its aesthetic and psychological functions for the city‘s inhabitants. The potential for new development of areas can be found not only in public spaces, but also in semi-private and private ones. In this sense, we have mapped out the current state of urban green areas and determine the untapped potential of development in small areas of greenery in Bratislava. Furthermore, we have analysed and described in detail the current state of urban greenery in the area under consideration, with special regard to the undeveloped potential of green areas. Successful revitalization of the green areas of the settlement is presented on examples from abroad, and the main problems encountered in the area under consideration are presented. In the next part, the contribution focuses on small areas of greenery and their contribution to the quality of urban life and explores the current trends and potential of development of this type of greenery in the urban environment. The research resulted in the creation of typology of small green areas in Bratislava and the design of measures to improve communication with the inhabitants and motivation to create these spaces within the urbanized environment. The graphical representation of individual types of small spaces and the demonstration of possible ways of communicating with the inhabitants towards a better communal city policy on green issues qualitatively enrich the proposed solutions.

Keywords: Bratislava city, small green areas, non used potential, communal (local) policy, public participation

An innovative approach to Floating Islands as multifunctional devices for ecosystem services provision

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Urban watercourses have been widely affected due to urbanization anthropic influences, decreasing the resource quality and potential ecosystem services they can provide. Between Nature-based Solutions (NbS) and Blue-Green Infrastructure (BGI) approaches, one that is becoming recognized as a potential strategy for urban watercourses recovery are the Floating Treatment Wetlands (FTW). FTW has been presenting efficiency on water cleansing, habitat provision for fauna and aesthetic improvement worldwide, however, FTW application is still negligible in Brazil. This project aims to demonstrate FTW application in ponds within an urban area, by creating prototypes, evaluating its role over wild fauna habitat provision, aesthetic benefits and water quality.

As methods, Design Thinking (DT) and Lean Start-up (LS) approaches were used to create FTW prototypes which were installed into two ponds with different characteristics in the metropolitan region of Sao Paulo, Brazil. Faunal usage and plant development were verified through photographic and observation record. Water samples were taken and analysed to evaluate physicochemical parameters.

Results have shown stability and functionality of the prototypes built from low cost, eco-friendly and accessible materials with potential for large scale production. Vegetation development and faunal usage indicate that FTW is functioning as habitat provision and biodiversity enhancement. Site visitors' opinions demonstrate general acceptance as well as aesthetic enhancement. Water depuration efficiency was not significant due to the project scale restrictions.

Similarly to other projects using FTW worldwide, this device presented noticeable changes in the applied context. DT and LS approach provided tools to create a reproducible device, allowing the general public to implement this BGI elsewhere increasing ecosystem service provision. In conclusion, this project provided an example of applied NbS and BGI typology for urban ponds.

Keywords: Phytoremediation, Urban water improvement, Alternative water treatment, Product design and innovation, Demonstrative project

Transformation towards Water Sensitive Communities: Experiences from Water Scarce Cities

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The fast rates of urbanization have negatively impacted on the living environment, on the health and well-being of communities. A main challenge is securing sufficient water resources and develop an efficient water management system to fulfil the rising demands. Cities in arid and semi-arid regions, which account for one-third of the total cities worldwide, require the most efforts to provide adequate water to their inhabitants. These countries require sustainable integrated water management solutions that are applicable and efficient. One of these is Egypt, a developing country, with 99% of its population concentrated in the Nile Delta and Valley. The country's water resources are decreasing and is already facing water scarcity that hinders its need for establishing new communities. This research addresses the concept of water sensitive urban design, as it provides a holistic approach for water management, with the aim to provide a framework for application of integrated water management for different water issues in Egypt. The used methodology consists of selection of a set of criteria and parameters upon which a comparison of three cities is held. Lima, Windhoek and Adelaide were selected based on having close climatic conditions and water issues, along with efforts towards sustainable water management. We examined the different integrated water management approaches in these cities, along with learned lessons from each city. The study then provides recommendations for applying a water sensitive approach to urban design in Egypt.

Keywords: Water Sensitive Urban Design, Integrated Urban Water Management

T0400

Ecosystem services spillovers from trees could reduce or increase urban heat inequities depending on the spatial patterns of residential segregation. A case study from Santiago de Chile.

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Urban vegetation plays a key role providing ecosystem services (ES) in cities. Unfortunately, urban vegetation is often unequally distributed among socioeconomic groups. Environmental inequity issues have been largely reported in the literature. Nevertheless, urban vegetation inequity studies have generally assumed a localized provision of services by vegetation, disregarding the potential spatial transference of ES. Indeed, regulating ES provided by trees, such as temperature reduction services, are usually transferred from the immediate location of trees to neighboring areas, potentially modifying the apparent level of ES inequity if only a localized approach is considered. Thus, some higher-income neighborhoods could act as subsidizers by sharing ES with lower-income neighborhoods, therefore reducing ES inequity, whereas others may trap ES within, thus increasing inequity. Sharing ES between different income neighborhoods is probably related to the spatial patterns of residential segregation. Hence, city areas with higher levels of segregation should have higher than apparent levels of ES inequity, while less segregated areas should have lower than apparent inequity levels. This work tests this hypothesis in Santiago de Chile, by assessing how the patterns of residential segregation affect the level of environmental inequities related to temperature reduction services provided by trees. The study uses census data, remote sensing images, and spatial analysis techniques to compare if differences between the spatial association of socioeconomic with vegetation variables, and socioeconomic with temperature reduction ES data, are coupled to the spatial patterns of residential segregation at different scales. Results show that residential segregation could reduce or increase the level of ES inequity depending if segregation patterns dominates at the local or larger scale. These results are useful for developing urban planning strategies for reducing ES inequities.

Keywords: Ecosystem services, Environmental inequities, Urban vegetation, Urban planning, Residential segregation

P0156

Landscape ecology - an evolutionary analysis of the design practice.

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The landscape design joins ecology as a way of responding to the unilateral approach of urban development and the disorderly growth of cities, initiated by the great technological changes of the eighteenth and nineteenth centuries and which continue to this day. The current term for this union is landscape ecology, although such an expression can be considered a pleonasm, since landscaping, by definition, should be ecological. However, the theoretical and anthropized construction of the notion of landscape has led to this separation, thus the mention of ecology has made itself necessary.

There are few practical analyzes of this ecological approach in landscaping projects, which demonstrate the gap between the theoretical discussion and the practical application of a landscape ecology design.

This research is an analysis of three case studies occurred at distinct times that approached a temporal evolution of the practice of landscape ecology. The analysis carried out by the present study started from the study of the site, the design and the connection with the environment in each project, which allowed collecting design indicators.

As a result, a table was developed, crossing information from the three studies and their indicators, which helped, finally, to identify suitable project practices for a pilot ecological project idealized for the city of Rio de Janeiro, Brazil.

Keywords: Landscape ecology, Ecological measures, Landscape change, Project practices

T0800

Dynamic planning of adaptation technologies across sectors using multi-objective optimization for Suwon-city

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Climate change already affects local communities, and these impacts are projected to become more severe and intense in the future (IPCC, 2012). The benefits of implementing climate adaptation at the local level have been widely recognized with increased numbers of adaptation planning support tools provided by various actors (ICLEI, 2010; Giordano et al., 2013). Yet, the issues raised by climate change demand a long-term perspective and challenge traditional values and priorities in planning, which makes adaptation planning a burden for decision-makers (Carlsson-Kanyama et al., 2013). A recent suggested strategy is using the concept of "adaptation pathways" to systematically and dynamically sequence adaptation solutions across a long time-frame (Haasnoot et al., 2013; Kwakkel et al., 2016).

Applying heuristic, machine-learning algorithms reduces the burden of decision making by retrieving and storing information (Shah and Oppenheimer, 2008). As such, optimization algorithms have been used to draw many adaptation pathways for specific sectors such as, agriculture and water resource management (Tanaka et al., 2015; Beh et al., 2015). This study develops a method to consider the interactions between adaptation technologies across multiple sectors to identify the optimal adaptation pathway using a multi-objective genetic algorithm. Based on the selected site, Suwon-city, a specified design structure matrix of 6 adaptation technologies (debris barrier, detention tank, bioswales, etc.) and problem definition will guide the optimization process to identify a pareto of cost minimized/adaptation maximized, optimal adaptation pathways.
Benchmarking this case study and methodology, decision-makers will be able to actively engage in developing their adaptation pathway. The option to integrate and disintegrate adaptation planning across climate impacts and sectors ultimately lowers the knowledge barrier while maintaining high scientific reliability in the results.

Keywords: Local Planning, Climate Adaptation, Decision Support, Optimization

Urban community foodsheds in Tokyo Metropolis

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Cities around the world have been promoting various types of urban farming to make cities livable, sustainable, and resilient. One of the characteristics of urban farming in Asian cities is their small-scale local food system derived from an urban form that includes micro-scale productive green spaces. This research explores urban community foodsheds, the locally grown food flows between urban communities, in Tokyo Metropolis.

Two experience farms, where professional farmers teach urban residents how to farm, in Nerima City were selected as case studies. Based on questionnaire surveys to 138 participants regarding their prosumer-based farming and food sharing called “Osusowake”, the food flows were mapped in ArcGIS.

Most participants lived within walking/biking distance of the farms (median: 0.8km) and harvested 55% of their annually consumed vegetables. Additionally, 96% of them practiced “Osusowake” and shared 27% of their production to an average of 4 relatives and/or friends. Half of the “Osusowake” recipients also lived in Nerima and about a quarter within the same neighborhoods as participants (median: 4.5km).

Urban foodsheds derived from experience farms are remarkably small and community-based. These farms could play an important role not only in encouraging healthy lifestyles in urban communities, but also in strengthening social ties within them. Although not currently integrated in the planning theory, these socio-spatial aspects are indispensable for re-designing the urban fabric for future cities.

Keywords: urban farming, productive green space, local food system, community foodshed, Tokyo

What have we learned from nature restoration and collaborative ecological landscape design in urban area in Japan?

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What is urban ecology and biodiversity? What have we learned from collaborative ecological landscape design in urban area? We have been designing landscape even in urban areas, based on vernacular design (ecology, regional culture and so on) for the past decade. The aim of these projects is to create an area for preserving biodiversity, children's play and ecological education that can simultaneously form part of an ecological network in an urban area. We have been designing to have interdisciplinary research and proposing to install the layer for children's play and biodiversity in an urban area. We would like to discuss the problem and future issues through our projects, exotic species, children's play and managing urban nature from a landscape designer's point of view.

Multi-Functional Landscape Planning (MFLP, Ito et al. 2003, 2014, 2106) method have been used for the projects. MFLP approach will be effective to evaluate for the planning of a project such as urban park. According to this method, the space is divided into a number of layers (layers of vegetation, water, playground and ecological learning), which overlap each other. Thus, during the creation of a multi-functional play area, children are able to engage in "various activities" as its different layers are added on top of each other. In addition, they will learn something new about its ecology when they are playing there.

We should consider "landscape" as an "Omniscape" in which it is much more important to think of landscape design embracing not only the joy of seeing, but stimulating a more holistic way of using body and senses for learning. And landscape designers and architects need support of biologist/ecologist for ecological design and planning. Consequently, we would like to continue these projects as long as possible and raise children with the experience of nature in their childhood, which will create more diverse cultures and biodiversity together even in urban areas.

Keywords: ecological design, biodiversity, Nature restoration, collaborative landscape design, ecological education

Urban farming, productive green space, local food system, community foodshed, Tokyo

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Increasingly apparent effects of climate change in urban areas (such as urban heat island or flash floods) have been among the most important factors negatively influencing the quality of life in cities in recent decades. Cities can address these challenges in various ways. Improvement and intensification of urban greenery (UG) is one of the possible solutions (rather as a complement to the technological measures). Planning, implementation and maintenance of UG is highly demanding because of limited space, financial resources, as well as because of low awareness about the broad range of (co-) benefits provided by UG. We claim that a multidisciplinary approach could enhance the decision makers' ability of finding the most suitable way of climate change adaptation in cities.

This contribution presents and discusses a combination of methods, which can serve as a support mechanism in the planning and decision-making process regarding urban greenery. In our case, the general preferences, attitudes and feelings about current state of specific sites are explored using mental mapping. The residents' preferences towards certain elements and aspects of UG are analysed using choice experiment. Outputs from the physical mapping of the greenery are used to assess benefits provided by UG (using the ecosystem services concept).

The above described multidisciplinary procedure was applied at Pastýřská stěna – an urban green place in the city of Děčín in Czechia. Comprehensive results were obtained thanks to application of a broad range of methods. Mental mapping identified the most popular and unpopular places and revealed the reasons. Based on choice experiment people prefer i) walking, ii) path reinforced by stones and ii) mixed forest. Ecosystem services assessment identified a range of ecosystem services provided by the UG in the area. Based on these results, a number of recommendations for the decision makers on how to maintain and develop the area has been made.

Keywords: Urban greenery, Planning, Climate change, Choice experiment, Mental mapping

Agenda for Urban Farmland Conservation and Green Infrastructure Development in a Sprawled Suburban City in Tokyo, Japan

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Urban environment in many Asian cities can be characterized as the islands of planned development in the sea of urban sprawl. In the sprawled urban areas in Tokyo where urbanization occurred without master-planned infrastructure, residential and agricultural land uses are mixed together. Urban planners used think that this was a failure of modern urban planning, but recently, there are views to re-evaluate the situation in a positive way. This research, based on land use analysis, urban design proposals and communication among various stakeholders, aims to establish a new agenda of urban land use planning that re-evaluates the value of scattered urban farmlands and introduces the idea of green infrastructure development in Nishitokyo City, Tokyo. The agenda was structured around the benefits of urban farmlands including the conservation of cultural landscape, the promotion of citizens' health through fresh foods and recreational/educational opportunities, the enhancement of ecosystem services such as climate mitigation, flood prevention and disaster risk reduction, and the development of alternative food system. In order to implement the agenda, several model projects and programs are proposed including the construction of various model housing with private farmlands (detached houses, townhouses and apartments), the introduction of rental farmlands to residents of local communities and remote urban areas, the renovation of factories and warehouses with rooftop farmlands and organic restaurants, the promotion of agri-lifestyle, the support for young entrepreneurs and the establishment of district-scale management organizations. The proposed agenda will be formalized as a proposal to Nishitokyo City mayor from the city's urban planning committee and is expected to change the existing planning policies and introduce new projects and programs associated with urban farmland conservation and green infrastructure development.

Keywords: urban farmland, green infrastructure, sprawled suburb, Tokyo

P0113

Linking the urban health to the quality of the blue infrastructure: a proof of concept for understanding the environmental dimension of antibiotic resistance

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Urban health is directly linked to the quality of the environment. In urban and peri-urban areas, the aquatic ecosystem plays a special role for the human health, a major challenge being to understand how certain environmental features are linked to the urban blue infrastructure quality and influence the epidemiological patterns of different public health threats, such as bacterial infections produced by antibiotic resistant bacteria (ARB). The aim of this paper is to present the proof of concept and preliminary results of a project linking geographical, hydrological, and physio-chemical conditions to some particular microbiological characteristics, such as the presence of ARB and associated genes (ARG) in natural or polluted aquatic environments.

The tested hypothesis is whether wastewater treatment plants represent hotspots providing the perfect environment for the occurrence, enrichment and dissemination of antibiotic resistant 'super-bugs' in the aquatic environment. The study design includes an upstream-water treatment plant-downstream transect for measuring parameters referring to (i) micro-climate and spatio-temporal geographic features, (ii) river flow properties, (iii) physio-chemical characteristics and (iv)microbiological properties. By applying multi-variate analysis tools we test potential correlations among the descriptors, in order to identify the main directions of variability in the data. Particularly, we explore whether the presence of certain pollutants in the wastewaters changes and even enriches the bacterial community in ARB and ARG. Thus, specific ARB/ARG could be further released into the downstream aquatic systems reaching different crops, vegetables or animals and subsequently adversely impact the environment and the human health.

The proposed approach provides interdisciplinary links between various urban ecosystems and their quality. This could lead to strategies for sustainable development and to an improvement of the urban health.

Keywords: urban health, blue infrastucture, quality of the environment

P0037

Urban green areas for the enhancement of ecosystem services and human well-being: the case study of Turin (Italy)

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Urban green areas are important for sustainable and healthy cities' development, supplying several ecosystem services such as air quality, carbon sequestration and storage and citizen's inclusion. In the last few years, numerous researches were carried out in order to develop urban planning model to maximise ecosystem services, due to an increasing interest on air pollution and climate changes' issues. The objective of this work is to study of Turin's green areas and their related ecosystem services at the neighbourhood scale. Turin is in the West Po Valley in Piedmont (Italy) close to the Alps and it is characterized by a low air circulation and high air pollution. It is the Turin's Metropolitan City's capital, characterised by 312 municipalities, covering 6.827 km2 with about 2.270.000 inhabitants. The city of Turin extents over 130 km2 where nearly 883.000 people are living in. The analysis, supported by a bibliography research, was carried out with QGIS, an open source GIS (Geographical Information System) software, to show the results as maps. This allowed to overlap the data related to Turin's green areas, with the socio-demographic characteristic of neighbourhoods, in order to understand the relationships between urban green areas and citizen's life quality. All data were freely available on web or obtained by municipality's offices. The data concerned the typology of urban green areas, their floristic composition and their extension. The research highlighted the green areas' distribution among the 23 Turin's neighbourhood. According to the bibliography, some parameters linked with ecosystem services, were applied to the Turin's green areas. This approach was used to highlights the neighbourhoods that supply more benefits. The methodology of research and the preliminary results will be discussed. The research suggests strategies for cities' planning aimed at maximising the supply of ecosystem services of urban green areas.

Keywords: Air quality, Citizen's inclusion, GIS, Mapping, Urban ecology

Validating users' preferences for accessibility to green spaces in cities: a planning framework to increase cultural services

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The critical role of greenspaces in cities is widely considered to have positive implications for health and for the provision of a complete set of ecosystem services in cities. Highly linked to the concept of ecosystem services is the issue of accessibility to those ecosystems and places providing the services. However, a gap often exists between the presence of existing greenspaces and the demands and preferences for accessibility of different social groups (e.g., children and elderly people). The purpose of this paper is to present a planning framework for urban greenspaces that considers social demands and preferences for accessibility. The framework is necessary for strategic investments for sustainable urban resource management, and it is designed to be used in different urban contexts and different objectives of greenspaces in terms of planning and design of greenspaces. The framework is structured in three phases. First, preferences are validated by questionnaire survey to examine how the different design criteria and the respective major aspects affect the preference of elderly people and children using parks. Second, accessibility to greenspaces of each social group is assessed through spatially explicit GIS-based indicators that combine socio-economic and land-use data with the road network information. Third, the gaps between social demands and the presence of greenspaces in cities is clarified and improvement strategies are discussed. An application of the planning framework is presented for the cities of Catania (Italy) and Nagoya (Japan), each characterized by different types of greenspace and high urban density.

Keywords: cultural services, green spaces, accessibility, preferences, resource management

P0087

Smart Green City in China: a New Agenda for Urbanization

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Smart green cities, which apply the new generation information technology in all of urban construction, could promote the efficiency of urban infrastructure and services greatly. They also support the sustainable development of economy and encourage participatory governance through the elaboration management of nature resource, social capital and intellectual capital, so as to realize the high quality of urban life and urban development. In China, smart green cities and the development of new urbanization have become the national strategies. The construction of smart green cities is also thought as a proposed method to accelerate new urbanization, and the way to sustainable development. Firstly, the paper discusses the implication of smart green city for Chinese new urbanization. Secondly, the paper analyzes the Smart Green City Program in Urban China, including smart green city strategies initiative, evaluating indicator system, and major infrastructure project for smart green city construction. Thirdly, different development modes for Chinese smart green city are explored with developed countries. Meanwhile, problems facing to Chinese smart green city construction are also emphasized. Lastly, the paper gives the relative policy suggestions to green smart city planning and construction combined with new urbanization strategy.

Keywords: Green smart city, new urbanization, China

Strategic Urban Ecosystem Planning in a Changing Climate: Growing the Resilient Urban Forest Today for the Sustainable and Healthy City of Tomorrow

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Oxford defines resilience as:
• the capacity to recover quickly from difficulties; toughness;
• the ability of a substance or object to spring back into shape; elasticity
Applying the definition to city life, one might conjecture that resilience is a pre-requisite for a sustainable urban ecosystem. While I would never equate a city itself with resilience given all the layers of Governance / political brinksmanship and what that instigates, what a city does do is demand resilience from everything that resides within it. Envisioning a city's residents, I can think of none that better represents the definition than the urban trees that reside in a city's Urban Forest. Their capacity for resilience and adaptation is an essential ingredient in sustainable planning and design.
The well documented array of Ecosystem Services (ES) benefits our urban trees afford human residents range from reduced air pollution, energy consumption, the UHI effect and stormwater runoff to increased water filtration, carbon storage, habitat diversity and improved public health.
Almost all these cost-effective benefits are provided by the mature tree's canopy, but that canopy does not exist in a void. It is only part of a complex system which has at least half its primary functions underground, providing structure and sustenance for what exists above - something our present planning and design has completely overlooked. Efforts to obtain these benefits have focused on planting more and more trees instead of addressing the inadequacy of our current approach and the urgent issues of those already in the ground.
While spatial development must occur, Climate Change is our reality and thus, adaptive Urban Forest planning, design and management are paramount.
This practice-based presentation offers documented, innovative strategies and protocols that actually GROW urban trees into maturity - enhancing their ability to cost-effectively contribute to a sustainable and healthy urban ecosystem.

Keywords: Urban Forest, Urban Ecosystem, Resilience, Adaptation

T0065

Opportunities and Challenges of Forest Landscape Restoration (FLR) in Latin America and the Caribbean

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The potential of forest landscape restoration (FLR), as a nature-based solution to restore ecological integrity of landscapes and deliver multiple benefits for all, is tremendous. FLR is an approach to restoration that allows us to better understand where, how, and with whom to restore to create thriving, low-carbon and resilient landscapes. The key is to work towards both regaining ecological functionality and enhancing human well-being and livelihoods by bringing people together to identify an optimal mosaic of land uses and transitions, across broader landscapes.

To date (01/2019), there have been 57 pledges (from national and subnational governments, associations, private sector) totalling more than 170 million hectares of commitments under the Bonn Challenge. Implementation of these restoration interventions can contribute to domestic objectives such as food production and stabilisation of riverine areas whilst contributing to the Aichi Targets, Paris Agreement, Land Degradation Neutrality, and the Sustainable Development Goals (SDGs).

The International Union for Conservation of Nature (IUCN) is employing FLR and using the Restoration Opportunities Assessment Methodology (ROAM) to guide the decision-making process for increased connectivity between landscapes, ecosystems and habitats; supporting work on 40 assessments in 26 countries, together with governments and partners to apply ROAM to identify opportunities and strategies to recover deforested and degraded ecosystems in an ecologically, economically and socially compatible way, and facilitating high-level political support in the FLR process.

At IALE 2019, representatives from the IUCN secretariat will present the results of ROAM from Latin American countries with a focus on the various stages involved in the process such as analysing restoration opportunities, the economic benefits of landscape restoration and the prioritisation of specific restoration actions or particular areas to start restoration.

Keywords: Landscape restoration, Sustainability, Ecosystem Services, Bonn Challenge, Restoration Opportunities Assessment Methodology (ROAM)

T0020

Spatial interaction between urbanization and ecosystem services: a case study of the Changsha-Zhuzhou-Xiangtan urban agglomeration in China

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Exploring the spatial interaction between urbanization and ecosystem services can provides a new perspective for urban development planning and environmental protection. At present, most of the existing researches on the relationship between urbanization and ecosystem services focus on regional scales and cannot reflect local spatial changes; lack of researches on spatial interaction laws and clustering patterns of ecosystem services and urbanization on local scales. Taking the Changsha-Zhuzhou-Xiangtan urban agglomeration in the process of rapid urbanization as the research object, this study selects the basic data of land use, economic, society and other basic data of the 2015 Changsha-Zhuzhou-Xiangtan urban agglomeration to quantify and map the level of urbanization and the value of ecosystem services, and uses grid analysis and the spatial autocorrelation model to analyze the spatial interaction between urbanization and ecosystem services of urban agglomerations. The results show that: (1) the spatial distribution hierarchical differences of ecological service value are obviously different, the high value of ecological services are mainly distributed in waters and forest land, while the low values are mainly distributed on the grid with more than 50% of construction land; (2) The regional spatial distribution of urbanization level is obviously different. The urbanization level from high to low is urbanized area, area under urbanization and ecological areas. (3) The level of urbanization is significantly negatively correlated with various ecosystem services, and there is spatial heterogeneity. The spatial correlation between the urbanization and ecosystem services is different in various regions with different degrees of urbanization. Finally, we made a number of recommendations for land use planning and eco-environment planning in different regions.

Keywords: Ecosystem services, Urbanization, Spatial correlation, Spillover effects

T0212

The Rieselfeld district in Freiburg: promoting sustainable urbanisation and resilience levering on green blue infrastructure

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The Rieselfeld district, a settlement of 70 hectares situated in the western part of Freiburg in the Land of Baden-Württemberg, provides about 3,700 residential units for approximately 10,500 inhabitants, and is one of the largest newly developed projects in the region. Its implementation, on a former brownfield, began in 1994 and has since then been oriented towards key ecological objectives, such as low-energy construction, district heating networks fed by a combined heat and power plant, integration of solar energy, rain water collection and reuse, and slow mobility. Ecological principles play a major role. The adjacent natural reserve, 'Freiburger Rieselfeld' (250 hectares), is one of the largest in the Land, and is a very successful local recreational area. The water scheme provides for separate collection, treatment and reuse of rainwater. The ground scheme includes as its main characteristics the minimization of soil sealing, the removal of polluted soils throughout the area, and a qualitative landscape design of all public spaces. A volunteer working group of Rieselfeld's residents has been dedicated to nature protection, with local 'rangers' who sensitize inhabitants and visitors to nature protection and biodiversity. Benefitting from the outcomes of a recent international workshop on sustainable districts, the proposed contribution will highlight how Freiburg has been consistently and successfully facing major challenges, including climate change and rising demand for affordable housing, progressing development regulations, and mostly innovating through ambitious climate and energy plans, green blue infrastructure, as well as active civic participation.

Keywords: Sustainable urbanisation, Green Blue Infrastructure, Eco-district, Landscape ecology, Urban biodiversity

Creative tensions in City Teams: Bringing together conflictious stakeholder for successful urban transformation

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Enhanced urban resilience and social cohesion are needed to cushion forthcoming urbanisation and densification trends. Complex and diverse challenges like this do request a comprising approach. Unilateral top-down planning of urban green NBS do not fulfil the needs of urban dwellers any more. Therefore, co-creation of adequate measures (e.g Edible City Solutions) in multilateral City Teams opens up ways of implementation of innovative ecologically and socially resilient solutions. Bringing together the diversity of stakeholders to form the future of their City leads up to a potentially conflictious constellation. Yet, the City Team approach is able to provide guideance to effectively govern inclusive urban transformation processes. The situative management approach provides a tool to manage possibly opponent stakeholder. With sets of factors and indicators rapidly arising conflicts can be assessed and the work in the City Team is notably governed tightly in terms of management of situations and leads to smooth operations. Hence, the procedures of the City Team resembles a transdisciplinary project with „hard-to reach“ but crucial aims for the benefit of us all.. Finally, City Teams claim high expenses but reach ambitious goals to eventually tackle environmental, economic and social challenges in urban areas. Moreover, this approach provides the base to mainstream and replicate approved measures and methods to move beyond pilots and demonstration project and thus truly change planning and design in cities.

Keywords: Co-creation, Urbanisation, Stakeholder Management, City Teams, Planning Methodology

Symposium 36

The importance of coppice forests for landscape diversity and the factors influencing the proportion and distribution of young growth stages.

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COST Action FP1301 'EuroCoppice' Innovative management and multifunctional utilization of traditional coppice forests - an answer to future ecological, economic and social challenges in the European forestry sector has established the extent, status, continuing importance and potential for development of coppice as a management system for broadleaved woodlands across Europe. The outcome was a policy paper highlighting the unique characteristics of coppice woodlands and the contribution these make to rural livelihoods, the bio-economy, environment and cultural heritage. It suggested that coppice forests have become a neglected resource in recent times and highlighted the enormous untapped potential. Structural diversity in woodlands is important for both sustainable production forestry, ensuring that after crop harvesting there are replacement trees to provide for the future, as well as for many forms of wildlife some of which are highly protected. While these aspects have been well studied individually the distribution of woodlands managed rotationally as coppice, providing a continual resource of young growth in the landscape, how this has altered over time, and the impact of changing patterns has only recently begun to receive attention. There have been significant changes in woodland owner profile, management aims and market for products throughout Europe and beyond. These are generally considered to have contributed to the perceived decline in management and consequently reduced the availably of those with appropriate skills to carry out this work. However, this trend could equally be a change in management aim, perhaps away from timber production and towards provision of other ecosystem services such as protection (e.g. preventing soil erosion and increasing stability) wildlife conservation or recreation. Where there is coppice, with ownership willing to manage it on rotation, and demand for the product, this will only be realised if there are workers available to carry out the necessary tasks. Whatever the underlying reason the decline in coppice management is affecting the relative proportions of young stage growth in forests and so affecting the landscape in a number of ways. But how much does this matter? And if it important how can it be addressed? This symposium with explore these questions, reflecting on the human factor in determining the relationship between woodland structure, ecology, and socio-economics.

Coppice woodlands in South East England: the socio-economic and non-market factors influencing structural diversity in the wooded landscape

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The value of coppice woodlands has changed. Historically the key role was providing fuel, arguably the Industrial Revolution depended wood with industry developing where it could be sourced. The woods that were commercially viable are the ones that remain are key elements providing structural diversity in the landscape, with less valuable areas converted to farmland or developed. This story is interesting but, although fuel production remains important biomass is now a globally traded commodity, harvested by machine, transported long distances and disconnected from the local economy and woodlands are increasing valued for wider, non-market benefits they provide to society. But how can the 'value' of attributes that are not traded be calculated and, with no direct commercial value what drives coppice management?

Non-monetary valuation systems have been challenging economists across the natural resource management agendas and, although not perfect, methods are emerging. But, while the benefits of managed woodlands for health, wildlife, recreation and air quality are universally acknowledged and tree planting initiatives promoted the link to the local economy seems to be broken. This paper will explore these issues and how they might be addressed.

Keywords: Coppice woodland, Natural Capital , Ecosystem Services , Landscape

T0364

The social-ecological system of coppiced forest in the Italian Central Apennine

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Though the importance of coppicing for the conservation of forest biodiversity is acknowledged, little is known about plant diversity and how it may be affected by the perceptions, constraints and regulations governing how loggers choose to exploit forest resources. Unstructured and structured social surveys were performed along with structural and compositional vegetation sampling. Principal aim was to determine how the ecology of the understory plant diversity, may be affected by direct and indirect interactions between formal and informal rules applied in coppicing management. We identified social-ecological variables that influence change in understory plant communities and we explored how commercial, private and group property loggers are influenced by these variables in deciding whether a forest is suitable for coppicing. Our insights suggest that the users prefer specific forest conditions because they facilitate efficient harvesting. These conditions also happen to be compatible, in three age classes i.e. post-logged, recovering and old coppice stands, with the short term dynamics of the coppice forest understorey (i.e. from 2006 to 2011), particularly for the maintainance of the specialist forest species pool at the landscape level. Finally the stand attributes considered to be indicators of productivity drive decision making almost independently from (but largely compatibly with) formal rules. This is true across the three groups of loggers. These attributes seem to act as determinants of the conservation of the functional diversity of understory plant species suggesting an overall landscape-scale stability of this coppice forest system. We conclude that economically viable coppicing can occur after the stumps have been allowed to regenerate and grow beyond a certain diameter, highlighting the importance of maintaining the traditional local approach where active coppice parcels are interspersed by abandoned stands.

Keywords: Coppice rotation cycle, Social-ecological resilience, Traditional knowledge integration, Landscape, Understorey vegetation

Shaping future forestry for sustainable coppices in southern Europe: the contribution of LIFE FutureForCoppiceS project

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Coppice forests are widely distributed in southern Europe, where they cover over 20 millions ha and shape the landscape of hilly (sometimes very famous like "Chianti") and mountainous areas. Coppice is an ancient system which provides several goods, from firewood to non-wood ones, in addition to ecosystem functions. Nonetheless, coppice is barely considered in Sustainable Forest Management (SFM) scenarios. In this context, the project LIFE14 ENV/IT/000514 FutureForCoppiceS, was aimed to improve SFM of coppice forests and to evaluate the sustainability of the main management options in a frame of changing environmental conditions. It benefited of a network of 45 plots, established in three different European Forest Types (beech mountain forests, thermophilous deciduous forests and evergreen broadleaved forests), and regularly monitored over the last 10-45 years by CREA Research Centre for Forestry and Wood. A total of 38 consolidated and newly established indicators, dealing with the all six Criteria of SFM, were tested. Twentysix out of 38 SFM Indicators resulted appropriated and provided an integrated picture of the sustainability of different coppice management options: traditional coppice lead to an enhancement of productive and socio-economic functions; coppice under natural evolution showed a positive environmental impact underlined by its important role in carbon cycle; conversion to high forest by periodic thinning promoted both environmental (carbon stock, biodiversity, energy for forest waste) and socio-economic aspects. Since each management option considered in FutureForCoppiceS resulted to promote different expressions of sustainability, their coexistence and contigoussness, is the solution highly recommended in a global changes context. The proportions among the different management options need to be carefully evaluated and planned, from local up to regional scale, depending on the specific socio-economic and environmental conditions.

Keywords: coppice, Sustainable Forest Management, biodiversity, global changes, silviculture

T0138

Interspecific variation in growth responses to tree size, competition and climate of western Canadian boreal mixed forests

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Tree growth of boreal forest plays an important role on global carbon (C) cycle, while tree growth in the western Canadian boreal mixed forests has been predicted to be negatively affected by regional drought. Individual tree growth can be controlled by many factors, such as competition, climate, tree size and age. However, information about contributions of different factors to tree growth is still limited in this region. In order to address this uncertainty, tree rings of two dominant tree species, trembling aspen (Populus tremuloides Michx.) and white spruce (Picea glauca (Moench.) Voss), were sampled from boreal mixed forest stands distributed across Alberta, Canada. Tree growth rates over different time intervals (10 years interval, 1998-2007; 20 years interval, 1988-2007; 30 years interval, 1978-2007) were calculated to study the effects of different factors (tree size, competition, climate, and age) on tree growth. Results indicated that tree growth of two species were both primarily affected by competition or tree size, while climatic indices showed less effects on tree growth. Growth of trembling aspen was significantly affected by inter- and intraspecific competition, while growth of white spruce was primarily influenced by tree size, followed by competition. Positive relationship was found between growth of white spruce and competition index of coniferous group, suggesting an intraspecific mutualism mechanism within coniferous group. Our results further suggested that competition driven succession was the primary process of forest composition shift in the western Canadian boreal mixed forest. Although drought stress increased tree mortality, decline of stem density under climate change released competition stress of surviving trees, which in turn sustained growth of surviving trees. Therefore, climatic indices showed fewer effects on growth of dominant tree species compared to other factors in our study.

Keywords: boreal mixed forest, tree growth, competition, climate change

Symposium 38

3-D landscape metrics and visualization techniques - applications in spatial planning, environmental assessment and participatory decision processes

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A key element of planning and managing of green infrastructure in urban and rural areas in support of regulating and cultural ecosystem services and for enhancing biodiversity is their functioning and functional connection. The functioning of such areas relies on the type of ecosystems contributing to the green infrastructure, their spatial dimension, but also on the quality of such areas. For instance, the quality of woody areas which are particularly valuable for structuring landscapes can range from highly heterogeneous, natural and undisturbed to very homogeneous, degraded and disturbed . So far, mainly 2-D metrics have been applied to assess the character and quality of the green infrastructure, while their vertical structure was only rarely considered. Even more, also the quality of urban and peri-urban green areas considering their contribution to regulating and cultural services is largely dependent on 3-D shapes that could either enhance or disfavor the provision of such services. Thus, a challenge consists in developing mathematical approaches that support the 3-D characterization of green areas and the translation into quantitative or at least qualitative information how it contributes to their capacity to provide ecosystem services. A broader perspective complementing existing approaches related to the analysis of terrain features could be beneficial and bring new insights. Another challenge is the use of new techniques for visualization of 3-D structures in a way that supports the involvement of perceptions of planning actors in highly realistic manner. Digital visualization techniques but also approaches such as 3-D printing could provide solutions. Particularly planners could benefit from tangible 3D-models of the green infrastructure for communication with citizens. Consequently, in this symposium, we invite presentations that address 3-D metrics and how these can be derived from spatially highly resolved data sets such as LIDAR data or other data sets. We invite presentations that address innovative mathematical approaches to translate 3-D structures into metrics that support the assessment of ecosystem services. We welcome presentations that present novel methods, techniques and technologies for 3-D visualization. We will discuss existing and potential future applications of 3-D metrics and 3-D visualization techniques in spatial planning, including urban and landscape / regional planning. We welcome particularly presentations that showcase the application of 3-D or combined 2-D/3-D metrics at different scales or address innovative applications in participatory decision processes. Our symposium intends to develop a special issue in Ecological Indicators that builds the bridge from indicator development towards implementation.

T0210

3D point clouds as a new language for linking landscape ecology and participatory planning

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Current urbanization processes profoundly disrupt the environment but generate many opportunities to create more liveable, healthy and resilience environments. With many of the world's fastest growing cities located within the tropics and their high vulnerability to climate change, they call for integrated solutions linking urban and ecological functionalities. While design is increasingly being recognized as common ground to bring scientific knowledge into decision making, it has mostly been used to create place specific responses expressing particular values until now, rather than framing the natural and physical sciences to become more salient and find legitimation. New technological achievements in data acquisition and processing, as well as simulating and visualizing landscapes are however opening new ways to foster iterative feedback loops between data obtained from the environment and the process of designing and planning. For example, new sensing technologies, such as LIDAR technologies, can on one hand be used by architects to design urban landscapes. On the other hand, engineers and scientists can process the same data to quantify ecological processes.
This contribution illustrates an integrated science-design approach applied in the frame of the first national assessment of ecosystem services in the tropics. We demonstrate how an iterative loop between landscape design/planning and the estimations of ecosystem services based on LIDAR data can help incorporate scientific knowledge into the design of an urbanized area to foster ecosystem services provision. We then discuss to what extent this approach can create a knowledge-driven rather than a data-driven design and planning process and conclude on the use of point cloud data as a new language to integrate landscape ecology and landscape planning.

Keywords: 3D visualization, landscape patterns, ecosystem services, landscape planning, urbanization

T0078

Using 3-D metrics in spatial planning – application areas and suitability of indicators

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This talk gives an overview on application fields of 3-D indicators to better inform spatial planning and on potential indicator approaches.
Spatial planning is still mainly based on planar projections of most data with topographical parameters being often the only 3-D information considered. Attempts to incorporate more intensively 3-D aspects come mainly from urban planning and architecture, focusing on built structures and their impacts on shadowing, noise or wind regulation. Other approaches, e.g. from forestry make already use of laser-scanned data to describe the complex structures of forest ecosystems. Thus, both of them address primarily the micro-scale whereas there is no valid approach how to assess jointly green and grey infrastructure and how to reach out to the meso-scale (landscape).
Areas of implementation, where the consideration of 3-D structures of vegetation could be highly relevant are, among others, the development of efficient green infrastructures for regulating services, habitat connection, flood regulation or for informing on the aesthetic value of the environment (recreation). Height differences and layers, density and size / area of influence of single vegetation elements with their impacts on the light and water regime would be highly interesting indicators. This information needs to be complemented by information how such vegetation structures will develop over time (intra- and inter-annually). The latter can only be based on long-term time series or on modelling vegetation development. Such models could be tremendously data demanding and their ability to be easily transferred to larger scales is very limited.
Thus, aggregated indicators that tell about the quality of vegetation types and their structure per assessment unit (e.g. per ha) and their impact in the surrounding spatial context would be needed and initial ideas how to gather them will be discussed.

Keywords: 3-D metrics, spatial planning, green infrastructures

P0111

Visual models as predictive tools for assessing future ecological landscapes and supporting management decisions: validation vs. reality

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Landscape changes driven by human activities strongly influence aesthetic qualities and functionality of the landscape. Hence, most decisions regarding landscape management include a "subjective" component, for which ecological data alone is not sufficient. While landscape planners have access to biophysical data for decision making, they often do not have necessary information about social variables, such as aesthetic tastes and feeling or functions of a place. Visualizing future landscapes under alternative management scenarios and assessing their social and ecological implications could be a valuable tool, aiding land management decisions.

Towards these ends, empirical, quantitative ecological data on vegetation composition, pattern and processes (in an LTER site in Israel) were translated into a computerized, 3D visual representation of current and future landscapes.

Our preliminary objectives were to visualize major landscape shaping processes, such as wildfire, drought and species colonization, to assist managers, planners and the public; to envision the visual significance of management alternatives over decadal time scales and to validate the similarity between the 3-D model and reality.

The visual model we developed is based on 30 years of scientific knowledge and ecological data describing vegetation processes in Ramat Hanadiv Nature Park, a case study which represents a set of conditions and processes relevant to many landscapes in Israel and in Mediterranean ecosystems worldwide. Validation was necessary to demonstrate similarity between the 3-D model and reality before studying its role in decision-making. Validation was performed by comparing the current state model representation with real world photos from the perspective of the observer. The model was found to be a valid representation of reality (G-test; $p<0.0000$).

We are currently examining the visual model as a decision-making support tool, regarding how it impacts decisions compared to verbal

Keywords: Visualization, Future landscapes, Mediterranean, Validation, landscape model

Three-dimensional Point Cloud Data Based Eye-level Urban Greenery Assessment and Greening Simulation Model

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Reaching a minimum level of urban greenery has been studied as a goal of urban planning and management. Assessing tree cover density using remotely-sensed imagery was often applied to measure urban greenery and high-resolution images that Google Earth provides were applied to increase accuracy. Because remote sensing images were overhead view, it cannot capture the street-level, eye-level view of urban greenery. To overcome this limitation, Google Street View (GSV) images were applied street level greenery. GSV enable assessing the eye-level urban greenery, however, it is impossible to analyze the effect of planting vegetation. Though many studies assessed urban greenery with different methods, little is known about how to improve the greenery effectively.

We have developed a model that eye-level urban greenery can be assessed with three-dimensional point cloud data. Furthermore, by manipulating point cloud data, vegetation planting effect on greenery improvement can be simulated.

In this research, street and open space were chosen as the two main types of virtual study areas. Different conditions such as the width of roads and the interval of planted trees were applied to investigate the effect of planting vegetation on eye-level greenery. The planting simulation and the greenery assessment were conducted on these sites to investigate effective planting methods according to site characteristics. In the open space, the effects of tree, shrub, and grass were similar, while on the street, the shrub and grass were found to be efficient.

The model developed in this study is able to evaluate the eye-level greenery and simulate planting effect on eye-level greenery. The data used in the assessment was three-dimensional point cloud data, similar to the data generated by Light Detection and Ranging (LiDAR). Therefore, this model can be used to assess greenery using data built up through LiDAR, and can be used to plan ways to improve areas with low greenery.

Keywords: Green View, Urban Street Planning, 3D Simulation, Urban Greenery Management

T0325

Topographic controls over soil-vegetation relationships in the Southern Urals, Russia under climatic changes

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Spatial relations between forest and steppe communities are commonly highly sensitive to climatic changes. However, the result of their competition for space may be mediated by relief which can either enhance or smooth climatic signals. Since vegetation and soils have different characteristic time scales, discrepancy between their properties are believed to indicate possible expansion of communities following trends in heat or water supply. We tested the hypothesis that the movement of forest-steppe boundary in the Southern Urals, Russia, takes place and depends on topographic conditions. We calculated the set of relief morphometric attributes from DEM and classified multichannel Landsat 8 space image in SAGA software to relate occurrence of vegetation types (broad-leaved forests, shrub communities, and steppes) to topography. Discriminant analysis was used to calculate the posterior probabilities that the community at each pixel occurs in typical topographic conditions for each vegetation type. Field data was used to calculate probabilities that chemical and color properties of soils (Chernozems and Phaeozems) correspond to typical values for each vegetation type. We tested the hypothesis that if vegetation type occurs in untypical topographic conditions, soil properties correspond to another vegetation type and this indicated forest expansion to the steppe niche or vice versa. The results showed that at the north-facing slopes oak forests and shrubs more often occur on soils with steppe-related properties. This testifies decrease of steppe communities following current increase of winter precipitation in the region despite decrease of summer precipitation. On narrow ridges with shrubs forest-related soil properties occur frequently. Absence of forests in these habitats is most likely explained by fire events. Steppes are stable on flat plato with Chernozems. However, after fires steppes can conquer the former forest habitats and prevent forest recovery.

Keywords: forest, steppe, relief, relationships, probability

The role of 3D metrics in landscape divisions and their practical significance in environmental protection

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In 2004 Poland ratified the European Landscape Convention but only in 2015 it was implemented into the Polish legal system. This Act, by introducing an obligation to carry out a landscape audit, takes into account the provisions of the Convention, mainly in the field of landscape identification and assessment as well as the introduction of instruments aimed at landscape protection, management and planning. The aim of our analysis is be to present the possibility of using 3D landscape metrics in landscape divisions and their practical significance in environmental protection. When defining landscape typology, a very important criterion is the aspect of altitude, which concerns both natural elements as well as the land cover structure (e.g. the height of architectural objects). The importance of 3D metrics, i.e. those that use the aspect of height, increases with the detail of landscape division, and more precisely with the possibility of using various data for their analysis. Landscape metrics using the height element are able to provide reliable information on the dynamics of landscape changes, which further enables to undertake or abandon tasks aimed at least at maintaining the current condition of the landscape and also indicates areas that should be protected. Landscape metrics make it possible to track changes within the landscape structure (e.g. the rate of fragmentation or disappearance of characteristic landscapes). The possibility of graphic presentation of the calculated metrics, which enables their interpretation in a direct way, is particularly important here.

Keywords: landscape audit, landscape typology, 3D metrics, landscape protection and management

Landscape Visualization: Its Application for Participatory Decision Making

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The process of engaging communities, stakeholders, and public in decision making has been always a crucial factor in natural resource management. Recently, most of environmental research, assessments or modelling do not conduct without some sorts of reference to stakeholders and their involvement in the process. Although this is a positive development, in myriad of cases, stakeholders' engagement has been quite nominal, and complete successful engagement is barely achievable. Various restrictions cause unwillingness for public to fully participate in decision making. So, here an important question comes up. What are the best approaches which increase public participation for mitigating environmental problems and enhancing nature friendly attitudes and behaviors in society while they meet the aims of participatory methods? Some scholars advocate that visualization can improve understanding of the participants about the issues and potential plans and enhance their ability to communicate their knowledge and ideas. In other words, the use of visualization can fulfill the criteria of an engaging participatory approach, fill the gaps between planners and public and provide a common language among them. Visualization is a graphical approach for displaying information, and can be referred to any techniques for creating images, diagrams, or animations to communicate a message. The general procedure of visualization is to turn raw data into visual components. In this paper I am going to review application of visualization in some participatory management and decision making in different times and parts of the world with various stakeholders and planners.

Keywords: Landscape Visualization, Participatory Decision Making, Public Participation, Stakeholders

T0943

Innovative design and inventory technologies in historical urban complex on the example of terraced of terraced landscape in a UNESCO protected area.

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Cultural heritage, starting from antiquity to the present day, from materiality to immateriality, carries a potential that is still being discovered and valorised as a source of knowledge for future generations. Since the landscape and architectural heritage of the developed area is extremely important in the design process, there is a need to make an accurate model of the relief of the land on which is located. Only with a precise knowledge of topography and detailed architectural inventories will it be possible to carry out thorough analyses. Context is extremely important in this type of projects and its exact mapping is necessary. Thanks to the use of Photogrametry technology, it is possible to achieve architectural solutions tailored to environmental needs. They can be single sculptures, as well as whole buildings or cities. In order to reconstruct, transfer the actual area to a 3D computer model, we can use both terrestrial and autonomous Drone photographs with GPS. Together with partners from ETH Zurich – Drone Harmony, it was possible to develop a pipeline for conducting work, using state-of-art tools, in historical, hardly accessible areas. Thanks to the use of modern technologies, hardly accessible areas of the hills can be accurately catalogued, which will make it much easier to preserve their appearance and identity. The Bussolino project itself is a study model of the rules of practice (system of work) in similar cases. In Europe, similar regions are located in Poland, the Czech Republic, Germany and Ukraine. The future of our civilization today is to care for the natural heritage of our planet. With the use of appropriate tools, it will be possible to achieve modern and innovative design effects and to show a non-standard system of designing the future, directed towards the environment and natural heritage.

Keywords: Heritage, Architecture, Technologies, Digitalisation, Landscape

P0065

Effects of land use on stream water quality: How do landscape composition metrics influence predictions?

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It has been widely acknowledged that both land use and landscape attributes are crucial factors impacting the physical and chemical parameters of receiving waters. Therefore, it is important to understand how various landscape attributes and measures influence land use predictions of water quality. The combined effects of land use and landscape attributes (e.g., stream proximity, slope and accumulation) on water quality was examined across the semi-natural catchments of the Czech Republic via the application and enhancement of multiple landscape composition metrics. The predictive power of metrics was explored for eleven water quality parameters using linear regression. Predictions for water quality varied depending on which metric was applied. Metrics incorporating stream proximity measured by Euclidean distance in combination with slope and/or log-transformed accumulation were optimal for predicting the effects of forests on nitrite, orthophosphate phosphorus, pH and total phosphorus as well as the effects of meadows on calcium, electrical conductivity, nitrite, orthophosphate phosphorus, pH and total phosphorus. Incorporating landscape attributes did not improve predictions of calcium, electrical conductivity, nitrates and total suspended solids from forests or predictions of total suspended solids from meadows. Thus, the inclusion of landscape attributes into metrics can improve the model accuracy for certain land use-water quality relationships. Comparing the predictive ability of multiple metrics allows for an identification of the most appropriate metric as well as an understanding of the influential factors within land use-water quality relationships. Findings can be used to locate areas with the strongest influence and prioritize management strategies.

Keywords: land use, water quality , catchment, geospatial analysis, landscape composition metrics

T0605

Human-wildlife interactions in peri-urban areas: does the 3D fingerprint of the landscapes matter?

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The development of urban areas in the detriment of natural areas such as forests induced an increasing number of human-wildlife interactions, especially at the growing urban fringes. The landscape patterns play an important role in determining the animal distribution and movement. Usually, the patterns are assessed in a 2D framework, but there is certainly a loss of information when one neglects the third dimension, since it is closer to terrain's reality and it also includes information regarding the vegetation structure and density. For instance, one could expect that wildlife movement is impacted by three dimensional arrangements of structural elements such as steep slopes, deep valleys or other terrain irregularities occurring at a fine scale. Therefore, we tested the hypothesis whether the 3D fingerprint of a landscape is important in characterizing the preferences of certain species.

We conducted a study in the Romanian Carpathians, in a city whose peri-urban area is acknowledged for frequent human-wildlife interactions with species such as bear, wild boar and fox. We discussed with various categories of stakeholders and we identified the locations where such interactions were most frequent. We assessed the landscape patterns by computing some basic 2D metrics and their 3D counterparts such as area, distance and shape, on the basis of fine resolution elevation data derived from a LiDAR point cloud. The main aim was to link the spatial patterns with the occurrence of certain species.

Such approaches would bring important insights for a better quantification of wildlife habitat characteristics. In turn, this could be useful to planners in designing corridors and migration routes or for a suitable resettlement of species.

Keywords: 3D landscape patterns, human-wildlife interactions, Romanian Carpathians

P0114

3D printing of landscapes: from technical advances to expectations of end-users

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There is a continuous need to develop interactive and complex visualization tools, which meet the expectations of stakeholders and planners. Potential solutions might stem from other disciplines and knowledge transfer to Landscape Ecology is therefore necessary. We focus on a novel technology with multiple applications: 3D printing, which nowadays comes closer to the end-users. Applications of 3D printing technologies for representing 3D surfaces related to life or Earth sciences started being recently explored.

We present the proof of concept of a project aiming to make 3D printing useful in the framework of landscape analysis and visualization. The main aim is to develop a user-friendly software tool with multiple functionalities, making it possible to realize physical models of various 3D surfaces occurring in Earth Sciences. Therefore, we intertwine two major directions, both referring to the interaction with potential beneficiaries. The first one refers to increasing the awareness on the capabilities of 3D printing technologies and to understanding the needs and the expectations of end-users. The second direction refers to the techniques that lie behind the 3D printing process. We expect to understand the usefulness of topics such as multiresolution, level of detail, smoothing and representation of prominent features.

Such an approach could provide new perspectives regarding the applications of the 3D printing technologies and could lead to novel functionalities, thus demonstrating how reciprocal feedback are beneficial both for the developers and for the end-users.

Keywords: 3D printing of landscapes, digital surface model, 3D surface, physical model, stakeholders

T0376

Differentiating between 2D and 3D landscape metrics: the role of surface variability

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Landscape metrics are acknowledged to be a reliable tool for quantifying landscape patterns. However, they are limited to the two dimensional paradigm and neglect the vertical structure of landscapes. This was already pointed by previous researches, where 3D versions of some traditional measures were discussed and a difference between the 2D metrics and their 3D counterparts was highlighted. On the other hand, for measuring the surface variability, on can compute well established standalone indicators, related to local landform and roughness. There is still a need to understand how the local vertical structure and the underlying topography of the patches, as quantified by landform parameters, impact the differences between the 2D and the 3D metrics.

The numerical descriptors measuring the three-dimensional variability can be classified by using various criteria. We took into account the nature of the indicators and we grouped them in two main classes (i) indicators relying on local statistics such as average roughness, RMS-deviation for elevation and elevation-relief ratio and (ii) indicators derived from local geometry of the terrain such as slope and curvatures. We firstly investigated the dependencies and correlations inside between the various descriptors considered. We then explored how the values of these descriptors influence some basic metrics such as area, perimeter and shape when passing from the 2D to the 3D framework.

The analyses actually combine two approaches: the three-dimensional indicators, which are defined locally, around a focal cell, and the metrics, which are defined at patch level. The synergy between the two scales could reveal information regarding the internal structure of patches. Moreover, it could contribute to understanding how to define the elementary unit when considering landscapes in the three-dimensional context.

Keywords: 3D landscapes, landscape metrics, surface variability, terrain roughness

Do we need 3D-landscape metrics?

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Landscape ecology provides a conceptual framework for a deeper understanding of distribution patterns of ecosystems, their interactions with ecological processes and their temporal dynamics. Thereby, the use of landscape metrics is widespread in the analysis of landscapes. With appropriate GIS software and the increasingly good availability of geodata, these can be calculated quickly for large areas. Landscape metrics can be used in ecological models, landscape assessment and characterization, and landscape planning.
As a predominantly basic approach, the so-called "patch-corridor-matrix model" has been the used to capture landscapes, regarding them in a simplified way as mosaics of discrete elements. Since most spatial information has been collected and evaluated in two dimensions to date, landscape metrics often refer to only two-dimensional information. However, valuable information is lost as this merely two-dimensional approach does not consider ecologically meaningful 3D-structures like terrain shape or elevation. Furthermore, the value distribution of environmental variables can oftentimes be better described in the form of ecological gradients rather than categorical map patterns. Therefore a gradient concept of landscape structure was proposed.
With the increasing availability of elevation models, e.g. from laser scanning, and the ever improving performance of GIS systems, it was also possible to develop and calculate 3D landscape metrics and to create 3D visualizations.
Since these developments have been going on for several years now, it is time to ask what has been achieved and whether such 3D measurements are actually needed. Were these approaches successful? What restrictions, advantages and disadvantages have been shown? The presentation will give an overview of the application of 3D landscape metrics. When does it make sense to use them? Do these also make sense for the evaluation of ecosystem services? What is the need for further development?

Keywords: 3D - lndscape metrics, landscape structure

T0073

Integrating the three-dimensional pattern metrics and circuity-theory to develop the greenspace ecological networks

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The construction of greenspace ecological network can increase the connectivity between fragmented habitat patches and will be greatly contributed to the preserving of urban biodiversity.
However, previous studies of urban ecological network are mostly based on two-dimensional (2D) data of vegetation to assess habitat quality and connectivity, and there has been little consideration on how the three-dimensional (3D) vertical structure of vegetation and associated habitat quality may impact on the connectivity development. Taking the main urban area of Nanjing, China as the case study area, we used Light Detection and Ranging (LiDAR) data and high resolution remotely sensed images data to calculate five 3D metrics to categorize habitat types and identify ecological sources through a case study of. Then we applied circuit theory to calculate the current density and thus to identify ecological corridors and key ecological nodes in the study area. We found that 3D vegetation metrics can identify habitat patches with critical vegetation structure better compared to conventional 2D metrics and can present a more fragmented and heterogeneous condition. The ecological sources were mainly distributed in the north and east of the main urban area of Nanjing, with the ecological corridors locating in the north and southeast part, and both ecological sources and corridors were mostly comprised by complex vegetation structure. Overall, this study concluded that the integrated application of LiDAR data and image data presents an effective way to characterize habitat structure and estimate greenspace 3D connectivity. The results of this study provided an important reference for the construction ecological network in Nanjing. The integrating of 3D greenspace metrics with circuit theory will provide a novel and important tool for researchers and practitioners for scientifically preserving biodiversity and ecosystem function.

Keywords: LiDAR, 3D metrics, Ecological network, Green sapces, Circuit theory

Analyzing urban thermal environment corresponding to the 3D urban spatial pattern

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Compared with traditional 2D landscape pattern index, 3-dimensional landscape pattern index can better describe and quantify the real urban landscape, which will be very helpful to find out the factors corresponding to urban thermal environment change. In this study we will first develop several novel 3D landscape metrics (eg. Sky view factor (SVF), rugosity, 3D green volume and lacunarity index) based on high precision classified airborne LiDAR data and remote sensing data in Nnanjing City, China and then by coupling these metrics into the urban multi-scale environmental predictor model (UMEP) to simulate urban thermal environment pattern. The relationship between thermal pattern and urban 3D pattern was then analyzed. The results will help to improve urban landscape pattern (eg. Green spaces) on considering the real 3D urban landscape pattern and mitigate urban thermal environment.

Keywords: 3D, landscape metrics, green space, thermal enviroment, climate change

Symposium 39

The design of the contemporary cities through a green and blue infrastructure for Ecosystem services provision

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Landscape ecology is one of the major challenges of the Anthropocene, and the ecosystems services (ES) most directly linked to human well-being and benefits through the provisioning, regulating, and cultural services they provide. Urban planning of contemporary cities has to deal with old and new challenges regarding the environmental and landscape quality strictly link with the human well being. Considering the grey infrastructures of cities composed by the mobility system, the housing equipment, the public services and technological areas for inhabitant, urban areas require a green and blue infrastructures that compensate and integrate the grey'one providing important ES.

Blue and Green infrastructures (BGI) were defined in the EU Biodiversity strategy 2020 as a:

• "territorial tool for natural regeneration, to re-establish a specific ES and landscape conservation;

• can promote the multiple deliveries of ES, improving the general ecosystem functioning;

• mapping ES for GI is essential for planning purposes, especially ones focused on environmental and landscape protection, but the spatial definition of GI is dependent on the assessment of state and trends of ecosystems and their services".

In contemporary cities, many urban issues could be addressed through BGI with the potential to complement or even replace this grey infrastructure. BGI has practically developed a thought nature-based solution (NBS) as actions that implement an ES approach, thereby addressing ecological, social and economic challenges. NBS are "living solutions inspired and supported by the use of natural processes and structures, and are designed to address various environmental challenges in an efficient and adaptable manner, while simultaneously providing economic, social, and environmental benefits" (European Commission, 2015). Green Infrastructures (GI) become the ecological structure (the spatial bones) for the strategic design of contemporary city, which creates new ecologically oriented landscapes and inclusive public spaces. The GIs are intended as continous network composed (or including) natural and agricultural areas, open spaces and historic built environment characterised by different values and functions from the city center to the peri-urban areas (where the leisure and cultura functions and the values of ecosystemic (multi)functionality of soil characterises the GIs). Green infrastructures become a design tool to achieve nature-based solutions, integrating systems of natural areas, agricultural landscape and water resources with slow mobility networks and energy infrastructure. BGI are a territorial tool for natural regeneration and landscape conservation promoting the multiple deliveries of ES, improving the general ecosystem functioning. Gis and ecosystem services model are tools supporting the evaluation of the planning strategies sustainability (land use transformation) and the monitoring of the plan imlementation. The symposium will host presentations of case studies related to the integration of BGI and NBS in Landscape planning for Ecosystem services provision. Particular focuses will be dedicated on the approaches for the designing of BGI based on the analysis of landscape ecology and their processes using innovative techniques of Ecosystem services assessment (mapping, modelling and monetary quantification) at different spatial and temporal thresholds and on the implementation models and tools (renouvated governance model based on alrge partnerships towards Ecosystem services implementation).

T0701

The Padova Walls and Water Park: how to employ a renaissance urban asset in our days

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The "Padova Walls and Water Park" (Parco delle Mura e delle Acque di Padova) is a large scale urban project developed and fostered by the Paduan Association "Comitato Mura" in partnership with Padova Municipality and local Universities. The project integrates the city's Venetian Renaissance Fortification System (1513-1543) into a circular route 11 km long. Several parts of the ancient walls have been, in time, modified, reduced or demolished and often are not visibly perceived by passers-by. The project aims to restore the Memory of the Walls that were, proposing an itinerary conceived within 7 functional layers:
Layer 1: Hospitality (recreational and accomodation facilities, hubs)
Layer 2: Mobility (trekking, cycling, horse riding)
Layer 3: Culture (visits, conferences, workshops)
Layer 4: Events (City Walls Interactive Museum, theatre, festivals)
Layer 5: Itineraries (speleological and high line trails)
Layer 6: Water ways (rivers, canals, floodplains)
Layer 7: Nature (ecological corridors, greenways, environmental education)
The project's core remains the wall system with it's historical, architectural and cultural relevance, while the constantly evolving mission is dialoguing between layers which develop and cross each other around the Wall's osmotic ring.
The renaissance urban human texture unites with the urban nature texture, represented by the city's "green" and "water" ecological system that has survived to our days. The project aims to recover and restore the city's natural elements in order to benefit the residents' health and wellbeing, biodiversity conservation and urban ecology sustainability.
The natural cityscape should then expand in a territorial and disciplinary way, generating a multitude of different landscapes available for all, within and outside the City Walls: The Total Human Ecosystem.
By now, some project parts have been realised, while other are still being developed.

Keywords: urban ecology, green infrastuctures, architectural assets, renaissance fortifications, eco-urbanism

P0203

Oxygen to Human. Introducing an advanced natural approach in landscape ecology design

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Putting human being at the center of the architectural discourse has created adverse conditions for the environment. In an evolving anthropocentric perspective, the role of landscape ecology is to incite a new relationship between man, technology and nature. At this regard, one emerging approach consists in pushing nature performances to its maximal potential with punctual, adaptable and scalable living solutions in the built environment, here defined as Advanced Natural Approach. Nowadays, the technology innovations could serve these living solutions integrating and supported by nature resources, and not vice versa. The aim of this research, developed by Material Balance Research Politecnico di Milano, is the application of this approach through the definition of an architectural demonstrator placed in Milan: Oxygen to Human (O2H). Milan is facing an air pollution crisis affecting the health of its citizens and that can be solved either with policies either with urban solutions. Among the latter, few installations and facade panels exploiting photosynthetic living microorganisms, as microalgae, has been implemented in order to answer to this major issue. Microalgae are microorganisms able to capture carbon dioxide while producing more O2 than plants can produce. They are directly responsible of almost the 50% of the photosynthesis on Earth, and can be cultivated in closed engineered devices, named photobioreactors (PBRs). In particular, O2H is an evolution of the common PBR into an urban device that can be placed in different urban contexts, responding to the pollution concern and respecting feasibility, maintenance and security requirements. Moreover thanks to sensors and displays, citizens can read its environmental benefits in terms of CO2 reduction. Through photosynthesis It will then release releasing oxygen for inhabitants, producing biomass for the production of compost for green urban spaces as an innovative and strategic added value for the city.

Keywords: urban photobioreactor, landscape ecology, microalgae, air pollution, performance driven design

CLEVER Cities up-running co-creation of Nature-Based Solutions: The Launch of urban Action Labs in Milan, Italy

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The CLEVER Cities project was launched in three front-runner cities (London, Hamburg and Milan) in the Summer of 2018, and mainly aims at implementing tangible and innovative Nature-Based Solutions (NBS) in cities through an inclusive co-creation approach. The City of Milan launched in November 2018 the Urban Innovation Partnership (UIP), which consisted in a challenging stakeholder mapping and engagement process, facing a complex positioning of the CLEVER Cities project scope within the multitude of urban greening and resilience city-wide strategies. The UIP establishment is the first step towards setting-up of an active stakeholder engagement and local actors participation in co-creation urban living labs, the so called CLEVER Action Labs (CALs).

In particular, this research discusses the ongoing planning process for testing the implementation of NBS in three CALs in Milan as experimental co-design and co-creation process. The ideation is mainly based on co-designing, co-implementing and co-managing the possible NBS interventions with a multiplicity of local stakeholders while involving community members and citizens.

The process of running the CALs was kicked off in January 2019 with the core UIP members and in continuous ongoing work to develop a complete co-creation pathway with local stakeholders. The shared governance process envisaged a theory of change that helped creating the vision, impact and expected outcomes for each CAL.

The planned co-creation activities are expected to officially start in June 2019, and are summarized as follows: (1) bottom-up activation of citizens through a public tender for promoting green roofs and green walls interventions on private buildings; (2) community based co-design of the new Giambellino 129 public park, coordinated with ERDF funded rehab of Lorenteggio social housing complex; and (3) the vertical green walls and green noise barriers on the new Tibaldi train stop.

Keywords: Nature-based Solutions, CLEVER Cities, urban regeneration, Co-creation

T0860

A multimethodological approach toward the evaluation of Ecosystem Services. A case study in the South of Milan

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Between urban and periurban, the projects, aimed at treating the Marginality of fragile areas with a transdisciplinary approach, can contribute to the rigeneration of neglected site and provide ecosystem services (ES) by integrating agricultural activities, public space and goods within a common landscape matrix.
Three key elements should be fostered to achieve this objective: (i) the agricultural use should be based on crop differentiation, multifunctionality and mixed activities; (ii) an innovative model of private-public partnership should be implemented as a participative governance; (iii) the project should be permeable and interconnected with the surrounding territory.
Evaluation models can be implemented in order to support the design phase, maximize the ESs' value and promote the inclusion of multiple stakeholders within the decision process.
The case study is Parco della Vettabbia, a periurban agricultural areas in the South of Milan, where an innovative project, promoted by the UIA project "OpenAgri", is proposing a new multilevel approach to the territory based on the synergic actions of agrifood, environmental and social startups, public authorities, research bodies, NGOs, civil society.
A multimethodological approach, including the GIS for the landscape project and the implementation of indicators for the measurement of the ESs according to a Multicriteria Decision Analysis (MCDA) perspective has been implemented, to support the decision process.
The challenge at stake is to address the early design stages to the achievement of three different as well as interrelated goals: (1) specific, to maximize the contribution of each activity to the ESs value, (2) internal, to promote the interactions between the activities, and (3) external, to enhance the synergies with the environmental, economic and social context.

Keywords: fragile areas, transdiscinplinary landscape design, landscape ecology, ecosystem services, MCDA

P0122

Providing ecosystem services through urban forestation planning – A green infrastructure approach for the metropolitan city of Sao Paulo, Brazil

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Green infrastructure is an intervention strategy, which comprises Nature-based Solutions on landscape planning and design that contributes to cope with issues related to Anthropocene impacts such as the lack of urban vegetated areas. Green areas are responsible to supply ecosystem services (ES) such as urban heat island control, soil permeability, bioremediation, stormwater control, human well-being and social uses, and biodiversity. This project aims to present an urban afforestation plan that offers ES for a neighborhood within a metropolitan watershed in Sao Paulo, Brazil.

The study area is located in the west zone of Sao Paulo and it has 59 hectares. The local was evaluated based on field visits, satellite images, thermal map, and current green vegetation measurement. An urban forestation plan was created using draw software and planned green vegetation index was measured.

Were selected native trees with big size and large crown from different successional ecological stages for the plan. Three schemes of planting were created, which are: 1) pioneer (P) and secondary (S) trees alternated in one side for streets up to 7 m width; 2) P and S trees alternated in both sides for streets between 7 to 10 m width and; 3) lines with S on sidewalks and P on central bed. Climax and S trees were planned for public squares and large open areas. The planting scheme is proposed to create homogeneous distribution all over the area attending arid regions, creating shade in a short period and enhancing biodiversity. Green vegetation cover will increase from the current 18% to 37.37% with this forestation plan. Other predicted ES are local thermal comfort, air humidity, and soil permeability increase. Other urban forestation projects that increased vegetation cover area have been presenting significative local temperature decrease and increasing human well-being and biodiversity. We conclude that green infrastructure projects can integrate nature in urban planning guarantying ES.

Keywords: Plant shading, Urban ecological succession, Local biodiversity enhancement, Regional temperature relieving, Heat island control

Survey of the Social Environmental Designs for Ecosystem-based Adaptation and Preliminary Disaster Prevention utilizing the Green Infrastructure and Eco-DRR from the research of Kumamoto Earthquake

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The concept of “Green Infrastructure” and “Eco-DRR” is developed in Europe and North America lately, and it started to spread around in Japan after the Tohoku earthquake and tsunami in 2011. Landscape ecology is parallel with this conceptually, as well as in terms of spatial scale. Its successful focused researches and social implementation are becoming pervasive.

The new concept is to solve various problems by local resources and pearls of wisdom, it connects local communities to the world while it’s mainly led by front liners and researchers in engineering and ecological fields that little attention is paid to the aspects of arts and designs. It’s still not well-penetrated despite the validity and functions of the concept are well verified. Thus, it’s vitally important to work on the insufficient.

Considering the geographical location of the islands of Japan, natural calamity is unavoidable. We have to embrace the nature, co-exist with it and move forward as our ancestors did. In this presentation, we will focus on the report of the viewpoint of “Green Infrastructure” and “Eco-DRR” as design establishment for life protection with our focus especially on public understanding to the designative concept and its relationship with landscape ecology.

A series of earthquakes including a magnitude 6.5 foreshock and a magnitude 7.3 main shock struck at Kumamoto on 14th and 16th April 2016, with numerous serious structures collapsing in Kumamoto city and neighboring cities. Rebuilding and rejuvenating schemes are being actively implemented in the city with the directions to increases its city value and redevelopment with large scale green lands. We had several surveys in their disaster area and we try to establish a social environmental design for ecosystem-based adaptation and preliminary disaster prevention utilizing the green infrastructure and Eco-DRR.

Keywords: green infrastructure, Eco-DRR, design, natural disaster

T0859

From Landscape Vulnerability to Green Infrastructures values: towards a new governance

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Due to the growing attention on Green and Blue Infrastructures (GBI), the planning tools are increasingly exploring their inclusion. At the core of the debate is how to incorporate GBI in planning process to make them able to address our challenges: adaptation, decrease of environmental risks, creation of benefits to society.
Based on the outcomes of a multidisciplinary research developed within the Alpine Space project Los_Dama!, the paper presents a multiscale method for the GBI analysis and valuation aimed at integrating landscape dimension, ecosystem services (ES), GBI, nature based solutions (NBS) into the planning policies. The method, tested in the Italian pilot area (i.e. the Green Crown of Turin), applies an ES approach and makes visible the multiple functions of GBI and their added value to society and the strong interplay between social and ecologic systems.
Steps of the research:
1. Preliminary evaluation of the landscape vulnerability of the green crown and its land units;
2. Evaluation of vulnerability has been developed with suitable indicators;
3. Socio-economic analysis of the pilot area, including the mapping of ES, their providers and beneficiaries, and the identification of governance tools fitting with the ES enhancement;
4. Identification of the ES able to reduce the main vulnerabilities, for each land unit: this phase allowed to define the set of the prior ES for each land unit;
5. Assessment of the scarcity and abundance of the ES able to reduce vulnerability;
6. Economic evaluation of the GBI in the pilot area. This step has been developed using the contingent valuation methodology, the sole able to capture non-use and indirect values in a Total Economic Value framework;
7. Choice of NBS able to implement the ES needed form each land unit.
The method has been tested and refined through a participated process aimed at the development of a governance tool for the area of 14 municipals and of a project embracing an area of 4 municipals.

Keywords: Landscape vulnerability, green and blue infrastructures, ecosystem services, nature based solutions, governance

Urban ecological design in the era of the Anthropocene: a process of landscape reclamation

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This paper examines landscape as a flexible and adaptive organizing element for ecologically responsive city-making, in the era of the Anthropocene. From an operational and performance standpoint, the focus of interest is on the abandoned "brownfield" sites in inner cities and city peripheries where Landscape Urbanists create structuring framework plans, emphasizing on ecological restoration and social rehabilitation. Five design paradigms are studied, focusing on water-related sites. Through a systemic view and an environmentally driven design approach they form hybridized socio-ecological infrastructures stressing open-endedness and adaptation to change over time.

Keywords: landscape ecology, urban metabolism, landscape urbanism, drosscape, water management

Cold and wet island effects of urban green spaces in cold winter in Beijing, China

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Rapid urbanization leads to various environmental concerns, and urban heat island is one significant problem that needs solving. Construction of urban green spaces in urban landscape is considered to be the most effective way to mitigate urban heat island. Previous studies have proven that no matter air temperature collected on the ground or LST extracted from remotely sensed data is taken into account, urban green spaces not only serve as urban cold island, but can influence the adjacent neighborhood. Such studies may give insights to urban planning and lead to a healthier city.

Field observation of air temperature and relative humidity was carried out in and around 3 parks in cold winter in Beijing, China, a typical mid-latitude city. Results show that in winter night, urban green spaces are both cold and wet island, whose cold island intensity ranges from 1.37 to 3.86 ℃ and wet island intensity ranges from 3.00 to 6.19%. Larger parks have stronger cool and wet island effect at night. While at winter noon, urban green spaces are wet island but not always cold island, and the existence of large water area within park may strongly affect park's wet island intensity. Though significant difference was observed among different samples outside urban parks, parks' influence on its adjacent neighborhood was not observed in this research as expected. This may suggest that in winter, thermal condition on streets is more likely to be affected by buildings and structures nearby.

Keywords: urban green spaces, urban heat island, cool island, wet island

T_1003

Introduction of ecological corridors in Tirana city planning

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Tirana has experienced a ten-fold population increase during the transition from its communist past during the last 30 years. The controlled and centralized nature of urban livelihood was rapidly replaced by free movement and rights to live anywhere, albeit not matched with dynamic urban city planning. Consequently, the city experienced an unprecedented urban sprawl associated with illegal constructions while its urban environment suffered severe habitat loss and decimation of green spaces among others.
The new urban plan is formalizing most of existing buildings within the urban texture of the city and trying to preserve the last remaining patches of green spaces. Nonetheless, Tirana is surrounded by a National Park and several local parks which provide the main recreational areas, but all these parks have remained isolated and not connected with each-other. This paper, suggests potential alternatives for creating ecological corridors in Tirana which could be beneficial for nature and people alike as they would connect the city ecology with its surrounding parks. Apart of ecological functions, such vegetation corridors would provide a positive impact on local climate as well with reduction of heat waves, improvement of air quality and flood prevention. The survey provides several challenging examples on how to provide for vegetation linkages even in public spaces including open squares or roads.

Keywords: Spatial planning, ecological corridors, city planning, climate change, Tirana

P0090

Exploring the potentialities of a new integrated system of grey, green and blue infrastructures for improving flood protection and wastewater remediation

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Most of the sewers designed between 19th and mid-20th-century, use single-pipe systems that collect both sewage and urban runoff produced on streets, roofs and other impervious surfaces. During heavy storms, the flow capacity of this type of collection systems, known as Combined Sewer Systems, may be exceeded and the overflow is diverted into a receiving water body - RWB – through spillways without any control and remediation. In northern Italy, RWBs are often unlined rural canals that are part of a larger network, originally developed for irrigation and drainage of rural areas and now able to provide ecosystem services. The recurring release of Combined Sewer Overflows (CSOs) in these RWBs can increase the risk of chronic pollution, affecting water used in agricultural and environmental contexts (i.e. for crop irrigation and, indirectly, aquifer recharge).
In this paper, an integrated strategy to control and improve the quality and quantity of flow diverted by a CSO into a rural canal and its downstream propagation is tested through a modelling exercise on a real case study in the area of the metropolitan city of Milan. The integrated strategy consists in a combination of grey, green and blue infrastructures and exploits the integrated storage and self-depuration capacities of a first flush tank, a constructed wetland and a semi-natural stream to obtain acceptable flow rates and adequate water quality in the final RWB.
The results of the integrated system, have been evaluated through a model based on simplified equations of water and pollutants dynamics, and show good performances, both in terms of flow control and pollution mitigation. Adopting the biological oxygen demand concentration as a proxy of the whole load, in particular, CSO flow BOD's values resulted reduced more than 90% (requiring one-third of the investment with respect to traditional CSO control based on first flush tank), making water suitable for environmental uses and irrigation purposes.

Keywords: Control of combined sewer overflow, Rural canal network, Ecosystem services, Grey, green and blue infrastructure, Urban-rural environment interface

P0151

Assessing mismatches in the provision of urban ecosystem services: a methodological approach to support the design of green infrastructure

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Enhancing knowledge about how ecosystem services (ES) are provided and benefited from is essential for designing and managing green infrastructures (GI), to ultimately improve human health and quality of life in urban areas. The present study aims to map and assess mismatches between supply and demand of ecosystem services. Specifically, it compares the amount of services that urban dwellers currently benefit from with the capacity of green spaces to provide services and the ES demand, in order to assess two mismatches: "unsustainable flow" and "unsatisfied demand" of services, respectively. The methodological approach includes: the identification of services providing and demanding areas; the quantification of ES supply with biophysical methods coupled with access analysis; the quantification of ES demand based on quality standards; and the assessment of mismatches through the spatial explicit comparison between supply and demand of services. The methodology was applied to recreation and food supply in two municipalities of the city of Havana. Results show that recreational uses of some urban green areas may generate overcrowding in these spaces. Regarding food supply, an unsatisfied demand mismatch emerged in both municipalities. These outcomes can support planners in managing the sustainable use of GI network. Moreover, they provide useful information to guide the expansion of GI into cities and thus, to achieve an equitable distribution of ES benefits. However, its applicability requires a deep understanding of local specificities including demand levels, accessibility to ES, the structure and function of green areas, and sustainability thresholds.

Keywords: urban ecosystem services, green infrastructure, mismatches, recreation , food supply

P0198

Agent-based simulation as an innovative approach to the design of green compact cities

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The goal of increasing the provision of green space in our cities might clash with the need to keep them compact and therefore efficient and sustainable. Yet, designing settlements that ensure easy access to green space and services, while also being compact is not straightforward. That is because any attempt at improving the living conditions of a household, in terms of centrality and green space provision, affects, and is affected by, the possibility to guarantee equally good conditions to other households. Design tools then, in order to be effective, should be able to handle these complex interactions.

This paper presents a possible solution to the above dilemma in the form of an agent-based model simulating the interactions of several hundred virtual households, from which the ideal design eventually emerges. Each household is assigned a unique attitude, in terms of its preference towards centrality, proximity to green space and density. During a simulation, households try to maximize their utility without overly detracting from their neighbors' via an embedded cooperation mechanism.

Results show that settlements characterized by a clear urban-rural boundary and an even distribution of green spaces provide the highest benefits to their inhabitants, but that the boundary should be a bit rougher when the population is less sensitive to density. Large parks are to be preferred when citizens accept higher densities and/or travel is faster along some directions. The application of a rent formation model on the outputs of the agent-based model showed that configurations supplied by the latter are remarkably equal, with the poorest fifth of the population being able to choose from half of all locations and households of different income levels residing next to one another.

The proposed approach may be used for the design of new settlements as well as the densification of old ones.

Keywords: population density, centrality, planning support, agent-based modeling

The Regional Green Network: designing new landscapes in a complex region

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The Regional Green Network (RGN) of the new Lombardy's Landscape Plan allows to deal with cultural landscape and environmental protection in an integrated way. The project consists in a green infrastructure based on the Regional Ecological Network (REN), with further components such as agriculture, culture, historic and leisure sites. It assumes landscape and environmental asset of the region, finding out the main focal points where green network and landscape cornerstones converge, aiming to integrate the diverse components of the system in a multifunctional perspective. The RGN will be exploited at different territorial scale, from the regional to local level planning, in a multiscalar perspective, detailing and implementing the green network in the local land use plans. The RGN is the main structure to sketch the detailed design of the local urban and peri-urban forestry with an integrated, interdisciplinary, participatory and strategic approach in planning and managing "green" resources for their economic, environmental and sociocultural benefits. The RGN provides a comprehensive and integrated planning approach to the natural, cultural and rural systems favouring usability of RGN by soft mobility network (pedestrian, cycle paths) and ensuring the ecological continuity at territorial scale. The RGN fulfils both the approach of the EU "Green infrastructures strategy" and the European Landscape Convention principles, with recognizing the need of a comprehensive approach between cultural and ecological aspects in landscape planning, delivering a set of ecosystem services in which nature, landscape and culture can exploit benefit in urban and peri-urban areas and derelict sites. This bridges rural and urban areas, improving urban environmental, biodiversity, climate quality and citizens' sense of place. This is particularly important in the metropolitan region of Milan, where live 35% of the regional population and with the presence of seven million people daily

Keywords: Regional Green Network , Landscape planning , ecosystem services, green infrastructure, multifunctionality

T0197

Creating opportunities as a form of planning for cultural ecosystem services

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Despite being intangible, subjective and difficult to measure, cultural ecosystem services (CES) are easier to perceive and experience than many other services and therefore more meaningful to people. They contribute greatly to personal satisfaction, the quality of urban life and achieving sustainability. Yet, little attention has been paid to how CES might practically be incorporated into urban planning. The paper addresses this gap by (1) examining the challenges planners might face when handling CES, (2) establishing strategies for addressing the challenges, and (3) highlighting key factors planners should consider when planning for CES. CES differ greatly from other ecosystem services – they are definitionally vague, difficult to quantify, often bundled with other services, and depend on users' perceptions and involvement in specific places and times to be generated. To overcome some of these challenges, we suggest that planners should seek to create opportunities for CES to "hatch" and "grow" as people encounter nature in cities. This paper draws from theoretical considerations of the CES concept as well as greenspace planning scholarship and practice. We identify five factors that need to be considered when providing opportunities for CES generations: people, places, practices, past and purpose. They interact dependently in creating opportunities for CES generation meaning that change in any one factor while keeping other unchanged will alter the outcome of planning and consequently may decide the success of the planning process. We see the proposed '5P' framework as a useful mean for planners when implementing CES in urban planning. We also provided a descriptive overview of application of the 5P framework to a park analysis on the example of the Grič Park in Zagreb, Croatia.

Keywords: cultural ecosystem services, urban greenspace, planning, sustainability, urban nature

P0094

Linking natural and social capital through green infrastructures to foster urban well-being

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A socio-ecological perspective recognizes cities as complex socio-ecological systems that represent the right context where the natural and social dimensions are interconnected. These interrelations can be well represented by urban Green Infrastructures (GIs) since they support both the natural and the social capital, by preserving ecosystem services and urban well-being. In this context, the aims of the research are: (1) to collect data about the different urban GIs at urban level, as surrogate of the potential provision of ecosystem services, and (2) to identify suitable and available indicators in the official national database that can describe at the urban level the social capital, according to the Millennium Ecosystem Assessment framework. The results of the correspondence analysis between urban GIs' types and the 116 Italian provincial capitals show that the first three components explain 68% of the overall variance. In general, the Italian cities under study have been ordered according to the complexity degree of GIs, ranging from "Green uncultivated" to "Urban forestation". This has made possible a first link between the complexity of GIs and their potential natural capital provision. On the other side, the results of the correspondence analysis between the indicators used to describe the social capital and the cities under study show that the first two components explain 94% of the overall variance. In this case, the Italian cities have been ordered according to the basic services offered to guarantee a good quality of life as well as the involvement of citizens in the urban decision process. Since the green space can play an important role in fostering social interactions and promoting a sense of community and, at the same time, can support the provision of natural capital at urban level, it is important to have available indicators at urban scale suitable to put the MEA framework into operation and link natural and social capital through GIs.

Keywords: complex socio-ecological systems, green areas, urban well-being

T0328

Greening the space – co-designing the city under socio-economic transformation.

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City centers, especially those densely built-up, suffer from insufficient greenery. This results in the threat of flooding, urban heat island and air pollution. Because the space is limited, the solutions should be based on small local interventions, which supports ecosystem services provision. The City of Lodz (central Poland) except struggling with environmental risk also faces social and economic challenges. The modern city planning for human health and well-being requires implementation of green infrastructure in harmony with citizen's needs. Therefore, we asked residents how the city should look like. The research shows results of the participatory process in city design by using workshops, questionnaires, and interviews. It provided a range of information, including general need for greenery and request for particular types of green and blue infrastructures. Due to characteristics of the inner city, research focused on the design of places important to citizens everyday life, like backyards, streets and neighbourhood space, and the way their redesign could improve urban resilience through delivery of ecosystem services. The presentation will reveal needs of citizens and lessons learned from the process.

Keywords: city design, participatory process, stakeholder involvement, green infrastructure

Air Purification by Urban Park Trees in Hong Kong

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INTRODUCTION: Particulate matter (PM) pollution in urban cities is of great concern for public health, and urban vegetation planting is generally accepted as an effective and eco-friendly way to alleviate the PM pollution through deposition and dispersion process. However, beyond landscaping aesthetics and recreational purpose, park designs which are based on their ecosystem services always received limited concerns in Hong Kong. The present study aims to quantify the PM leaf deposition by urban parks in specie- and park-level respectively. Tree species selection and urban park design will be suggested and recommended to help improve the local air quality.
METHOD: A tree inventory is conducted in 32 urban parks representing different park age and land use type. Several tree characteristics, such as tree height, crown dieback, and canopy width are measured at the meantime. Ten dominant tree species are used to evaluate the PM leaf deposition by using laser particle size analyzer. Dust weight per leaf area and per tree bases of each species are calculated and compared. The i-Tree Eco model is used to quantify the ecosystem services provided by urban parks, with the incorporation of local environmental data such as hourly air pollutant concentrations and meteorological data. Tree and shrub information of each park are input to the model, and dry deposition of air pollutants (e.g., PM2.5, and PM10) are estimated and compared between different park types.
RESULTS: In species-level, the PM accumulation by trees differ significantly between tree species. This difference possibly results from the leaf characteristics, such as leaf texture and surface roughness. In park-level, air pollution removal of old parks is significantly higher than that of newly established parks since old parks have more mature trees which have higher rates of pollutant removal. No significant difference in air pollution removal is found between urban parks from different land use types.

Keywords: Urban Parks, Air Purification, Landscape Trees

Symposium 40

Challenge and opportunity in the creation of bee landscapes

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It is highly relevant and timely for us to convene and organise a workshop on 'Bee Landscapes' as part of the forthcoming 10th IALE World Congress in Milano, Italy, 2019. Particularly in relation to the theme of the congress which is: Nature and society facing the Anthropocene challenges and perspectives for landscape ecology. This proposal is put forward by Wageningen Environmental Research (who have been commissioned by the Dutch ministry for Agriculture, Nature and Food Quality - Landbouw, Natuur en Voedselkwaliteit to act as a knowledge partner for the Dutch National Bee strategy). The issue of pollination has risen to the top of the environmental policy agenda and has attracted the attention of the world's press and media and the relevance of bee landscapes has increased in relation to the publication of the IPBES ‘Assessment Report on Pollinators, Pollination and Food Production’. The decline in pollinating insects is partly a result of our unsustainable exploitation of the natural world and threatens the food security of billions of people, leading scientists to believe that destruction of nature is at least as dangerous as climate change. The economic damage caused by crop failure is a further and sometimes more immediate reason for politicians and policymakers, together with agri-business and industry to turn their attention to this problem. Diverse initiatives ranging from detailed research on individual pollinator species, the creation of pollinator habitat, development of citizen science to monitor pollination in the development of general and specific policy and practice have emerged across all of the major continents.

P0085

An agent-based model to assess the effects of deforestation and landscape changes on pollination networks

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Pollination networks occur when sessile plants are visited by mobile animals, a process essential for the delivery of pollination services to crops and natural environments. But while pollinators foraging behaviour is crucial for network formation, the effects of landscape patterns on these processes is still poorly understood. While general patterns have been identified, the mechanisms determining how the spatial distribution of forests can affect pollinator movement and network structure needs further assessment. Gathering empirical data, however, has many logistic and methodological difficulties, since pollinators are usually quite small and difficult to be followed. Here we present an agent-based model (ABM) that simulates the movement of bees over heterogeneous landscapes and captures pollination events, so that we could directly asses how varying landscape patterns may affect pollination networks. We simulated bee movement and network formation on virtual landscapes within a gradient of forest loss. The ABM produced expected trends in network structure. We found increases of complementary specialization (H2') and a decline in network connectance with increasing forest cover, reflecting the increased foraging abilities of specialized pollinators as more high-quality habitat is available in the landscape, a pattern predicted, but not recorded, by previous studies. We attribute the results obtained primarily to a shift from specialist to generalist pollinators with increasing forest loss, a trend that has been observed in some field situations. Additionally, network nestedness was not associated with of forest cover, but was positively related to patch size, also supporting results obtained in the field. This illustrates the potential value of ABMs to explore the dynamics of plant-pollinator networks, and understand the mechanisms underlying landscape change effects. This model could readily be adapted to many contexts and be used to aid landscape planning.

Keywords: Plant-pollinator networks, Complimentary specialization, Netlogo, Atlantic Forest, Network struture

T0854

Restoring and reconnecting (bumble)bee habitat in an agricultural landscape in the Netherlands

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As a response to concerns for the conservation of pollinator diversity, mitigation measures are being initiated in the Netherlands by a wide variety of organizations and private individuals. Most of these efforts focus on the restoration of floral resources, by sowing wildflower mixtures and/or improving terrain management. Such initiatives are, however, rarely part of a coherent management plan at landscape scale, even though connectivity between both new and existing habitat patches is essential to improve effectivity for bee conservation, as flight ranges of many bee species are limited to hundreds of meters. Here, we show first results of an initiative in which a wide variety of stakeholders, including e.g. local governments, nature managers, farmers and scientists have joined forces to increase floral resources in the Geuldal area (Southern Limburg, the Netherlands) in order to promote bee populations, with a focus on bumblebees. Effects of five different types of habitat measures (e.g. sown wildflower strips and alternative pasture and hedgerow management) are being monitored by comparing plant and bee diversity in comparison to control sites both within and without the Geuldal area.

Keywords: Pollinators, Floral resources, habitat connectivity, monitoring

P0077

Social-Ecological Beekeeping Units: Approaching bees as natural resource and component of human well-being in two different geographical sites in Galicia (NW Spain).

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In recent years, substantial decline in the abundance and diversity of pollinator insects have been documented. The loss of pollinators is susceptible to cause serious consequences both in biodiversity and in the productivity of crops. Bees may not be the only pollinators among insects, but it should be underlined that honeybees have a high pollinator efficiency. This is due to their eating and social behaviour. In addition, bee activity supplies many other ecosystem services of provisioning, regulation and cultural. Moreover, beekeeping can play a remarkable role in income supplement and the economic diversification of the most deprived rural areas.

In this study, we develop the concept of social-ecological-beekeeping units with the aim to identify the resilience elements of beekeeping as both a natural resource and a component of human well-being in two different geographical areas. For this, the conceptual framework of social-ecological systems is applied and the concept of the social-ecological unit is adapted to the peculiarities of beekeeping. We choose the two proposed areas on the base of assumption that having different biophysical and social characteristics, the functioning of the system should be equally different. As well, ecosystem services supply by beekeeping are analyzed, emphasizing their bundles and trade-offs. Finally, scenario planning is used to search for sustainable and desirable futures. The study seeks to contribute to the better knowledge of resilience of the studied systems, generating knowledge that facilitates decision-making. The expected results are a) the delimitation of social-ecological-beekeeping units, b) the characterization of the delimited social-ecological-beekeeping units and their governance mechanisms; and c) the comparative analysis of the resilience of the social-ecological-beekeeping units characterized.

Keywords: beekeeping, social-ecological systems, resilience, ecosystem services

T0083

From potential to practical: Conserving pollinators in urban public greenspace

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A recent focus on cities as conservation targets is justifiable as many rare or declining bee species have been documented in urban greenspaces. However, in order for pollinator conservation to succeed long term, we argue that far greater consideration for the humans in urban ecosystems must be made. In our experience, conservation potential is difficult to achieve when conservation goals, aesthetics, and safety concerns are not shared or communicated between city residents and conservation practitioners. Likewise, from a bee ecology perspective, many questions remain unresolved regarding optimal design and management practices for pollinator habitats in cities. Our insights are informed by a decade of experience studying the ecology of vacant land within Cleveland, Ohio, USA, a shrinking city that currently encompasses > 27,000 vacant lots. Within a network of these vacant greenspaces, we investigate economically feasible urban vegetation designs, with the goals of improving habitat quality for arthropods and beautifying the city. We have encountered many challenges in applying recognized socioecological frameworks to our study, particularly when establishing native plants as vacant lot conservation plantings. In this presentation, we will share our experiences as evidence of practical realities faced in following best practices, and highlight successful methods employed by our research team and others when implementing community driven conservation.

Keywords: vacant lot, pollinator, bee, socioecological, urban conservation

T_8801

Using floral strips in sunflower-dominated landscapes to promote wild bees and pollination services

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The intensification of agricultural landscapes has negatively affected the diversity and abundance of pollinators, with important repercussion in crop production. Sunflower (Helianthus annuus) is highly dependent on pollination by bees and, thus, it is one of the crops potentially more affected by the decrease in pollinator populations. Sowing floral strips along the margins or within the crops has been proposed by the European Union as a measure to mitigate pollinator crisis in agricultural fields. In this contribution, we analyze the effect of a sown floral strip (composed of a 12-species floral mixture) on the presence of bees and on seed set in adjacent sunflower fields. Twenty two sunflower fields were sampled during 2017 and 2018 in Cuenca (Spain). Eleven fields had floral strips sown and the other eleven fields were located close to semi-natural habitats but without floral strips (used as control). Pan-traps were used to collect bees in semi-natural habitats, in floral strips, and at different distances within sunflower fields. Visual counts were also conducted to estimate bee visitation rates to sunflower heads. Finally, we estimated seed set in all the studied sunflower fields. Our results show that the abundance of wild bees was significantly higher in fields with floral strips, although no significant differences were found in species richness and diversity of bees between floral strip fields and control fields. Visitation rates to sunflower heads and seed set were higher in the fields adjacent to floral strips. The effect of the floral mixture on bee abundance and seed set was more significant in the second year of sampling, due to a more favorable climate that increased floral coverage. Our results suggest that sowing floral strips in sunflower-dominated landscapes might be an effective agri-environmental measure to promote both pollinator conservation and agricultural production.

Keywords: Agricultural landscapes, Floral strips, Pollinators, Sunflower, Wild bees

T0863

How to use Citizen Science to promote action on wild pollinators

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Pollinators are in decline and this has great effects on the landscapes, both natural ones as urban and agricultural landscapes. The willingness of people and organisations to act on this is generally high, but it is a challenge to get this organised and form projects on landscape level, rather than individual organisations.
"The Netherlands buzz" is an example of such a project that has run in the Netherlands the past three years. It is a citizen science project in with different organisations (Naturalis Biodiversity Center, Natuur&Milieu, IVN Natuureducatie and LandschappenNL) work together to promote better food and nesting resources for bees in the environment. This is not only done by the four partners, but more players are involved: municipalities, educational institutes and citizens. Raising awareness is also an important goal that is addressed in this project as well as finding new partners that also want to help the bees. An overview will be given about the project, do's and don'ts and suggestions on how to start similar projects. There will be room for some questions and discussion.

Keywords: Citizen Science, Wild bees

P0089

Estimating effects of changes in human disturbance regime on honey production using native honey bee at landscape scale in tropical forests of Siem Reap Province, Cambodia.

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Honey is an important non timber forest product for cash income in Siem Reap Province, Cambodia. Local people put simple devices in shrub forests and native honey bees naturally colonize in these shrub forests utilizing these devices. Thus honey production depends on shrub forest and a large part of shrub forest are derived from small scale clear-cut by local people for fuel wood in this study area. Recently forest use of local people has been changing from traditional use to conversion into a large scale agriculture and monoculture plantation. If a shrub forest grow up to high forest, native honey bees will not colonize, therefore it is expected that shrub forests, where local people can perform beekeeping, are decreasing in this study area. We detected changes in human disturbance regime using time series Landsat images. Using time series tasseled cap wetness derived from Landsat image of 2004 to 2017, we detected clear-cut area and investigated following land use. This analysis revealed that number of a large scale clear-cut area had been increasing and large part of clear-cut area was converted into agricultural land (cassava) or monoculture plantation (oil palm, cashew nut). The change of human disturbance caused the decrease of shrub forest and negatively affected honey production in this study area.

Keywords: honey production, beekeeping, human disturbance regime, tropical forest, Landsat

Effect of landscape structure on pollination service by the native honeybee (Apis cerana) to hyuganatsu (Citrus tamurana) in Aya UNESCO Biosphere Reserve

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We examined the relationship between pollination of hyuganatsu (Citrus tamurana) (as an ecosystem service) by native honeybees (Apis cerana) and the landscape structure in Aya UNESCO Biosphere Reserve located in Miyazaki Prefecture, Japan. A total of 24 hyuganatsu trees were selected in 16 orchards, and the number of honeybees visiting each tree was counted in 2016 to 2018. A land use map of the study area was developed by photo interruption on the orthophoto for measuring areas of each land-use type around target trees as an indicator of landscape structures. A stochastic model for predicting honeybee visits, regarded as an indicator of pollination service, was developed using the area of natural forest and the total area of agricultural field and grassland as explanatory variables. The difference in bee-finding ability among observers was also considered as an observation model. The estimated model parameters suggested that both the area of natural forest and total area of agricultural field and grassland positively affected pollination services by native honeybees and these effects varied with year. The effect of agricultural land on pollination services by native honeybees was positive in this study, while this effect was negative in many other studies. This result of the present study is positive effects of long-term effort for organic and reduced-chemical farming promoted by Aya Town.

Keywords: pollination service, Aya UNESCO Biosphere Reserve, effect of landscape structure, Apis cerana, Citrus tamurana

P0024

Land use and climate interactions and their impacts on beekeeping livelihoods in the taita hills Kenya

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Smallholder farmers in sub-Saharan Africa can potentially improve their resilience to environmental shocks and stresses by diversifying their livelihood activities. Beekeeping is often a common additional livelihood to help smallholder farmers diversify and enhance their livelihoods, however, it is unclear whether this activity is resilient to environmental shocks and stresses. Using qualitative interviews across the Taita Hills, Kenya we investigated beekeepers' experiences with and perceptions about beekeeping. Results demonstrate that beekeeping can enhance the livelihoods of smallholder farmers, but only if key challenges can be overcome. Challenges highlighted in this study included: drought, pesticide use, deforestation and land use conflicts. The changing environmental conditions across the altitudinal range influenced the occurrence and scale at which these challenges were experienced, with drought featuring strongly in the lowlands and deforestation and land use conflicts in the highlands. This study finds that beekeeping has great potential for livelihood diversification; however, to realise this potential as a way to mitigate the impacts of climate change, an integrated approach to land use planning is needed, along with capacity building to manage challenges. This is particularly important if beekeeping is to be a sustainable livelihood diversification activity in mountain landscapes – such as Taita Hills – given predictions about increased aridity in lowland regions and population shifts to higher altitudes, which could drive further land use change and livelihood conflicts in the future.

Keywords: sustainability , adaptation, ecosystem , mountain , poverty

T0808

How to optimise the creation of beescapes through a EU wide mapping approach

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The decline of bees is one of the main and most worrying manifestations of biodiversity loss due to human activity. The creation of bee-friendly landscapes, particularly in agricultural areas, is key to revert current trends. In this presentation we illustrate two spatially-explicit, fine-resolution methods that can be applied to inform landscape planning and design when ecosystem services supporting agriculture should be enhanced. This is often the case for pollination and biological pest control. The first example is a model to map and assess the overall suitability of landscapes for pollinators, combining expert knowledge and field data on the role of seminatural-habitats in supporting pollinators in agro-ecosystems. The model was applied for the entire European Union at 100 m resolution, and can be used to identify areas where potential suitability for pollinators is low, as target of policy interventions (e.g. creation of flowering strips, enhancement of the ecological equipment). The second is a connectivity-based method that supports planning choices on where to establish or enhance Green Infrastructure in cropland at the fine scale, taking into account benefits from increased biodiversity and costs related to potential decrease of agricultural production or income lost. The approach can be used for example in landscape panning on in the implementation of rural development measures aiming at increasing biodiversity in agricultural land. An application in a high-intensity agricultural area in Northern Italy is presented to explain the potentiality and constraints of the methods. Based on these two exercises, current research gaps and needs in terms of knowledge and data towards the establishment of long term bee-landscapes are discussed.

Keywords: Bee-landscapes, Pollination, Biological Pest control, Green Infrastructure, Landscape planning

T0811

‘Bee landscapes’ as an effective strategy to counter the decline of pollinating insects; an example in the Netherlands

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Wild pollinators are declining in occurrence and diversity and numerous species are threatened with extinction. The decline of pollinators will have far-reaching consequences on terrestrial ecosystems and the landscape services that they provide. Of the European flowering plants e.g. 78% are pollinated by insects and 84% of European crop species benefits from insect pollination. Diverse initiatives all across the globe have emerged, ranging from detailed research on individual pollinator species to the creation of pollinator habitat by local actors.

‘Bee landscapes’ as an effective strategy

We propose ‘Bee landscapes’ as a strategy to restore the natural diversity and numbers of pollinators on a regional scale. We define ‘Bee landscapes’ as regional initiatives in which different stakeholders (business, authorities, NGO’s, citizens) join forces and undertake joint action to create a coherent habitat network for wild pollinators.

We present an example of the emergence of a Bee landscape in the province of South Holland (the Netherlands). In this area the regional authority, a large company and us as a science institute started an initiative to safeguard wild pollinators in the region. In this process we considered the region as a socio-ecological network and focused on the stakeholders in the first place. We facilitated the emergence of a social network around the ambition and provided them with scientific knowledge in the form of ‘building blocks’ for an ecological pollinator network. This enabled them to take effective and aligned action. Also it helped them to connect actions for biodiversity to other measures and ambitions to obtain other landscape services that they wanted.

Furthermore we will present success factors and obstacles for stakeholder networks that want to take collective action for biodiversity that were emerging from an analyses of a number of initiatives.

Keywords: wild pollinators, governance, socio-ecological networks, landscape

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Ecology, water and the city: strengthening water-sensitive planning with Nature-Based Solutions in urban contexts

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Worldwide trends in the increase of impervious surfaces and climate change are leading to the rise of urban flooding and degradation of urban ecosystems. Increased urbanization and precipitation extremes define changes in hydrological regimes that are challenging the traditional city drainage infrastructure and causing impacts on urban areas, communities, environments and economies. For these reasons, water-flow regulation represents a crucial ecosystem service in urban contexts, and land use planning and management strategies are focusing on the ecosystem's capacity to regulate water-flow as the most promising way to address the city's capability of dealing with flooding occurrence.
Parallel to these issues, there is a rising demand for the provision of ecosystem services and functions in contemporary cities, especially when looking at the increased urban flood risk levels associated with other urban issues as the Urban Heat Island, social degradation and soil sealing. This requires a shift from planning approaches that rely on conventional systems and devices (grey infrastructure), to those aimed at transforming the eco-hydrological footprint of the city by using nature to address the enhanced flood risk and the current urban challenges. Among the different Nature-Based Solutions available in cities, innovative drainage-related concepts and methods, such as Sustainable Urban Drainage Systems (SuDS), are based on an ecosystem urban drainage approach. SuDs aim at restoring or re-creating a more naturally-oriented water cycle in urban areas by minimizing the impacts from the development on the quantity and quality of the runoff, maximizing amenity and biodiversity opportunities and specifically slowing water down before it enters a watercourse. Integrating water as early as possible into decision process on land use and grey infrastructure design can achieve (sub)optimal solutions and implement efficient and effective best management practices. This symposium presents research, practical applications, methodological approaches on the use of SuDs to address water-related urban issues. Examples of SuDS experiences, designed and/or employed across international urban contexts, are welcome to explore and discuss the current state of art, what has been done and what may offer new possibilities to encourage a real transition to a more sustainable management of storm-water in cities. By comparing these different experiences, the symposium discusses possible trajectories of the ecosystem - based approaches to climate change adaptation in spatial decision making processes, such as urban planning of new water-sensitive developments or regeneration projects. The symposium also analyses barriers, challenges and lessons learned about the implementation of sustainable urban drainage systems in both new and existing urban developments.

T0545

Multi-target blue green infrastructures for urban regeneration and runoff control using a network of LID-BMPs. The case study of Naples

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Climate change and its effects on urban areas represent a current phenomenon of considerable importance for people life quality. The mitigation of climate change effects and adaptation to its impact requests new techniques and solutions. In details, the management of urban water drainage systems assumes a considerable importance on the control of runoff impacts.

The effects of extreme rainfalls on cities are well known, very often resulting in increasingly frequent flooding of urban centres.

In the new context of stormwater drainage management models, an important role can be played by innovative design approaches, the Low Impact Development (LID) technologies of Best Management Practices (BMPs) related to the control of urban runoff. The main goal of these strategies is to increase urban resilience to flooding risk.

In this paper the performances of the existing urban drainage system are analysed for a very densely urban area, recreating the pre-urbanization and post-urbanization "hydraulic scenario" through GIS applications.

The analysis phase will be followed by the implementation of possible design scenario using a methodology implemented to create a multi-target blue-green infrastructure. The methodology proposed is structured on three parallel and interlinked segments, aiming at urban space physical renovation (space), social and gathering spaces creation (sociality), environmental resources re-activation (runoff). It allows implementing a project/plan at district scale, acting not only on buildings and pipeline system performances but also on the provision of LID-BMPs in order to create an urban blue green infrastructure able to simultaneously mitigate the flash floods and provide a system of public spaces designed through a place-based social-driven approach.

Keywords: blue-green infrastructure, Nature-based solutions, Low Impact Development, Social spaces, Place-based design

T0948

Sustainable Urban Drainage Systems in Eastern Europe: an analytical overview of constraints and enabling conditions for the development of water-related Nature-Based Solutions

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The analytical overview is based on case studies in L'viv (Ukraine), Mahilĺoŭ (Belarus) and Pskov (Russia) with their distinctively different governance set-ups representative of broader Eastern Europe. The aim of the study was to understand, why Nature-Based Solutions (NbS) are not in use in the region, even though they appear to be appropriate choices to regulate urban flow. A specific research objective was to identify specific barriers and opportunities for the transfer of NbS and other technology and management innovations promoting Sustainable Urban Drainage Systems (SuDs). For this we have considered institutional enabling and disabling conditions related to policies and regulation, standards, dominating mindsets, historical backgrounds (i.e. so called institutional legacies) etc. The study results were informed by desktop research (including the analysis of relevant national legislation, standards, evidences from relevant initiatives and projects), as well as semi-structured interviews with relevant stakeholders (municipal servants, architects, NGO experts and activists, academics).

The broad issue is that as such, SuDs are not considered important to develop. This is supported by technical standards and building rules, which provide only for hard infrastructure, while NbS are recognised as risky from management perspective, they do not appear to be financially attractive and acceptable by stakeholders. This entails a broad range of more specific issues, such as deficit of local expertise for designing and managing SuDs, self-reinforcing consensus of technical experts and politics that other than NbS shall be preferred, and disfunctional mechanisms of public participation, where planning decisions are taken before the actual procedure of public hearings. We could not identify the conditions that would be clearly enabling, except that ready designs may have good chances, if they are externally funded and small-scale.

Keywords: Sustainable Urban Drainage Systems, Nature-Based Solutions, Transfer of innovations, Eastern Europe

The Benefits of Nature-Based Solutions in Urban Landscapes in terms of Improving Ecosystem Services; The Case of the URBAN GreenUP Project in Izmir

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In urban landscapes nature-based solutions (NBS) are generally accepted to help enhance environmental quality, such as improving air quality, minimizing heat waves and urban heat islands and supporting bio-diversity. Therefore, they have started to propose and implement these solutions for many European cities to tackle these problems. URBAN GreenUP is a five-year project funded by Horizon 2020 and aims to create evidence of the NBS's impacts in urban landscapes to fight climate change and build more sustainable environments in front-runner cities, like Izmir.

This paper aims to put some of the expected outcomes of the proposed plans through a test before implementation to evaluate the improvements in terms of ecosystem services and compare the results with baseline values of the NBS in two demo sites. Five regulating ecosystem services including carbon sequestration and storage, air purification, oxygen production and runoff retention are calculated by using the i-Tree Eco model. Results show that there are noticeable improvements for the ecosystem services generated by the demo sites. In conclusion, some recommendations are given to enhance the services in demo sites to attain the expected goals and overcome the challenges of creating more sustainable and resilient green areas in Izmir.

Keywords: nature based solutions, regulating ecosystem services

Watersigns. Memories of water and urban design strategies

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Every living being has a strong relationship with water. Without water there is no life. However, water could also give us death. The destiny of living beings is therefore linked to the destiny of water. Even the whole landscape is connected to the destiny of water. This is unavoidable since on average man is made up of about 70 percent of water and this very vital fluid is the most abundant material on earth. However, water does not have its own fixed form or state but, in spite of that, it molds our planet. This also happens because all the bodies of water present on the earth are in close relationship with each other through the hydrogeological and hydrological cycles. These cycles make all the bodies of water a single closed system that is influenced by the actions that are exerted on it. For this very reason, we can say that water preserves the memory of man's actions. Another way that water contains memories is in the artifacts that man has built to use it. These artifacts is actually a water sign, or a memory deposit linked to the use of water by man. Other signs that are fixed in memory and that also depend on water are the consequences of climate change. These types of memory contained and represented by water can offer a key to reading and perhaps even a solution to the problems that characterize the Anthropocene. In our time there is certainly no lack of technology tools to solve environmental issues, but even the most powerful technology might not be decisive if we forget the origin of the problems. This could be the key to understanding the urban design strategies that have solved the problems caused by water with water. The aim is to find, in the different forms of memory of water, those signs capable of inducing design strategies compatible with the environment and affordable to the inhabitant of the Anthropocene. Therefore, the study focuses on architectural works that solve environmental and urban issues with water and memory as design materials.

Keywords: urban landscape, low technology, awareness, sustainability, environment

Mapping Water

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Fresh water availability is one of the main challenges of the current century: water is both a critical resource and a responsibility now and for the future. Climate changes affect the hydrological balance and the current water management increases the vulnerability of the whole water system. Water is usually considered in planning, as a physical network, a single element or a topic for hydraulic risk, but it never exists as a functional and connected system at the basis of the evolution of life and landscapes. The common planning tools don't deal with water as a structural element of the basin territory, so the urban growth and the landscape changes add vulnerability to the whole territory and damage the water resources. Indeed, each land transformation affect the hydrological cycles, including the ground water: water is threatened any time that a plan is approved. Mapping hydrological functions allows us to understand how water and soil together form the landscape and to give water a new key role in plans and programs.

The water map has been developed studying the linkages between the main hydrological/ecological functions and the land cover elements. It allows to understand the specific role of each landscape tesserae in relation to water and to highlight the Ecosystem Services that derived from the water cycles. The water map, bringing out the relationships between water and soil, is a useful tool to characterize hydrographic basins, to assess scarcity and abundance of hydrological functions, to understand the relationships between settlements, human activity and water. Furthermore, to put water as a central issue in planning helps to increase the stakeholders consciousness of water.

The water map has been used in four different sub-basins of Po river basin, together with spatial indicators, in order to: develop the Ecosystem services mapping and assessment, orient Green and Blue Infrastructures plans and plans in general, choose suitable Nature Based Solutions.

Keywords: Water, hydrological functions, Ecosystem services, Green and Blue Infrastructures, Nature Based Solutions, water consciousness

Transitioning to a water-sensitive paradigm through and with Sustainable Urban Drainage Systems (SuDS)? - Analysis of transformative dynamics in Linz (Austria) and Toulouse (France)

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Conventional urban stormwater management is characterised by centralised technical and governance structures. While this management paradigm has become widespread in practice, its increasing ineffectiveness calls for a systemic transformation towards a water-sensitive paradigm. A promising strategy involves the development of Sustainable Urban Drainage Systems (SuDS), through which natural processes are mimicked to handle floods. This paper analyses the role of SuDS as vehicles of change. An indicator-based approach has been created and applied for the assessment of techniques, governance and policy at the neighbourhood and city level in Linz (Austria) and Toulouse (France). Findings show that the mere implementation of SuDS appears to have little effect on transitioning and radical paradigm shift in both cities. Little change has unfolded on the governance structures and the underlying engineering culture. Actually, the SuDS concept is only partly implemented and even in demonstration projects showcasing comprehensive SuDS deployment, the principles behind the conventional paradigm dominate. Demonstration projects seem to have limited upscaling effects. Thanks to engaged leading actors, ambitious approaches have been undertaken and shift is unfolding. Policy narratives are also underpinning this notion. Action on the social sphere of the system is urgently needed, if radical change is to be attained.

Keywords: Sustainable Urban Drainage Systems (SuDS), stormwater management, socio-technical transition, radical change, institutions

Estimating the Relationship of Urban Blue Infrastructure to and the Mitigation Effects on Land Surface Temperature in the Urban Environment

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Urban heat island (UHI) effect has various negative impacts on urban ecosystems and human beings. Mitigation of urban heat island using nature-based solutions is highly desirable. It was well known that urban green infrastructure (UGI) can effectively mitigate UHI effect. Urban blue infrastructure (UBI), i.e. urban surface water, has similar function with UGI, however, the mitigation effect of UBI on the urban thermal environment is not well understood. This study conducted in Wuhan city in central China aims to explore the relationship between UBI and land surface temperature, to examine the mitigation effect of UBI on surface urban heat island, and further to test whether the effect is influenced by the landscape feature of UBI itself using normalized difference water index (NDWI), maximum local cool island intensity (MLCII) and maximum cooing distance (MCD). Our results showed that (1) there was significant negative linear relationship between land surface temperature and NDWI larger than its threshold value. Therefore, NDWI was an effective biophysical parameter to delineate the information of UBI. (2) The surface temperature of UBI decreased logarithmically with the area of UBI. (3) MLCII and MCD can serve as the effective indicators to quantify the mitigation effect of UBI. The examined maximum cooling distance can range from 555m to 1275m, and the maximum local cool island intensity can vary from 7.2℃ to 12.8℃. (4) The mitigation effect of UBI indicative of MCD and MLCII was indeed influenced by landscape features of UBI itself. Quantitative relationships existed between the maximum local cool island intensity, maximum cooling distance and landscape indices of UBI, which demonstrates that the larger the area, the more complex the shape, the better the UBI can regulate urban thermal environment. These new findings can provide insights for urban landscape planning and improving urban thermal environment using nature-based solutions.

Keywords: land surface temperature, urban blue infrastructure, normalized difference water index, cool island intensity, cooing distance

LIM: inovative technology for designing, building and management of Green Infrastructure Projects

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This study proposes the Landscape Information Modeling (LIM) as a technology which, by using a programming code for Rhinoceros graphic software, simulates aspects of built and natural environments in order to support landscape projects that integrate environmental, social, cultural and economic issues. In order to structure the LIM, a set of design parameters were defined, characterized by their diversity, adaptation and responsiveness. The model includes socioecological and hydrological parameters, and several variations that can be proposed to address the best solution for each context. In this sense, the Jaguaré Basins were selected to apply the LIM and verify their feasibility and performance related with green infrastructure projects. The Jaguaré basin, located in the West Zone of the municipality of São Paulo, covers an area of 28.2 km². The integration of basin parameters and data enable the assessment of the degree of response and adaptation of green infrastructure technologies and, therefore, their intelligence and adaptability to the different scenarios. The LIM allows to generate diverse alternatives of green infrastructure project for the basins, foster a greater creative exploration of the different geometric patterns that the free spaces can assume in the urban fabric, assuming new structural properties and functions beyond traditional interventions, in order to allow us to really understand how these systems work in the landscape, instead of simply manipulate them by the construction, for instance, of a concrete reservoir, without understanding the consequences for the water, soils, plants, animals and people in an everchanging environment.

Keywords: Landscape Information Modelling, Green Infrastructure, Nature Based Solutions, Climate Change, Urban Adaptations

T_8747

Analyzing the spatial equity of the benefits of Sustainable Urban Drainage Systems – case study from Mediterranean urban context

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There is a rising demand to enhance the provision of ecosystem services in cities, especially when looking at the issue of risk of urban flood associated with climate changes and urbanization processes. Among the set of Nature-Based Solutions used in urban planning, Sustainable Urban Drainage Systems (SUDS) represent promising systems to reduce the negative effects of urban water run-off and to increase a wide set of Ecosystem Services in cities.
However, SUDS can impact differently in the urban fabric and generate positive effects on particular portions of cities. Such inequalities could be even more pronounced for SUDS that are developed in private areas, such green roofs or other private green spaces. Planning of SUDS should try to foresee not only the number of potential beneficiaries but also their location in the city, as water sensitive urban planning must deal with distributive, procedural and contextual dimensions of equity.
In this paper, we present different spatially explicit planning scenarios of SUDS location for a high density urban basin in Sicily. Particularly, we evaluate the relation between the quantitative performance of SUDS in terms of reduction of risk from water run-off and the number and spatial location of beneficiaries (intended here as residents of different social groups). Results suggest that benefits on the overall water run-off might not necessarily match the possible beneficiaries. Trade-offs among their overall performance and the number and location of people living close by the areas where run-off is reduced are highlighted.

Keywords: flood risk, sustainable urban drainage systems, spatial equity, spatial planning

T0668

Potentialities, uncertainties and opportunities for storm water modelling introduction in NBS urban planning

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Planning Nature-based solutions for water regulation in cities is a multifaced issue. The complexity of the relationships among the different urban components and systems (e.g. green/grey infrastructure, rigid/overlapping normative, perceived socio-economic benefits) coupled with new pressure factors as, climate change and economic crisis, call for innovation in the planning process aiming at a more flexible and performance-oriented approach. In this context, models could allow planners to understand the general behaviour of the system and, consequently, to decide strategic proposals in terms of NBS with respect to the considered processes. Indeed, modelling allows system complexity to be investigated by simulating the water fluxes underlying environmental and territorial processes at different temporal and spatial scales. However, a recognition of the potentialities, uncertainties and opportunities for modelling introduction in urban planning looking at different scales and objectives is required.

In this work, different applications of SWMM model for NBS and green infrastructure planning are presented considering several aspects as new developments/urban regeneration objectives, neighbourhood/district scale, climate adaptation/resilience plan. The case studies are all localised in the Apulia Region (Italy) as representatives of urban contexts with dry-hot climates, where the water availability and economic resources can be constraints for the NBS development. The comparative evaluation of these study cases then results in a first criteria list supporting the inclusion of modelling into the urban planning process of NBS for storm water regulation.

Keywords: modelling, green infrastructure, storm water managment, resilience, urban planning

The research on the application of water sensitive urban design in sponge city construction of China

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In order to achieve sustainable and comprehensive urban rainwater management, China has proposed the theory of sponge city, and with the rapid development of sponge city construction, urban rainwater management field has ushered in a rare opportunity for development. But in the process of implementation, sponge city construction has faced a lot of obstacles, such as the lack of overall view, so that to select site randomly and reconstruct the park blindly, professionals do not grasp the crucial concepts and planning key points clearly. Water sensitive urban design was first put forward by Australia, and because of the advantages it contains, rationality, scientific, sustainable, ecological and so on, it has been used extensively by countries around the world, and many countries constructed lots of successful cases. This paper analyzes the main characteristics, researching paths, researching contents of water sensitive urban design overseas, and on the bases of its achievements, combining with problems emerged in the construction of sponge city in China, and the status quo, demand, target of development of cities, this paper applies water sensitive urban design to the sponge city construction, to research the technique, construction approach and implementation strategy of the sponge city construction. So that we would promote and improve the research of sponge city, and look forward to its development trend, at the same time, to accumulate experience of sponge city construction and to provide a theoretical basis for rainwater management in China and better construction of ecological city.

Keywords: water sensitive urban design, sponge city, rainwater management

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Landscape monitoring: best practices and new developments for an integrated assessment of landscape change

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Landscapes are important not only for providing sustenance, they also impact the well-being and perceived quality of life of the population, encompass cultural values such as identity and heritage and are the basis for recreational activities and tourism. However, landscapes are rapidly changing across the world. Comprehensive methods for landscape monitoring are thus imperative, both for assessing change in landscape patterns and processes, as well as determining how this change is perceived by and affecting the population. Consequently, landscape monitoring initiatives have been launched at different geographical scales and with varying purposes. For example, in Europe, signatory countries of the European Landscape Convention are obliged to monitor landscape change, and we observe considerable efforts in the landscape research community to develop monitoring tools that are in concordance with the European Landscape Convention in that they measure both the physical and the perceived landscape. Various national programmes have been launched that are in line with the ELC. For example, in Switzerland, a comprehensive set of indicators has been developed and assessed in 2013 through a national survey combined with assessment of bio-physical indictors of landscape change, including artificial light emissions at night or changes in the diversity of agricultural usage. However, since 2013 the tools and datasets have evolved, and we are now presented with novel and innovate means to measure changes in landscapes and their perception. Other successful landscape observatories include the Landscape Character Assessments in the UK, the 3Q national landscape monitoring in Norway or more regional monitorings, including the Observatoire Citoyen du Paysage, Belgium, Wallonia and many others, including the monitoring of designated and/or protected areas. Outside Europe, similar initiatives have been launched at different scales, including local monitoring programmes (e.g. of protected areas) and regional initiatives. Because landscapes and societies are so diverse, a range of different approaches has been developed, with a considerable potential for cross-fertilisation of ideas between different programmes and between researchers from different fields (natural and social sciences and humanities). In this session our aim is therefore to bring together landscape researchers from a range of disciplines and settings to share their ideas and findings on successful, integrated landscape monitoring that couples physical changes as well as changes to how societies view and relate to landscapes (following the definition of landscape from the ELC).

The questions we aim to focus on are:

• How can we monitor landscape change in an integrated manner?
• What novel methods and data sources are available to address diverse perspectives on landscape?
• How can we address emerging trends and new challenges through monitoring?

To make the session broadly appealing yet thematically focused, we will invite talks related to different aspects of monitoring, including:

• Holistic landscape monitoring (interdisciplinary approaches, qualitative approaches, landscape character assessments, art-based approaches)
• Policy-making and landscape monitoring
• Concepts and landscape theories relating to landscape monitoring
• Novel methods and data sources for landscape monitoring (including social media)
• Participation in landscape monitoring, including citizen science

The talks may be conceptual in nature or present empirical data and findings. We invite speakers from a range of backgrounds, including, but not limited to: landscape ecology, geography, sociology, psychology, forestry, agriculture, tourism studies, remote sensing, GIS and others.

The landscape services of urban spontaneous forests in Padova (north-eastern Italy)

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Transposing scientific concepts to develop solutions to societal challenges is complex but also an important requisite when aiming to a sustainable future. Understanding the relationship between benefits linked to societal values and the landscape is therefore crucial. The concept of 'landscape services' has been introduced to describe the intensive pattern-process interactions connecting natural and human activities. The structure-function-value chain framework enables to incorporate landscape services into future design. In this study we investigate the value given by citizens to unconventional forest areas within an urban landscape as case study of the structure-function-value chain to further develop our knowledge on landscape services in cities. We have used three parameters able to capture the variability that can be observed in the urban green areas and that represent the three elements of the chain: size, species richness, and awareness. We selected 23 woodland spontaneously growing on abandoned areas in the urban landscape of Padua (north-eastern Italy), and considered their size as a spatially explicit characteristic of these landscape elements. We surveyed all the vascular plants to obtain the species richness of each forest patch that can be used as an indicator of the ecological function of these landscape elements. The people knowledge of one of these urban voids represents a clear indication of their awareness towards these green urban areas. In other terms, the people consciousness is a way of valuing the landscape elements. A total of 212 plant species were identified. As observed from a 3D scatter plot, these three variables are correlated. This indicates that larger is the forest area, higher will be number of species and higher is the possibility that citizens are aware of that forest. The observed structure-function-value chain can help to delineate specific indications and value these urban landscape features within urban planning strategies.

Keywords: landscape services, spontaneous afforestation, human awareness, urban wilderness

T0219

Landscape monitoring and performance evaluation to establish learning landscapes

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Integrated landscape initiatives (ILIs) are an effective process to develop landscapes pursuing the Sustainable Development Goals (SDGs). Such initiatives envisage a multi-sectoral process for landscape development. A common understanding of the landscape, a visioning process and thereon based negotiations, the development of objectives and the design of measures are usually considered as good practice. Iterating this process prepares the floor for a "learning landscape". A learning landscape adapts to pressures and pulses and hence, is more resilient. However, we are often lacking a sound monitoring and evaluation (M&E) system that considers local and overarching qualities and enables explicitly the learning. In two case studies in Switzerland, we developed an M&E scheme that covers three aspects of an ILI: process, initiative outputs, and the performance of the region.

For the development of this scheme, we monitored process quality by a set of closed questions that were responded by participating stakeholders once in every project phase. In addition, we defined initiative- and region-related indicators in the landscape initiative. We used them for deliberating possible future development pathways while employing land-use change model outputs. The same indicators were foreseen to use in the follow-up monitoring. Process indicators made the extent to which participation in the process was successful transparent. Particularly, the perception of stakeholders' inclusion was useful for these reflections. Region indicators assessed the economic, social and environmental dimensions and provided an overarching analysis of the situation. They assessed the long-term effects of planned measures. Initiative-specific indicators measured the quality of the process outputs, in particular, recreation and agricultural road infrastructure was focused.

In this contribution, we discuss how the landscape performance indicators help create a learning landscape.

Keywords: lanscape, monitoring and evaluation, landscape development, process

Monitoring mountain summer farming landscapes in Norway through an area frame survey

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From 2009 to 2015 NIBIO supplemented its national monitoring programme of the agricultural landscape with an area frame survey of mountain summer farming areas. A representative sample of 300 randomly selected 5x5km squares was field-surveyed. Various map data, agricultural databases and place names were used to focus the field recording. Parameters registered per site included accessibility, organisation, current use, woodland regrowth, fences, scenery, and location of buildings. For each building, type/function, construction, wall cladding, roof material and state of repair were recorded. In addition, other cultural heritage objects were registered, e.g. grave mounds, charcoal pits, and pollarded trees.

C.1700 mountain summer farming units were surveyed. Only 4% of them were still used for milk production, 29% included fenced hay meadows or pastures in use, 57% were in leisure use only, and 27% were abandoned. A minority of the fenced areas were still open vegetation, the others were in succession to woodland regrowth or planted with forest. More than 7000 buildings were observed, including barns, farm cottages, holiday cabins and buildings for other purposes like milk processing or storage, machinery, etc.

In general summer farm locations survive because they are converted to leisure use, while buildings that have lost their function are neglected and left to decay. Regional patterns could also be detected. For example, sites in East Norway were most easily accessible, while West Norway had the largest proportions of completely abandoned units and of buildings in ruins.

Geo-referenced and digitised results provide a basis for repeat surveys. Data can be used to evaluate the effectiveness of agricultural and environmental policies, and contribute to further policy development. They can also serve as a frame of reference for evaluating situations in smaller study areas.

Keywords: Cultural heritage, Land use change, Shieling, Systematic spatial sampling

T0109

Landscape Ecology Time Analysis of Wetland in Pesnica Valley, Northeastern Slovenia

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Pesnica valley was in year 1953 one of the largest wetlands in Slovenia. The agrarian operations between years 1964 and 1968 destroyed wetlands. Nevertheless, there are still endangered plant and animal species present. The research was based on aerial photos from years 1953, 2006, 2010 and 2013 on the basis of which we have made vector maps with polygons of land use categories in the programming environment CartaLinx. The field visits of research area served us for the precise determination of land use. Vector maps were exported in programming environment Idrisi32 and transformed into raster maps. With comparing of thematic electronic maps of individual categories of land use for years 1953, 2006, 2010 and 2013, we got insight in changes which occurred from year 1953 to 2013. Our focus was on five major categories of landscape categories which were further specified in subcategories: agricultural and areas with agricultural activities, forests and areas covered with trees, reinforced and related areas (building and roads), wetlands and related areas, waters.

In year 2013 ecological network was composed of areas overgrown with trees, water surfaces, land reclamation ditches, dead riverbeds, floodplains and surfaces which are due to »lack of maintenance« overgrowing - succession.

Although entire wetland has been destroyed there are still present remnants of wetland (river beds, meadows), some of old river beds have been incorporated in new waterbeds. There have been new landscape elements created – reclamation ditches. They have enabled endangered species to survive destruction of wetland. Their spatially distribution enables migrations and recolonisation of landscape elements after “maintenance work” of water management company.

Important is to mention ecotones which have important role in the landscape and are reducing negative impact of agriculture on landscape elements, are home for endangered species, enables migration and food source for animals.

Keywords: time analysis, wetland, landscape diversity, deaf space, landscape structure

Time-series Change of Ecological Services at the Area of Complex Earthquake Disasters by Analysis using InVEST

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There is a huge number of researches on the eco-application of proceeding in various countries and it is vitally important to verify their validity. Here, InVEST refers to the ArcGIS tool for the integrated review for ecological services and its compensation. When compared with other countries in a global point of view, Japan is a country with high number of natural calamities, significant causalities, economic loss and damages by earthquakes, typhoons, and eruption. The damage is especially big when a hazard comes right after another one.

Complex disaster refers to the occurrence of multiple disasters instead of one. Such as, in 2016, Kumamoto prefecture was hit by earthquakes with magnitude as large as 7 and within another 2 months, by heavy rain and the damage was tremendous.

This research focuses on the analysis of the changes of the land cover as reflected in satellite pictures of the whole Kumamoto prefecture taken after the complex disaster, the earthquake in April 2016 and heavy rain in June 2016. Also, it's a review on the ecological services with the use of InVEST. A special focus is paid on the review of the soil retention and the quality changes of the eco-habitant as reflection of the disaster damage reduction measures. In addition, there is an analysis on the change of land coverage on area-unit level with Mashiki-machi, the epicenter, as the target. Furthermore, projection was plotted for the ecological services implemented as the reconstruction plan.

Keywords: Eco-DRR, Kumamoto Earthquake, ecological service, Complex Disasters

Identification of landscape character for urban waterfront landscape based on HLC and LCA：A case of urban waterfront area, Wuhan

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As the birthplace of the city, the waterfront bears witness to its development history. However, the constructive destruction of modern cities leads to the disruption of spatial structure of traditional cities, monotonous of urban cityscape and the loss of urban characteristic. This phenomenon is attributed to two aspects: (1) Ignoring the integrity of the city's natural background and urban cultural background, the landscape elements of urban waterfront cities are fragmented in the spatial dimension. (2) Neglecting the analysis of urban evolution and development mechanism leads to the disorder of urban landscape elements in the time dimension.

LCA and HLC are important methods and tools for landscape character assessment. HLC pays attention to time depth, which is an effective segment of historical landscape character recognition. It is mostly used for local administrative and site scales. LCA can accommodate more landscape character and has obvious advantages in the identification of landscape character at national and transnational scales. They are complementary to each other, providing a way to identify urban landscape character types and integrate waterfront urban landscape elements. Therefore, this paper draws on LCA and HLC to explore the possibility of integrating urban landscape elements on the local scale of China and improving the self-identity of the area.

This paper will take an empirical research in the Wuhan waterfront area which is a typical space emerging by the natural and cultural landscape resources. The steps for identification of Landscape character based on HLC and LCA as following: Firstly, analyzing the characteristics of the natural and cultural context and the spatial evolution, along with selecting the cultural and natural factors, such as mountain, water, building density, building height, time depth, visual perception and other essential factors. Secondly, identifying landscape character types in different period by superimposing and clustering the data based on GIS platform. Thirdly, Collect public comments based on social networking platforms as identifying public perceptions. Finally, recommendations for resource integration and environment optimization are provided.

Keywords: Landscape character, Shanshui city, Cityscape, Wuhan

Physical and social aspects of forest preference and recreation – approaches to a comprehensive monitoring

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Forest monitoring normally either focuses on physical aspects such as tree species, stand structure, etc. or on social aspects such as forest recreation and preferences. However, in forest recreation, both the physical characteristics of the forest as well as the social aspects play an important role. The question arises whether National Forest Inventories (NFIs) and socio-cultural forest-monitoring surveys could be combined to explain and possibly even predict forest recreation patterns from forest-related and visitor-related data.
In order to achieve this, we tested two approaches. In the first one we took the most relevant parts of the questionnaire from the Swiss socio-cultural forest-monitoring survey and used them in a forest visitor survey at NFI sample plots. In addition, visitors were asked to rate the visual attractiveness of the NFI-plot and the surrounding forest. NFI-data were collected from 4 systematically arranged 50x50 m plots, covering the forest area visible to visitors from the footpath. Multi-level modelling combining both plot-related inventory data and visitor-related questionnaire data showed that forest attractiveness is determined by both social and physical factors.
In the second approach we used photographs of NFI sample plots with known forest data in an online survey in the whole of Switzerland. Again, the respondents were asked to rate the visual attractiveness of the forest depicted. Regression models and multi-level modelling were again used to combine physical forest data and questionnaire data to predict visual attractiveness and recreational usage of forest.
Results of both studies will be presented and compared. Ultimately, an evaluation of the results of both approaches can provide indications to how a comprehensive forest recreation monitoring including both physical and social aspects could be conducted effectively.

Keywords: integrated forest monitoring, preferences, recreation, multi-level modelling

Extracting perceived landscape properties from texts for Landscape Character Assessment

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Landscape Character Assessment (LCA) is a pioneering and widely recognised framework for landscape assessment and monitoring. However, it has been criticised as being dominated by expert views and by overemphasising visual aspects of landscapes. Furthermore, methods applied in LCA are rarely updated and often used for relatively small territories. We have previously showed the potential of texts in travel reports and books to extract not only visual, but also aural perception of landscapes. And in this work, we will explore how such information can be collected and integrated into existing LCA of the English Lake District. The challenges we will address in our ongoing work are threefold. Firstly, to identify online texts describing our landscape of interest we need to have a list of search words that covers different groups of landscape users (e.g. 'incidental outsider' vs. 'empathic insider'). Secondly, found texts should be filtered in order to keep only texts describing first-person landscape perception and assigned to areas of distinctive landscape character in the Lake District. Finally, added value to the LCA framework will be assessed through interviews with experts.

Keywords: landscape monitoring, landscape character assessment, user generated content, natural language processing

P0033

Landscape Dynamics Typology Tool (LDTtool) – A new way to assess landscape dynamics

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Habitat loss and fragmentation are pointed as the major causes of biodiversity loss and thus regarded a central issue in conservation biology. Landscape composition and configuration changes can co-occur and interact, but the separation of their independent effects is necessary to better understand the overall impacts. Much work has been done recently on this topic and new bibliography has emphasized the vital need to distinguish the different effects of amount and geometric changes in landscapes because, for instance, habitat loss is not the same as habitat fragmentation per se and their impacts are often distinct. The Landscape Dynamic Typology (LDT) method is based on a list of "Types of Dynamics" that can occur in a binary landscape, obtained via combination of two metrics that can increase, decrease or remain the same in a period between two dates: Area to assess composition and Number of Patches to assess configuration. The LDT has a wide range of application in topics related to biodiversity conservation, invasive species, ecosystem services and resource planning. Its usage can be very straightforward using a Geographic Information Software but, depending on the input data, the work load can be heavy. For that reason, we developed the LDTtool, an ArcGIS toolbox that implements the LDT within ArcMap. The LDTtool is designed to facilitate and automate the application of LDT method. One of its strengths is the simplicity of the underlying method established on basic spatial metrics. That also makes the results expressed in values variations and maps easy to interpret. The possibility to adjust some parameters such as analytical grids and the minimum patch size, are also advantages at the user's disposal. LDTtool is an easy-to-use tool that adds value to landscape assessments, mainly if land use, land cover or habitat changes are a central topic of the study. In this work we present the toolbox functionalities and provide a demonstration of its application.

Keywords: landscape dynamics, landscape composition, landscape configuration, land cover change, spatial metrics

Flood hazard at coastal regions: Change detection and dominant influencing factors identification

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Understanding the characteristics of the flood hazard is a prerequisite for the quantification of climate change impacts and planning effective adaptation strategies. Empirical analysis of the influence factors on flood hazard, however, remains inadequate. Here we took one of the most densely urbanized regions in the world, Pearl River Delta, as an example to analyze the long-term changes in flood hazard in the last decade. Using MODIS 8-day composite product and surface water fraction mapping convolutional neural network developed in previous studies, weekly inundation maps were produced, which are further used to generate flood hazard maps in Pearl River Delta. Together with the nighttime light data, socioeconomic data and the climate data, the long-term relative impacts of climate change and urbanization change on flood hazard were analyzed. The results would provide a good reference for flood control and water resource management at coastal regions, especially in the metropolitan areas.

Keywords: Flood hazard, Change detection, Influencing factors, The Pearl River Delta

Survey on community livelihoods and landscape change along the Nzhelele and Levubu river catchments in the Limpopo Province, South Africa

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Global environmental change (GEC) is one the pressing global challenges in attaining sustainable development. Landscape change is a major driver of GEC and it affects climate change and sustainable livelihoods of rural communities. How humans interact with the landscape has implications for environmental change. Changes in the environment due to land cover and land use can negatively affect the functioning of the ecosystem. Nevertheless, comprehending the proximate and underlying drivers of landscape change are often poorly understood in particular in small rural communities in developing countries such as South Africa. Accordingly, the aim of this study is to determine the underlying and proximate drivers of landscape change in Nzhelele and Levubu river catchments Limpopo province from 1990 to 2017. The two catchments where selected because they lie in Venda, a former homeland in apartheid South Africa, characterized by environmental degradation and poverty. Moreover, less attention has been focused on determining the proximate and underlying drivers of landscape change in the study area yet comprehending these drivers are crucial for sustainable livelihoods, GEC, climate change mitigation and adaptation. A survey and focus group discussion where utilized to glean the proximate and underlying drivers of landscape change from the villagers. In addition multiple satellite images for 1990, 2000, and 2017 where obtained and a land use land cover analysis using object based image classification and analysis was conducted to identify the location and extent of landscape change. The results indicate that the agriculture, urbanization, deforestation and soil erosion are the major proximate drivers while the economy, livelihoods, politics and culture are the, major underlying drivers. A framework for showing how intertwined the underlying and proximate drivers of landscape change and how it relates to GEC, sustainable development and climate change is also developed.

Keywords: Landscape change, Livelihoods, South Africa, drivers

T0352

Exploring sensitivity of perceived elements in landscape to change through user-generated content

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Landscape indicators should take into account not only notionally objective physical landscape properties, but also ways in which landscapes are perceived. However, just as physical landscapes are not homogenous, neither are the communities using them. The potential of user-generated content or social media has recently gained attention as a potentially efficient source of information about landscape use over large spatial extents, especially with respect to recreation and landscape preference. However, little effort has been made to link ways in which landscape is described in such sources to the potential for landscape change. We report on an ongoing study analysing not only which landscape elements (e.g. meadows, hills or forests) are described in user-generated content, but also the properties of these landscape elements and their potential sensitivity to change. Furthermore, we stratify our data according to a simple classification of users based on a) their origin (e.g. are these tourists or locals) and b) their activities (e.g. how do these users "consume" the landscape). Our aim is to demonstrate how user generated content can provide us with deeper insights into landscape perception and preference than simple counts of visitation, and in turn provide outputs which can feed into landscape indicators in the long term.

Keywords: User generated content, Landscape indicators

T0703

Drivers of change in a coastal landscape: Case of The Yali wetlands, Central Chile.

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Worldwide, there is limited knowledge regarding coastal landscapes, particularly in topics related to dynamics and evolution over time. These landscapes although, are considered one of the most fragile and complex to be studied, mainly due to the interrelation of marine and terrestrial ecosystems.
Central Chile had witnessed a significant landscape transformation, including the expansion of forest plantations and urban expansion generating conurbations along the coast. In this context, the Yali coastal system runs from the commune of Algarrobo in the north and Santo Domingo in the south, on the coast of the Valparaíso region. This system has large dunes, forest, and sclerophyllous scrub and a significant presence of wetlands, highlighting the Yali wetlands. All these systems are highly fragile and complex, which are affected by the anthropic activity of the sector, mainly related to the forestry industry and urban expansion. This research sought to analyze the central transformations of the coastal landscape of Yali, for which Landsat images were used between 1989-2018, which were radiometrically and topographically corrected. The classification was made using the Random Forest model, where in addition to the bands the NDVI, NDBI, NDWI, EVI, ARVI, SAVI indexes were used. An analysis of landscape metrics was also carried out through the FRAGSTAT program. The results show an increase in the categories Forest plantation (+7000 ha), Urban areas (+2000 ha), Croplands (+5000 ha), and Scrublands (+9000 ha). The categories that showed a decrease in the area were Grasslands (-30000 ha), Scarce vegetation (-4000 ha) and Wetlands (-100 ha). Concerning landscape transformations, the changes associated with productive activities stand out, but also natural processes related to ecological succession. The metrics showed a homogenization of the landscape associated mainly with the expansion of forests plantations.

Keywords: Landscape Changes, Wetlands, Central Chile, Random forest, Coastal landscapes

T0884

Assessing the "Landscape quality" and the Cultural Ecosystem Services through quantitative and qualitative indicators: an overview of the literature

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The Landscape quality assessment is a central issue for many National or European policies. The European Landscape Convention requires the establishment of Landscape quality objectives for all places of life, both ordinary and outstanding.
How to assess the Landscape quality? Which indicators allow to measure it?
The open landscape (rural, natural) or urban (especially of the ancient centers or settlements) is a palimpsest of historical permanencies. The historical and perceptive dimensions (linked to the senses and to the meanings attributed by people) –which are parts of the Cultural Ecosystem Services– make the landscape an evidence of the nature-culture relationship established over time.
Many studies for the assessment of the historical and perceptive landscape components are of qualitative nature. Quantitative landscape indicators are mainly used to assess other landscape components (ecological indicators, geomorphology, land use, etc.).
The challenge is the integration of the qualitative/quantitative approaches and to define indicators to assess the historical and perceptive landscape components, able to be both measurable, achievable and context specific, mutable, due to the change over time and space of meanings, values and people behaviors in response to economic or social drivers.
In this context, the aim of the contribution is to provide, by a literature survey, a scientific framework that integrates contributions from different disciplines currently working on the topic (economy, sociology, heritage preservation, ecology, territorial and landscape planning). The contribution will highlight: 1. Methodological approaches, proposed indicators for the the assessment of historical/perceptive landscape dimensions, limits and potentialities; 2. Operational repercussions mainly at the Italian level (e.g. in the definition of assessment procedures for landscape compatibility of territorial transformations, or in relation to the Payments for Ecosystem Services).

Keywords: Cultural Ecosystem Services, Landscape assessment, Landscape quality objective, Landscape indicators, Landscape heritage

T0444

Monitoring the visual landscape quality based on farm census data

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Agricultural land management shapes about 40% of the EU-28 surface (Eurostat) and about 35% of the surface of Switzerland (FSO). Agriculture thus has a major impact on the visual aspect of the landscape. Depending on the type of activities, agriculture provides services and causes disservices for the visual landscape. In order to measure these services, a composite landscape indicator was developed to be included in the Swiss agricultural life cycle sustainability assessment. The composite landscape indicator consists of the two following independent sub-indicators: the 'Area weighted Preference value' and the 'Aggregated Diversity Indicator'. The two sub-indicators consider the preference values of the most frequent crop types and farmland features, which were collected by means of a survey based on a representative sample of the Swiss population. The indicator follows life cycle assessment (LCA) standards regarding its conceptual base and the aggregation rules. The solid conceptual base of the applied landscape aesthetic theory combined with LCA principles makes the indicator reproducible and independent of the observer, while preference values add human values, which is essential when reporting on visual landscape quality. Data on the farm's land-use activities is the base to calculate the composite indicator. This makes the indicator attractive for performing a systematic monitoring in Switzerland, as no additional data has to be collected. In a first application, based on a national farm census, 91% of Swiss farms were evaluated. The remaining 9% were not evaluated since preference values for a substantial proportion of land-use types such as vegetables and vineyards are missing

Keywords: Indicator, Visual landscape quality, agriculture

An integrated monitoring of landscape perception

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Landscapes across Europe are changing rapidly. For planning and policy-making it is important to monitor these changes and how they impact landscape perception by the public. We take the example of the Swiss landscape monitoring programme as an integrated, indicator-based assessment of changes in physical landscapes and in people's perceptions. Since 2008, more than 30 indicators relating to physical and perceptual aspects of Swiss landscapes have been developed and empirically measured. Currently, the Swiss landscape monitoring programme is being methodologically evaluated and developed further. Through this process, new landscape relevant topics were identified that have so far been lacking in the landscape monitoring. We thus propose the addition of a set of new indicators to assess aspects of landscape perception such as dark skies, tranquillity and soundscapes. These new indicators are operationalized and assessed jointly with existing perception-based landscape indicators (including e.g. perceived landscape beauty and place identity) through a written survey among residents in Switzerland (n=800). We present results from this survey and highlight the influence of different variables (e.g. physical landscape indicators, socio-demographic variables) on different aspects of perceived landscapes. Furthermore, we explore the combination of physical and perception-based indicators into an integrated model of landscape quality.

Keywords: landscape monitoring, social and cultural landscape values, place identity, perceived landscape change

Integrating wilderness qualities into landscape monitoring

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Contemporary changes in lifestyle and a growing urban population have led to an increasing demand for wild, untouched nature. Although such wilderness areas are often expected to be found in mountain areas like the European Alps, many of them are currently put under threat due to land use change, tourism and infrastructure projects. Despite these developments and its significance for society, wilderness remains a landscape quality that has largely been neglected by the wider landscape research community so far. In this study, we approach wilderness as a culturally constructed concept that emerges at the interface between people and their environment. Through the use of a multi-methodological study design, we aim to 1) explore people's understandings of wilderness in the mountain region of South Tyrol (Central Alps), 2) to quantify and map the study site's wilderness qualities according to these understandings, and 3) to compare these wilderness maps with the results of a standardised, expert-based mapping approach (Radford et al. 2019). Our results reveal three distinct wilderness understandings (i.e. 'Area with no human impact', 'Remote and large area', and 'Area where nature can self-develop') that differ in terms of selection and weighting of wilderness attributes. When translating these wilderness attributes into spatial indicators, three wilderness maps are produced that differ in their localisation, spatial extent, and distribution of wilderness qualities across elevation classes. Comparing these maps with an expert-based approach further reveals that the latter is capable of capturing highest wilderness qualities of all understandings but without differentiating between them. Based on these results, this presentation reflects on the complexity associated with the quantification and mapping of wilderness qualities at the interface between humans and the environment, and discusses potentials and limitations of its integration into landscape monitoring.

Keywords: wilderness, landscape quality, landscape perception, mapping, cultural ecosystem service

Symposium 43

Planning with nature for sustainable landscape development: lessons-learned from around the world

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Planning with nature for sustainable landscape development can be understood as developing integrated strategies that consider nature-based solutions (NBS). Such solutions are actions which are inspired by, supported by, or copied from nature to address societal challenges such as the prominent sustainable development goals (SDGs). By harnessing ecosystem processes, NbS shall not only alleviate challenges and contribute to the SDGs, but also induce several co-benefits to human well-being. In addition, NbS are claimed to often be more cost-effective than technical alternatives.

For many NBS, a successful implementation requires transdisciplinary planning and design at the landscape scale, integrating information from various disciplines and involving diverse actors. Supported by initiatives from IUCN, the European Commission, the US Army Corps of Engineers and others, an increasing number of projects are currently underway around the world which take up and apply the idea of identifying, planning and implementing nature-based solutions.

The objective of this symposium is to synthesize the emerging knowledge and experiences in planning with nature and NBS at the landscape scale. In particular, we are interested in empirical studies focusing on theoretical categorization and synthesis of NBS, on provision of spatial information relevant for planning, on approaches for identifying and integrating relevant actors in the planning process, on the creation, assessment and valuation of nature-based and technical solution options regarding their contribution to the alleviation of challenges and the attainment of SDGs. Finally, we are interested in potential impacts the planning processes had in practice and on the governance structure ensuring the implementation of NBS.

Planning nature-based solutions in the Lahn river landscape

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Nature-based solutions (NBS) have the potential to help addressing societal challenges in sustainable ways. For example, NBS in river landscapes such as revitalizing floodplains not only decrease flood risks for downstream communities but also provide benefits for a set of other ecosystem services and biodiversity. The aim of this contribution is to create and assess spatial scenarios for the development of NBS in the Lahn river landscape in Hesse, Germany. The research questions are: What NBS are potentially suitable to address key societal challenges for the local communities? What are plausible spatial scenarios for the development of NBS in the Lahn river landscape? What impacts might those scenarios yield, both regarding the societal challenges as well as concerning the provision of co-benefits? Our research design consists of a transdisciplinary landscape planning process. Societal challenges are derived from outputs of stakeholder workshops. We identify suitable NBS in a literature review and design scenarios that differ in the pathways of change and comprehensiveness of NBS uptake. The scenarios integrate local knowledge with expert-based insights regarding the allocation of NBS in a landscape context. Finally, we estimate scenario impacts using GIS-based ecosystem services models. Results include a systematic overview of local challenges and sustainable development goals, suitable NBS, and their potential benefits. We present three scenario pathways and spatial futures of NBS development. Impact assessments shed light on specific implications of each scenario pathway. We find that a full NBS scenario pathway presents greatest overall benefits, but will require political will, public support, and institutional change. Taken together, novel evidence is provided regarding suitable methods and potential results of a landscape planning approach to NBS design. We close by identifying frontiers for further research and experimentation in practice.

Keywords: landscape planning, nature-based solutions, ecosystem services, transdisciplinarity, scenarios

A health-data led approach to green and blue infrastructure and health studies-A case study of Ireland

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Provision of evidence based information is needed for incorporating green and blue infrastructure designs into the human environment for health benefits. Most empirical studies that assess or quantify the human health benefits of green and blue infrastructure are EITHER based on the availability of data on the location of green and blue infrastructures i.e. green and blue infrastructure led (GBI-led) OR alternatively on research interests on the impacts of green and blue infrastructures on particular health conditions (Health-led). While these two study orientations (GBI-led and health-led) usually lead to conclusions that confirm the impact of the presence or absence of green and blue infrastructure on human health, they usually exclude the possible influence of other spatial health determinant factors e.g. socio-economic factors such as poverty, level of education, background, ethnicity etc… Consequently, in order to avoid this biases, this study explored a health-data led approach, which first identifies clusters of good and bad health outcomes in Ireland at multiple scales (using Anselin Local Moran's I spatial clustering algorithm), before confirming their associations with the presence or absence of green and blue infrastructures. The results indicate that even though green and blue infrastructure has detectable impacts on health outcomes in Ireland, other factors such as socio-economic deprivation also play a big role and should therefore be given equal consideration within national health planning frameworks, schemes and discussions. Furthermore, findings from working at multiple scales under this study (using the health data led approach) also suggests that guaranteeing more effective healthcare planning (through more deliberate green and blue infrastructure designs in combination with other social and economic strategies) requires the provision of georeferenced, multi-temporal health data at more scales and/or planning units than currently available.

Keywords: Health-data led, Green and blue infrastructure led, Health led, Green and blue infrastructure, Socio-economic deprivation

Regional policies to better protect natural heritage of peri-urban open spaces: example from European Union

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Each year in the European Union more than 1,000 km² of land is used for new housing, industry, roads or recreational purposes. About half of this surface is actually "sealed" Many of those land use changes are related to urbanization processes of the landscapes, but are taking place beyond the administrative boundaries of the cities in the cities fringes or in the extend of functional urban areas. Due to that, the new transitional peri-urban landscapes (PULs), which are joining urban, rural and natural characteristics, emerge. New developments taking place in the PULs encourages the process of adding new urban functions into different parts of PULs and foster significant investment pressure and diminishing of peri-urban open spaces (PUOS). This unfavorable situation affects the natural heritage of PUOS.

In our research we performed a comparative study of six case studies regions, located in four main parts of the European Union, namely North (Germany – Saxony Anhalt), South (Spain – Basque Country), West (Belgium - Flanders) and East (Hungary - Hajdú-Bihar, Poland – Mazovia and Slovenia – Kranj). In the first part of the study we analyzed land cover changes in those regions, aiming to assess the processes of PUOS diminishing and the expansion of urban fabric into PUOS. In the second part of the study we performed analyze of the policy instruments, which are the binding governance documents in the case study regions at the regional level. Structured interviews were conducted with local experts, working in the field of policy making in the case study regions. With the second step of our analysis we aim to assess the necessary improvements to the policy instruments, aiming to better protect natural heritage of PUOS.

Our study delivers important lessons learned related to the governance of natural heritage in PUOS, which are transferable within and beyond European context.

Keywords: Governance, Peri-urban open spaces, Regional policies

Place attachment through interaction with urban green space: a cross-cultural study

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People's quality of life is considerably influenced by the possibility of creating a bond with a place and attaching meaning to it. This so called place attachment is driven by (1) physical place characteristics, (2) residence length and (3) social neighbourhood properties. Physical place characteristics govern place attachment mainly through the perceived/experienced locations. Due to global mobility and migration – mainly to urban areas – residence length, and in many cases social neighbourhood quality, tends to be decreasing. It is largely unknown how these trends affect place attachment, in particular how the shrinking length of residency in today's global societies affects place attachment. We know that urban green space (UGS) can foster place attachment. But how easily and quickly can mobile societies understand and appropriate UGS that has been established over centuries? How is UGS perceived by people who have been socialized in environmental surroundings that differ considerably from those of their current (temporary) residence? Hence, little is known about the differences in perceiving and utilising UGS by migrants, who have experienced the cognitively decisive phases of childhood and adolescence in different cultures and environments. This paper examines the role of UGS in the establishing feeling attached to place among local and Afghan immigrants in Iran. The data were collected with the use of in-depth interviews and open discussions with 18 locals and migrants conducted in urban green space in Iran. We used two different types of urban green i.e. Persian garden and contemporary urban green space. The findings show that identity and cultural background play a significant role in describing UGS and attaching meanings to it. When people are describing UGS, they refer to an innate and natural characteristic which comes from their culture and childhood images.

Keywords: Place attachment, urban green space, migrating people, meaning of place

Territorial fragilities in Italy. Which role for the landscape design.

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The reflection on landscape I would like to propose is framed within a research project carrying out by the structure I belong, the Department of Architecture and Urban Studies (DAStU) of the Politecnico di Milano.
Selected by the Italian MIUR as part of the Department of Excellence initiative, it proposed an interdisciplinary research focused on the Territorial Fragilities, trying to explore the complex and multifaceted processes linked to the weakening of the relationship between territory and society.
The research group I am involved in, composed by Andrea Arcidiacono, Stefano Boeri, Alberta Cazzani, Antonio Longo, Laura Montedoro, Andrea Oldani, Alessandro Rocca and Michele Ugolini, all DAStU professors, focuses the role of landscape design in relation to the regeneration of fragile territories in Italy.
Landscape design, especially in time of environmental and ecologic transition, should work on the weaknesses of the surroundings through an interdisciplinary approach that allows to disjoint and analyse the various aspects a territory is composed by: different scientific knowledges have to take part in this process and to coordinate themselves in order to reach integrated landscape design. Designing a landscape means to structure a dialogue among different fields but also among different public actors of the territory and stakeholders. Transdisciplinary goes hand in hand with a transcalar approach: each discipline requires appropriate scales to analyse problems and potentialities and develop solutions that then the landscape design coordinates operatively, as an active network related both to the large scale and to the human one. The dimension of the landscape and the view of the horizon are therefore closely related to the measures and gestures of the human beings, expression of a social dimension still in transition.

Keywords: landscape design, territorial fragilities, ecologic approach, interdisciplinary approach, transcalar approach

T0160

Stelvio national park: interregional planning for future landscapes

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The territory that belongs to the Stelvio/Stilfser joch national park, rich with natural and human alpine heritage, is administrated by three political institutions: the Lombardia region and the Trento and Bolzano/Südtirol autonomous provinces. The interregional governance of the national park gave birth to an experience of dialogued planning involving not only institutions but also local population and companies. The plan of the park implements a shared choice on different territories, and predisposes the governance of areas of development through the choice to establish limits that help keeping ecological integrity. With this aim, have been marked on specific maps quiet areas that intend to be an interregional instrument for environmental protection and regulation of land resources use. Human settlements are present in the outlined protected zone and economic development, strictly connected to local resources, obtains a regulation on landscape impact and evaluation of traditional materials and architectures. In fact, the constitution of dialogs between protection areas and touristic infrastructures development, is a main theme of the plan and the connected document of regulation. This planning action constitute, in my academic Phd research program, a case study for the management of anthropic pressure linked to tourist development in mountain regions and protected areas.

Keywords: Spatial planning, Interregional governance, National park governance, Ecosystem services management

Urban regeneration with productive nature-based solutions – what are the framing conditions? Examples from seven post-industrial European cities

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Post-industrial urban areas face challenges such as economic decline, inequality, security issues, and low environmental quality. Within the H2020-project "proGIreg" (productive Green Infrastructure for post-industrial urban regeneration), front-runner cities Dortmund, Turin, and Zagreb will create Living Labs and test 8 different types of NBS to foster urban regeneration. Follower cities in Eastern and Southern Europe will explore replicability and adaptability of NBS to their local context. The NBS, including biotic regeneration of industrial soils, community-based agriculture and aquaponics, will be co-produced by local governments, citizens and NGOs, SMEs, and academia. This quadruple helix approach ensures technical and social innovation, increased social inclusion, enhanced environmental quality and new business opportunities.

This paper presents the baseline for the NBS benefit assessment and framing conditions for integrating productive NBS in local spatial planning. For seven cities, policy and planning frameworks as well as stakeholder landscapes have been examined, spatial indicators have been collected, and strength, weaknesses, opportunities and threads for implementing NBS assessed. At least all of the three Front Runner cities have stakeholders specialized on certain NBS and established relationships with certain stakeholder types – bringing all stakeholder types representing the quadruple helix together, will pose a major challenge. Regarding the NBS assessment, indicators are available on city-level but often not for sub-areas, such as urban regeneration areas. Limited availability of baseline data needs to be compensated by additional data collection. The paper will relate the findings to existing NBS frameworks such as from EKLIPSE and suggest paths to deal with lack of spatial data. We will conclude with recommendations for a spatial analysis framework for productive NBS to be applied in other post-industrial cities.

Keywords: post-industrial cities, urban restoration, productive green infrastructure, NBS assessment

P0183

The Isar-Plan: Design of a socio-ecologically resilient waterscape through polycentrism and living labs

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Human alterations of the Isar River flowing through Munich, Germany, resulted in the degradation of riverine habitats, the decrease of the recreational potential and an insufficient flood protection at the end of the 20th century. In response to this, a River Restoration Project (the Isar-Plan) was completed in 2000-2011, implementing a number of nature-based solutions along the Isar and up to central Munich. The Isar-Plan is one of the world's most famous urban river restoration projects, mainly due to its innovative socio-ecological approach to restoration practices. While the concept of Living Labs is still emerging, in the late 90's the Isar-Plan was a pioneer project applying this approach for selecting and implementing nature-based solutions along the Isar. Despite the involvement of multiple governing authorities involved in the decision-making process of the Isar-Plan, the polycentric governance that led to the success of the project has to date not been studied. This paper presents the results of an ex-post-analysis of the Isar-Plan planning process based on stakeholder interviews and literature reviews. The contribution describes how the Isar-Plan governance arrangement was set up and discusses the existing Living Lab guiding frameworks. Furthermore, the analysis of this case study demonstrates how polycentricity facilitated trust, learning, and the co-design of a resilient waterscape. Finally, the article highlights the long-term challenges of Living Labs.

Keywords: stakeholder engagement, socio-ecological restoration, polycentric governance, nature-based solution, river management

Analysis of the perceived preference for different landscape features based on age and gender

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The general approach to perception involves the detection of a single aspect of an object in the environment by sensory mechanisms, whereas environmental perception is concerned with a more holistic process of cognition, interpretation and valuation. The perception of landscape environment features impact on the psychological evaluations based on a person-environment interaction context. It is therefore necessary to understand the values attached to landscape features in terms of individual preference. In this study, the perceived preference of individuals is elicited in order to analyze the feature of the mountain landscape environment that would yield higher preferential value based on age and gender. The study involved a cross-sectional survey of 200 respondents drawn from a population of lecturers and students of the Benue state university, Nigeria through non-probability convenience sampling method. 137 respondents were males while 63 were females between the ages of 21 to 50 years old. A 3 page questionnaire which included 6 color photographs selected from 30 photographs captured in specific locations in the Obudu mountain landscape environment in Nigeria was developed and modified to measure the preference for particular landscape elements. The findings revealed that perception is enhanced by the modifying factor of meaning giving to a particular landscape feature from memory of past encounter which could be generational due to urban growth. Additionally, individuals react to different types of water bodies in diverse ways and as they aged, their affinity for the thrilling aspects of nature reduces. Also with regards to gender, difference occurred between male and female in their preferences for the mountain landscape features. Finally, landscape planners can utilize the outcome of this study in terms of provision of landscape types with regards to age and gender of users for a sustainable urban development.

Keywords: Mountain, Perception, Preference, Landscape features, Age, Gender

T0670

Exploring Co-Benefits, Negative Externalities and Impact Pathways of Nature-based Solutions in Urban Areas

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Nature-based solutions (NbS) have gained recognition as cost-effective solutions to current societal challenges of cities. Compared to traditional technological solutions, NbS may provide economic advantages in terms of reduced capital costs, and costs for maintenance and operation. However, the cost-effectiveness assessment of such solutions extent well beyond comparing costs. It also requires the assessment of positive and negative impacts on socio-ecological systems on the short and long term. Nature-based solutions use the provision of ecosystem services by green infrastructures to simultaneously provide multiple co-benefits for human health and well-being, social inclusion, cohesion and equity, urban environmental quality, climate change, water management, and economic development. Moreover, negative externalities may raise in some cases, e.g. forced displacement of marginalized and vulnerable communities. Knowledge about positive and negative impacts should be further explored in order to introduce, replicate and upscale NbS across cities. The present research aims to assess direct and indirect co-benefits and negative externalities in environmental, social and economic terms associated to nature-based solutions. To this purpose, suitable case studies of a variety of NbS applied in urban areas are collected from the scientific and gray literature. The assessment focuses on specific aspects such as receptors i.e. who and what is affected, spatial scale, magnitude and likelihood of benefits and negatives externalities, as well as the pathways by which solutions reach and impact receptors. Results synthesize a cross-comparison between solutions based on the previous aspects for each co-benefit and externality. These outcomes will help to anticipate impacts of similar NbS practices and, thus will support the design of more effective solutions for urban challenges.

Keywords: nature-based solutions, co-benefits, negative externalities, ecosystem services, urban green infrastructure

T0158

The adoption of an Ecosystem services-based approach for green infrastructure design: practical insights from the case study of Rescaldina Municipality (Milan Metropolitan city, Italy)

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The integration of Ecosystem Service (ES) into spatial planning is an open challenge necessary to improve the Natural capital and to enhance human wellbeing.
Despite significant recent progress in mapping and assessment ES, their integration in a Planning process (and also in Strategic Environmental Assessment – SEA) is limited and still in its infancy.
The abstract aims to present a recent urban planning experience conducted in the municipality of Rescaldina (northern part of Milan metropolitan city, Lombardy region, Italy) where the new edition of the Local Plan was defined through an ES-based approach. The Local Plan and SEA were adopted in October 2018, the final approval is forecasted for March 2019.
The planning process started with ES mapping and assessment, provided by the SEA, showing the state and trends of ES provision and addressing policymakers in the definition of the sustainable urban development strategies.
ES mapping was pivotal for the design a Local Green Infrastructure (LGI) combining ecological aspects, rural landscape and recreation activities. LGI is the framework for setting and addressing Nature-based solutions (NBS) as an important key factor towards sustainable goals combining environmental, social and economic challenges. The LGI strategy was included both in the strategic component of the Plan and in the regulative part ensuring its operability and practical application.
The adoption of a strategy (LGI) in common between planning and SEA process has strongly influenced policymakers spreading the awareness on ES and using an ES-based approach for sustainable Land use management.
The methodology used in the case study could be replicable and feasible in other contexts, also with different territorial level (supralocal, regional, national).

Keywords: Landscape Planning, Green infrastructure design, Ecosystem Services, Nature-based solution, Planning regulation

T0045

Shaping Human Behavior, Saving Forest Genetic Resources: The Case of Forest Landscape in the Philippines

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Forest genetic resources (FGRs) provides a wide range of benefits such as better protection of ecosystems, healthy evolution of trees, additional sources of food, timber, medicinal plants and other products that may be derived from the forest. The availability of FGRs relies from the diverse formation of forest. Application of the use and conservation of FGRs is interrelated with the management and implementation of forest restoration activities. While protection of the forests preserves the FGRs, the use of knowledge in FGRs provides a science-based solution to effective forest establishment and restoration. With the increasing vulnerability of the Philippine forests to various threats, there is a need to conserve and apply the use of FGRs. However, it is always important to consider the root cause of all the factors affecting the degradation of forests as well as the FGRs. This paper aims to discuss the effects of the existing factors to the country's forest, as well as to FGRs. Ultimately, the author hopes to provide a new perspective in FGR conservation with respect to human behavior as the main driver of change. Human, being the think tank of the planet who creates solutions and causes problems, is the main driver of change. Hence, the need to conserve the FGR and effective management of forests is parallelly equated with the need to shape the human behavior. Changing the human behavior that favors actions towards the conservation, sustainable use and management of FGRs should be a challenge to, and priority of the government, academe and nongovernment organizations

Keywords: Drivers of Change, Forest Genetic Resources, human behavior, Philippines

City scale landscape planning based upon prioritization and governance of NBS

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As a topic theme in sustainable development worldwide, nature-based solutions recently attract more and more attention in China since ecological civilization progresses rapidly. Whereby, how to systematically apply NBS on city scale is yet decided. This paper proposed a prioritization process as well as a relevant governance system for NBS to be applied in a mountainous city in southwest China. Ecological vulnerability and social imperativeness were applied to prioritize different NBS. For better implementation of NBS, three governance hierarchies are proposed according to China's planning system and management structure of local governments. The prioritization and governance of NBS leads to a city scale landscape planning with proposed landscape infrastructures, landscape governance units and relevant governance strategies to be compared and discussed in an international context.

Keywords: Landscape planning, Nature-based solutions, Sustainable development goals, Govermance, International Cornparition

P0004

Sustainable landscape planning and development pattern based on Internet of Things

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The objectives of landscape planning and construction are to sustainably use local land and related resources to constantly improve and enhance local people's quality of life, and promote and ensure the aim of local sustainable development. The planning, construction, and management of landscape involves various aspects, and is a process of long-term, continuous and integrated feedback and improvement, during which some unexpected situations and changes may appear, one-off plan cannot be perfected through one or two stages, as it is a process of advancement-feedback-improvement. This paper proposed three key questions regarding the most effective use of internet of things (IoT) for process control system to develop a targeted sustainable landscape planning and development pattern. In essence these are "what?" (sensors based on Internet of Things), "where?" (ecological node) and "how?" (monitoring method), and Four circled procedure (present situation monitoring, landscape planning, effect inspection and adjusted landscape planning) involved to adapt and/or improve the urbanized environment to "near-nature". In addition, an evaluation is made of the ability of the information presented in sustainable landscape planning to meet criteria of credibility, salience and legitimacy when communicating with stakeholders. These focus on the need for applications of IoT techniques to be more systematically evaluated, ideally as part of landscape planning exercises where the benefits of particular approaches for different purposes across all stages of the decision-making process in landscape planning.

Keywords: Landscape planning, landsenses, ecological process, sustainable development, internet of things

Symposium 45

Conservation in the city

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In today's human-dominated world, biological conservation must occur in anthropogenic landscapes, including urban landscapes. Indeed, the role of cities in the conservation of biodiversity has recently been recognized. Cities, however, are designed first and foremost to provide human habitat and urban conservation must necessarily integrate human needs with those of other species. Achieving such integration is a key challenge of conservation and may pit the interests of humans against those of other species.

Urban conservation, however, can benefit urban human populations, thus making balancing the needs of humans and other species an opportunity as well as a challenge of such conservation. Recent studies document a number of benefits associated with exposure to biodiversity in cities. These benefits include enhanced mental and physical health and ecosystem service provision as well as mitigation of so-called "extinction of experience" through increased opportunities to interact and build connections with nature thereby increasing quality-of-life and understanding of and concern for conservation. Implementing conservation in urban settings could serve to ensure these and other human benefits and could help build human populations that better understand and are more supportive of conservation. However, understanding of and methods for integrating the needs of humans and other species in conservation are currently underexplored.

Additional challenges to urban conservation relate to high spatial heterogeneity in urban landscapes and in the human and wild species that inhabit them. This variation means that the physical environment as well as the manner in which urban humans and species interact with it varies dramatically within cities. This heterogeneity complicates efforts to implement city-wide conservation to support not only diverse species, but also diverse human populations. Addressing these challenges in urban conservation requires an understanding of urban environments and of the species and human communities in those systems as well as of the manner in which they vary within cities.

Urban conservation must thus be a multi-disciplinary endeavour, one that relies on input from a variety of perspectives in the social and biological sciences as well as from practitioners such as urban planners and policy makers. This symposium will bring experts from diverse fields together to present research and discuss different perspectives and approaches to urban conservation. A key goal of the symposium is the building of theory and identification of ways in which urban landscapes could be managed to support both human well-being and biodiversity conservation objectives. The format of the symposium will include paper presentations and a panel discussion centered on approaches and challenges to urban landscape management for both conservation and human well-being. Participants from a variety of disciplines and approaches (e.g., geography, ecology, conservation biology, anthropology, sociology, psychology, demography, urban planning, economics, health sciences) and from around the globe are invited to present and discuss their own work and to participate in panel discussions.

P0058

Effects of Urbanization on Reproductive Success in Common Milkweed

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Urban land use is expected to expand to accommodate the two-thirds of the global population estimated to live in cities by 2050. As a result, effects associated with urbanization are projected to impact key ecological processes such as pollen and seed dispersal in plants. Green urban corridors such as trails and open space next to railways may mitigate these effects by increasing connectivity among populations via, for instance, increased pollinator traffic. We investigated the effects of urbanization on reproductive success in the perennial plant Asclepias syriaca (common milkweed) along two urban-to-rural transects in the Greater Toronto Area, one of which primarily followed a green corridor. In this species, each flower has five pollen sacs that are removed and dispersed individually by insect pollinators, so that pollen removal rate can be reliably quantified. Regression analysis showed that pollen removal rate increased with distance from the Toronto city center but did not significantly vary between transects. Our results suggest that pollination rate in this species decreases with increasing urban land use and that proximity to a green corridor does not significantly impact pollen removal. Future work will involve identifying the landscape features that influence rates of pollination and gene flow among these populations.

Keywords: urban ecology, evolutionary ecology, pollination, corridors, reproductive success

T0523

Disentangling the influences of urban environmental attributes on bird morphological and life-history traits

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Urbanization filter bird species according to their morphological and life-history traits. However, how each bird trait is affected by urban environmental attributes is still seldom known. Moreover, landscape effects on Neotropical street birds are poorly investigated. Therefore, we aim at disentangling the influences of urbanization on two bird traits: body mass and clutch size. As species may share their responses with other species due to similar traits, we used the Hierarchical Modeling of Species Communities (HMSC) approach to identify regions of the landscape with common profiles based on community similarity. We also used HMSC to assess the influences of six predictors (exposure to noise, average height of buildings, distance from urban parks, proportion of vegetation, abundace of street trees and the richness of native street tree species) on the bird community through scenarios' simulations. We collected bird data in 60 locations distributed through the streets of the southern region of Belo Horizonte (Minas Gerais, Brazil). We observed that streets in urban regions sharing similar environmental conditions (such as high exposure to noise) had similar bird communities. The simulated scenarios showed, among other results, that body mass was negatively affected by average height of buildings and positively affected by exposure to noise, while the effects on clutch size presented the opposite patterns. Each urban aspect had distinct effects on each bird trait, therefore the bird community in each urban region was filtered by the environmental attributes which locally stand out. Thus, cities cannot be considered as gradients of influences, but highly complex and heterogeneous ecosystems.

Keywords: Neotropical city, Hierarchical Modeling of Species Communities, environmental filter, urbanization

Restoration Ecology techniques to improve Urban Nature: A literature review.

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Green and open spaces, from private gardens to green roofs and parks, functioning as ecological corridors and stepping stones, are the backbone of the Urban Green Infrastructure. We argue that, in built environments, species introduction techniques (e.g. hay transfer, seeds sowing of wild species and topsoil translocation) could be used to green certain degraded habitats (e.g. brownfields) but also relatively undisturbed ones (e.g. extensive green roofs). We hypothesised that a) urban restoration actions by means of assisted dispersal techniques were poorly documented in cities and that b) the lesson learned in restoration ecology could enable to draw some generalities and to draft guidelines for the implementation of such techniques in urban ecosystems.
The main aims of this review were to 1) find comprehensive works on species introduction techniques in restoration ecology; 2) find studies dealing with the mentioned restoration techniques in urban environment and related to degraded areas or novel but relatively undisturbed habitats; 3) draft guidelines for the implementation of assisted dispersal techniques for selected urban ecosystems, including their long-term monitoring and suitable bioindicators.
To answer the research questions, we run a systematic quantitative literature review searching for original research and review papers using selected keywords. The works matching the inclusion criteria were listed in a database containing further information necessary to cluster and sort them out. Results showed that: 1) in the last decade exhaustive work on species introduction and assisted dispersal techniques have been published mostly for central-eastern European countries and the USA; 2) restoration ecology techniques were not yet applied in the built environment with few exceptions. Finally, this review enabled to draft a guideline to optimise the restoration techniques suitable for biodiverse green roofs and other similar urban habitats.

Keywords: green roofs, hay transfer, wild species, assisted dispersal, urban green infrastructure

The effect of landscape history on contemporary conservation efforts in urban landscapes

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Urban areas are often hotspots of biodiversity. Moreover, many urban areas contain remnant natural areas. The conservation of these sites becomes increasingly important in this age of global human influence. Despite knowledge on the effects of humans on urban biodiversity, the role of history of the landscape is neglected. Recent studies have shown the existence of extinction debts in the response of vegetation in cities, yet accurate historical datasets of urban areas are rare. In our study area, Potchefstroom (South Africa), plant diversity surveys were performed in 43 woody and open grassland remnant natural sites in 1995 and 2012. The results indicated that indigenous plant species richness decreased significantly. Moreover, time lags of 20-40 years were present in the woody sites, while open grassland communities were generally associated with more contemporary landscapes. The aim of this study is to resample these sites again (2019) to determine whether the observed patterns and time lags have changed. Confirmation of similar results and drivers or potential increases in the rate of change can have significant impacts on urban nature conservation efforts and approaches. Already, business as usual is not enough and conservation strategies should include pro-active management designed for maximum persistence of species.

Keywords: time lags, extinction debt, grasslands, indigenous plant species richness

Spreading patterns of breeding birds in the urban woods of Nagoya City, Japan

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Nagoya City, located in central Japan, is a highly urbanized city, yet forests and parks still remain in some of the urban areas. A bird census in approximately 50 major habitats throughout the city has been performed every five years by the City of Nagoya, starting 1974. I analysed the population trends of breeding birds from 1984 to 2008 and observed that three species, Japanese Pygmy Woodpecker Dendrocopos kizuki, Narcissus Flycatcher Ficedula narcissina, and Large-billed Crow Corvus macrorhynchos showed an increase in their population and expansion of their range.

To understand the spread patterns of these species, I generated the habitat models of these three species by the logistic regression model.

Japanese Pygmy Woodpecker is a resident forest bird and primary cavity nester. The woodpecker spread gradually from the forests in the urban fringe (east) to parks in the urban centre (west). Variables for the woodpecker distribution models of breeding season and wintering season included distribution in the non-breeding season 5 years before and distance from a breeding site 5 years before, respectively. According to the results of regression models, the woodpecker firstly spread new site near a breeding site in the non-breeding season and started breeding in 5 years.

Narcissus Flycatcher is a summer breeder in Japan and nests in a tree hole. This flycatcher was only distributed in a mountain located northeast of Nagoya city in 1984. Equations describing the flycatcher distributions during the breeding season differed each year, and the only influential variable was the area of woods. There was no spatial autocorrelation for the distribution of this migratory flycatcher. This species distributed only several large forests in 1999, but it distributed the mid-sized urban woods also until 2008.

Large-billed Crows were dominant in forested areas and avoided parks enclosed with tall buildings in 1994, however, the crows became to prefer tall buildings by 2008.

Keywords: bird, urban woods, species distribution modelling

Microhabitat Pattern for Biological Conservation--Taking the Planning and Design of Beijing Daxing Country Park as an Example

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The biology in the city is closely related to the sustainable development of the city, urban development behooves balance the relationship between human habitation and biological habitat, biological conservation must occur in anthropogenic landscapes, including urban landscapes. Urban landscape contains biologically important habitats and is an important indicator of sustainable urban development, when we are planning and design shall we consider more about the biology conservation.

This context proposes the microhabitats models to protect birds. By investigating 24 urban green spaces in Beijing, we find that different land-cover types have a direct effect on bird habitats, such as vegetation, water and artificial paving. On the other hand, through the classification of land-cover types, 3 habitats and 14 microhabitats were obtained. Urbanization causes rapid changes in the landscape and land use, exerting a significant pressure on bird communities. Daxing Country Park is not only an important hunting woodland of the ancient royalty, but also a significant ecological barrier for Beijing.

Considering the unique plain feature of the site, the design forms the landscape structure and sets up scenic spots from the aspects of water network system, ecological protection, slow path system and crowd activities. By retaining and utilizing the vegetation, farmland and water system in the site, we conclude that in the landscape design, the woodland microhabitats are closely relate to the canopy density and shrub height. Vegetation coverage, open water area, water depth, and bank type can directly reflect the water microhabitats. The farmland size, agrotype, buffer belt form the field microhabitats. Thus, the blue and green intertwined microhabitat groups was formed.

Keywords: urban, biodiversity, conservation, microhabitat, landscape architecture

T0319

Dimming of LED street-lights facilitates dark corridors for nocturnal insects and bats

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Developments to facilitate sustainable management of public infrastructure include innovative street-light technologies which offer flexible adjustments of light intensities according to traffic volumes. We showed for the first time that intelligent street-light dimming between 30-40% may significantly contribute to dark corridors for nocturnal insects and bats. Weather conditions (temperature, precipitation) remained primary drivers, but dimming provoked significantly less caught insects and lowered bat activity at street lights. Among insect groups, Heteroptera and Hymenoptera appeared particularly responsive to dimming: for both groups, dimming caused significantly less caught individuals compared to full-light conditions, while the response to dimming was not significant for Coleoptera and Diptera. For bats, urban exploiters (Pippistrellus s.l.) prevailed, while rare, light-adverse bats (Myotis s.l.) were only rarely recorded at street lights. Our findings demonstrated that street-light dimming constitutes a sustainable measure to mitigate negative impacts of light at night for some species groups, while the light tolerance of light-adverse species was clearly beyond the feasible level of dimmed street lights.

Keywords: artificial light at night (ALAN), street-light technology, light pollution, mitigation strategies, conservation management

P0108

Consistent versus episodic management and the long-term fate of ecological restoration in urban forest patches

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To test the impact of the intensity of management intervention on long-term success of ecological restoration in urban forest patches, we analyzed vegetation structure and community composition in 3 large urban parks in New York City, 15-20 years after restoration was initiated by removal of climbing invasive woody plants and planting of native trees. Analysis using data from 30 plots, > 6,000 records of management, and 7,626 records of species abundance reveals significant relationships between plant community differences among restored plots and intensity of restoration treatment. Less intense management was also more episodic, suggesting that consistent timing is also important to achieving desired long-term outcomes in plant community composition and structure. These findings indicate the importance of site-specific approaches and consistency in ongoing management to long-term positive outcomes of ecological restoration in urban forest patches.

Keywords: urban ecology, urban park, forest patch, plant community, vegetation dynamics

Integrated Analysis of Social-ecological Functions of Urban Green Spaces in Traditional Village of Penglipuran, Bali, Indonesia

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Urban green spaces provide a variety of ecosystem services. However, methods to evaluate both ecological and socioeconomic benefits of urban green spaces in a truly integrated manner are not well established. This study aims to fill in this gap by applying various methods to gain a whole picture of a myriad of benefits provided by traditional, urban green spaces in Bali, Indonesia. Focusing on telajakan, a type of traditional green space, located between the frontal wall of a Balinese housing compound and a road, the study utilizes and explores various methods such as telajakan vegetation survey and measurement, household socioeconomic survey, and in-depth homeowner interviews in order to arrive at a more comprehensive conclusion on the changes of telajakan plantings, uses of telajakan space, and socioeconomic drivers that inflict these changes. By conducting telajakan vegetation survey and measurement, and homeowner interviews, we have already found that: (1) diversity of planted species is decreasing but there is room for maintaining functional diversity by planting indigenous species with multiple functions; (2) aesthetic, economic, and religious functions are strongly favored plant functions by homeowners; and (3) semi-public nature of telajakan is being lost but new meaning is given to telajakan's functions and a new form of social interaction is observed. In Penglipuran traditional village, we have added household socioeconomic questionnaire to the methods and are currently analyzing the additional data. We hope to find an interaction between the vegetation survey results and the sociocultural and economic data to arrive at a conclusion that will better describe the socioeconomic drivers that affect homeowners' behavior and the kinds of plants planted in telajakan and the way they manage it. The results of the study will add further insights into the difficult question of conserving local culture and tradition in the rapidly changing social-ecological systems.

Keywords: Urban green spaces, Ecosystem services, Social-ecological systems

T0162

Neighbor mimicry in front yard vegetation and its effects on city-scale plant biodiversity

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Residential yards make up a large portion of land in urban areas and can contribute to biodiversity conservation as well as ecosystem services such as urban heat island mitigation, provisioning of food from gardens, and human-environment interactions. People choose how to design their yards based on their aesthetic tastes, level of concern for the environment, and neighborhood norms. Some studies have found evidence of neighbor mimicry in yard design, where nearby yards have similar plant species composition and/or vegetation structure. We investigated the variability in front yard vegetation in sixteen neighborhoods in Chicago, selected to span gradients in income and race. We addressed the following questions: Can we explain and predict variability across residential yards? and What effect does this variability have on large-scale urban biodiversity? We used measures of species turnover (e.g. Sorenson's index) and spatial autocorrelation of species richness (e.g. Moran's I) to detect patterns of neighbor mimicry at different spatial scales and linear regression to determine whether neighborhood demographics (e.g. age, income, race, education level) predicted diversity patterns. We identified 462 plant species, about 400 of which were intentional (non-weedy) species. The percent of residents with a bachelor's degree in a neighborhood was the best predictor of the mean number of intentional plant species per yard ($R2 = 0.70$). We found significant positive spatial correlation in intentional plant species richness between yards that were 2 yards apart and 10 yards apart, suggesting that mimicry occurs both between close neighbors and within the broader neighborhood. Neighborhoods with older residents also had more similar yards. Finally, using the Chao2 estimator to scale up species richness from the sampled neighborhoods to the entire city, we estimate that there may be over 700 intentionally planted species in the city of Chicago.

Keywords: urban, plant, biodiversity, design, scale

P0109

Influence of urban tree species and noise levels on of Brasilia city's avifauna, Brazil

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Urbanization transforms natural ecosystems and negatively impacts flora and fauna. Even tough, birds can make cities their refuge and carry out environmental functions. It is commonly believed that urban trees affect richness and abundance of urban birds species in urban areas and more recently it has been found that avifauna is also affected by noise. Despite noise pollution, green infrastructure in cities may shelter and provide resources for the survival of birds in a hostile environment. In this scenario, Brasilia city was founded in 1960 as a park city where long green corridors stand along roads and streets. Despite this, studies that relate the influence of tree species composition and noise levels on Brasília's avifauna are unknown up to date. This work aims to evaluate the influence of tree floristic composition and noise levels along a 14 km road, which thoroughly cross the city, on the composition and abundance of bird species. Birds were surveyed at 32 fixed sampling points along the 14 km road on days of high noise and days of reduced noise. Concomitant to bird survey, sound levels (dB) on sampling points were measured and all trees along the 14 km road were identified. Preliminary results showed that 54 bird species belonging to 25 families inhabit the surveyed area. Furnarius rufus Gmelin, 1788 (clay john), Tyrannus melancholicus Vieillot, 1819 (suirir) and Columba livia Gmelin, 1789 (pigeon -domestic) were the most abundant bird species. These bird species have high tolerance to habitat modifications and can provide ecosystem services in cities. Higher levels of noise resulted in lower bird species richness, a fact that reveals the susceptibility of the most of local bird native species to the effects of urbanization.

Keywords: city, urbanization, noise pollution, urban birds, urban trees.

P0028

Social and ecological drivers of change over time in urban forest patches across five North American cities

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Forest patches are hotspots of biodiversity in urban regions, yet social conditions also influence their composition, condition, and function. Therefore, there is a need for multi-scale studies that compare trends in forest biodiversity among cities while also considering social context of forest patches. We are pursuing this challenge as a group of ecologists, social scientists, and managers of urban forest patches from five large cities within the United States: Baltimore, Washington DC, Chicago, New York and Philadelphia. Our conceptual framework envisions urban forest patches as the center of socio-ecological systems. To empirically expand this framework, we are using integrating high resolution tree canopy maps derived from remotely sensed data and extensive field measurements to identify changes in the composition and condition of urban forest patches over time and across urban-to-rural gradients. Socioeconomic and housing data, management and stewardship datasets, and manager knowledge are also being used to understand management approaches to forest condition, and how management and stewardship affect the composition and condition of forest communities. Results will be applicable not only to our five study cities, whose managers and stewards serve a combined population of more than 12 million people, but also to municipalities that face similar challenges.

Keywords: urban ecosystem, socio-ecological systems, forest patch, landscape change

T0528

Urban back gardens in landscape-scale conservation planning: what are the barriers and facilitators for urban residents to manage their spaces for wildlife

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Gardens contribute substantially to the green infrastructure of many cities; for example 20-27% of UK urban areas are estimated to be gardens. Gardens can contribute to conservation at the city scale, while providing important opportunities for people to engage with the natural world. Enhancing gardens for wildlife conservation and landscape-scale connectivity is challenging as residential gardens are owned and managed privately by individuals. Few studies have looked at motivations for gardening for wildlife. We adopt a behaviour change model to understand people's motivations in managing their gardens, and look explicitly at their self-reported willingness to adopt more wildlife-friendly management strategies. Using a stratified random design, we distributed surveys to 2053 houses in 20 areas across the city of Derby, UK. Areas were stratified by a measure of deprivation and to ensure good spatial coverage of the city. The survey included questions on self-reported gardening activities, including provision of wildlife-friendly features; motivations and barriers to gardening; perceptions of respondents' neighbourhood and their garden's place in the neighbourhood; a psychometric measure of nature connectedness; and willingness to consider management changes in their garden and neighbourhood. The survey was piloted in an additional area of 200 houses, with a 28.5% response rate. We received 254 responses to the full survey (12.4% response). We apply a behaviour change model to survey responses to identify the phase of behaviour change residents were in (Detection, Decision, or Implementation). We explore relationships between phases of behaviour change and sociodemographic characteristics of respondents, nature connectedness, people's relationship to their neighbourhood and characteristics of the local neighbourhood. Findings from the study should inform more effective targeting of communication to engage people in pro-conservation garden management.

Keywords: Urbanisation, Connectivity, Gardens, Behaviour change, Nature Connectedness

P0018

Changes in spider assemblages and their preys along an urbanization gradient in the city of Torino (NW-Italy)

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The process of urbanization implies substantial changes in environmental conditions and landscape structure, with potential repercussions on local biodiversity. We here investigated the response of spiders and the abundance of their preys to different ecological alterations related to urbanization, i.e. urbanization density, isolation of natural patches and temperature increase. The study was set in Torino (NW-Italy), where we identified 15 sampling plots along a gradient of urbanization, from suburbia to the city centre. Spiders and other ground arthropods were collected by means of pitfall traps, equipped with a temperature datalogger. We first showed that temperature increased along the urbanization gradient, confirming the occurrence of an Urban Heat Island (UHI) effect in the city of Torino. We then highlighted how urbanization causes the functional homogenization and shifts in the functional composition of spider communities, with potential cascading effects on the entire community of ground arthropods. Finally, we modelled the activity density of spiders and their potential preys against urbanization density, air temperature and patch isolation and demonstrated how different groups of arthropods respond differentially to these alterations.

Keywords: Araneae, ground arthropods, urban ecology, UHI-effect, patch isolation

Conserving Urban Biodiversity: Design Strategies for the Production of Urban Landscapes in Italy

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Since the 1990s, the role that biodiversity plays with regard to environmental processes and human well-being has been the focus of a lively scientific international debate. More recently, growing attention has been paid to the conservation of biodiversity in urban and peri-urban contexts. Public open spaces are proving to be valuable resources in this process, driving an important shift in current design approaches towards strategies that foster the harmonious coexistence between different species. The design of urban and peri-urban public open spaces is increasingly addressing not only aesthetic, fruition and social well-being issues, but also topics related to ecological functions and urban metabolism. While in Europe and the United States several exemplary projects have been already implemented (e.g. the Garden in Motion in Paris by Gilles Clèment, the Südgelände Park in Berlin by OkoCon and Planland, the WWT Wetland Center in London), in Italy, landscape architecture projects specifically addressing biodiversity as a criterion for the design of urban and peri-urban public open spaces are still a limited number. However, some experimental case studies can be detected. The proposed paper will discuss recent landscape architecture projects in Italy, whose design strategies aim at conserving and enhancing biodiversity in highly fragmented urban and peri-urban contexts. Analysing some specific design issues, such as the search for a spatial continuity – that is crucial to guarantee an appreciable degree of biodiversity – and the fostering of a blending of different values and uses (culture/nature, fruition/conservation), the paper will discuss the current relationship between public open space and urban biodiversity in Italy, identifying design strategies oriented to multifunctionality and thus integrating ecological, social and spatial quality.

Keywords: urban biodiversity, urban landscapes, landscape architecture, public open spaces

T0180

Designing nature in cities to safeguard meaningful experiences of biodiversity in an urbanizing world

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Urbanization separates people from the experience of nature, affecting the way they value and benefit from nature's quality. Conserving biodiversity in cities has been proposed as a win-win solution to jointly achieve ecological objectives and avert this extinction of experience. But to date, knowledge about the role that biodiversity plays in providing well-being benefits remains scarce, and we have limited evidence about the means that can enhance people's interaction with nature. Here I present two related studies. The first explores the relationship between biodiversity and well-being of visitors of public gardens in Israel, by conducting an ecological (birds, plants and butterflies) and social surveys (n=600). Results indicate that people do not perceive much of the biodiversity present and that well-being-biodiversity relationships are mediated by relatedness to nature. In other words, people who perceived themselves as more related to nature benefited more from species-rich gardens, while there were no, or even negative effects, of biodiversity on well-being benefits for people who were less related to nature. Efforts should thus be made to identify the means to bring biodiversity to the forefront and intensify the interaction between people and nature. The second study, tests how this can be achieved using 'priming', a technique whereby exposure to a stimuli influences people's behaviors. We conducted an experiment with 303 participants, in which we tested the effectiveness of nine different stimuli on nature interactions and well-being outcomes during a 30-min urban walk. Results show that priming for smelling flowers and touching nature have a significantly more positive effect on well-being than the control condition with no priming, by increasing nature interactions. Thus, designing stimuli that prime people to get closer to nature can serve as an excellent tool to enhance meaningful interactions with nature and mitigate the extinction of experience.

Keywords: Health and Wellbeing, Ecosystem services, Extinction of experience, Human-dominated landscapes, Conservation psychology

P0195

Conservation of bats along an urbanization gradient: The effect of vegetation structure, buildings and artificial light

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Urban landscapes are highly heterogeneous composed of a mosaic of biological and physical components. Many species such as bats can coexist in urban landscapes and even may take advantage of this heterogeneity. However, little is known about the role of vegetation structure, buildings and artificial light along an urbanization gradient. We analyzed the relative importance of vegetation structure, spatial patterns of buildings and light intensity on bat activity and activity of selected species along an urbanization gradient (forest, sparse-developed, moderately-developed and highly-developed areas) in Vienna, Austria. We conducted acoustic surveys on 129 sampling points distributed over the four urbanization categories in summer 2015. Vegetation structure was quantified as vegetation clutter, number of trees, and proportion of understory and canopy cover. The occurrence of buildings and their composition and configuration were quantified using a multi-scale approach. Light intensity was determined using a lux-meter and a light pollution map to examine the influence of light at a broad scale. We found that highly-developed areas had the highest bat activity, whereas sparsely-developed areas had the lowest activity. The activity of selected species varied among the four urbanization categories, highlighting species-specific habitat requirements. In general, vegetation structure and proportion of buildings had a significant effect on bat activity. Activity of Nyctalus noctula was mainly affected by vegetation clutter, whereas activity of Hypsugo savii increased with the proportion of buildings at the 500 m radius buffer. Only Pipistrellus kuhlii responded positively to artificial light. Our results highlight the challenges to conserve bats in urban landscapes. To support a high number of bat species, it is essential to maintain large number of trees. Within built-up areas, open spaces should be preserved and smaller buildings should be maintained.

Keywords: Bats, Urbanization gradient, Built-up areas

Birds in parks: The spatial pattern and factors of bird habitat and birdwatching, Beijing, China

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Birds play an essential role for urban dwellers' well-being. Parks are important bird habitat in urban areas and also accommodate most human-bird interactions in cities including causal bird encountering and birdwatching. While previous studies have examined how park landscape and other characters may impact bird habitat conservation and/or hosting birdwatching activities, few researchers investigated the association between parks' abilities to provide bird habitat and hosting birdwatching activities. Is there any common factor impact both a park's attractiveness to birds and birdwatchers? Besides bird presence, is there any other park characteristic that may affect its attractiveness to birdwatchers? This study aims to explore these questions in the parks of Beijing, China. We ask three questions: (1) What are the spatial patterns of parks' bird habitat and birdwatching in Beijing? (2) For parks having bird habitat and/or hosting birdwatching activities, what characteristics may affect the amount of habitat and/or birdwatching activities they provide/host? (3) What characteristics differentiate parks with/without bird habitat or birdwatching activities? Our findings may reveal the potential synergies and tradeoffs between bird conservation and birdwatching, and therefore inform park managers on setting up reasonable goals/priorities for birds/ birdwatchers.

Based on our 3-month bird census survey of seven parks and high-resolution land cover map, we applied MaxEnt model to estimate bird habitat area in the 102 urban parks in Beijing. We extracted birdwatching records from "China birdwatching record center" website and used the number of records to represent the active level of birdwatching. Park characters examined included total area, age, landscape configuration, distance to downtown etc… Results showed 66 out of 102 parks have bird habitat with an average of 23 ha and 27 parks appeared in birdwatching records since 2009.

Keywords: Urban bird, park, birdwatching, urban ecology, Beijing

Symposium 46

Landscape trajectories during the long Anthropocene: dialogues between ecology and archaeology

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From micro to global scale the human impact is the real protagonist of the Anthropocene across the long-term timescale. It is impossible to look at environment and landscape without take into account the longue durée processes of the anthropic activities. The driven forces in landscape change are strongly related with historical dynamics. Changes in political regimes, social structures, economic mode of productions, cultural and religious influences – traditional domain of Humanities – are phenomena tangled to many ecological and environmental factors. Understanding landscapes in the Anthropocene is impossible today without a cross-disciplinary approach. Especially Archaeology is a disciple that in the last decades have increased a lot the attention to human-environment interactions and landscape formative-processes. The landscape trajectories are investigable through two different point of view. Vanished landscapes are the main object of analysis of many "archaeologies" (landscape archaeology; environmental archaeology; geoarchaeology) and "paleo" disciplines (paleoecology; paleoclimatology; paleogeography) aimed to reconstruct the a non-visible past. The second approach is focused on the contemporary landscape as palimpsests formed by various historical layers in which is possible to detect evidences of the relationship between human footprint and ecological patterns. Nevertheless, both of these approaches, one based on "hidden traces" and the other on current layered contexts, have a common ground on the idea of Landscape as a complex and heterogeneous mosaics of spaces in which it is possible to read both the temporal dynamics (historical stratification) and the specific characteristics of individual patches situated in various ecotopes, a series of hierarchical relationships between climatic conditions, substrates, landforms, soils, vegetation and human activities. The main aim to this session is to combine and stimulate a interdisciplinary debate between the (many) Archaeologies and Landscape Ecology and Environmental in order to address the following issues across different regions all over the world. The following themes will be explored:

– Methods for multi-disciplinary analysis of formation, change, abandonment and resilience in rural landscapes (from Prehistory to Present day)

– Archaeology as "ecological" disciplines

– Historical perspective of relationships between man and plants (domestication, introduction, extinction, cultivation, exploitation and disturbance of natural vegetation) in forming the plant landscape.

– Anthropocene landscapes: evaluating the human impact in the landscape from historical to ecological perspectives and return.

Contributions regarding different geographical areas and focusing on session key themes from Archaeological and/or Ecological disciplines will be strongly encouraged (single excavations contextualised in a wider territorial context; regional and micro-regional data from survey and landscape archaeology projects) as well as broader overviews.

The papers of this session will offer a methodological dialogue between historical and archaeological issues and landscape ecology.

P0129

The use of LiDAR in reconstructing lost landscapes of abandoned Ruthenian and German villages in southern Poland

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Due to the post World War II border shifts and the policy of ethnically homogenous nation-states, expulsions and forced displacements of ethnic minorities took place across the whole Central and Eastern Europe. Particularly in the mountainous borderlands, the land abandonment turned out to be permanent. The cessation of most human activities triggered succession processes and massive land-cover transformation, but at the same time it saved from distortion most of the pre-war man-made landforms and landscape pattern recorded in the relief. These processes can be observed in dozens of deserted villages in the Carpathians and Sudetes in today Poland, formerly inhabited by Ukrainian and German-speaking communities respectively. The reflection of past landscape imprinted in the microtopography forms a unique cultural heritage of communities that no longer exist.

Our main goal was therefore to reconstruct the lost pre-war cultural landscape by means of airborne laser scanning, field survey and archival cadastral maps. To do so, we selected three study sites located in the Bieszczady Mountains, the Przemyśl Foothills (both in the Carpathians) and in the Kłodzko Region (in the Sudetes). Each site comprises two former villages, which were subject to the lowest in the region human impact over the last 70 years. We focused on the detection of man-made landforms recorded in the relief, such as agricultural terraces, patterns of ploughing, hollow ways and farmhouse foundations. As we use LiDAR data in our research, the secondary aim was to critically assess its value and application opportunities in detecting past landscape features hidden under vegetation in different succession stages. We point out new interpretation possibilities arising from working with point clouds and not only end products (raster elevation models or just shaded relief), and the need of combining LiDAR with other data sources (archival and field-based) for correct and effective interpretation.

Keywords: landscape archaeology, cultural heritage, forced displacement, World War II, mountainous borderlands

P0121

Effects of colonisation on an Indigenous landscape in southeastern Australia

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The region around Yass, NSW, in south-eastern Australia, was for several thousand years home to Aboriginal people who used 'firestickfarming' to encourage particular food-plants and create grasslands. This was attractive to British sheep-pastoralists who moved in during the 1820s and 1830s, eventually creating a town and a major transport route, which in turn encouraged more settlers. 'Gold-rushes' in the 1860s further modified the landscape. The poster will show images of remnant pre-colonial vegetation and of 19th century colonial land use.

The authors are both archaeologists with a special interest in landscape. AC co-directed the Vinhais Survey in northern Portugal (1988-94) and PB has extensive knowledge of Indigenous land-use.

Keywords: Aboriginal Australia, Firestick farming, Colonialism, Pastoralism, Goldmining

T0011

Historical Ecology: a Robust Bridge between Archaeology and Ecology

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Historical ecology is a holistic, practical framework for the study of landscape change. It draws on concepts, methods, theories, and evidence, drawn from the biological and physical sciences, ecology, the social sciences, and the humanities. Historical ecology defines ecology to include humans as a component of all ecosystems, and defines history as the history of the Earth system as well as the social and physical past of our species. Applicable to spatial and temporal frames at any resolution, historical ecology finds rich data sources at the landscape scale, where human activity and biophysical systems interact and records are plentiful. Historical ecology is designed to assist collaboration among differently trained researchers and other stakeholders who could be impacted by a project, including the residents of the area under study. This framework provides an intellectual arena in which diverse communities can exchange information about the past and present of a landscape or region and discuss various courses of action for its future. As in any contact zone, such exchanges require translation, coordination, and a strong commitment to dialog on the part of all stakeholders.

Keyword: collaborative framework

T_0965

Landscape trajectory reconstruction of Sele coastal plain: from the Magna Grecia settlement of Hera Argiva (Southern Italy) to present day.

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The Sele river coastal plain, located in Campania (southern Italy), is a depressed area along the continental margin of the southern Tyrrehenian Sea
Settlement of the sanctuary of Hera Argiva by Greeks occurred in 6th century B.C.
The stratigraphic succession was reconstructed through the study of the material extracted from 16 deep boreholes. The analysis of 120 sand samples and 101 mud samples allowed the characterization of the depositional environments.
Pollen analysis was performed on 4 samples which were suitable to obtain significant data. Paleoclimate computer simulation was used to reconstruct the main climatic traits of the area around the time of settlement.
These datasets were integrated in GIS environment and used to infer and map historical ecological conditions and vegetation characteristic, which can then be compared to the present state.
The reconstruction depicts a densely forested landscape and different phytocoenoses adapted to the different ecological conditions present in the area.
The most extensive was probably a deciduous oak woodland, in which prevalent tree taxa belonged to genera Quercus, Alnus, Carpinus and Corylus.
The presence of Abies and Fagus, although less conspicuous, suggest the possible composition of plant communities located at higher heights.
Mediterrranean sclerophillous vegetation was present as well, with a prevalence of Quercus ilex associated with Olea, Pistacia and Phillyrea.
The constant presence of Vitis sp. is definitely worth mentioning, as it implies interesting bioclimatic and phytoclimatic considerations.
Palynological and morphologic data suggest the persistence in the site area of humid habitats, possibly wetlands, some of which connected to the sea water.

Keywords: Sele river coastal plain, stratigraphic succession, Pollen analysis, GIS environment, Mediterrranean sclerophillous vegetation

Pines and Mines. Shaping the landscape of Sounion National Park (C. Greece) since the antiquity

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The east part of Lavreotiki peninsula (that is now designated as a National Park, i.e. Sounion N.P.) is well known for its unique mineralogical diversity and as one of the few sites in the world where mining industry has developed since the 3rd millennium BC. This activity (mining of silver and lead) lasted till the end of the 2nd century AD. In modern times, mining activity lasted from 1860 till 1982. Nowadays, the dominant element of the vegetation across the old mining sites is Pinus halepensis forests and woodlands, at various successional status due to the variable fire regime that characterizes the peninsula. Nevertheless, the area in question is known to have been covered by P. halepensis forests also in Classical times. Still, no data are available concerning the Roman and Byzantine Era.

In the present study, a first attempt is made in order to follow the pattern of pine forests and woodlands expansion and decline in relation to the mining history of the area. For the ancient period, the sparse information provided from this era literature was our study material, in relation to critical approaches of contemporary researchers on the subject. As far as the modern mining period is concerned, reports of travelers and the maps of Kaupert for the 19th century and old photos, old newspapers and other old editions for the early 20th century have been exploited.

In the former case, it seems that the impact on the forest cover by the ancient mining activity has been minimal. In the later case, the mining activity and the construction of secondary infrastructure have affected the forest cover on the peninsula. Still, after the conclusion of the mining activity and the gradual evacuation of the infrastructure, pine establishment is been recorded in ex-mining associated sites, providing an excellent example of the mining and pine forest cycle that have might be shaping Sounion National Park area over centuries.

Keywords: Mediterranean ecosystems, Vegetation history, Resilience, Dispersal

T0761

An agricultural system in a hostile environment: the Late Roman site of Umm al-Dabadib – Kharga Oasis (Egypt)

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This work, funded by an ERC consolidator Grant, focuses on archaeological and environmental methodology used to investigate a chain of Late Roman fortified settlements of the Kharga Oasis, located in Egypt's Western Desert, that in the Fourth Century AD represented a portion of the southern boundary of the Roman empire. The best-preserved site is Umm al-Dabadib (25°43'47.66"N; 30°25'20.03"E) containing the virtually intact remains of an imposing settlement with a vast and elaborated agricultural system. The site fully represents the struggle between man and environment on a knife edge. The core of the archaeological site was built in the early Fourth Century AD and abandoned only one hundred years later. The state of preservation of the Fortified Settlement is remarkable: the remote position, the excellent building technique, the lack of reuse, and the local climate all contributed to its preservation for sixteen centuries. The desert environment preserved not only the architectural features, but also the physical remains of the agricultural system. In Umm al-Dabadib, we are not simply facing the ancient Roman centuriatio (field division), but also the actual remains of subterranean aqueducts (qanat), covered conduits, open-air canals, outlines of fields, cultivated soil. The research work by a combination of classic and innovative investigation techniques (3D survey, archaeological excavations of the built-up area and the agricultural system, archaeobotanical analyses, ceramic studies, analyses of satellite images), allows an integrated analysis of a unique cultural landscape built seventeen centuries ago at the edge of the inhabited world.

Keywords: Desert irrigation, Qanat, Archaeology, Ecology, Cultural Landscape

T0200

The transformations of the agricultural landscape between the 6th and the 1st millennium BC

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Since the arrival of the first farming communities in the Iberian Peninsula, different farming systems have followed one another, depending on a variety of factors such as the needs of the human community involved, its size, the surrounding environment, the climatic conditions or the types of crops chosen. There are two main options: an intensive agriculture that prioritizes obtaining a higher yield per unit area or an extensive model that seeks to increase production from multiplying the cultivated area. These are choices that will be ultimately conditioned by environmental conditions and the size of the groups.

Archaeobotanical work allows approaching these changes and exploring the modalities of each option. In the earliest phases of the Neolithic in the Iberian Peninsula, the archaeobotanical evidence suggests that intensive agricultural models were developed managed by small groups of people. Later, the processes of population aggregation were accompanied by a change to an extensive model that allowed obtaining resources from a larger cultivated territory. These models alternated at different times throughout prehistory, but at the beginning of the 1st millennium BC this system underwent a further transformation that had a profound impact in the landscape and on the way food was produced. The simultaneous introduction of cultivated fruit trees and iron tools transformed the agricultural landscape of Iberia. New tools and new crops allowed the expansion of arable land, which in turn led to the agricultural colonization of new territories and consequently an increase in population. This growth was accompanied by the emergence of urban communities and the development in some areas of a real market agriculture, which had a significant impact on the environment of these territories.

Keywords: archaeobotany, agriculture, landscape

P0167

Ancient Soil bioengineering and floristic resilience for archeonaturalistic restoration in Sicily

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The Sicilian archaeological landscape in the Anthropocene is threatened by invasive species, soil occupations, hydrogeological and marine (erosion and beach) imbalances. These contrast with the original landscape and the “ancient soil bioengineering" techniques (oppidum, drainage, etc.), in which the reuse of residual vegetation, wood and plants with high root capacity was already a circular economy. In an archaeological site the plants, in addition to the naturalness of the landscape, must be coherent with the ancient landscape respectful of the history of the places. For this reason it is necessary to explant the invasive species, especially if they are dangerous for the ruins. Camarina archaeological site, due to the man imbalance (sea, dunes, wetlands and fluvial areas), was the first opportunity to apply a method of an ancient landscape multicriteria analysis. This is based on Historical, Ecological (eg: bioindicators - Ellemberg, 1974), Biotechnical (eg: synthetic indexes of radical architecture - Cornelini Pirrera Federico 2008) and Landscape compatibility. The analysis uses a database of over 250 historically appropriate species (about 60 found in Sicily), whose sources derive from Latin and Greek (Apicius, Catone, Columella, Pindaro,Plinio,Virgilio,etc.), paleobotanical, artifacts and coins ones. The first case studies (a Palermo lab, Camarina, Cava d'Ispica and Bannata) were reunited in the "Kore Gardens" campaign (2011), dedicated to the myth of Demeter and Kore (goddess of vegetation) linking more than 11 species (wheat, barley, pomegranate, fig, flax, mint, poppy, etc.). Similar research, linked to mythology, has led to fertility-results related species also in MesoAmerica with similarities between Goddess Demetra (wheat) and God Ixchel (corn). New fillips of this historical resilience are derived for the sites crossed by the Ancient Sicula Transversal and thanks to applications deriving from the ancient recipe books, including Archestrato da Gela ones.

Keywords: Archaeological imbalances in the Anthropocene , Database of Ancient flora, Historical sources & Historical circular economy, Multicriteria Analysis, Ecological restoration for the archaeological landscape

The Archaeological-Natural Resilience in the Proto-urban Megalith site of Pietra Tara. Monte Gallo Palermo

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Archeology, naturalistic and urbanistic value exchange their roles, merging them, over time and in the plurimillenennial history of Palermo, with the Climate Change that threatens the possible disappearance of an archaeological and botanical resilience, in Monte Gallo in the Oriented Nature Reserve opposite the island of Ustica, in the site of megaliths of Pietra Tara (1300 - 700 Cal BC). This is the unique site with a megalithic / cyclopean character known as a transverse septum, developed around the "pseudo menhirs", carbonated landslide blocks, adapted and stabilized vertically. The archaeological area is divided into two portions: a lower area close to the sea and a high area, semi covered by landslides from the cliff above. Pietra Tara is inserted in the Mediterranean megalithic architecture, characterized by megaliths / monoliths with cultual intentionality, referring to the "Sacred Landscape". Surface analysis showed a tsunami, which determined the end of the life of the site because close to the coast, with the partial destruction of the fortification wall, and which gave rise to an archaeological resilience, of chronological passage, from the Bronze Age to the Iron Age, visible in the Phoenician site attested near the small landing place. The residual naturalistic botanical value, today, should be reread in the light of the ancient megalithic landscape that culminates with the identification of a botanical resilience of continuity of cold climate plant species, on protohistoric terraces. The oak forest vegetation in Pietra Tara is an exceptional botanical resilience being, the new oak grooving in formation on the fabric of the ancient building, a re-adaptation of the old forest to the cold Wurmian climate. Megalithic city & Metropolitan city, botanical & urban resilience in the light of Climate Change are a kind of “historical courses and recourses” and a warning against urban decay, in a city with two Naturalistic Reserves bordering the urban area.

Keywords: proto-urbanization, sacred archaeological landscape, protohistoric terracing, tsunami, plant resilience of cold climate

P0133

Lithic and megalithic itineraries in the Sicilian naturalistic archaeological landscape

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The lithic landscapes, preserved in the Sicilian Museums and outside them, are treasures and indicators of itineraries of economic-cultural exchanges that took place during the Millennia. Exchanges with lands and peoples far from the Island are intertwined with exceptional events of past Climate Change and exposed by geoarchaeology, the disappearance of large rivers, lakes and wetlands now dried up and unknown tsunami. They are new Sicilian archeology itineraries, key points of the archaeological landscape, with the sea routes that since the Neolithic along the North-South axis, transported raw materials through the inland riverways landscapes of the island then navigable. The jadeite axes, found in the Museum of Ceramics of Caltagirone, the green stones and ancient artifacts, suggest trade between northern Italy and the Ossidiane of the Aeolian Islands. The cyclopean megalithic architecture of the sites of Pietra Tara, Cuntarati, Cozzo di Crasto, the protohistoric sanctuary of Ficuzza (with culinary affinities between the Sicilian protohistoric populations and Iberian ones, connected to sectors of the astronomy for spectacular solar alignments to the solstices or moonstices) remain the cardinal points of historiography, and despite the Anthropocene degradation, maintain a direct link to the ancient Floristic landscape present in the Archaeological Parks.Thus in the megalithic/lithic landscapes, we sometimes find fauna elements (turtles) and several botanical elements of great resilience such as the oaks that refer to the wurmiam period, or bogs and forest wrecks to Abies Nebrodensis that paleobotany brings back to other latitude. Ancient landscape, therefore, declinable under the various aspects that can be identified as aspects of the "Outdoor Museum Landscape".
A landscape in which one can "read" the knowledge of the man of the past for that ecology aware of the power of nature, therefore still respectful over time and various places, today irretrievably lost.

Keywords: outdoor diffused museum, prehistoric human resilience & plant resilience, Geoarchaeology and Archeoastronomy , Green stones, Ossidiane and jadeite axes, River routes

T_9015

Using soil charcoal to explore the ecosystem history

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Up to date the soil charcoal has been mainly research object of the archaeological investigations, much less used in studying history of ecosystems. The soil charcoal is result of local burnings and therefore allows to identify the species composition of historical vegetation and date the fire events in definite locations.

The aim of present study is to analyse the character and location of the soil charcoal according to agricultural land use intensity. The fieldwork was carried out in Karula National Park in southern Estonia where 64 sites were sampled. Differently managed sites were included long time arable fields, former slash and burn fields, experimental slash and burn fields, recent forest fire areas and the long-time forest sites. The former land use was identified using historical maps from 19th and 20th century. Different statistical methods (correlation analysis, T-test) were used to analyse the data.

The soil charcoal were found in all land use types. The location of charcoal in the long-time arable were the most different from the others because the charcoal was maintained only in lower border of humus there. In the recent forest fire sites the charcoal was found in highest positions. The results demonstrate that the depth of charcoal rich layer was best associated with intensity of historical cultivation. From arable fields were found mostly spruce charcoal, in former swiddens and forests the pine charcoal dominated. The weighted average dates of charcoal from humus layer of former slash and burn sites were 1566–1805 ca AD, these dates correlate with literature data on the wide use of regular slash and burn cultivation. The weighted average dates of charcoal from historical forest sites were -3731-1672 calAD. The comparison with archaeological findings confirm the wildfire events.

The age, species composition and location of soil charcoal reflect the agricultural land use intensity and the wider use of soil charcoal could be suggested.

Keywords: land use, soil charcoal, wildfire, slash and burn cultivation, pedoanthracology

T0103

Distinct phases of natural landscape dynamics and intensifying human activity in the central Kenya Rift Valley during the past 1300 years

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Environmental and socio-ecological stresses affecting the semi-arid regions of equatorial East Africa highlight the need to place current human-climate-landscape interaction in a proper long-term context. We present a detailed reconstruction of past human influences on the central Kenya Rift Valley landscape against a backdrop of natural climate-driven ecosystem dynamics over the past 1300 years, based on proxy data of vegetation dynamics, animal husbandry, biomass burning and soil mobilization extracted from the sediment record of Lake Bogoria. In contrast to archaeological evidence showing that agriculture spread from the Lake Victoria region to the central Rift Valley by the mid-first millennium CE, the first unambiguous ecological signature of human activity appears in our records in the mid-15th century. After a ~150-year period of wetter climate when trees expanded in the seemingly undisturbed open savanna woodland, reduction of woodland elements followed by the appearance of cereal pollen likely reflects the establishment of mixed farming. Animal husbandry became a significant ecological factor from the early-17th century, reaching near-modern levels by the mid-19th century after severe early-19th century drought had substantially changed human-landscape interaction. Evidence for soil mobilization and a short-lived peak in biomass burning reflects the 19th-century establishment of irrigation agriculture in the vicinity of the lake, while renewed expansion of forest and woodland reflects the return of a wetter climate and the abandonment of farmland in upland areas of the Bogoria catchment. The principal signature of human activity since the mid-20th century is widespread soil erosion due to rapidly intensifying land use.

Keywords: Anthropocene, climate-human interaction, East Africa, paleoecology, vegetation dynamics

Deciphering the trajectories of historic landscapes for assisting the historic landscape characterization in Kuling Town, Lushan national park, China

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Contemporary landscapes are facing increasing pressure from the urbanization, industrialization, globalization and recreation, etc. As a result, there is a negative landscape change which causes the character of the landscape weakened. Deciphering the trajectories of historic landscape can clearly capture the coherence and identity of landscapes. It should not be ignored when we understand and interpret the landscapes.

Historic landscape characterization (HLC) as a tool from the archaeological and heritage perspective, will contribute to landscape planning, monitoring and management. The research is executed in Kuling town, Lushan National Park of China, which is issued as a cultural landscape in 1994 by UNESCO. The numbers of historical villas and gardens are suffering from landscape fragmentation and a degradation of the landscape qualities and values. It requires a holistic framework for protection and management.

The research is undertaking by the following steps. Firstly, historic landscapes of Kuling town are divided into 5 time periods: before 1895, 1895-1928, 1928-1949, 1949-1978, 1978-today. Secondly, analyzing the historic maps and mapping the time depths of Kuling town in a GIS. Thirdly, we use the two steps cluster analysis in SPSS software for visualizing the historic landscape types. Lastly, integrating the results of the visualization by e-cognition software and rectifying the results by manual identification. Consequently, 5 historic landscape types and 12 landscape units are defined. This procedure will provide a baseline information for integral protection and management of historic landscapes in Kuling town.

Keywords: time depth, historic landscape character, GIS

Antica Trasversale Sicula's project: an interdisciplinary approach for the reconstruction of the transhumance road system and the "victims of the Anthropocene"

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The aim of this paper is the diachronic analysis of the Sicilian landscapes related to the transhumance phenomenon and to offer a report on the "victims of the Anthropocene". This analysis would offer an interdisciplinary approach between the topographic studies related to the transhumance routes (trazzere in Sicilian) and the data and the analysis realised in the GIS for the project Antica Trasversale Sicula, a wider research project carried out in the past four years dedicated to the study and to the realization of an ancient way in Sicily based on the trazzere's system. As for the topographic studies, Dinu Adamesteanu was the first to suggest that the trazzere were part of the Prehistorical villages' road system and, later, of the Greek settlements. Furthermore, Giovanni Uggeri suggested that some Archaic roads were probably Prehistoric transhumance routes. Between October 2017 and 2018 it was mapped and traversed the way that connected the most important Archaic settlements in Sicily. The missions were the promotion of a trans-island way, the verification of the topographic studies, and the economic increase of the economically depressed inland territories. Furthermore a GIS was created, in collaboration with the LabGIS of the Touristic Department of Sicily, for the incorporation of the data from both the ancient road system and the fieldwork campaigns of 2017 and 2018 (goo.gl/sAk4MB). Specifically, the archaeological data for the transhumance routes identification are the upland places of worship, and the places of worship connected to the bovine and the water cults. Recently, Luigi Santagati has proposed the identification of the transhumance routes of the island through the toponomastic analysis. The transhumance routes are mostly overlaid on the Antica Trasversale Sicula way. Finally, in order to present the results of the field campaigns of 2017 and 2018, a short report on the bad effects of the Anthropocene on the Archaeological Landscape will be presented

Keywords: Transhumance routes, Archaeological Landscapes, Victims of the Anthropocene

Symposium 47

Biophysical Methods for the Quantification, Mapping and Assessment of Ecosystem Services

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At least since the well-known Millennium Ecosystem Assessment and follow-up studies such as TEEB, IPBES and MAES mainstreamed the concept of ecosystem services to a broader community, the need for solid methods to map, assess and map ecosystem services has increased. Describing the benefits of ecosystems to the human wellbeing, common classification schemes group ecosystem services into provisioning, regulating & maintaining and cultural services. Especially the services of the first two groups have strong linkages to the biophysical structures, functions and conditions of ecosystems and their compartments. To determine the service provision in biophysical units, biophysical quantification methods and spatially-explicit methods to map them are required. Usually methods measure or model specific indicators to address a specific ecosystem service. By linking different methods, bundles of ecosystem services can be quantified and synergies respectively trade-offs can be identified and assessed. The selection of biophysical ecosystem service indicators and methods needs a clear foundation in ecological core concepts developed in landscape ecology and neighbouring disciplines (e.g. research on biodiversity, ecosystem structures, processes and functions).

The aim of this symposium is to discuss the state of the art of biophysical methods, available data and their utilisation in the assessment and mapping of ecosystem services on different spatio-temporal scales. It will show approaches used in actual studies and their linkages to landscape ecological thinking. In addition, indicators to monitor the state and trend of ecosystems and their services will be discussed.

T0613

Lowland riparian hardwood forests – regulating services of the European remnants

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Riparian mixed forests of oak, elm and ash species along the great rivers (EU code: 91F0) are valuable habitats protected by EU Habitat Directive. They naturally occur in the floodplains within the range of episodic inundations. Today, in most areas across Europe they are extremely rare due to deforestation, drainage and river engineering. The remaining small forest patches are important parts of riparian ecological corridors and biodiversity hotspots, and provide valuable ecosystem services (ES) to humans. However, unlike other forest types, due to their rarity and often low accessibility their ES potential has not been properly recognized and assessed to date.

The aim of this work was to estimate the potential of riparian hardwood forests to provide 13 regulating services and identify interactions (synergies and trade-offs) among them. We followed the CICES v5.1 theoretical framework and classification system to distinguish and define services. Waste decomposition, soil quality maintenance, erosion control, water flow regulation, pollination, pest control and regulation of the chemical condition of freshwaters and atmosphere were among the investigated services. Riparian forest potential was estimated by reference to different characteristics of ecosystem condition, comprising environmental quality and structural and functional ecosystem attributes. We used mechanisms already known from the literature to develop a set of ecosystem-condition-related indicators designed for ES assessment. The condition of riparian forests was evaluated through extensive field work and direct measurements carried out on 6 selected test sites located along the middle Vistula River.

The results show that human actions to reduce flooding initiated changes in soil and plant composition, which in turn affect ES available to people. The assessment provided a scientific basis for formulating a number of recommendations regarding the protection of these unique and endangered forests.

Keywords: ecosystem condition, ecosystem potential, ecosystem services, interlinkages, Vistula river valley

T0822

Impacts of forest management on ecosystem services: reliable projections require fine-scale information on landscape characteristics

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Boreal forests provide a wide range of ecosystem services (ES). They regulate climate through carbon (C) cycle, and provide timber and renewable energy. Dead wood maintains the nutrient cycle of forest and is a habitat for threatened species. Producing energy from harvest residues has been proposed as a means of mitigating climate change. However, it also reduces the C stocks and the availability of deadwood. Ignoring the temporal dynamics of the C cycle might add remarkable inaccuracy to the landscape level estimates of these ES. They can be best quantified by coupling dynamic modelling of C cycle with spatially explicit information on forest characteristics. Here we introduce results from two studies. Their objectives were 1) to develop a framework to map the current status of the C budget of boreal forests and 2) to apply the framework to investigate the impacts of alternative bioenergy scenarios on key ES indicators: C budget, timber and energy wood production, and deadwood potential. Simulated estimates of the C stocks of biomass, litter and soil were connected to multi-source forest inventory data in southern Finland. In the simulations, forest management followed the national recommendations. The framework produced more reliable estimates of the current status of the C budget than tools based on simple, land cover -based proxies. Intensive removal of harvest residues and stumps in the final felling reduced the soil C sink and the deadwood potential compared with a situation where no harvest residues were extracted. The results illustrated that the landscape level projections of ES depend highly on the changes in stand age class distribution, depending on the simulated harvest regime. The framework can be applied to identify trade-offs and synergies between ES to support sustainable land use planning. It integrated simulation models with extensive forest inventory data, producing high-resolution maps of the responses of ES to forest bioenergy production.

Keywords: ecosystem services, carbon, bioenergy, deadwood, modelling

T_8918

Quantification and mapping of regulating and provisioning services in urban areas making use of a system dynamics model

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There is a growing evidence that the use of statistical, process-based, and mechanistic models can provide robust information for the quantification and mapping of provisioning and regulating services, and the planning of Nature-based solutions providing them. These models can allow identification and relation of main factors of biophysical structures and processes, taking into account how the condition of ecosystems or living features (e.g. health conditions of trees) could increase or decrease the supply of ecosystem services (ES). However, they i) usually assume that conditions do not change over time; ii) rarely consider causal loop interactions among biophysical structures, processes and human actions; iii) do not model multiple ES at once. In this research, we present a system dynamics modelling approach to quantify and map several regulation and provisioning services and disservices simultaneously supplied by urban nature-based solutions, which acknowledges temporal changes in the system. To illustrate the approach, we develop and present the results of an urban forest model applied to Valdebebas Park (Madrid, Spain). Five regulating services (carbon sequestration, temperature regulation, air pollutant filtration, and water flow maintenance), one provisioning service (plant material for direct use or processing), and one provisioning disservice (plant residues for landfill or waste treatment) were quantified and mapped in biophysical units. The model includes morbidity dynamics of trees triggered by their location (street vs open spaces), lack of water, and waterlogging, as well as the influence of human management. The results show the potential of system dynamics models to quantify bundles of ES in a spatio-temporally explicit form and their usefulness to inform urban planning and decision making regarding implementation of nature-based solutions.

Keywords: System Dynamics, Nature-based Solutions, Ecosystem Services, Urban Planning

T_0975

A tiered approach for biophysical ecosystem services quantification, mapping and assessment

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There is a vast amount of biophysical ecosystem services (ES) research methods, originating from decades of landscape ecological studies, environmental monitoring programmes, direct measurements, remote sensing or process-based modelling. The design of a tiered approach for ES quantification, mapping and assessment, ranging from relatively simple (Tier 1) to complex (Tier 3) methods, can help to harness this variety of methods and to integrate them. The tiered approach is combining for instance expert- and land cover-based ES mapping approaches and the use of existing ES indicator data with more complex and comprehensive ES modelling frameworks. Depending on the purpose of the study, data and resources availabilities, the most suitable approach can then be chosen and applied. In many cases it is not necessary to apply the most complex methods, for instance if the purpose of a study is to provide an overview or to raise awareness of ES supply or demand on a larger scale. Depending on the ES, the study area setting and the specific questions to be addressed in a study, a higher tier level does not necessarily mean a more sound or more applicable result. In the presentation, the tiered approach will be introduced along with some application examples from all tier levels

Keywords: ecosystem services, mapping, assessment, integrated approach, model

T_8882

Risk of unsustainable use of ecosystem services through capacity / use assessment: current state and scenarios for support decision making

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Analysing whether or not societies use ecosystems sustainably is a major socio-ecological challenge. Using a French protected area as a case study, we assessed the current level of risk of unsustainable ecosystems use by relating ecosystem services (ES) actual use to ES capacity. Then, based on four scenarios, we explored potential trajectories of ecosystem use depending on plausible socio-economic developments.

We used the ES matrix approach in a peri-urban Natural Regional Park in North of France, assessing ES capacity and use separately mobilizing the expertise of two different experts panels. The difference between the ES capacity and use, named the balance score, was used to define levels of risks of unsustainable uses.

A feedback meeting, an online survey and a comparison with indicators of human pressure and biodiversity intactness were used to check the relevance of the obtained balance scores. One of the main outcome is to pinpoint ecosystem types and ecosystem services at risk and to provide evidences for policies and management actions promoting sustainable use. Our results indicate that most of the balance scores are positive. However, 32% of balance scores point to a high risk of unsustainable use, mainly for regulating services and agricultural ecosystem types.

We then develop exploratory scenarios at the horizons 2050 in collaboration with park managers. Using four story lines based on possible management choices, we determine their impacts on land use/land cover changes and ES use intensity changes. This approach allows to identify sustainable use of ecosystem services at regional scale pathways that provide important support for decision makers of the protected area and support to orientate actions plans in the current revision of management documents in the Parc.

Keywords: Ecosystem services, Land use/ Land cover changes, Sustainability, Expert-based matrix, France

T0443

Ecosystem services of German landscapes

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German landscapes provide important ecosystem services (ES) of local, regional and national/transnational scale and are crucially important for the economy and people of the country. The start of a national ES valuation and accounting process was initiated in context of the EU Biodiversity Strategy 2020 demand in 2011 is commissioned by the German Federal Agency for Nature Conservation (BfN) with funds from the German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU).
In the presentation, we discuss the methodology of national assessment of ecosystems, their conditions and services in Germany in the frame of the EU-Biodiversity Strategy 2020 and based on TEEB/MAES/SEEA recommendations. Furthermore we discuss interrelations between biodiversity and ES at landscape scale.
Following parts are in focus:
I. (Landscape)Ecosystem approach (types on different scales, extent accounts in Germany over time)
II. Condition (pressure and state indicators) of German landscape-ecosystem main types
III. Biophysical assessment of selected landscape services on national scale
IV. Approaches to an integrative assessment with reference to the entire landscape

Keywords: assessment, biodiversity, indicator, mapping, national scale

T0504

A cumulative indicator for mapping recreational ecosystem services supply and demand in Germany.

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The German approach for the mapping and assessment of ecosystem services (ES) proposes indicators for evaluating ES supply in terms of ES potentials, for estimating ES demand, as well as for analyzing the relationship between them. Regarding recreational ecosystem services the spatial relationships between supply and demand are particularly important because of their uneven spatial distribution and because the supply depends heavily on the direct, in-situ and outdoor interactions of people with the natural environment. Only few studies have so far assessed associations between such supply and demand at EU member state levels.

This contribution introduces a cumulative indicator for describing spatial supply-demand relationships of recreational ecosystem services in Germany, with a specific focus on leisure and weekend recreation. The indicator takes into account the landscape quality relevant for recreation and the accessibility of suitable areas for the population. The proposed final indicator represents a spatially explicit quantitative estimation of the supply level of the population with recreational ecosystem services as well as the corresponding service provision through our landscapes.

We first present our approach for the spatial analysis based on a broad spectrum of landscape metrics and the best available spatial data. We then describe the spatial results of the analysis, emphasizing spatial differences between the identified supply and demand, and discuss the usefulness and implications of the results for policy making on national and sub-national levels. Finally, conclusions are drawn concerning potential improvement options, next research steps and lessons-learned.

Keywords: recreational ecosystem services, spatially-explicit indicators, mapping and assessment, national ecosystem assessment, quantification

T0249

Ecosystem functions and services: from plot to landscape scale

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Ecosystem research is generally restricted to ecosystem functions or processes transferring energy and matter within and between ecosystems (biogeochemical cycles, primary production, etc.). In the context of ecosystem services, ecosystem functions are used for their assessment and are beneficial to humankind. Large-scale mapping of ecosystem service provision leads to great methodological challenges when it comes to bridge the gap from point to landscape. Although current earth observation techniques, remote sensing and proximal sensing, are able to provide high-resolution data, plot-scale data covering a wide range of environmental parameters are still a requirement for most functional ecological studies. In addition, detailed experimental surveys provide great opportunities for upscaling purposes and have long been recognized in landscape ecology research. Although regression models and artificial neural networks are valuable for fully exploiting the information of 'local' data, some problems hinder the progress of this type of landscape scale modelling: (1) statistical correlations do not necessarily reflect causal links; (2) empirical modelling lacks transferability and generalizability at a certain stage. Here we present various upscaling techniques from ecosystem and landscape research in the Alps to highlight opportunities and challenges as well as possible improvements of experimental sampling based on trajectories of land-use / land cover (LULC). Complemented by top-down studies that use remote sensing data indicators to analyze specific target processes (i.e. land surface temperature as an indicator of evapotranspiration and / or energy balance), a wide range of scaling issues are presented for discussion, contributing to the increasing demand for scale-issues in environmental research.

Keywords: spatial scales, ecosystem functions, spatial modelling

T0664

Identification of hotspots and bundles of forest ecosystem services in Europe

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Forests cover about 40% of the European Union (EU) and provide an incredible amount of ecosystem services to the European population, including supply of timber, regulation of water flows, sequestration of carbon, stabilization of slopes as well as cultural values and recreational opportunities. Over the last decade, most of these services have been mapped at relatively high resolution (1 km) using moderately complex modeling techniques (Tier 1), therefore providing relevant insights about their supply patterns. However, little has been done so far to combine the information brought about by these maps in a way that can support the EU policy. What seems to be missing is the delineation of forest areas that supply large quantities of multiple services as these may be the target of conservation initiatives; the investigation of relationships among different forest ecosystem services (FES) as this may support the identification of FES whose improvement brings in wider benefits; and the identification of areas providing specific sets of FES as these may be assigned ad hoc management approaches.

Our study aims to fill this gap by building maps for the main FES and use them to delineate FES hotspots, assess the occurrence of synergies and tradeoffs among FES and identifying spatial bundles of FES in the EU. Maps were based on available datasets or generated through simple modeling, whereas raster analysis and correlation were used for the identification of hotspots and the investigation of synergies and bundles.

Results show that FES tend to be positively related to each other and that similar sets of FES can be found at different locations across the continent, therefore informing about the potential (ir)replaceability of these areas in terms of FES supply. Data presented may be used to identify areas to preserve through targeted conservation actions and locations where specific FES-based industries may thrive or be promoted with ad-hoc policy.

Keywords: ecosystem service mapping, synergies, tradeoffs, EU policy, GIS

Carbon Quantification in a Mining Forest towards Valuing Ecosystem Services

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Forest ecosystem is primarily valued for its basic goods or provisioning services but less for its regulating services that are often perceived to be free and limitless. Its role in climate change mitigation as a net carbon sink is less recognized. Assessing its value is an important step towards promoting conservation and more responsible decision making.

The study assessed the carbon storage potential of a conifer forest in a mining area. It estimates the amount of biomass, carbon and CO2 stored in the entire forest ecosystem. The carbon pools investigated include: trees, understorey/herbaceous (U/H), course woody debris (CWD), necromass/litter, roots and soil carbon.

There were three types of stand investigated based on crown stocking density (CSD): high (2/3 CSD), medium (> 1/3 - < 2/3 CSD) and low (>1/3 CSD). Classification of forest types was carried out using the Google Earth image of the area and it was processed through GIS. Amount of biomass and C/CO2 stock per stand type, are as follows: high stand type has a biomass density of 234.45 Mg ha-1 with C content of 199.06 Mg ha-1 and CO2 equivalent of 792.87 Mg ha-1. The medium density stand has 216.32 Mg ha-1 of biomass accumulated, C content of 188.91 Mg ha-1 with 692.67 Mg ha-1 CO2 equivalent. While the low density stand showed a biomass content of 83.5 Mg ha-1, 123.03 Mg ha-1 of C and 451.12 Mg ha-1 of CO2 stored.

As expected, high density stand topped in carbon stored because of the presence of big and matured trees that yield high biomass and carbon density plus highlighted by soil C. Comparing further the amount of C/CO2 stored among C pools, it is ranked as follows: soils > trees > roots > necro/litter > CWD > understorey/herbaceous. Much of the C/CO2 in this study is in the soil opposite to most broad-leaved forest which is primarily stored in the tree component. Hence, soil plays a very important role in the carbon assimilation process of a coniferous forest.

Keywords: ecosystem services, biomasss, C and CO2 sink, stand density

T0604

Integrated mapping and assessment of agroecosystems in Northern Germany

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Agroecosystems account for almost half of the land use in the European Union (EU). In Germany specifically, more than half of the surface area is used for agriculture. Well-managed agricultural land can provide multiple ecosystem services, essential for the maintenance of quality of life and conservation of biodiversity. However, changes in the condition of agroecosystems impair the delivery of these ecosystem services and hence human well-being. Environmental pressures such as soil erosion, soil biodiversity loss, soil compaction, organic matter decline, soil sealing, and contamination are, together with changing climate and water regimes, degrading these ecosystems.

In response to these increasing pressures, the EU established a dedicated working group on Mapping and Assessment of Ecosystems and their Services (MAES) to support the implementation of the 2nd target of the EU Biodiversity Strategy to 2020 and to map and assess the condition of European ecosystems and the services they provide. As part of its work, MAES has developed a framework and a series of indicators to map and assess ecosystem condition in the EU.

The aim of this study is to conduct an integrated assessment of ecosystems and to test the indicators proposed by MAES for the assessment of ecosystem condition. The study applies an operational framework for integrated mapping and assessment of agroecosystems in the Northern German Federal State of Lower Saxony, considering specific conditions related to the EU policy objective "healthy soils". For this purpose, a stepwise approach is followed, including: i) the identification of the policy objective "healthy soils" as a theme for assessments; ii) the identification and mapping of agroecosystems; and iii) the selection, quantification and mapping of indicators of agroecosystem condition. The study also identifies pressures and management practices that affect the condition of agroecosystems which may support planning and decision making.

Keywords: ecosystem state, ecosystem condition indicators, healthy soils, Lower Saxony

T0614

Quantification and modeling of multiple ecosystem services in the Venice lagoon (Italy): an analysis from a sustainability perspective

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The Venice lagoon (north-eastern Italy) is a complex social-ecological system in which multiple ecosystem services (ES) are co-produced. Among these ES, some are directly resulting from ecosystem functioning, whereas others are mediated by human activities that can produce feedbacks on the same ES (e.g. through overexploitation) or on other ES (e.g. through side-effects on other ecosystem structures and processes). We therefore expect the sustainability/unsustainability of the patterns of multiple ES patterns to emerge from different levels of ES provision and from the interactions among ES. The aim of this work is to analyze the sustainability of the ES patterns provided by the different lagoon sub-basins based on the assessment and modeling of multiple ES, and to explore how this perspective can inform the lagoon management. In order to do so, a set of 13 ES, five regulating, four provisioning and four cultural ES, has been quantitatively assessed using biophysical indicators. Furthermore, a modeling application has been implemented, that dynamically models the provision of multiple ES and their interactions, to evaluate the potential trends of the multiple ES in each sub-basin. The results reveal an association between the potential ES trends and two aggregated indicators (MED/DIR and PRESS/DIR) calculated based on the ES assessment, suggesting that a relative indication on the sustainability of the patterns of multiple ES can be obtained from the analysis of the mapping results. Furthermore, the association between the modeled trends and the sub-basins' degree of confinement suggests that confined and not-confined sub-basins might have different requirements from a management perspective. Management trajectories that aim at improving the sustainability of the provision of multiple ES are suggested, and their linkages with the implementation of existing directives are discussed.

Keywords: Sustainability, ecosystem services mapping, coastal lagoon, modeling, trade-offs

T0145

Assessing the decrease in soil-related ecosystem services by soil erosion

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The potential of ecosystems to provide ecosystem services (ES) is controlled by their condition. As a degradation process, soil erosion alters ecosystems and their condition, leading to a decrease of soil-related ES supply. Therefore the prevention of soil erosion in agrarian landscapes by appropriate management measures is mandatory to maintain a continuous supply of a wide range of ES, including the provision of crops and water filtration. In soil science, erosion is in the first place assessed by the loss of material. In the ecosystem service approach, the ES control of erosion rates is defined as the mitigation of the potential soil loss (mainly by vegetation ground cover) – mostly described in the form of prevented loss of soil material.

A more holistic concept is needed for soil-related ES in order to consider the diverse and complex interlinkages within ecosystems and to appropriately address the impacts of soil erosion on ecosystem condition and service supply. The linkage of loss rates with changes in soil-related ES enables the transformation of loss rates toward the assessment of soil erosion impacts on ecosystems and their services. This will emphasise the importance of the ES control of erosion rates and farming practices preventing soil erosion.

The talk will present a framework for the assessment of the mitigated impacts of the ES control of erosion rates on soil-related ES. It combines mapping and assessment of changing soil-related ES based on soil loss scenarios. The scenarios represent the structural and mitigated impacts of soil erosion on soils. This enables the assessment of mitigated losses in soil-related ES that correspond to the long-term effects of the ES control of erosion rates. Data from the application of the framework in a study area in Northern Germany will highlight its potentials in broadening our understanding of the interlinkages between ES and the effects of conservational land management in sustaining long-term ES supply.

Keywords: soil erosion, soil-related ecosystem services, ecosystem condition

A two-dimensional assessment framework for quantifying cultural ecosystem services of green infrastructures in urban area: a case study of parks in Three-hills and Five-gardens area in Beijing, China

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As an important urban green infrastructure, parks can provide rich cultural ecosystem services (CES). The Three-hills and Five-gardens Area in Beijing is the famous historical and cultural scenic resort. It is a comprehensive urban area, which includes royal gardens, modern parks, universities, business districts, and residential areas. The study evaluates CES of 15 parks in the study area from the perspective of ecosystem service assessment. Based on the CES of MA and the social function of urban green space, the concept of CES of parks is reinterpreted. Two-dimensional assessment system of CES is constructed by combining the relationship between objective attributes of parks and subjective perception of the public. The assessment system is composed of subjective dimension and objective dimension, including 5 categories (historical heritages, landscape aesthetics, recreation, education, health and fitness) and 11 subclasses. Based on data collection and field investigation, objective dimension assessment is implemented by the methodology of rating scoring and scenic beauty estimation (SBE). Subjective dimension assessment is implemented by questionnaire and grading method. By comparing the results of the subjective and objective evaluation, the reasons of leading differences between subjective and objective assessment on CES capacity of parks is explored, such as the limitations of the service audiences, the visibility level of historical and cultural heritages and the frequency of visitors using the parks. According to the comparative analysis of objective assessment and willingness to pay, 4 types of parks are defined. The two-dimensional assessment framework can provide a reference for the assessment of CES capacity of the parks. Quantitative assessment method is conducive to clear the differences of parks in providing services for people and enhancing human well-being. These can guide the planning and construction of parks in the future.

Keywords: cultural ecosystem services, two - dimensional assessment system, quantitative evaluation, green infrastructure, parks

Ecosystem Services Changes between 2000 and 2015 in the Loess Plateau, China

Dan Wu, Naifeng Lin

The Loess Plateau of China is one of the most severe soil and water loss areas in the world. Since 1999, the Grain to Green Program (GTGP) has been implemented in the region. This study aimed to analyze spatial and temporal variations of ecosystem services from 2000 to 2015 to assess the effects of the GTGP, including carbon sequestration, water regulation, soil conservation and sand fixation. During the study period, the area of forest land and grassland significantly expanded, while the area of farmland decreased sharply. Ecosystem services showed an overall improvement with localized deterioration. Carbon sequestration, water regulation and soil conservation increased substantially. Sand fixation showed a decreasing trend mainly because of decreased wind speeds. There were synergies between carbon sequestration and water regulation, and tradeoffs between soil conservation and sand fixation. It was concluded that ecological projects have contributed significantly to the rehabilitation of the fragile ecosystems of this region. To make these projects more successful and sustainable, long-term management procedures are necessary to maintain and consolidate the improvements.

Keywords: carbon sequestration, water regulation, soil conservation, sand fixation, the Loess Plateau

Symposium 48

The role of landscape experiments to inform large-scale habitat restoration

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Large-scale habitat restoration has been widely adopted as a strategy to combat extreme habitat loss and fragmentation - a major driver of global biodiversity decline. Much of this restoration action is aimed at joining up fragmented habitats through the creation of habitat corridors and stepping-stones, as well as improving habitat quality through site-scale actions. However, we know relatively little about the ecological consequences of creating and restoring habitats, and about the relative value of potential actions to restore species and the functions they perform in an ecosystem. Much of the scientific evidence used to underpin landscape-scale restoration comes from studies of habitat fragmentation, and there is little evidence to suggest that the ecological consequences of habitat loss and fragmentation (and associated extinction debts) are reciprocal with the benefits of habitat restoration and creation (and associated immigration credits). As a result, there is now much debate in the scientific and conservation communities on how to prioritise alternative site and landscape-scale restoration actions.

A greater use of experimental approaches could help to resolve this situation and increase the chances of teasing apart the relative merit of various site and landscape-scale restoration actions for biodiversity. However, there are two fundamental challenges to large-scale habitat restoration experiments. The first is a trade-off between the 'spatial scale' necessary to ensure ecological realism and obtain evidence applicable to practical conservation versus the ability to exert experimental control and replication. The second challenge is related to 'temporal scale' and the potentially significant time lag in biodiversity responses to habitat restoration. This time lag, often called 'immigration credit', based on a combination of habitat development, species colonisation and establishment processes may be considerable for poorly dispersing species in slowly developing habitats in highly fragmented landscape (e.g. forests).

This symposium will bring together researchers' working on a range of restoration experiments that have used different approaches to overcome these spatial and temporal challenges. These studies range from fine-scale highly controlled 'manipulative' experiments to large-scale 'natural' experiments (where researchers overlay an experimental design on an ecosystem where change has occurred beyond their control) but all of which have the potential to provide important evidence to inform future landscape-scale restoration efforts.

T0737

Landscape-level revegetation reverses the decline of woodland birds in rural environments

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Restoration of vegetation through replanting (revegetation) is undertaken in many regions worldwide where excessive loss of natural habitats has occurred. It generally is assumed that this will reverse faunal decline and restore the original biota. We employed a natural experiment, using a 'whole of landscape' design, to test the benefits of restoration for woodland birds in farmland environments in SW Victoria, Australia. We selected 43 landscapes, each 8 km2 in size, and surveyed birds at 12 sites (1 ha plots) stratified across each landscape. The study landscapes were selected as three sets in which wooded cover was either: a) primarily remnant natural vegetation; b) a mixture of remnant and replanted vegetation; or c) primarily replanted vegetation. In each set, wooded vegetation cover ranged from <2% to ~19% of the landscape, the remainder being open farmland with areas of scattered trees. There were two key results. 1) Progressive loss of remnant woodland led to a decline in landscape-scale species richness of woodland birds and a simplified avifaunal composition; but as landscapes increased in cover of revegetation this trajectory was reversed, species richness increased, and species composition was enhanced. 2) The trajectory of recovery is not simply a reversal of the trajectory of decline. For a given cover of wooded vegetation, species richness was lower in revegetated landscapes and the avifaunal composition differed in predictable ways. Revegetation contributes to avifaunal conservation by restoring wooded habitat in depleted environments. This attracts woodland species back into rural landscapes; but does not necessarily provide suitable habitat for entire assemblages, at least in the short-term. Importantly, revegetation is amenable to individual land managers, it has multiple values for a farm enterprise, and the ecological benefits accumulate to enhance conservation of native fauna at landscape and regional scales.

Keywords: biodiversity, restoration, landscape change, future landscapes, farmland conservation

T0214

Animal diversity responding to different forest restoration landscapes in the Qinling Mountains, China

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China's primary forest has gone through the extensive deforestation and further restoration since 1950s. However, little is known about how animal diversity responds to habitat restoration, and about the relative value of different restoration actions to restore species in the forest landscape. Here, we used camera trapping technology to monitor diversity of large-and-medium mammals (weight >1 kg) for three years (2014~2017) in four forest types in the Qinling Mountains: high-elevation primary forest, low-elevation primary forest, secondary forest, and plantation forest. Our results showed that: (1) the animal species richness in four forest types were very similar to each other, while low-elevation primary forests had the most wild animal species (n=18). (2) Comparing the total relative abundant index in different forest types, low-elevation primary forest had the largest RAI (3.00%), followed by plantation forest (1.77%), then secondary forest (0.89%), and high-elevation primary forest (0.74%). (3) low-elevation primary forest was the most preferred habitat for 13 species, high-elevation forest was most preferred by 5 species, and plantation by 3 species, whereas secondary forest was most preferred by only 1 species, indicating their relative importance for different species in this area. (4) Our study reveals that both plantation forest and secondary forest in the Qinling Mountains played also an important role of supporting animal species. Thus a comprehensive management of habitat-restoration in landscape is required for biodiversity conservation in the Qinling Mountains.

Keywords: forest restoration landscape, animal diversity, camera trapping, the Qinling Mountains

P0068

Soil moisture decline following the plantation of Robinia pseudoacacia forests: Evidence from the Loess Plateau

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Soil moisture is the foundation of ecosystem sustainability in arid and semi-arid regions, and the spatial-temporal details of soil moisture dynamics of afforested areas can benefit for land use management in water-shortage regions such as the Loess Plateau of China. In this study, spatial-temporal variations in soil moisture under Robinia pseudoacacia plantations on the Loess Plateau were analyzed. A total of 147 observations of oil moisture content (SMC) data to a depth of 500 cm soil profile were collected in 23 counties via field transect surveys and analyses of published literature. The results suggested that 1) the depth-averaged SMC was generally lower under forest sites than under cropland, both in the shallow layers and in the deep profiles. This finding implied that, compared with the native vegetation, the introduced R. pseudoacacia plantations caused intense reductions in soil moisture. 2) SMC was positively correlated with climatic factors (mean annual precipitation (MAP), mean annual temperature (MAT), and the Palmer drought severity index (PDSI)), indicating that the SMC under R. pseudoacacia plantations was highly consistent with the hydrothermal conditions at the regional scale. 3) The decreasing amplitude of SMC was linearly related to the increasing number of restoration years, especially in the areas below the 500-550 mm precipitation threshold. This finding showed that the restoration ageing sequence was an influential factor that affected the regional SMC variation in R. pseudoacacia plantations on the Loess Plateau. Our results suggest that afforestation activities should be avoided if the local total precipitation is insufficient for replenishing the soil moisture and that local tree species with a lower demand for water resources should be considered a top priority for further afforestation of the Loess Plateau.

Keywords: soil moisture , precipitation gradient, afforestation stage, Robinia pseudoacacia, Loess Plateau

P0192

Socio-ecological perspective on prioritising semi-natural grassland restoration sites and actions: the experience of LIFE project GrassLIFE (Latvia)

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GrassLIFE project aims at active protection of five grassland habitats of EU importance on 1320 ha (5.6 % of the total area) in Latvia. Due to the fact that there is a general scarcity of scientific evidence from landscape experiments to inform the restoration decisions, the restoration challenge of such scale requires the development of a novel approach for prioritising the restoration sites and actions. Semi-natural grasslands are ecological systems intricately linked with and affected by the social systems of local farmer communities and conservationists. To address the restoration sites as socio-ecological systems, a two-level approach was developed and prioritisation criteria for each level were set up. Landscape-level prioritisation process included the analysis of national policies and habitat connectivity needs identified by a grassland connectivity model developed in the project. Site-level prioritisation process was based on interviews with farmers willing to participate in the project as partners, and the pre-restoration assessment of grasslands. We emphasize the notion that grassland restoration actions should consider not only the potential for restoration of structures, functions and typical species of habitats but also the potential for restoration of economically feasible farming system and development of management strategies for areas, which are difficult to integrate in the daily farming practices but important for habitat connectivity. We conclude that in order to ensure the cost-effectiveness and sustainability of the investments in restoration, the landscape-scale restoration experiments should factor not only ecological but also social aspects of grasslands.

Keywords: prioritisation, ecological restoration, management, connectivity, habitat

Symposium 49

Challenges for subterranean landscape conservation in the world's karst regions

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Landscape ecology has advanced environmental conservation because it helps expand attention from single sites to larger scale patterns and processes and to understand complex interactions existing among a mosaic of elements. This has enhanced understanding of the complexity of natural systems and informed land management strategies. Karst environments have particular hydrogeological and ecological features and are among the most fragile ecosystems in the world. They furnish valuable natural resources, such as water, and represent suitable habitat for the survival of many rare or endemic species. Despite this, the importance of these ecosystems has so far been largely ignored by the broader scientific and conservation community, leading in many cases to overexploitation of subterranean resources, degradation of the environment (both on the surface and underground), as well as habitat and biodiversity loss. Subterranean ecosystems are in many cases still poorly mapped because of limitations in exploration and therefore subterranean spatial patterns are typically less well known. While terrestrial systems are normally represented as surficial environmental units, in the presence of karstic phenomena it is important to consider also the close relationship that exists between the surface and underground landscape systems. This has repercussions also in conservation strategies for these areas, where it is common to consider strategies for the conservation of single caves (e.g. the European Habitat Directive for the conservation of habitats defines a cave as 'a punctual element') or of single endemic species or taxonomic groups that are easily detectable in the surface. However, it is increasingly recognized that many conservation and land-use issues can only be tackled in a sensible way by considering broader landscape frameworks, in particular natural hydrogeologic drainage systems, within which caves are important elements. Our understanding of karst systems as a whole suffers from of lack of large-scale, comprehensive studies that consider the subterranean ecosystem as a (three-dimensional) landscape. By changing this perspective and acknowledging the complexity of these environments, we will be able to integrate ecological processes, biodiversity patterns, energy flows, hydrological properties, and geomorphological features. In order to develop our research, it is necessary to move towards highly multidisciplinary studies that are able to link subterranean elements and features and understand the ecological processes of the ecosystem as a whole. Because human activities strongly modify existing landscape patterns and processes, the understanding of their impacts on karst systems is essential for rational land use planning, management and biodiversity and resource conservation. We seek original studies, conceptual works, case-studies and presentation of past, ongoing and planned research projects dealing with subterranean environments. Contributions are encouraged from fields that can contributes to advances in understanding about these peculiar ecosystems: geology, hydrology, soil science, biology, taxonomy, zoology, ethology, ecotoxicology and others. We are particularly interested in studies leading to better understanding of the composition, structure and function of subterranean landscapes; energy and material flows; functional links between patterns and processes; relationships between aboveground and belowground environments; subterranean biodiversity conservation; human impacts; valuation of services provided by subterranean ecosystems.

This symposium will stimulate interactions between researchers involved in the study of these complex and intriguing systems and promote a debate about shifting attention towards a large-scale perspective that integrates both biotic and abiotic features to understand their spatial patterns and functional links with the final aim to enhance conservation strategies.

Landscape conservation of karst regions

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A complex system of ecosystems, as a “landscape” is defined, is a model in which subterranean systems can easily be integrated. Caves are in fact ecosystems themselves but connected to each other in extensive and complex systems (landscapes). Here, much of the connectivity between the units of the landscape is underground, with aquifers and caves that form a continuous layered tissue whose accessibility and 'invisibility' have contributed to make it among the less studied natural landscapes (and hence known) in the world. In this presentation we aim to provide a conceptual framework to address the research on the conservation of the subterranean environment by applying principles of landscape ecology. This imply to identifying the main karst elements, to map them into a real-world case and to determine the structure of the landscape by means of elements composition and configuration. Ecosystem functions can be described, as well as biodiversity patterns and related to biophysical structure of the landscape. The way in which structure, biodiversity and functions relates may reveal important insights into the functioning of the whole karst systems. In this framework, threats and anthropogenic alteration to the karst landscapes are also important to be considered in order to understand the effects of human impact. Moreover, the provisioning of ecosystem services is essential to deliver the concept that karst regions are vital for human well-being because the host valuable resources and are place of fundamental ecosystems process such as water purification and storage. Finally, we aim to discuss the effectiveness and limitations of the existing conservation normative tools and their possible implementation at the light of a more comprehensive approach.

Keywords: Subterranean landscape, Ecosystem services, Karst

Protecting the World's Longest Cave: Should We Think About Caves or Karst Landscapes?

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Much of the area above and surrounding Kentucky's Mammoth Cave System and related caves, which total nearly 1,000 km in length, has been designated as a US national park, as well as a World Heritage Site and International Biosphere Reserve under UNESCO. The caves are still being explored and many passages extend beyond the 21,400-hectare national park. The park area hosts one of the most biodiverse cave communities in the world, and there are important historic and archeological resources—the most extensive deep exploration by ancient people known took place in Mammoth Cave. Of 160 recorded cave species, 52 are obligate cave dwellers, 19 are endemic, and several are federally endangered species.

There are two classes of cave resources threats. Intrinsic—from within—harm can occur where people go into caves for tourism, exploration, or to exploit or damage resources. Extrinsic threats can be much more widespread and pervasive, and could include impacts to water quality (and thus aquatic communities) from pollution introduced from a large area on the surface, or in some cases quarrying where the rock itself containing the cave is removed. The aquifer of the Mammoth Cave System drains a recharge area of 365 km2, much of which is in agriculture, with numerous potential contaminants including fecal bacteria, pesticides, chemical fertilizers, and sediment. An interstate highway and railroad line, with potential sources of contaminants, also pass across the recharge area.

Scientists at the park understand that both types of threats are present. Park staff and numerous partners within the Biosphere Reserve are working to protect the caves and the broader karst landscape by developing modern cave and karst management planning, implementing cave biota and water quality monitoring programs, encouraging research, managing cave visitation, enhancing regional efforts to protect ground water and air quality, and developing surface use management planning.

Keywords: Karst, Subsurface, Conservation, Caves

T0695

Vulnerable invertebrates in shallow subterranean habitats of Washington, D.C.

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Washington, D.C., a relatively small city (177 km2) with close to 700,000 residents, is home to an assemblage of subterranean invertebrates living in shallow subterranean habitats. Hypotelminorheic habitats are perched aquifers with an underlying clay layer, rich in organic matter from decaying leaves, and a surface outflow (or seep) inhabited by stygobiotic fauna. These habitats are quite abundant in areas with the appropriate physical conditions, however are rarely studied. A total of seven amphipod and two isopod species were found in over 200 seeps in Washington, D.C. The amphipod Stygobromus hayi is endemic to D.C. and is on the endangered species list due to its limited range and rarity. The most abundant Stygobromus species inventoried in this study is from the Stygobromus tenuis group, and is currently being described as a new species. Crangonyx shoemakeri was found in neighboring seeps to Stygobromus, however rarely co-inhabited the same site, indicating differing habitat preferences and/or competition. Environmental factors were recorded at each site to determine habitat preferences and overall health, including pH, DO, conductivity, temperature, nitrates, phosphates, and radon. Stygobromus amphipods, the most adapted to subterranean life, prefer habitats with cooler waters and lower conductivity, while Crangonyx amphipods, known to inhabit wetlands, preferred seeps with warmer waters. Caecidotea kenki, a subterranean isopod, is a generalist with no environmental preferences and was found with either amphipod species. While some seeps are found in Rock Creek Park, the majority of these habitats are located in Southeast, D.C., a historically low-socioeconomic borough of the city, highlighting the importance of urban conservation work. Increased protection is needed from development, water quality degradation, and erosion from storm water runoff.

Keywords: Stygobromus, Conservation, Hypotelminorheic, Urban

P0187b

Designing soil in the Antropocene Era: Territorial upgrade through the reinterpretation of “soil consumption” in the framework of landscape resilience

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Soil is a non-renewable resource, able to provide functions and services for local communities. The millennial transformations of the territory, have modified soils structure and composition, threatening some ecosystem functions essential for the support of the human habitat.
This awareness influences policies and agreements on a global scale, within new paradigms of development and evolution of anthropic dynamics, in an attempt to limit the negative and irreversible consequences to environment. It drives to a rethinking of the territorial management which is translated into a revision of the planning practice.
EU community introduced "zero net soil consumption" as a target for 2050, transposed by EU member.
In Italy the concept of soil consumption is defined "as a variation from a non-artificial cover to an artificial cover of the ground". The approach is fragmented and prescriptive. It misses the connection between pattern and process, necessary for managing the environmental dynamic, involved in the link between soil and ecosystem services
There are conceptual and operative limits in the translation of the objectives into effective planning and design tools.
It’s suggested a critical reinterpretation of the concept of "soil consumption". The approach proposed is to integrate different spatialities (soil-subsoil-surface), emphasizing the pressure that every layer exerts on the other, avoiding or threating ecosystem services. The attempt is to find effective design tool, in which the transformation and design of soil become the starting point for shaping the territory.
The result will be the design of renewed and highly contextualized landscapes, as consequence of conscious and sophisticated actions. This approach allows a territorial upgrade to contemporary objective and needed, increasing the level of compatibility between the evolution of the human habitat and the maintenance of regeneration times of nature, necessary for preserving ecosystem services.

Keywords: soil, ecosystem services, landscape design, land take, land managment

Diversity of aquatic cave animals and their conservation status in China

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Karst landscape in China is widespread and diverse. It contains several types of karst landforms, including tower karst, pinnacle karst, and cone karst formations, along with other spectacular features such as natural bridges, gorges, and large cave systems. As a part of karst landscape, cave is an extreme environment for animals. China is home to the great diversity of aquatic cave animals including amphipods, shrimps, crabs and fishes. For example, China is the richest country in the world in terms of cavefishes with more than 76 endemic stygobiotic species and an additional 70+ nonstygobiotic taxa. As fieldwork continues, more species are being found and described. Most of them are found in the southwest, primarily in the karst of the Yunnan-Guizhou Plateau. Caves and karst habitats are fragile environments, and those aquatic cave animals are extremely sensitive to environmental change. Threats from rapid economic growth in recent decades have increased the need for conservation efforts for cave-dwelling communities, and the conservation of Chinese cavefishes and other aquatic cave animals is an urgent issue, in particular. Human activities such as agriculture, transportation infrastructure development, quarrying, and water extraction represent growing threats to karst habitats and cave ecosystems. Recently, cave tourism development became a new threat to the cave fauna. Despite high species diversity and endemism among many groups of aquatic cave animals, most groups have not been intensely studied and the taxonomic and conservation status of many groups are poorly understood. Meantime, the significance of karst ecosystems is not widely recognized despite cultural significance and economic dependence on karst resources. At this time, there exist no national protected areas specifically for cave organisms. Although several species of cavefish have been added to the IUCN Red List for China.

Keywords: Species diversity, Aquatic cavefauna, Karst landscape, Threats, China

Symposium 50

Disturbance, degradation, and restoration in fragile ecosystems: Implications for resource distribution and ecosystem service

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Fragile ecosystems are particularly sensitive to natural and anthropogenic disturbances such as wildfire, grazing, land use change, erosion, and other natural hazards (landslides, floods etc.). Owing to the lack of resilience, disturbances in such systems generally lead to the redistribution and loss of resources (i.e., soil, water, and vegetation), and the alternation of the functions and structure of the ecosystem and landscape. Subsequent restoration efforts, although effective to a certain degree, may not restore the original ecosystem services in most cases. This symposium welcomes experimental, modelling, theoretical, and social-economic studies that investigate the impacts of natural and anthropogenic activities on a broad range of fragile systems, including both not limited to arid and semiarid, polar, mountain, wetland, coastal, and man-made ecosystems. We aim to create a diverse, interdisciplinary symposium representing the broad range of research into the impacts of disturbance and subsequent restoration on ecosystems and landscapes at various levels.

Biodiversity Maintenance Mechanism of Community Succession in Karst Rocky Desertification Restoration Area in Yunnan, China

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Karst rocky desertification（KRD） is a process of land degradation and dynamic evolution resulted from the fragile ecosystem in Karst mountainous regions and the improper economic activities of human beings. At present, there are few studies on the temporal and spatial sequence and diversity maintenance mechanism in community succession about rocky desertification. So we take field research through the method of “space instead of time” in KRD area of Jianshui County, Yunnan Province,China. Results show: (1) Vegetation restoration in KRD area of Jianshui County follows the general rule of drought succession, and plantation accelerates the succession of vegetation restoration, but it is more vulnerable to suffer invasion due to simple species composition and community structure. (2) In the primary stages of KRD vegetation succession, plant types in each habitat are quite different, indicating that the theory of niche differentiation occupies a more important position. when the karst plant community develops into a stable climax community with superior environmental conditions, species with the same habitat conditions coexist, and species coexistence mechanism is more in line with the neutral theory. Therefore, this study can provide theoretical basis for guiding vegetation restoration and ecological reconstruction of degraded ecosystems in the southwestern karst region.

Keywords: Karst rocky desertification, vegetation restoration, community succession, species diversity

P_0225

An Integrated Geographic Information System for the conservation of biodiversity on Mediterranean coastal dunes. The case of CALLIOPE (LIFE17-NAT_IT_000565)

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We present an Integrated Geographical Information System (IGIS) for the conservation of biodiversity on Mediterranean coastal areas built in the context of the European project CALLIOPE ("Coastal dune hAbitats, subLittoraL sandbanks, marIne reefs: cOnservation, Protection, and thrEats mitigation- LIFE17-NAT_IT_000565). The IGIS CALLIOPE was built with Open Source software and tools and is organized according with the INSPIRE protocol. It includes both, the georefered data describing the elements of conservation concern (e.g. habitats and species of European conservation concern according with the Habitats Directive 92/43/EEC) and the maps of threats impinging natural biodiversity. The IGIS-CALLIOPE, which is a valid support for planning conservation actions on coastal dunes, represents at the same time a sound frame for monitoring and forecasting the effectiveness of the conservation actions under different scenarios.
We illustrate some examples of conservation actions planning and monitoring on coastal dunes of the Adriatic coast supported by the IGIS-CALLIOPE.

Keywords: Biodiversity mapping , Conservation actions, Monitoring , Threats mapping

T0538

Enhancing protection for wetlandscapes

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Governments worldwide do not adequately protect freshwater ecosystems and therefore place freshwater functions and attendant ecosystem services at risk. Particularly vulnerable are wetlands, which form a large majority of the world's freshwater ecosystems and are being lost or degraded more quickly than any other type of ecosystem on the planet. Scientific evidence of the importance of these wetlands to downstream ecosystem functions and associated services is needed to support policies that promote their protection and restoration. Here, new mapping methods to detect wetlands are combined with new surface-subsurface models that estimate wetland surface and subsurface hydrological connections (i.e., transit length and transit time) to neighboring wetlands and to downstream waters in wetlandscapes in Alberta, Canada. The role of this portfolio of hydrological connections in regulating biogeochemical functions (e.g., nitrogen removal and phosphorus retention) and biodiversity functions is then explored in both intact and restored wetlands. Results indicate that ecosystem services in restored wetlands do not return to the level of wetlands in natural landscapes. These scientific findings provide clear evidence of the interdependence of hydrologic connectivity on biogeochemistry and biodiversity and that the entire portfolio is needed to maintain ecological services and functions upon which society depends. Policy makers need to develop management strategies that recognize and protect the complexity of hydrologic connections that wetlands provide and the portfolio of ecosystem services wetlands provide.

Keywords: wetlands, restoration, ecosystem services, management, conservation

T0652

Effects of invasive plant species Quercus rubra on native forest ecosystems

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Due to human influence, many exotic species have successfully established in several regions across Europe in the last century, affecting biological diversity and ecosystem services; among these, red oak (Quercus rubra L.) is a widespread invader of European temperate forests.
In Northern Italy, mesophytic mixed oak forests are among the most threatened by red oak invasion.
The aim of this work was to evaluate and quantify the ecological impact of red oak forest (ROF) on the natural mixed forests (MF), representing the original vegetation of the Po Valley. In particular two different investigation approaches were carried out.
The first one involved six forest stands (3 MF and 3 ROF) to study possible changes of ecosystem properties following the replacement of MF by ROF: we considered humus forms, soil chemical properties (3 sampling layers), bacterial biomass, microarthropod (0-10 cm layer) and plant communities diversity and composition.
We used ANOVA to assess differences in abiotic and biotic factors among woodland types; ecological determinants of the structure of the two woodland types were investigated by redundancy analysis.
The second study evaluated and quantified the impact on humus forms and soil properties, investigating in detail the spatial variability of two paired plots of MF and ROF. Soil sampling was performed from 3 layers; the impact of forest conversions was evaluated considering the forest type as a fixed effect in a linear mixed model and testing for autocorrelation among the model residuals.
Our work provides evidence that Q. rubra impacted MF, affecting above all soil organic layers, resulting in a shift from Mull to Moder humus forms, and exhibiting low/modified levels of microarthropod and plant biodiversity. The soil-detailed study also showed greater soil acidification, higher C:N ratio and soil organic carbon stock in ROF compared to MF; many of the detected modifications were more evident with increasing stand age.

Keywords: alien species, red oak, forest conversion, ecosystem modification, humus forms

P0096

Utilization of mangroves in Grand-Popo District, a hotspot of mangroves in Benin, West-Africa

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Understanding interactions between an ecosystem and surrounding communities is central for designing valorization and sustainable management scheme of that ecosystem. Mangroves are one of the most productive ecosystems worldwide, yet among the most threatened. This study was conducted in Grand-Popo district, a hotspot of mangroves in Republic of Benin. The aim was to assess (1) main activities of local communities in relationships to mangroves and its variation across villages, gender, and age category, (2) plants and animals collected and used from mangroves and adjacent areas, and (3) local perception on the relationship between their activities and degradation of mangroves and potential effects of mangroves' degradation on their life (security, income, health and culture). Data were collected through individual interviews (n = 360) in nine villages surrounding the district. Results showed that ten activities were practiced of which fisheries (31.65%), wood collection (22.73%) and Cyperus articulatus collection (21.67%) were the most frequent. Fishery activities include the collection of fish, shrimps, crabs, and oysters. Wood collection mainly includes the collection of firewood and wood for construction and mostly targets Rhizophora racemosa and rarely Avicennia germinans. Most (58.33%) of informants believed their activities do not negatively impact mangroves despite their large recognition of the decrease of mangrove areas (75% of informants).

Keywords: Mangroves, R. racemosa, A. germinans, Grand-Popo, Benin

Forest cover change after 17 years of Participatory Forest Management implementation in Malawi

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In Malawi, forest co-management was adopted in 1999 to curb deforestation and forest degradation in Miombo woodlands. However, the effectiveness of forest co-management since its implementation has not been assessed. The study objective was to assess the impact of co-management and government management strategies on forest cover in Miombo woodlands in Malawi between 1999 and 2018. Land cover classification and change detection of Malawi was conducted for 1999 and 2018 using Landsat images. The overall classification accuracies for 1999 and 2018 images were 88.2% and 86.8%, respectively. The woodland user and producer accuracies were >75%. The results showed 35% loss of forest cover from 4,368,538 ha to 3,200,594 ha between 1999 and 2018. However, when 11 co-managed and 12 government managed sites were analysed, no significant differences were observed between 1999 and 2018; Kruskal-Wallis $X2 = 0.571$, $p = 0.45$ (co-managed); $X2 = 0.003$, $p = 0.954$ (government) despite the overall decreases in both management regimes. Forest co-management might have slowed the process of deforestation and degradation. However, further loss in forest cover might have irreversible detrimental effects if immediate and sustainable solutions will be limited. The modification of co-management is recommended for sustained ecosystems' health and livelihoods.

Keywords: LULCF , Miombo,, Classification, Management, Sustainability

P0123

Demo-genetic modeling of the effect of forest fragmentation on plant population viability: parameterizing a HexSim model with 10 years of field data

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In order to understand the mechanisms behind global change effects on ecological systems, it is necessary to study individual components of the system. Integrating the results becomes a challenge, as it is difficult to validate the holistic understanding of system behavior against data. HexSim provides a simulation platform for integrating many different processes, including land-use and land-cover change, environmental heterogeneity, demography, dispersal and gene flow. While HexSim was developed with animal populations in mind, it can be adapted to plants with the use of transition matrices for pollination and seed dispersal. Here, we use 10 years of ecological data from surveys and field experiments to parameterize a model for the hummingbird-pollinated tropical understory plant Heliconia tortuosa. By varying levels of habitat loss and fragmentation we examine H. tortuosa population viability under different landscape scenarios. We use independent demographic data and population genetic data from 11 microsatellite markers, to validate the model using pattern-oriented modeling.

Keywords: HexSim, simulation model, plant demography and genetics, tropical forest loss and fragmentation, hummingbird pollination

Mapping degraded alpine rangeland based on quantitative assessment of degradation classification in Lhasa river basin, the Qinghai-Tibetan Plateau

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The Qinghai-Tibetan Plateau owns the wold's largest alpine rangeland ecosystem, which plays an important role in holding carbon storage and providing forage production. Alpine rangeland ecosystem in Qinghai-Tibetan Plateau is extremely fragile and suffering continuous degradation. Monitoring rangeland degradation requires an accurate understanding of the status and spatial pattern of degraded rangeland. In this paper, a novel way combining field data with remote sensing information was proposed. Degradation classification was identified by multivariate hierarchical analysis based on 270 sample plots including vegetation characteristics, soil physicochemical properties and geographic features. Determined remote sensing data variables corresponding to field indicators of classification system, the spatial pattern of rangeland degradation was mapped by GIS layers. The results showed that clustering analysis divided degradation classification into five classes: non-degraded, slight, moderate, severe and extreme. The ordination analysis suggested that the classification was feasible, and different variables play diverse roles in the ordination space. Dominance of Cyperaceae plants, soil total nitrogen content, soil organic carbon content, soil total carbon content, soil bulk density, soil pH, dominance of Miscellaneous plants and elevation are most significant factors for rangeland degradation of all the seventeen variables. Non-degraded rangeland accounted for 4.34% in the rangeland of this area, located in the southeast of the Lhasa River basin. The extreme class distributed sporadically in this region, with 16.06% of the rangeland area. Assessing and mapping rangeland degradation provides important basis for rangeland protection and management, especially in large scale.

Keywords: Rangeland degradation, Field-based classifications, Remote sensing, Qinghai-Tibetan Plateau

Spatiotemporal heterogeneity of land use change due to the ecological restoration and urbanization in the Chinese loess hilly region

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Context: The ecological restorations may result in the drastic land use changes, as well as the rapid urbanization. These land use changes can have spatial differentiations due to varied biophysical and socio-economic contexts. Moreover, the land use changes are driven by different factors over time at the different stage of urbanization. Therefore, this spatiotemporal heterogeneity must be understood for better planning and management of restoration activities.
Objectives: In order to unveil the spatiotemporal interaction of ecological restoration, and the rapid urbanization, this study explore the patterns and mechanism of the land use dynamic change at space and time dimensions.
Method: We analyze the LULC patterns based on the land use maps of Yan'an City for 1990, 2000, 2010 and 2015, including the three phases such as agricultural development, ecological restoration, and rapid urbanization. The logistic models are used to identify the driving forces from 20 topographic, location, social or economic factors such as altitude, slope, GDP, population density, distance to rive, etc. We try to explicate and simulate the interaction process and its spatiotemporal heterogeneity by coupling the ecosystem service (ES) assessment models, ES requirement model and CA-Markov model.
Results and conclusions: The analysis of land use change and driving forces shows that there are high spatial temporal differences on the patterns and the driving factors. The comparison of the requirement and provision of the ecosystem services at specified location can induce the change of the land use. Based on above research, the CA-Markov model is efficient in simulating and predicting the land use patterns. Understanding how the land use changes might be influenced by the ecological restoration activities, economic development and urbanization will help ecosystem managers achieve sustainable management.

Keywords: land use change, ecological restoration, spatiotemporal heterogeneity, driving factors, ecosystem service

T0005

Landscape identity post-wildfire in mediterranean ecosystems: study cases at the coastal range in central Chile

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Due to anthropogenic factors and abrupt changes of land cover, the Mediterranean ecosystems were exposed to the severities of wildfires and mega-fires which have taken place with more frequency during the last decades. Through semi-structured interviews, we study how key persons from the communities of Quillón, Florida, and Yumbel, in the range of coastal Central Chile, perceive the landscape identity after several wildfires that came true during 2012 and 2017. The main goal was to develop a comparative base to investigate the devastating (or not) change that exists in the identity of the personal landscape in relation to its everyday landscape. The 12 interviews were textually analyzed (Atlas.ti) according to three categories: visual elements of the visual landscape (before and after the fire), perception/identity (identity of the landscape, landscape-related identity, and landscape practices), and government management at the landscape level (before and after the fire). The results of the interpretation of the responses were categorized in: 1) personal affectation for landscape loss in their physical characteristics (land cover), however, the grief was more palpable about lost farms /plantations and their economical cost; 2) the relationship between the perception and identity of the landscape were seen in three groups: personal and collective perceptions/memories about their own landscape, temporality before/after 2017 where the wildfire followed predictable patterns, and memories about previous wildfires before charged with a sense of sadness and abandonment; 3) the community's expectations and the reality of the government relief after the disaster are important factors in success or failure of the recovery process in natural and social features after the wildfire.

Keywords: Landscape Identity, Wildfires, Chile, Mediterranean Ecosystems, Visual Landscape

P0118

On the distribution of soil C, N, P in the salination-affected plant communities of the Yellow River Delta, China

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Soil carbon (C), nitrogen (N) and phosphorus (P) are important soil properties to determine nutrient limitation and plant productivity in terrestrial ecosystems. Up to 90% of in the Yellow River Delta (YRD), China, has been affected by soil salination due to groundwater overdraft, in proper irrigation, and land use and land cover change. The objective of this study is to evaluate the impact of different types of plant communities on soil quality in a saline-alkaline system in the YRD. We investigated the seasonal variation and vertical distribution of soil C, N, P, and C/N ratio by choosing four dominant plant communities, namely, alfalfa grassland (AG), Chinese tamarisk (CT), locust forests (LF) and cotton field (CF). The results showed that soil organic carbon (SOC) content in CT and LF was higher than that in AG and CF in each season, especially in the top soil layer ($p<0.05$), then decreased significantly with the soil depths ($p<0.05$). The total nitrogen (TN) content did not show strong variation among vegetation types and decreased slowly with the soil depths. The C/N ratio was generally low and it was higher in CT (9.60) and LF (11.69) than that in AL and CF ($p<0.05$). The available phosphorus (AP) did not show a regular trend for different plant communities, but the low AP content showed that soil was generally P limited, particularly for the AG (≤6.29 mg kg-1) and LF (≤4.67 mg kg-1), probably due to strong P immobilization in saline-alkaline region. In this study, plant communities were closely related to soil nutrients and C/N ratio with the season dynamics, therefore we suggest that protecting natural vegetation and developing optimal vegetation are critical to restore land degradation in the YRD.

Keywords: Soil nutrients, C/N ratio, Vegetation types, Human disturbance, Yellow River Delta

T0029

The effects of landscape pattern evolution in Liaohe estuary to changes on water quality

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This research systematically examined the ecological sensitivity of the Liaohe estuary in Panjin City, Liaoning Province to changes in the area of sea used for various activities based on data from remote sensing images in 1990, 2000, 2007 and 2014. First, the ecological sensitivity mechanisms of the major sea use activities were analyzed, including land reclamation, farming and industrial activities along the shore. Second, an Ecological Sensitivity Index (ESI) to changes in the area of different marine uses was constructed as the ratio of the variation of ecosystem services values to sea use intensity. The dynamic changes in ESI were calculated from 1990 to 2014. Finally, the spatial patterns of ecologically sensitive areas were obtained using spatial analysis tools in ArcGIS. The results showed that the area of sea used for human activities increased significantly from 2977.32km2 in 1990 to 3059.96km2 in 2014. The major types of change were open aquaculture, marine aquaculture and marine industry, which were mainly developed on former Suaeda salsa communities and mudflats; The hemeroby index (HI) tended to increase particularly from 2007 to 2014, while the ecosystem services value showed the opposite trend, declining from 4.65×109 Yuan to 3.34×109 Yuan. This suggested that the HI was significantly negatively correlated with the ecosystem services value. The value of the ESI was 2.5 in 2001, and then increased to 4.7 in 2007 and to 4.8 in 2014. Overall, in the past 25years, the Liaohe estuary ecosystem has shown a low sensitivity to changes in the area of the sea used for human activities. Although there has been an increase in human development and use in this region over the past ten years, their impact on the whole estuarine ecosystem has not been very strong.

Keywords: Sea area changes, Hemeroby Index, Ecosystem services value, Ecological sensitivity analysis, Liaohe estuary

T0257

Loss of soil resources by dust emission due to human activities

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Dust emission processes has major implications for loss of soil resources (clays, nutrients) and human exposure to air pollution. Many soils throughout the world are currently or potentially associated with dust emissions, especially in dryland zones. The research focuses on dust processes in semi-arid soils that are subjected to increased human activities of urban development and agriculture. A boundary-layer wind tunnel has been used to study dust emission and soil loss by simulation and quantification of high-resolution wind processes. Field experiments were conducted in soil plots represent long-term and short term influences of land uses such as agriculture (conventional and organic practices), grazing, and natural preserves. Fluxes of particulate matter (PM) were calculated. The emitted dust-PM was analysed for physical and chemical properties. The results showed changes in dust fluxes in response to the anthropogenic influences on the soil to provide quantitative estimates of soil loss over time. Substantial loss of PM10 (particulate matter that is less than 10 micrometer in diameter) was recorded in most experimental conditions. Integrative analyses of the soil properties and dust experiment highlight the significant implications for soil nutrient resources at annual balance and management strategies as well as for PM loading to the atmosphere and risk of air pollution.

Keywords: semi arid, dust, soil erosion, air pollution, PM

T0279

Using rare earth elements to quantify post-fire resource redistribution in a grassland-shrubland transition landscape

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Drylands cover more than 40% of the Earth's land surface and support over 2 billion inhabitants. Many drylands are undergoing rapid increases in fire activity and are highly susceptible to post-fire redistribution of resources (e.g., soil, water, and sediment), a process that is known to cause land degradation. However, a quantitative understanding of fire-resource interactions and post-fire sediment redistribution is still missing, due to the lack of well-tested and reliable field-level tracer methods, particularly at the fine spatial scales of vegetation microsites (shrub, grass, and bare interspace). We established a prescribed fire experiment in a grassland-shrubland transition zone in the Chihuahuan Desert, New Mexico, USA, to investigate soil resource redistribution by wind and water using multiple rare earth elements (REE) tracers. Results show that the shrub microsites had the lowest water content compared to grass and bare microsites after fire, even when rain events occurred. Significant differences of total soil carbon among the microsites were not detected one year after the fire. The REE tracer analysis shows that a majority of the wind-borne sediment in the unburned site was derived from bare microsites (88.5%), while in the burned site it was primarily sourced from shrub (42.3%) and bare (39.1%) microsites. Vegetated microsites which were predominantly sinks of soil resources in the unburned areas became sediment sources following the fire, highlighting the influence of fire on biogeochemical cycling and land degradation dynamics in this semiarid landscape.

Keywords: Land degradation, Ecosystem change, fire

T0143

Construction land expansion and its impact on regional vegetation dynamics in Southwest China

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Based on 1998, 2003, 2008 and 2013 four Night-Time Light data, a comprehensive analysis of the situation of the extension of construction land was carried out. At the same time, the change of vegetation coverage in barrier area was analyzed by using MODIS-NDVI data, and the influence of construction land expansion on vegetation dynamics was discussed by combining Night-Time Light data and the Slope trend. The results showed that the (1) construction land of study area increased by 19282.31 km2 from 1998 to 2003. Among them, Guangxi and Sichuan's construction land area increased most. Compared with the whole country, the intensity of construction land expansion was at a moderate level. The expansion intensity in 1998-2003 was the largest, with an average of 5.23%. During the study period, the focus of construction land moved southward. In the whole study area, the complexity of urban patches was higher, but the complexity of spatial morphology decreased gradually. (2)The vegetation showed an overall improvement trend. Vegetation coverage in each region was Chongqing > Yunnan > Guizhou > Sichuan > Guangxi > the whole research area > Qinghai Tibet area, and the improvement of vegetation coverage in each area was obviously better than that in degradation. (3) Overall, the development of urbanization in the study area was negatively correlated with vegetation cover, and the influence degree differed in different regions. In the urbanization level raising area, the vegetation coverage decreased with the increase of urbanization level; while in the urbanization level decreasing area, the vegetation coverage was unchanged or slightly reduced as with the decrease of urbanization level.

Keywords: Urban expansion, Night-Time Light, vegetation dynamics, NDVI, Southwest China

Degradation, disturbance and restoration of dragon´s blood forests on Socotra Island

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Socotra is the largest island of the Socotra Archipelago. Origin of Archipelago is continental and was separated from Africa during the middle Miocene about 17 Ma years BP, in time when pre-adaptation of modern lineage of Dracaena to arid environment started. Archipelago is a part of Republic of Yemen, lying on the border of the Indian Ocean and the Arabian Sea. Dracaena cinnabari is an unique monocotyledonous tree, tertiary relict, endemic species and forests of this species occurring on the Island belong to one of the oldest ecosystems of the world. Many authors call D. cinnabari as the flagship and umbrella species of the Socotra. D. cinnabari now occupies only 5% of its potential habitat on the Island, total occurrence of habitats with D. cinnabari reaches over 50,000 ha, but there are only 230 ha of forests. Such huge decline of population was caused by long-term harvesting of resin called dragon´s blood since ancient time which is lasting until now and accompanied by overgrazing that make impossible the natural regeneration. This population degradation can be intensified by current global climate changes. All trees were recognized from satellite imagery on the Island. The population counts more than 80 thousand individuals divided into 20 sub-populations. We expressed for each sub-population their size, number of trees, tree density, area of habitat types. Nature conservation importance index was counted for each sub-population. The influence of cyclones affecting the Soqotra in November 2015 was further determined based on a statistical forest inventory of D. cinnabari population before and after the cyclones. Two models of future sub-populations development were compared for scenarios - with and without cyclones. The extinction time for each sub-population was estimated ranging from 31 to 564 years. The reforestation efforts were also evaluated comparing fenced and unprotected, irrigated and unirrigated trials.

Keywords: Dracaeana cinnabari, Dragon´s blood tree, Socotra Island, Decline, Disturbance

T0635

The changes in the vegetation patterns in human dominated landscapes caused by disturbances and degradation.

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The aim of this study is to obtain data about human-dominated habitats in Estonian landscapes for modelling vegetation change. Fieldwork was carried out from 2015 to 2017 in 35 randomly dispersed 1 km squares. Vegetation plots were recorded in habitats that were likely to change; e.g. roadside verges, clear-cuts, neglected and abandoned land. These habitats are vulnerable to disturbances, such as management or climate change.

The results showed that over 60% of the 1 km squares that were studied contained abandoned or neglected parcels, which indicated the decrease in agricultural land use. In such cases fast-growing local competitors, such as Filipendula ulmaria, Aegopodium podagraria, Urtica dioica, Phragmites australis and Epilobium angustifolium, often dominate. Comparison of clear-cuts and forest habitats showed obvious changes in vegetation composition. Disturbed soil makes the habitat more vulnerable – new species have potential to invade, the number of forest species decline.

Vegetation analysis showed, that several habitats are threatened by invasive species, especially roadside verges and neglected or abandoned agricultural land. These habitats are vulnerable to vital invasive species as Sambucus racemosa, Melilotus alba, Galega orientalis, Bunias orientalis and Lupinus polyphyllus, which gain domination on other species and cause decline in species richness. Lupinus polyphyllus is mostly prevalent in Southern-Estonia, causing changes in several habitats, including forests. Melilotus alba is mainly present in linear features spread by wind and vehicles. Whereas, Sambucus racemosa (spread by birds) and Galega orientalis (durable seed bank in compost and manure) are found mainly in neglected or abandoned land.

The research showed that human dominated habitats are vulnerable to various types of disturbance, that cause changes in vegetation patterns. Invasive species affect local vegetation causing loss of diversity.

Keywords: Vulnerability to disturbances, Vegetation change, Estonian flora, Abandoned and neglected land, Invasive species

T0945

Effects of land use and cover change and disturbances regime on the spatial resilience characteristics of the coastal landscape of south-central Chile.

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Changes in land use / land cover (LULC) and disturbance regimes modify the spatial patterns and processes of the landscapes, affecting their capacity to provide ecosystem services (ES). To advance towards landscape sustainability, it is fundamental to understand how socio-ecological interactions affect the spatial patterns and therefore, the ecosystem services provision. In this context, the spatial resilience of socio-ecological systems that consider the importance of configuration, spatial context and temporal variation, can be very useful in the framework of landscape sustainability sciences. We studied the coastal landscape of south-central Chile. A spatially explicit gradient and multiscale approach was applied to address the importance of spatio-temporal patterns in the components of spatial resilience at the local and regional level. Configuration metrics estimated by moving windows techniques were applied to evaluate spatial arrangement, properties of localization, morphology. Cluster patterns and global and local spatial autocorrelation generated at different scales are analyzed to evaluate local and regional patterns of diversity, modularity and connectivity. Subsequently, the spatial resilience components are characterized from the local and regional variations in metrics and their relationship with the LULC / Disturbances / Spatio-temporal Patterns is evaluated, using map algebras, multivariate techniques and regressions. Preliminary results of the evaluation of the internal and external components, of spatial resilience are presented. The preliminary result, account for local and regional variations in patterns and spatial clusters, at various scales-regional extension, allowing to quantify the levels of the decrease in the diversity, modularity and connectivity of the landscape generated by progressive LULC change and anthropic disturbances.

Keywords: Spatial Resilience, Socio-ecological Systems, Landscape Sustainability, Ecosystem services

T0420

Quantifying the driving factors of land degradation and restoration using geographically weighted regression in a typical dryland region

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Restoration of the degraded lands on earth is the core component of the global Zero Net Land Degradation goal which is under the UN 2030 Agenda for Sustainable Development and aimed at least to neutralize the rates of global land degradation and restoration. In this study, we used the remote sensing derived land use data to explore the land degradation and restoration process, and the spatiotemporal variations of driving forces in the Loess Plateau of China. Geographically Weighted Regression methods were used to capture the spatial heterogeneity in the relationships. Firstly, we explored the land use changes during 1990-2000 and 2000-2015. Grassland degraded during the first period and then increased. Cropland increased firstly and then dropped dramatically as a result of national ecological restoration projects. Forest both exhibited a weak increasing trend in the two periods. Build-up lands increased significantly and continually. Next, GW logistic regression was used at the grid scale to analyze the influences of topography, climate and accessibility on land use distribution. Altitude, temperature and precipitation were the major determinants of forest and grassland patterns. In spite of altitude and slope, distance to settlements was another critical driver for cropland and accessibility to road and railway for built-up land. Finally, we used the traditional GWR to investigate the spatiotemporal variations of socioeconomic driving forces at the county scale. During 1990-2000, percentage of primary industry was the dominant explanatory variable for forest changes. Percentage of urban population showed significant relationships with grassland, cropland and built-up land changes. During 2000-2015, the influences of multiple socioeconomic factors showed more complex spatial patterns. From a spatial point of view, the variable relations of land changes to the driving factors can inform targeted land management and decision-making based on different local conditions.

Keywords: land degradation, ecological restoration, Geographically Weighted Regression, GW logistic regression, driving factors

Wetlands changes in the landscape of lowlands and uplands of the Czech Republic over the last 180 years.

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This paper presents results of study focussed on wetland changes in the lowland and hilly areas of the Czech Republic over the last 180 years. The main objective of this study was to test a methodology for analysing historical development of wetlands in the lowland and hilly areas of the Czech Republic, with emphasis on their spatio-temporal changes in the landscape. And with focus on the use of well-suited for GIS analysis and available archive maps to provide an overview of the historical location of wetlands. The sources used for the study included historical maps from the Stable Land Registry, a current orthophoto maps (2015-2017), the DIBAVOD database, the LPIS (Land-Parcel Identification System) database and field mapping (2015-2017). Three basic wetland biotope types were examined: wet meadows, wet meadows with woody vegetation, and marshes or swamps. Spatial analysis by using GIS tools were performed to analyse the spatio-temporal wetland changes. The total wetland area has decreased dramatically from 5,762 ha (over 9.5% of the territory included in the study) in 1825-1843 to 54 ha (0.9%) in 2015-2017. Extinct wetlands predominate (99.1%) in the area, while the shares of recent and continuous wetlands are nearly identical (0.5% and 0.4%, respectively). Further, the changes of wetlands on agricultural land in selected localities from this study, were described in more detail. The results of this study document fundamental spatio-temporal changes of wetland biotopes at the landscape level in the lowland and hilly areas of the Czech Republic. The most frequent change type is wetland loss in favour of arable land due to extensive agricultural management. The results of the study contribute substantially to the development of methods for the investigation of spatio-temporal changes in wetlands in the context of the landscape.

Keywords: wetlands, landscape changes, habitat continuity, land cover history

T0484

Fire history influences butterfly diversity in critically endangered south african renosterveld

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Renosterveld is a critically endangered, fire-prone, shrub-scrub habitat, occurring only in the fynbos biome of South Africa's Cape Floristic Region (CFR), a recognized global biodiversity hotspot. The remaining renosterveld patches in the agricultural mosaic of the Swartland harbour diverse insect life, including both generalist and specialist butterfly communities. Renosterveld is recommended to burn every 10-15 years for optimum plant diversity. Most renosterveld patches are on private farmlands and are not managed according to recommended practices, but are subject to both fire suppression and accidental fires. We surveyed 60 patches of varied size across the agricultural mosaic landscape for butterflies, to determine the influence of burn age (time since last burn of renosterveld) on butterfly diversity, specifically butterfly species richness, abundance and composition. We also tested environmental variables at the landscape scale (such as patch size, connectivity, adjacent crop type) and the local scale (such as vegetation height, vegetation cover and floral diversity). Preliminary results suggest that butterfly species richness and abundance increases with burn age and patch size. Our findings emphasize the importance of collaboration with renosterveld landowners, in order to establish ecologically meaningful management of remaining critically endangered renosterveld.

Keywords: agricultural intensification, fynbos, insect conservation, fire management, Mediterranean-type ecosystem

T0208

Cascading effects of tropical deforestation on pollen-mediated gene flow in a hummingbird-pollinated plant species

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The loss and fragmentation of tropical forests disrupt ecological interactions and are drivers of pollination decline. Understanding how deforestation influences plant-pollinator interactions is paramount for maintaining pollination success and ecosystem services. Here we examine the effects of tropical deforestation on pollen-mediated gene flow in Heliconia tortuosa. This hub species is pollinated by deforestation-sensitive territorial and traplining hummingbirds. Trapliners forage at large spatial scales and, compared to territorial hummingbirds, have a greater pollination success rate. Past studies show that deforestation negatively influences H. tortuosa fitness, with reduced seed set in small and isolated forest patches. It has been hypothesized that this is due to reduced pollen quality (reduced genetic diversity of pollen pools), a consequence of modified hummingbird availability and movement patterns. To test this, we used a stratified random sample of 20 patches near Las Cruces Biological Station in Costa Rica. Pre-dispersal seeds and tissue samples from adult plants were collected. Based on 11 microsatellite loci, linear mixed models show that small and isolated patches have reduced pollen pool genetic diversity and a lower number of effective pollen donor plants. Our results also indicate that patches with reduced traplining hummingbird availability have lower outcrossing rates. We hypothesize that these effects are due to an increased dependence of pollination by territorial hummingbirds, which transfer pollen among neighboring plants, resulting in reduced pollen dispersal kernels. Tropical deforestation negatively influences pollen quality in H. tortuosa, through a cascading effect that reduces the availability of traplining hummingbirds. Maintaining large patches of forest and establishing connections between isolated ones could enhance hummingbird movement and pollen transfer, contributing to the conservation of the H. tortuosa pollination network.

Keywords: Tropical deforestation, Pollination, Gene flow, Hummingbirds, Landscape composition and configuration

T0424

Precipitation drives the nonlinear trends of fire in Africa

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Landscape fire forms an integral part of the African savanna ecosystem, determining the ecosystem structure, function and dynamic. Here we applied ensemble emprical mode decomposition method to assess the nonlinear fire trends using satellite burned area data. Observations indicate that burned area shifted from increase to decrease over 2001–2016 with decrease fire rate expanded and intensified in the African savanna, ranging from (0.30±2.44) % yr-2 in 2001 to (-0.27±2.30) % yr-2 in 2016. We also find that the area with positve fire rate declined in each land cover type. Significant increase-to-decrease fire trend occupied 32.39% of the area ($p<0.05$), more than the area with monotonic increase fire trend (12.22%). Changes in precipitation contributed substantially (71.25%) to the burned area decrease over southern Africa. This also contributed to 35.70% of the burned area decrease over northern African, but here cropland expansion were almost as important, muting burned area (23.15%). More importantly, it noted that the response of burned area to precipitation is highly heterogenerous in space and over time. Precipitation has strong legacy effects on fire by regulating the fuel build-up and flammability. Generally, the correlation between burned area and precipitation was mostly positive for arid area (38.53%) and negative for more humid area (29.12%). Our study helps understanding the role of precipitation played in fire occurence and thus projecting future fire evolution trajectory.

Keywords: Africa, fire, ensemble emprical mode decomposition method, precipitation, burned area

T0053

Landscape changes of Dianchi Lakesides driven by ecological restoration projects, Southwest China

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Constructed wetlands become a general way to restore the degraded wetlands and lakesides globally, but few researches considered the landscape changes driven by large-scale restoration projects. Dianchi Lake was suffered serious water pollution and landscape structure damages in the last decades. We measured landscape structures and patterns of four periods based on remote sensing images from 2008 to 2016 and field survey to landscape changes in Dianchi lakesides under restoration projects. We found that farmlands decreased from 47.43% to 19.94%. Wetlands (water body and marshes), built-up areas and woodlands increased from 4.63%, 12.93% and 24.46% to 20.22%, 17.88 % and 29.42%, respectively. Landscape metrics indicated that the projects promoted the fragmentation, complexity and heterogeneity of landscape pattern. Bare lands, which transferred from the demolition of rural residential lands and the restriction of farming and deforestation, increased from 0.62% to 9.57%, but a large amount of them transferred into built-up areas later. The lakesides became artificial ones completely, with the increasing human disturbance, man-sensitive species excluded and man-tolerance species dominant, monitoring projects are needed to estimate the effect of ecological restoration projects on biodiversity. This research offers a valuable case to understand how landscape change under the restoration projects.

Keywords: landscape change, ecological restoration project, constructed wetlands

T_1001

Increased soil methane emissions and methanogenesis in oil contaminated areas

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Crude oil exploration and related activities cause severe soil contamination and land degradation. However, how soil CH4 and CO2 fluxes respond to oil contamination is poorly understood. To address this question, we conducted in situ investigation of CH4 and CO2 emissions in the Shengli Oilfield, China. CH4 emissions from contaminated soils were 60 – 1800 μg m–2 h–1, much higher than those from uncontaminated soils (29 – 33 μg m–2 h–1). CO2 fluxes of 2 – 78 mg m–2 h–1 were lower from contaminated soils compared to uncontaminated controls (78 – 104 mg m–2 h–1). The variance of CH4 and CO2 fluxes could be explained to 78.0% by soil properties and oil well age ($P < 0.001$) as suggested by redundancy analysis and variance partitioning analysis. Based on the Illumina MiSeq sequencing of the archaeal 16S rRNA gene, the relative abundance of methanogens over archaea increased by 8 times in contaminated soils compared to that in the uncontaminated soils, suggesting enhanced methanogenesis processes. The proportion of hydrogenotrophic methanogens over the total methanogens increased from 35% in the uncontaminated soil to 43% in contaminated soils, consistent with the higher apparent fractionation factor (αC) in the stable isotope analysis. Both microbial and isotopic results suggested that the hydrogenotrophic methanogenesis relatively enhanced with the oil contamination, with less dominance of the acetoclastic methanogenesis. The dramatically increased CH4 emissions under oil contamination call for great attention as a potentially important anthropogenic source of CH4 in the atmosphere.

Keywords: disturbance, soil oil contamination, methane, methanogenesis, Illumina MiSeq sequencing

P0100

Spatial and temporal transformation of radioactive contamination of agroecosystems during post-Chernobyl period

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After 33 years the Chernobyl catastrophe as a result of the decay and decrease in the concentration of long-lived 137Cs and 90Sr in the soil, the area of contaminated agricultural lands of Belarus with a density above 1.0 and 0.15 Ci/km2 decreased by about 1.7 times. At present about 900.0 thous. ha of agricultural lands contaminated with 137Cs with density 1-40 Ci/km2 are in agricultural use for production. The radionuclide transfer factor (TF), indicating the root uptake by the crops, vary in time, depending on the degree of fixation of 137Cs and 90Sr by the soil absorbing complex. Due the natural factors of soils change and undertaken protective measures productive crops comply to acceptable rules for the content of radionuclides. During the post-accident period, there was a significant decrease in the bioavailability and intensity of 137Cs migration in the soil-plant system. Its TF decreased in umbric albeluvisols, depending on their granulometric composition and water regime. In grain crops TF decreased in 3.0–6.7 times, in potato tubers – in 5.0–7.5 times. On histosols drainic, the availability of 137Cs has decreased on average in 2.5 times. During the post-accident period due to the high mobility of 90Sr in the soils, its conversion factors to crop production are significantly higher compared to 137Cs - more than 10 times in grain crops, and 5 times in potato tubers on average. The selection of crops and varieties with the minimal accumulation of radionuclides is the most affordable means to reduce the root uptake of radionuclides by the crops. We have developed a typification of agricultural lands contaminated with radionuclides, includes the forecast assessment of lands where possible to obtain products that meet hygienic standards for radionuclides, and an assessment of the impact of soil-landscape conditions on migration and redistribution of radionuclides in agroecosystems.

Keywords: agroecosystems, radionuclides , agricultural crops, soils

T0277

Overland water-flow mechanism for ring formation in water-limited environments: field measurements and mathematical modeling

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Vegetation ring is a unique vegetation pattern found in drylands. Most examples are found in clonal plants growing in sandy soils with confined root zones. Two main mechanisms have been suggested to explain ring formation in water-limited systems: 1) The water-uptake mechanism pertains to plants with large lateral root zones, and involves central dieback and ring formation due to increasing water uptake by the newly recruited individuals at the patch periphery. 2) The overland water flow mechanism pertains to conditions of high infiltration contrast between vegetated and bare soil, where overland water-flow is intercepted at the patch periphery. We show, using field measurements and numerical simulations, that the overland water-flow mechanism drives the formation of rings in the clonal species Asphodelus ramosus.

The infiltration contrast develops due to the aeolian feedback between vegetation and wind-induced particle transport. Fine particles settle at the patch center, and thus reduce soil water infiltration compared to those at the perimeter. This process results the development of surface-runoff source-sink relations between the patch center and matrix towards the ring's perimeter. The outcome of this process is the formation of three different micro-environments: the patch center, characterized by low soil water content, and the patch perimeter and matrix, characterized by higher soil water content. Competition for water resources between the ramets at the perimeter and the ones at the center leads to die-back and to ring formation. Field measurements of soil water content in rings of Asphodelus ramosus in the semi-arid Negev of Israel throughout four years show that the soil water in the ring's center is lower than that at the perimeter and the matrix. The soil water distribution across the rings is similar to the numerical simulations of a mathematical model for species with confined roots and highly seasonal rainfall in water limited systems.

Keywords: rings, infiltration feedback, clonal growth, vegetation patterns, mathematical modeling

T0302a

A model study of terraced riverbeds as novel ecosystems

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Riverbed terracing has been introduced in ancient times to retain water and soil, to reduce hydrological connectivity and erosion and to increase primary and secondary productivity of agro-ecological system. These presently abandoned human-made landscapes have become novel ecosystems and a potential source of ecosystem services to humans in drylands. For that potential to be realized, however, more information is needed about the soil-vegetation feedbacks that are taking place in terraced areas and their possible effects on biological productivity and diversity under variable rainfall regimes. We use a mathematical-modeling approach to study factors that regulate terraced riverbeds and affect community and ecosystem attributes such as productivity, functional diversity and resilience to droughts. We introduce a model that captures the relationships between rainfall pattern, runoff coupling between adjacent terraces, and the differential plant-community responses in the terraces in terms of biomass production and functional diversity, taking into account competition for water and light. Using this model we found that a large number of weak rainfall events results in lower total biomass and functional diversity across the terraced riverbed, as compared with a few strong rainfall events. We further analyzed the filtering of species traits from pools of functional groups that make different tradeoffs between investment in above-ground biomass to capture canopy resources and investment in below-ground biomass to capture soil resources. We found that pools characterized by concave tradeoffs give rise to higher functional diversity, lower biomass production and lower resilience to droughts, as compared with convex pools. We focused on terraced riverbeds, but the modeling approach can be used to study other contexts of dryland meta-ecosystems where local- and regional-scale processes, jointly with environmental factors, affect functional diversity and ecosystem function.

Keywords: terraces, ecosystem function, functional diversity, droughts, resilience

T0450

Simulating ecosystem services re-distribution under ecosystem-services-based mitigation programs in a landscape subject to urban expansion

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Urban and agricultural expansion pose concerns on the conservation of wetlands and the ecosystem services they provide. Environmental policies worldwide prescribe that ecosystem losses should be offset by restoring other ecosystems elsewhere. In ecosystem-service-based mitigation schemes, such an equivalence is assessed by a score that aggregates the levels of delivery different ecosystem services. However, the way level of ecosystem services are aggregated (e.g., weighted average, minimum, or maximum) might affect the way ecosystem services are re-distributed in the landscape. We developed a model to simulate the application of a mitigation scheme in the Beaver Hills sub-watershed, a wetland-rich region in Alberta (Canada) subject the urban expansion of the city of Edmonton. We considered three different wetland ecosystem services (flood control, water purification and habitat provision) and simulated different scenarios, each one corresponding to a different aggregation scheme for scoring wetlands (weighted average with equal weight, food control priority, water purification priority, habitat provision priority, minimum and maximum aggregation). Results showed that aggregation schemes have unintended consequences at the landscape scale. For example, an aggregation scheme giving priority to flood control impacts positively on water purification but decreases habitat provision in the landscape. Basing on our results, we provide five principles (substitutability, co-benefits and tradeoffs, landscape constraints, heterogeneity, precautionary principle) for the application of aggregation schemes in compensation policies for ecosystem services in landscapes. We also remark how some aggregation scheme promote more than other landscape multi-functionality.

Keywords: mitigation schemes, ecosystem services, wetlands, resource re-distribution, multi-functionality

T0021

The effects of landscape pattern evolution in Liaohe estuary to changes on water quality

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This research systematically examined the ecological sensitivity of the Liaohe estuary in Panjin City, Liaoning Province to changes in the area of sea used for various activities based on data from remote sensing images in 1990, 2000, 2007 and 2014. First, the ecological sensitivity mechanisms of the major sea use activities were analyzed, including land reclamation, farming and industrial activities along the shore. Second, an Ecological Sensitivity Index (ESI) to changes in the area of different marine uses was constructed as the ratio of the variation of ecosystem services values to sea use intensity. The dynamic changes in ESI were calculated from 1990 to 2014. Finally, the spatial patterns of ecologically sensitive areas were obtained using spatial analysis tools in ArcGIS. The results showed that the area of sea used for human activities increased significantly from 2977.32km2 in 1990 to 3059.96km2 in 2014. The major types of change were open aquaculture, marine aquaculture and marine industry, which were mainly developed on former Suaeda salsa communities and mudflats; The hemeroby index (HI) tended to increase particularly from 2007 to 2014, while the ecosystem services value showed the opposite trend, declining from 4.65×109 Yuan to 3.34×109 Yuan. This suggested that the HI was significantly negatively correlated with the ecosystem services value. The value of the ESI was 2.5 in 2001, and then increased to 4.7 in 2007 and to 4.8 in 2014. Overall, in the past 25years, the Liaohe estuary ecosystem has shown a low sensitivity to changes in the area of the sea used for human activities. Although there has been an increase in human development and use in this region over the past ten years, their impact on the whole estuarine ecosystem has not been very strong.

Keywords: Liaohe estuary, Landscape index, Correlation analysisi, Redundancy analysis

Symposium 51

Modeling the structure and functioning of forest landscapes under changing climate and disturbance regimes

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Forest ecosystems and their products and services play an important role to achieve ambitious climate change mitigation, but also have to adapt to climate change. The increasing demand for climate change mitigation and adaptation as well as the contribution of forests to a bio-based economy, sustainable development and biodiversity targets will lead to massive changes in forest management and forest resource use. Process-based forest models can assess the future provisioning of forest products and ecosystem services by simulating different management options allowing to assess the production of wood products, biomass, and regulatory services while forecasting changes in forest resilience under climate change. However, feedbacks between climate, natural disturbance regimes, and forest ecosystem management are still largely unexplored by models. This symposium intends to demonstrate how to integrate pressures by climate and disturbance regime changes into management-sensitive forest landscape models, focusing on multiple drivers of forest resilience and the individualistic, population, or landscape structural responses to management-induced ecosystem modification.

P0199

Integrated Biodiversity Conservation and Carbon Sequestration in the Changing Environment (IBC-CARBON)

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Climate change (CC) represents a major threat to biodiversity (BD) and to the sustainable provision of ecosystem services (ES). Successful integration of BD conservation into sustainable forest use under global change is a major challenge for the society. The consequences of the planned large investments in bio-based economy are poorly known, and the sustainability of these policies needs to be evaluated. Land use changes and increased biomass extraction can have far-reaching consequences on BD conservation, carbon (C) sequestration and soil quality, as well as downstream waters. To tackle these challenges, the multidisciplinary IBC-CARBON project (2018-2023, financed by the Strategic Research Council under the Academy of Finland) develops model based tools to determine spatially optimized, multi-objective land use in forest ecosystems. Integrated impacts of CC and forest policies on BD and ES are studied. Earth Observation based variables are developed to provide cost-effective tools to detect changes in forest BD and ES. Here we present preliminary results on the responses of C sequestration to alternative forest management and CC scenarios for a boreal landscape in southern Finland. The forest management scenarios were Business As Usual (BAU) following the national recommendations, and Biodiversity Conservation (BDC) in which all forest stands were set aside. The simulated C stocks of biomass, litter and soil increased in both scenarios over the simulation period 2017-2099 under the CC scenario RCP4p5. BDC produced substantially higher biomass C stock and somewhat lower soil C stock and lower C uptake rate than BAU. The differences were related to patterns in stand age structure, growth and litter production. The model will be further developed with measurements from unmanaged, old-growth forests to estimate their C sequestration potential. The national scale estimates of C budget and BD will be analysed together to support sustainable land use planning.

Keywords: climate change, forest modelling, biodiversity, carbon, ecosystem services

T0254

Fire driven changes in gallery forests communities in northern South America.

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Gallery forests are widely present in most savanna landscapes creating a mosaic of grass dominated systems with tree components and forest patches along a disturbance and environmental gradient characteristic. Interactions among water, nutrient availability and fire act as an active agent and maintain the savannas of the Orinoco basin in Colombia and Venezuela. Wildland fires have been a natural ecological process present for thousands of years in the tropics and they influence landscape structure, patterns and processes and have shaped today´s species composition and biological diversity. Under climate change, savanna fires are entering gallery forests where repeated fires kill only edge species most vulnerable to fire, leading to an alternative stable state of a savannas-forest interface, with forest tree communities dominated by fire tolerant species. We set 18 plots of 0.1ha along the edge from open savanna to closed forest in areas affected by repeated fires and areas where the forest was not burned. The goal was to identify how vegetation respond to fire through the analysis of compositional changes and identify the species present in areas most affected by fire. We found 110 species corresponding to 69 genus and 33 families. 27 species are more present in the fire affected forest areas, these species are highly resistant to fires but those communities have lower diversity. Overall frequent fires affecting forests have become more frequent and exposed forest have a strong edge effect in terms of biomass. Gallery forest are under a degradation process that is resulting into compositional changes, shrinking forests and overall will change any stable state that these systems might have had.

Keywords: mechanisms, community dynamics, forest edge, stable state, savannas

T0120

From mycelia to mammoths - simulating biotic disturbance agents in a changing world

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New biotic disturbance agents are emerging as the ever-growing global trade is rapidly increasing the number of invasive alien pests and pathogens that threaten forest ecosystems. Timely impact assessments of such invasions are therefore needed to contain their spread and concentrate efforts on the most harmful agents. Process-based simulation models are particularly well suited for this task. Here, we present BITE, a universal model to simulate biotic disturbance agents in forest ecosystems. Coupled with the landscape level simulation model iLand, BITE allows the quantification of the impacts of emerging pests and pathogens on forests in time and space. BITE uses biomass as a common currency for a variety of different disturbance agents and simulates the consumption of tree biomass by the agent population explicitly. Consequently, the framework is applicable across a wide range of biotic disturbance agents from fungi to large herbivores. In the context of new emerging pests lack of information is often the biggest obstacle for applying process-based models. BITE addresses this issue by employing a modular structure (e.g. modules for dispersal, growth and reproduction) which can be flexibly tailored to each particular agent and data situation. In addition, BITE can concurrently simulate multiple agents enabling the assessment of potential interactions between different agents. The simulation framework BITE thus provides a novel tool for quantifying the impacts of pest invasions in a changing world.

Keywords: biotic disturbance agents, invasive species, simulation model, forest dynamics

P0053

Effective allocation design of riparian buffer strips in plantation forest landscapes for controlling sediment discharge from logged forests in southern Japan

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Control of soil erosion and sediment discharge is one of the most important regulation services of forest ecosystems in mountainous regions. However, in forest landscapes dominated by plantations for timber production, logged forests became a significant source of discharging sediments. In these cases, riparian buffer strips are expected to reduce the sediment discharge to streams, while sparing production forests for riparian buffer strips will become a constraint reducing the timber productivity of the whole catchment. Thus, strategy for effective allocation of riparian buffer strips is desired as an optimal landscape design which is compatible to sediment control and timber productivity. This study aimed to present the effective allocation strategy of riparian buffer strips based on field experiments and modeling. We measured storage volume and movement rate of sediments in logged plantations and unlogged forests at different distances from the forest edges. The results demonstrated that the sediment movement increased with the unstable sediment volume which was influenced by both the sediment input from upper slope and the forest floor cover (litter and ground vegetation). Shrub density was also detected as an important element to increase the forest floor cover. Based on these experimental results, we developed a process model describing the sediment dynamics along the distance from the forest edge to logged and unlogged forests. By using this model, we predicted the sediment dynamics on a slope with scenarios of different logged area and width of riparian buffer strips. The simulated results indicated that 30 m width of riparian buffer strips will effectively reduce the sediment discharge from slopes to streams irrespective to the area of logged forests. Based on these results, we proposed an optimal buffer designs compatible to sediment control and timber productivity.

Keywords: riparian buffer width, water catchment, timber productivity, process model, optimal landscape design

T0671

Seed dispersal, climate change and disturbance scenario strongly and differently affect predictions of forest landscape models

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Forest landscape models (FLMs) simulate forest succession by seed production, dispersal, establishment, growth, competition, and mortality of trees in forested landscapes driven by site-specific climate, soil and disturbance conditions. Since FLMs differ in their purpose, concepts, and design, they can be expected also to differ in the sensitivity of their predictions to alternative prescriptions on seed dispersal, future climate, and disturbances. However, such differences have rarely been investigated and quantified.

We ran simulations with the FLMs iLand, LandClim, LANDIS II, and TreeMig in the same mountain catchment in the Swiss Alps, ensuring the same model conditions of species pool, past-to-current climate and scenarios for future (until 2100) climate, seed input (unlimited or spatially constrained), and avalanche disturbance frequency. The models agreed satisfyingly to data and among each other in the spatial distribution of tree species biomass in past-to-current simulations. Forward-looking simulations however showed quite different sensitivities to climatic warming, with predictions ranging from biomass increase due to enhanced growth and regeneration at higher elevations, to biomass loss due to drought-induced mortality under strong climate warming. Biomass dynamics exhibited species-specific patterns in all models. Dispersal limitation had a model-specific but generally small effect on forest biomass, with stronger effects depending on time periods, locations, species and competition. Disturbance frequency as expected had a strong effect on simulated species biomass.

Differences in FLM sensitivities were due to model-specific implementation and parametrization of key ecosystem processes such as mortality/longevity, CO2 fertilization, sprouting, and to the temporal/spatial resolution of each FLM.

These effects should be scrutinized for improving the models and be taken into account when choosing a FLM to guide forest planning and management.

Keywords: Forest landscape models, Spatial interactions, Climate change, Disturbances

The scaling of resilience: projecting regeneration failure under future climate and fire regimes for Greater Yellowstone

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Multiple drivers are expected to accelerate environmental change in the 21st century, but the resilience of landscapes to these drivers remains uncertain. In forests affected by large high-severity disturbances, sustained success of tree regeneration is a key component of resilience. We asked if expected changes in climate and fire regimes can lead to widespread regeneration failure of forest types currently dominating the Greater Yellowstone Ecosystem (GYE) in the western USA. We applied SVD (Scaling Vegetation Dynamics), a novel tool based on Deep Learning, to predict regeneration success for the three main forest types (lodgepole pine, Douglas-fir, and Engelmann spruce-subalpine fir) for the whole region (~2.5 million ha of simulated areas) under varying climate and fire scenarios. The deep neural network at the core of SVD was trained on post-fire regeneration success simulated by a detailed process based forest model (iLand) for a wide range of environmental and climatic conditions. Dynamic SVD simulations were initiated from the current distribution of forest types in the GYE and driven by spatially explicit fire perimeters derived via statistical projections of climate and fire dynamics. The probability of postfire regeneration success was predicted based on forest type, climate, and the current distance to adult seed trees at a spatial grain of 1 ha. The simulations considered potential negative effects of fire size (increased distance to remaining seed trees), fire frequency (lack of local seed trees due to frequent reburns), and climate (failing establishment of seedlings under severe post-fire drought conditions). The simulations reveal where and when current forest types are likely to fail to regenerate, and the conditions under which the resilience of current forest types to changing fire and climate regimes is severely threatened.

Keywords: SVD, forest resilience, climate change, scaling, deep learning

P0112

Population mechanistic models allow the identification of priority areas for restoration in Mediterranean pine forest landscapes affected by different fire regimes

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Fire is a main driver of landscape pattern and functioning that impacts on ecosystem service supply depending on disturbance regime. In the Mediterranean Region, wildland fires are becoming larger, more severe and recurrent due to global change, which compromise seriously forest resilience. We aim to identify target areas for restoration actions in a Mediterranean pine forest landscape of NW Spain, which is recovering after a megafire (11,891 ha; year 2012) that generated different scenarios of recurrence and severity. Within the fire scar, we modelled early pine mortality from biotic and abiotic predictors. Tree mortality was quantified in field plots of 2m x 2m as the seedling density difference between the third and fourth year after fire. As biotic predictors, we considered the cover of each understory shrubland species measured in the field plots. These variables were spatialized to the whole area using species distribution models based on spectral values collected by an unmanned aerial vehicle. Abiotic variables consisted of topographic predictors derived from a MDE at 2m resolution. Fire regime was set using a Landsat temporal series (1978-2016). The spatial output of the mortality model allowed for identifying critical areas where restoration actions should be implemented to recover, as fast as possible, the ecosystem services provided by the pine forest in pre-fire situation. Biotic variables would be the best predictors of seedling mortality at low recurrence and severity, due to competition interactions. However, at high recurrence and severity, abiotic variables would be more relevant since seedling density is lower and biotic interactions less relevant. Our correlative-mechanistic modelling approach, based on vital rates, is a useful tool for landscape decision-makers since it allows for evaluating spatial variations in natural regeneration at high resolution across large disturbed areas, detecting vulnerable zones requiring urgent restoration.

Keywords: forest resilience, interspecific relationships, population auto-succession, seedling mortality, unmanned aerial vehicle (UAV)

T_8897

Retrospective prediction of forest damage caused by storm 'Vaia': a comparison of three approaches to estimating the distribution of wind damage

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On October 29th 2018, storm Vaia locally exceeded wind speeds of 200 kmh-1, causing the overnight loss of over 8Mm3 of standing timber in the predominantly conifer forests of the montane and subalpine landscapes in northeast Italy. The economic losses caused by the storm are likely to be felt for many years, while disruptions to the ecosystem services provided by these forests are likely to persist for longer still. Given the projected increase in the likelihood of extreme wind events in Europe, and the uncertainty associated with these projections, it is paramount that the most appropriate modelling tools are adopted in forest planning and management to mitigate the risk of catastrophic wind damage.

Storm strength aside, the risk of wind damage to forests is driven by topography, land cover type, tree species, stand structure, soil type, and forest management practices. In complex landscapes such as those of the Italian northeast, the rugged topography is the main driver of the spatial patterns of wind acceleration/deceleration, and wind direction. Such complex terrain is outside the accepted slope steepness limits for linear airflow models, and is best suited to a Computational Fluid Dynamics (CFD) approach, although such models are burdened by very heavy computational loads and can be costly and impractical for large areas. In these situations, a valid alternative is to estimate wind patterns using TOPEX (an index of topographic exposure).

We compare three approaches to the calculation of localised wind patterns: a linear airflow model (the wind energy industry standard WAsP), CFD calculations, and TOPEX. We focus on 4 areas in the Trento province where damage from storm Vaia was identified using pre- and post-storm Sentinel 2 data. The wind patterns computed with the three approaches are mapped against vulnerability maps calculated with the wind-risk model ForestGALES and the recorded damage to evaluate the suitability of the three airflow modelling approaches.

Keywords: Forest wind damage, storm Vaia, airflow modelling, ForestGALES, WAsP

Symposium 52

Urban Sprawl: From Measurement to Management

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Current trends in land uptake for built-up areas in many parts of the world clearly contradict the principles and the spirit of sustainability. Landscapes in many countries have been massively altered by increasing urban sprawl in the last 60 years, e.g., in Switzerland. Spatial planning has not been able to stop the increase in urban sprawl to this day. Urban sprawl is a major cause of loss of fertile farmland, soil sealing, and loss of ecological soil functions. Expanding built-up areas reduce the size of wildlife habitats and increase landscape fragmentation and the spread of invasive species. Urban sprawl results in higher car dependency, higher greenhouse gas emissions, higher infrastructure costs for transport, water and electrical power, the loss of open landscapes, and the degradation of various ecosystem services. The awareness of the many negative impacts of urban sprawl on the landscape and on different areas of life has grown considerably in recent years. In order to discuss the problem on a quantitative basis, however, methods and data have only recently become available, which allow for a comparison of urban sprawl between different regions and between different time periods. To address the increasing problem of urban sprawl, there is an urgent need for improved landscape management frameworks and tools that consider the knowledge from landscape ecology. For example, settlement boundary lines, preventing a dispersed expansion of built-up areas, densification of existing built-up areas and minimum densities for new built-up areas, and the comparison of planning scenarios have been proposed. Quantitative measurements of urban sprawl would allow for establishing environmental standards, such as targets and limits to urban sprawl, similar to limits and standards in other environmental sectors such as noise limits and limits to water pollution. Based on such standards, legal requirements could be developed that would act as a reliable framework for all spatial planning actors. However, little is known about the effectiveness of these measures and their long-term effects on the landscape. Without rigorous measures, sprawl is likely to increase strongly in the future, but a few examples demonstrate that sprawl can be reduced. Banks can help avoid urban sprawl by divesting from sprawl, such as the Alternative Bank of Switzerland (ABS) does by not giving mortgages to construction projects that would strongly contribute to urban sprawl. This symposium will bring together researchers and planners to bridge the gap between the measurement and management of urban sprawl.

Using edge density metrics to assess landscape fragmentation along Quezon City's Mariblo creek system

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Urban rivers are important ecological corridors that connect patches with one other. Green spaces along these corridors serve as bridges between distant patches These corridors also serve as communities for biodiversity. However, the urbanization contributed to the rate of fragmentation of these spaces. Other effects of uncontrolled development such as loss of biodiversity, challenges in built-up area development and hindrances on ecological processes are also observed.

The study aims to assess the level of fragmentation of green spaces along one of the major tributaries of San Juan River, the Mariblo Creek in Quezon City. The study uses edge metrics as a basis for the assessment of its fragmentation. The study attempts to establish the relationship of edge density and fragmentation.

The research uses satellite imagery and GIS in computing the area and edge of the patches along the Mariblo creek system. Sections of the river are compared with one another to derive the relationship of the metrics used and the fragmentation of the green spaces along the creek. Ratio of the patch areas and the creek section areas are also compared for analysis. At the end of the study, the ratio of green spaces to the waterway is manifested in the irregularities of the green patches. This is an indication that fragmentation along the creek system is high. Recommendations on how to improve the current quality of the waterways are proposed. The level of fragmentation should be reversed in order to attain high levels of biodiversity, protection of the waterway and a balanced urban development.

Keywords: urban rivers, edge density, fragmentation

P0003

From urban sprawl to compact green cities – how much do we know, how much do we agree?

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While urban systems are expanding at very fast rates all over the world, understanding their spatial development remains a complex issue. The physical growth of cities assumes different spatial patterns, usually in the form of urban sprawl resulting from multi-dimensional drivers and causing multi-dimensional impacts. The need to manage urban sprawl has been widely promoted in science and policy-making. However, ensuring a high quality of life for urbanites demands integrative points-of-view for the types of compact development to promote, in particular regarding urban green spaces within densification processes. Urban sprawl and compact green cities require adequate and robust multi-dimensional spatially explicit indicators to support urban planners and policy makers. This poster will present the outcomes of the Special Issue of Ecological Indicators "From urban sprawl to compact green cities – indicators for multi-scale and multi-dimensional analysis". Based on conceptual papers and international case studies this poster explores the current international state of the art in developing, testing and implementing multi-dimensional and multi-scale indicators characterizing urban sprawl and compact green cities. The poster provides concepts and international case studies for land monitoring and planning recommendations fostering an integrative picture of the spatial behaviors of the urban ecosystem.

Keywords: Urban complexity, Compact city, Green infrastructure, Ecosystem services, Urban sprawl

T0928

Measuring the total impact of soil consumption

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Soil sealing has negative impacts both on Ecosystem Services (ES) and Landscape structure and functions. The impacts vary a lot, depending on the patterns of urbanization. They include direct impacts due to the sealed areas, and indirect impacts due to the disturbances from urbanization or to the lost their previous functions for the fragmentation and size reduction. These phenomena increase especially inside urban fringes, where the structural changes meet the problems caused by the processes speed, reducing the adaptation strategies of the ecological systems.
However, soil sealing management lacks a spatial strategical overview and doesn't take in to consideration the ES provided by fertile soils.
The research, developed in several years and on different case studies, aims to construct an adequate spatial indicator able to describe the total impact due to the patterns of the widespread urbanization on landscape. An indicator useful for ecological planning, considering the need to be easy to use, implementable, comparable and communicable. In order to measure the real pressure of the sprawl in different landscape units, we provided three spatial indexes based on the ratio between the sealed areas and the ones interfered from buildings and infrastructures.
The dimensions of the interfered areas were defined on the estimation of the minimum ecological functionality of the land mosaic tesserae. They are based both on experimental analysis and scientific literature, related to lowland agroecosystems in temperate climate. The three indexes allow to:
- Work together with the soil sealing indicators taking in account not only the soil consumption, but also the effects on ES;
- Define a set of indicators, as a "proxi" of the missing ES, to be use in territorial planning;
- Define areas in which the sprawl increase can raise the landscape vulnerability;
- Became an important part of aggregation indicators useful in the classification of peri-urban landscapes.

Keywords: Metrics, sprawl, patterns, ecological functions

Mapping urban area in China using Landsat and nighttime light on Google earth engine Platform: A multi-scale comparative perspective

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Urbanization has become one of the most important force shaping the development of the modern world. However, reliable delineations of urban area in large scales remain limited, hindering the scientific study of large-scale urbanization effect on eco-environment. In this paper, based on nighttime light data and Landsat images, an efficient and low-cost machine-learning approach for pixel-based image classification of urban areas was applied to monitor the urbanization process in China. To handle large variation across regions, we adopted a hexagonal tessellation mapping approach, and partition China into 3 sizes of equal-area hexagonal grids (1decimal degrees, 4decimal degrees, 8 decimal degrees). Then, each hexagon as the unit of analysis for training and for classification, random forest model and Otsu algorithm were used to identify the urban areas in Google Earth Engine. After comparing the accuracy of classification results in 3 sizes of hexagonal grids, the optimal scale was identified, and finally the 30 m resolution maps of urban areas in China during 1995-2015 were extracted effectively. This paper reveals the spatio-temporal dynamics of urbanization in China, which provides a basis for the planning and management of sustainable cities.

Keywords: urbanization, image classification, Google earth engine, China

Leading the way toward respecting limitations on a finite planet: Proposing quantitative targets and limits to urban sprawl

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Current trends in land uptake for built-up areas in many parts of the world clearly contradict the principles and the spirit of sustainability. Unlimited urban sprawl is an example of the tragedy of the commons. To address this rapidly increasing problem, there is an urgent need for the establishment of targets and limits to curtail urban sprawl, similar to limits and standards in other environmental sectors such as noise limits and limits to water pollution. The novel method of Weighted Urban Proliferation (WUP) can serve this purpose. The WUP is a combination of the amount of built-up areas, their dispersion, and land-uptake per person. We applied this method to Switzerland to examine the current state of sprawl, for historical analysis, and as a baseline for future scenarios. Based on our results, we propose the implementation of targets and limits for Switzerland, and a set of concrete measures to control urban sprawl and to use land in a more resource-efficient way. Without rigorous measures, scenarios of future urban sprawl for Switzerland for 2050 show that sprawl will continue to increase strongly, but a few examples demonstrate that sprawl can be reduced. For example, as a consequence of intense public discussion, the Swiss Spatial Planning Act was revised in March 2013 to make it tighter. The new WUP method has recently been implemented in Switzerland's landscape monitoring system. Banks can help avoid urban sprawl, such as the Alternative Bank of Switzerland (ABS) does, by not giving loans to projects that would strongly contribute to urban sprawl, i.e., a divestment from urban sprawl. The WUP method is highly suitable for performance control of targets and limits to urban sprawl once they will be implemented.

Keywords: built-up areas, landscape metrics, environmental standards, monitoring, limits

T_0967

Urban sprawl on the rise: Global trends 1990–2014

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Dispersed low-density development – "urban sprawl" – leads to more rapid land uptake than compact high-density growth patterns and has many detrimental consequences. We present and discuss here urban sprawl on the planet at multiple scales over a period of 24 years and in relation to socio-economic development. Daily increase in built-up areas was 25 km² per day, or 1.7 ha per minute. Urban sprawl has increased most rapidly in highly developed countries. The most sprawled continent is Europe, followed by North America. However, in terms of per capita values, urban sprawl is highest in Oceania and North America, exhibiting a minor decline since 1990, while it has been increasing rapidly in Europe, by 47% since 1990. There is an urgent need to stop urban sprawl.

Keywords: Urban Sprawl, Global Human Settlement Layer, Human Development Index, Landscape Metrics, Monitoring

The TOD Suitability Index: A Planning Framework for Transit-Oriented Developments (TOD)

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Cities are becoming more and more crowded but the remain as the commercial and business centers. Therefore, developers are continuing the trend of urban sprawl wherein with the car-dependent built-up areas being developed in locations with originally were used for agriculture or natural areas. These new urban developments lack mixed-use opportunities for new residents to work and do business, so constant travel to the main city center is needed. The lack of proper access to public transportation to these areas increases the need for automobile infrastructure to support its continued growth. A transit-oriented development (TOD) uses a planning and design strategy that ensures urban development around transit stations (i.e. bus or train) is compact, user-friendly, suitably dense, responsive and mixed-use. It integrates various land uses around transit areas for economic growth and pleasurable travel experience, while protecting and conserving the environment. TODs for new and old urban development will increase integrated green spaces, green infrastructure development, and better connectivity between urban developments. One notable case is that of Hong Kong where various areas were transformed into TODs—a process that decentralized and distributed places of work and residence into multiple locations, rather than in one general area. Planning a TOD considers multiple levels of assessment and evaluation. Given the complexity and uniqueness of potential TOD sites, a methodology focused on determining suitability for this type of development must be developed to guide city planners, policy makers, designers, target users and other stakeholders. The TOD-Suitability Index (TSI) provides a methodology that integrates green infrastructure, promotes quality of life and human well-being through improved public transportation system and improved streetscape and public space conditions.

Keywords: Urban sprawl, Landscape Planning, Green infrastructure development, Transit-oriented developments, Urban open space development

Urban Sprawl Metrics help to identify ecological impacts: Implementation and Application of New Neigbourhood Metrics to assess Habitat Network Structure and Connectivity

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Urban sprawl must be discussed in regard to its ecological consequences: water balance, thermal pollution, air pollution caused by traffic and visual/recreational landscape quality are closely related to patterns of urban sprawl. However, this contribution deals with the effects of urban sprawl on habitat connectivity. We know that in a biotope or habitat network connectivity is a key parameter for successfully establishing exchange of individuals and genes, for accessibility of resources and for enabling migration and dispersal. Settlement and transportation infrastructures and thus patterns and dynamics of urban sprawl directly affect permeability of landscape and its bio-connectivity. Hence landscape pattern assessment in regard to conflicts is a tool to proactively prevent or to mitigate serious impacts on biota from urban sprawl.

Jaeger et al. (2010) have presented a concept for measuring urban sprawl. They use metrics which analyze the neighborhood of an urban location by summing up the weighted distances between settlements. Such neighborhood based metrics can also be applied to basic questions regarding bio-connectivity. Adaptions and supplements of them can be used to describe form (e.g. mainland type, patchy type, linearity) and, when considered a combined analysis, they can answer questions like: which pattern of urban sprawl restrict permeability? How did urban sprawl and permeability develop in settlement history? Where do bottlenecks exist and which patterns do cause them? A graph analysis based key metric PERMC is introduced, which respects both bio-networks as well as urban infrastructures as barriers.

My contribution demonstrates the help of the metrics described above in landscape management using data from the grassland habitat network of the State of Baden-Württemberg and from state cadaster information system on settlement and road infrastructure. It concludes that urban sprawl metrics as introduced by Jaeger (2010) can be extended.

Keywords: urban sprawl, bio-connectivity, landscape metrics

T0825

Characterizing and understanding the transformation of urban morphology: a case study of Austin metropolitan area, Texas, U.S.

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Starting from 1990s, the "new urbanism" and "smart growth" policies have been advocated in the United States, by promoting compact urban forms to face up environmental and ecological problems due to urban sprawl. To assess the change of land change in terms of sprawl and densification, new methods to measure urban morphological forms are needed. Advancements in remote sensing, especially airborne Light Detection and Ranging (LiDAR), enable multidimensional measurements of urban morphology and its transformations. In this study, we focused on Austin, Texas, US, to characterize urban morphology zone (UMZ) transition in 2007-2012 and 2012-2017, with available LiDAR data. The overall UMZ classification scheme was mainly designed by the combining 3D building characteristic, percentage of impervious area and natural land covers.

Nine types of UMZs were identified. UMZ mapping results showed that most Austin urbanized area is categorized into UMZ "Low-rise" types and UMZ "sparsely Built", accounting for 31% and 44% of urban areas. Our UMZ mapping scheme also enables UMZ transition analysis: we found there was a tendency of sprawling from 2007 to 2012, e.g., the area experiencing urban sprawl had been much greater than the area experiencing densification. In sprawling process, natural types were transformed to UMZ "Open" types, UMZ "transportation", and UMZ "sparsely Built", accounting for 1%, 1.7% and 3% of the urbanized area, respectively. Remarkable UMZ transitions from UMZ "Low-rise" to "Mid-rise" types had been demonstrated in the densification process, by which more than 1000 Ha of UMZ area changes occur. The hotspots located at intensely UMZ transition areas were further explored to deeply understand UMZ transition. Thereby, factors such as adjacency to ecological environment, thermal comfort, demography of sub-region, affordability, access to economic centers and main roads, were tested. The study can improve the urban sprawl monitor and further urban planning.

Keywords: urban morphology, urban mapping scheme, transition, remote sensing, Austin

Symposium 53

Policy and governance innovation in agricultural landscapes: recent trends and future pathways towards enhanced sustainability and food security.

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Agriculture occupied in 2017 37.265 % of worldwide land surface, down from 39.47 % in 1991 (World Bank, 2018). Alas, its regional distribution and trends largely differs (World Bank, 2018), with a maximum of 43.5 % in the European Union in 2015 (yet down from 1961) and a minimum of 13.4 % in Pacific Islands Small States in the same year (yet up from 1961). Especially problematic is the regional miss-match between the "developed" regions where agriculture is increasing its efficiency and capacity to feed their own (largely stagnating) populations with high-quality food, and others ("developing") where population is exponentially growing and largely lacking access to healthy, affordable and sustainable food.

Furthermore, agricultural land is embedded in wider agricultural-dominated (rural and peri-urban) landscape mosaics that are currently undergoing shifts of unprecedented magnitude and complexity driven by changes in socio-economic, environmental and cultural conditions at scales that range from the farm to the global. This is all central to political, geo-strategic and social debates currently dominating the global arena, including: climate change, sustainability and food security. Alas, it also directly contributes to relevant discussions about the empowerment of local and regional actors in the face of globalization, the largely unresolved trade-offs and tensions between food production and environmental conservation, and between productivist and post-productivist approaches to agricultural production. These are all points that are commonly discussed on the policy and science arenas, whilst some other key points remain (so-far) relatively untouched. Amongst the latter, deeper and more critical insights are required on the complex dynamics of change, and generic lack of innovation, in the intricate and multi-scale framework of governance and policy instruments that drive decisions in agricultural landscapes. When addressing agricultural landscapes, most policy and governance approaches focus on food production and rural development and on how these are positioned to tackle the aforementioned global challenges. Nevertheless, by restricting the view point to this set of policies as pivotal and yet isolated pieces, we are missing the full picture of the processes of changes, including interactions with policies and governance models from other sectors (e.g. conservation) and better insights into the wider rural landscape that use a different kind of rationale. For instance, agricultural policies build on a voluntary menu-based structure of financial incentives, whereas spatial planning and environmental policies are based on restrictions of uses and practices, thus rendering their mutual integration virtually impossible. In response to such challenges, this session aims to combine theoretical arguments and empirical cases of policy and governance innovation around the world can help disentangle the potential of agricultural landscapes to help advance sustainability and food security. More specifically, we expect that each presentation will address at least one of the following three points in the symposium:

• Identification of key aspects of policy and governance innovation of relevance for agricultural landscapes (e.g. policy integration, improved public participatory procedures and standards….)

• Insights into how such innovation processes can help tackle more efficiently globally relevant challenges related to agriculture (climate change, food security and biodiversity conservation…).

• Regional and local case-study examples of good practices in governance and policy innovation for agricultural landscape sustainability and improved food security.

Are certification schemes promoting more sustainable farm management practices? A case study in the Montado of the Alentejo region, Portugal

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The High Nature Value (HNV) farming concept was introduced in Europe in the early 1990s, presenting a new approach to nature conservation, based on the interconnection between the domains of ecology, agriculture and public policies. One of its cornerstones is the idea that low intensity farming practices often correspond to an overall biological diversity in farmland. Typically, HNV farming systems are low intensity and input systems. Besides the classification of individual areas as HNV, the spreading of this concept intends to contribute to preserve and expand the agricultural systems of HNV in Europe through adequate support measures, namely under the Common Agricultural Policy (CAP). The importance of HNV framework lies in the fact that it goes beyond the traditional scale of preservation of restricted farm plots to the scale of landscape management.

There are agri-environment measures under the CAP which aim to support production modes that guarantee higher sustainability of the production. Integrated Production and Organic Production are the most commonly used. In order to access the agri-environment measures financial support, farmers willingly agree to comply with a set of rules and technical specifications. These measures have been in place since the start of the agri-environment schemes, though their effectivity in improving the overall sustainability of the farm system, is seldom addressed. This overall sustainability is particularly relevant in complex silvo-pastoral systems as the Montado in Southern Portugal, due to the close interaction between diverse components of the system.

Using an extensive cattle production system in a Montado area in the Alentejo region, Portugal as a case study, this paper assesses and discusses if the implementation of the agri-environment measures for integrated and organic production is indeed supporting more sustainable management of the system in an integrated way, and thus contributing to promoting the HNV Montados.

Keywords: HNV farming, Common Agricultural Policy, agri-environment measures, integrated production and organic production, Montado

Sustainable governance of historic agrarian landscapes: winter meadows of Ticino river

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The context of the experience is the river Po plain, rich in surface and underground waters and devoted to dairy agriculture. It faces to the loss of traditional agricultural techniques (marcite-winter irrigated meadows) due to a lack of specialized manpower (drowner); deficit of specific compensation in the RDP of Lombardy Region; no supply chain for the marcita milk; impoverishment of biodiversity.
Ticino Park has applied in the latest 10 years an alternative to the intensive agriculture: a high production agriculture that respects environment, reduces dependence on feed factories and on public contributions and preserves the traditional and historic landscape. The methodology entailed joint actions on different sectors (agriculture, culture, environment) supported by convergent projects and with constant involvement of farmers and universities, coordinated by the Ticino Park, and founded by public and private institutions (Lombardy Region, EU Life program, Cariplo Foundation, Monte di Lombardia bank). Two kind of actions have been undertaken: structural actions, as marcite restoration, winter submersion, biodiversity monitoring, course for drowners, cheese production; dissemination actions as itinerary, panels, traveling exhibition and videos on marcita; projections, large public and scientific conferences across Italy and Europe.
Main results have been the increase of biodiversity in winter irrigated meadows (amphibious, birds and flora and insects), the farmers' and inhabitants' awareness about the management of cultural and environmental heritage and the acknowledgement as a good practices of sustainable landscape governance (Mipaaf, Mibac, Feltrinelli foundation, Ruritage). We can consider this governance innovative because it overcomes preservation of an historic landscape for self-sustainable contemporary agricultural system with a dynamic feed system, providing high biodiversity and involving responsibly all actors in the landscape, specifically farmers.

Keywords: sustainable agriculture, meadows, historic landscape, governance, dynamic forage system

T0678

Vegetation cover and land opportunity cost drive landowner's willingness to set aside land for conservation

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The simplification of agricultural landscapes threatens biodiversity and the provision of ecosystem services. The maintenance of native vegetation inside rural properties can boost agricultural production and increase the resilience of ecological functions and services. Thus, understanding drivers that influence landowner's willingness to set aside native vegetation is key to articulate conservation efforts at larger scales. The Brazilian legislation requires all rural properties to have at least 20% of the property as a legal reserve (LR) with native vegetation, including riparian zones. Properties not meeting this requirement must restore or offset outside their limits (e.g. trading with landowners with LR surplus). The Government designed a public database in which landowners indicate their own LR, a great opportunity for a case study at broad scale. We used maximum likelihood estimation to model data from 4040 properties (2021< 20%LR, 1369~20%, 615>20%), covering one of the world's most important regions for coffee production, to investigate what factors modulate the (1) amount and (2) location of indicated LRs. Results show that the amount and location of LRs is mainly influenced by vegetation cover and opportunity costs. Properties with limited vegetation cover, high opportunity cost and low proportion of riparian zones are more likely to declare less than 20% LR, while properties with low opportunity cost and higher vegetation cover tend to indicate LR above legislation requirement (20%). Vegetated LRs are usually placed near rivers in steeper areas with low opportunity costs. In comparison, when they are not vegetated –and thus should be restored– LR are in flatter terrains, with higher opportunity costs. Despite the offset possibility, 50% of landowners we studied are willing to set aside at least 20% of their lands for conservation. Our results considering landowners interests can help predict more suitable areas for conservation set aside on private land.

Keywords: Ecological intensification, Conservation, Environmental policy, Land-use management, Landscape Ecology

Innovation approaches to governance of peri-urban areas: The case study of Agricultural Park Prato, Italy

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The presentation introduces innovation approaches of territorial planning reflecting actual processes and social changes that are taking place in Italy, respectively in Toscana region recently, incorporating new principles of land protection in general and setting up new categories of agricultural land protection.
The top-down approach is very strongly supported by bottom up activities aiming at multifunctional utilisation of cultural peri-urban landscape. The most innovative point is that peri-urban areas are not perceived only as supportive surrounding for cities, but rather as re-embedders of cities, moreover as the peculiar territories that make feasible treaty between the city and countryside. Moreover, selected territories are undergoing the social innovation process of re-territorialisation and re-localisation of agro-food system as being considered one of the main pillars of appreciation and empowerment of peri-urban area, peri-urban agriculture and local inhabitants, contributing to improvement of food security and local economy.
The aim of the paper is to analyse territorial governance instruments and their potential contribution to sustainable development of agricultural landscapes in peri-urban areas, based on insight into one case study of agricultural Park around city of Prato. Theoretical part will be checked up by complex local case study analysis of Agricultural Park of Prato bottom-up vision, which is also unique for the process of the birth and further development as the bottom-up initiative with its partially support of local municipality. Methodology of the paper is based on review of scientific literature, laws and territorial planning documents, accompanied by field research, photo-documentation and sociological research focusing on conduction of qualitative interview with key stakeholders from academia, nongovernmental organisations, governance and farmers in the area.

Keywords: peri-urban areas, territorial planning, agro-food systems, cultural landscape, food security

P0047

Land Sharing Initiative for preservation of traditional cultural landscapes

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During research for Master of Science in landscape ecology with title "Landscape Ecology Time Analysis of Wetland in Pesnica Valley", which also included study of legislation and agricultural policies, became clear that current agricultural and nature protection legislation does not provide adequate support for restoration and preservation of nature. Situation in rural areas with limitation for intensive agriculture is seen in loss of traditional cultural landscapes with their landscape and biological diversity. We have to mention also negative demographic trend, younger generations does not see perspective in traditional small scale multipurpose agriculture and we have population of elderly farmers who cannot work due to their age. Consequently the land is overgrowing and landscape and biodiversity of these landscapes is being loss.

There must be different option for restoration and nature protection with improvement of the economic, social and demographic situation of these rural areas.

Land Sharing initiative, eco-social innovation has proven that this is possible. Through intergenerational cooperation for traditional sustainable food production we can reverse negative trends in society and nature and at the same time provide new opportunities for development of rural areas. Pilot project in year 2014 has proven it.

If we want restore traditional cultural landscapes we must reintroduce traditional agricultural practices. Knowledge about it have elderly farmers, question is "Who is willing to go to farmers and cooperative grow food with them?". These are unemployed, socially and economic endangered people in urban areas.

Business plan was developed on the basis of integral approach and integral economy which encompass all realms of society and nature combined with Slovenian tradition of cooperatives.

Developed concept is WISE – work integration social enterprise.

Due to legislation problems in Slovenia we are looking for implementation of project abroad.

Keywords: integral approach, social inovation, intergenerational cooperation, preservation and restoration, WISE - work integration social entreprise

T0242

Perceived contributions of multifunctional landscapes to human wellbeing: Evidence from 13 European sites

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Multifunctional landscapes are characterized by various functions and values in space and time supporting human wellbeing. The relationship between multifunctional landscapes and wellbeing has mostly been studied using ecosystem services as a linkage. Knowledge gaps, however, still remain as to the relationships between multifunctionality and self-reported (subjective and perceived) wellbeing.

In this paper, we measure self-reported wellbeing through applying a free listing approach to the exploration of the relationships between landscape multifunctionality and wellbeing across 13 rural and peri-urban case study sites in Europe.

We developed an online survey (n=2,301 respondents), integrating subjective perceptions of wellbeing (free listing method) with perceived ecosystem service benefits (participatory mapping). Through content analysis and statistical methods, we explore the links between wellbeing (i.e. perceived wellbeing items such as tranquillity, social relations, and health) and socio-ecological properties (i.e. respondents' socio-cultural characteristics and perception of ecosystem service benefits).

We identified 40 different wellbeing items forming five distinct clusters: access to services, tranquillity and social capital, health and nature, cultural landscapes, and place attachment. Each cluster was related to specific study sites and explained by certain socio-ecological properties.

Our results point to the context-specific character of linkages between landscapes and human wellbeing. The inductive approach allows to specify pre-defined conceptualizations on wellbeing and their connections to the natural environment. The clusters highlight landscape-supported wellbeing is related to multiple interlinked items that can inform collective visions of wellbeing in future. For landscape planning and management, we highlight the need for place-specific analysis and consideration of perceptions of local.

Keywords: landscape, ecosystem services, self-reported wellbeing, PPGIS, cross-site comparison

T0560

The role of rural landscape in peri-urban areas: the Living Lab. of Chieri Municipality (Turin Metropolitan Area, Italy)

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Agriculture plays a key role in managing the peri-urban landscapes in Europe. Maintaining rural landscapes in urbanized contexts is a political priority and a scientific challenge. With the aim to identify strategies for the governance of rural landscape in peri-urban areas, several research projects were performed during the last years in the Turin Metropolitan Area (Italy). Chieri Municipality (36700 inhabitants, surface 5400 ha), recognized by UNESCO's Man and the Biosphere Programme in 2017, was selected as Living Lab. The links among farming systems, local food policies and ecosystem services provisioning were analysed with an interdisciplinary approach. Three main farm types were analysed: Crops and Grasslands; Vineyards and Orchards, and Horticulture. According to the farm's types, the multifunctionality assumes different aspects covering specific sets of sustainability needs and providing different ecosystem services at local and metropolitan scale. Agricultural production has also been considered as a component of the local food system, in a process of territorial analysis (Food Atlas project), aiming at understanding the priorities of a future local food policy. Moreover, the tools implemented by the LIFE SAM4CP project allowed to assess the potential ecosystem deficit connected to the application of the current Urban Plan. The following strategies were proposed: increasing rural farm networks and cooperation, promoting initiates for valorising the local food products, including farms in touristic and cultural networks and involve farmers in social and school programs. In conclusion, we believe that the information obtained is useful at political level in order to manage the whole territory in a sustainable development perspective. This methodology could be applied for decision makers and planners for implementing a participatory approach in environmental, social, and economic programs for peri-urban areas.

Keywords: multifunctionality, urban sprawl, food policy, ecosystem services

T0471

Improving the relevance of innovative agricultural innovations with key actors: case studies of technologies and practices from across Europe

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Actors, their constellations, and their interactions can play a central role in the success and relevance of agricultural innovations. This is especially true for the development of tools and practices that rely on agricultural data, broadly referred to as smart farming technologies (SFT). To understand how different actor types interact, and in which constellations they cooperate during SFT innovation processes, we selected 6 case studies of successful innovations, each from a different European region. The analysis of each of these innovations encompassed the origins of the innovative idea, its implementation and diffusion throughout a wider social system. These cases were interactively studied by closely looking at key actors, their functions, and events that affected their activities, using the timeline analysis methodology. Three case studies were innovative SFT products, and three were innovative practices using SFT. Interestingly, in both innovation types, innovators weren't the farmers themselves but came from the technological and digital sector. Close collaboration between innovators and farmers was a dominant interaction phenomenon throughout all phases of all innovations, and can be considered a key supporting factor for the success of the innovations. Other supporting factors included demonstrations and field days, motivation and positive attitudes of the innovators. Hindering factors were funding availability at mismatched time points, technology availability and compatibility, and infrastructure. Our findings suggest that including farmers and the innovators at all stages of developing agricultural tools and practices could lead to less regional "mis-matches" in terms of access to the innovations that ultimately contribute to the shape of farmed landscapes. We discuss our findings in the context of governance and policy innovations relevant to agricultural landscapes.

Keywords: actor roles, agricultural innovation processes, smart farming technologies

P0137

Social innovation as a driving force supporting revival of traditional farming in UNESCO site Vlkolinec, Slovakia

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The settlement Vlkolinec (Slovakia), thanks to its isolated location, preserved the historical character of a small rural settlement, and unique cultural and natural heritage with a significance extending beyond Slovakia. It attracts more than 70,000 visitors per year. Vlkolinec was declared a Reserve of Folk Architecture in 1977 and it was registered on the List of UNESCO World Heritage Sites in 1993. However, it suffers by the outflow of permanent residents and by a degradation the uncultivated surrounding landscape.
In time Vlkolinec became a city district of Ruzomberok and the city is interested in improving the quality of life of local communities and creating conditions for new green jobs in Vlkolinec. Therefore, in cooperation with the Catholic University in Ruzomberok and other partners, the INTERREG project "World Heritage Sites of UNESCO in the life of municipalities, cities and regions" has been elaborated. The project has been implemented since 2017 and one of its objectives is the reconstruction of the landscape features and historic structures of the agricultural landscape in the buffer zone through the revitalizing traditional farming.
Activities in Vlkolinec represents a social innovation further analysed under H2020 project No. 677622: Social Innovation in Marginalised Rural Areas (SIMRA). The aim of novel activities is improvement of quality of life for local inhabitants, support of the local economy and the return to traditional forms of farming, livestock and traditional crafts. Vlkolinec is relevant to current social innovation research as it is a reconfiguration of social practices, collaborations and networks structures. In particular, new partnerships have been created with universities, local NGOs and regional private and public organisations which reinforce the active position of City of Ruzomberok in preparation of revitalization plans. Civil society members contribute significantly to the initiation of the changes.

Keywords: Vlkolinec UNESCO site, social innovation, revitalising plans for buffer zone, traditional farming

T_0972

Agri-environmental collaboratives – experiences from Rural Denmark

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Collaboration among farmers, but also between farmers and other rural stakeholders, has increasingly been suggested as a novel way to sustainable landscape management. This is among other thinks reflected in recent changes to EU rural development policy that makes funds available for different forms of collaboration for the management and development of agricultural landscapes and experiences from many parts of world are being gained. The beneficial of such collaborations is that solutions on environmental problems can be solved on a landscape level and that farmers together can apply for financial support to land use activities as well as collaborations gives potentials for common learning. In this paper we analyze and discussed a Danish collaborative initiative initiated in 2000 and still running in the following called the 'Odderbæk Stream Association'. We look at the concrete outcomes of this initiative but we also pay attention to the parameters and framework conditions which have framed the success and constrain of the collaboration including how the farmers have organized them self, their external collaborators and how they have funded their management initiatives. The management initiatives include among other things river restoration, wetland establishment, common grazing and establishment of access to the landscape through various walking trails. The study is based on interviews with the majority of land owners in the case area, a focus group interview with the board of Odderbæk Stream Association as well as interviews with public authorities which have been working together with Steam Association. We conclude the paper with considerations on how such collaborative initiatives more effective can be support by public institutions and policies.

Keywords: Landscape governance, Collaboration, Farmland owners, Agri-environmental collaboratives

Landscape governance: exploring the meeting-point of agriculture and spatial planning policies

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Innovation in agricultural landscapes can be envisioned by exploring novel governance models restructuring existing arrangements across scales and sectors. Landscape is the locus where multiple policies superimpose, emerging from different scales of governance and from multiple sectors. More often than not these are missing articulation. In order to progress in the understanding of this situation, it has to be acknowledged that there is a diversity of typology of policies according to the underlaying mind-set of each policy arena, using different regulatory structures and tools of enforcement. Therefore the integration is ultimately carried out on the ground by local actors who by interpreting and responding to each policy framework manage the landscape and give shape to landscape changes. In Portugal the Municipal Master Plans are local planning instruments that regulate land uses and thereby restrict land development, both in urban and rural areas. These plans are expected to merge all policy instruments with spatial impact providing the public with information of all restrictions of uses and duties imposed on each plot of land, for whatever purpose. Having this context in mind, this communication aims to explore multi-level and multi-sector arrangements by focusing specifically on the interaction between policies as derived from agriculture and spatial planning. A multi-level (vertical) dimension of each policy and multi-sector integration (horizontal) as present in the local planning instrument are analyzed. A multimethod approach, blending geographical and lexical analysis tools is used. A range of case studies with varying presence of agriculture along the urban-rural gradient are presented to illustrate research findings as a basis for the conceptualization of governance models in place.

Keywords: governance, spatial planning, GIS, Common agriculture policy, Lexical analysis

T0199

Fragmented governance in the rural landscapes of Alentejo (Portugal)

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The rural landscapes of the Alentejo (Portugal) are undergoing a rapid process of change, with agricultural intensification potentially hampering their values and character. Whilst much of the rural landscapes in the region are still dominated by traditional multi-functional land-use systems, these are gradually becoming less competitive in a context of globalization, financialization and intensification. In such context, innovation is considered as a merely technological challenge, with other forms of innovation remaining largely marginal. The governance framework for land-use change currently in place is highly fragmented and uncoordinated, with an overall vision and strategy for the rural landscapes of the region largely lacking. Under such framework, the most likely future scenarios indicate to an increasing difficulty to tackle pressing challenges including climate change mitigation, biodiversity conservation and the protection of cultural attributes, whilst securing the financial sustainability of the rural sector. In response, this paper will discuss an analytical framework useful for identifying the key gaps in the current governance framework, and to envisage alternative options. Such framework includes the following sequential steps: i. Mapping the governance instruments and actors-networks driving rural land-use and landscape change in the Alentejo. ii. Identifying the miss-matches and trade-offs of relevance for the scalar, spatial and institutional coordination of governance instruments and actors, iii. Defining tailored solutions to fulfill these gaps. The paper will focus on the olive grove expansion and the crisis of the Montado, hereby considered as paradigmatic case-studies, We will close-up the paper by discussing how a joint consideration of the the territorial, social and institutional aspects of innovation can help design a novel governance framework more efficient for attaining sustainable regional development and territorial cohesion.

Keywords: Sustainable Development, Mediterranean Countryside, Landscape Governance, Territorial Cohesion, Agricultural Intensification

P0101

Agroecology and policy instruments for sustainable multifunctional agricultural landscapes

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Intensive food production generates high environmental and ecological costs. Agroecological transition is presented as a way to reconcile food production with ecosystem services provision and preservation of the natural environment.
These agroecological solutions rely on ecological dynamics at the landscape scale. They require optimizing land use and agricultural practices. When considered individually, a challenge may call for one precise solution which may conflict with solutions to other challenges. We assess these trade-offs using a system of models to identify, across scales, the synergies and antagonisms among a set of challenges facing sustainable agricultural landscapes.
Before generating scenarios for the interdisciplinary modeling teams, which include agroecological and econometric models focused on French datasets, we reviewed articles referencing agroecological solutions for different challenges. This metadata review, including economic, agronomy, epidemiology, and population biology journal articles, was the first step in identifying land use patterns and practices which target ecosystem services to reconcile agricultural production and biodiversity. We use this study in two ways: first we list antagonisms among solutions, i.e. landscape or farm practices that may cope with one challenge but worsen others; second, we list practices that could be combined at different spatial and temporal scales to formulate agroecological scenarios to be tested against other challenges through modeling.

Keywords: agriculture, ecology, interdisciplinary, interface, sustainability

T0599

Result-based payments as a novel pathway for more adaptive farm management - application to the silvo-pastoral system Montado

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The Montado is the silvo-pastoral system occupying more than 1M hectares in Southern Portugal, similar to the Dehesa occupying ca. 3M hectares in Spain. Despite the multiple public goods supported by the Montado, its extension has been regularly under decay since 1990. This decay is not due to the cut of the trees or the replacement by other farm systems or even urbanization, but mostly due to loss of vitality of the system, with decreasing carrying capacity and weakening of tree renewal. Assessments reveal non-adapted grazing, openings in the tree density and decline in soil fertility. Present management paradigms do not seem to support the sustainability of this system, and with it, of the resulting unique landscape. The coming Common Agricultural Policy considers the preservation of landscape and biodiversity as one of its nine main goals. It foresees a higher degree of flexibility in the national programes and tailor made solutions focused on results, not processes, benefiting farmers who go beyond the minimum required, in terms of environmental performance. In this context, result based payments are one of the possible pathways for increasing the outcome of agri-environmental payments. In this paper we focus on the process of joint construction along 2017, 2018 and 2019, by researchers, farmers and policy makers, of a set of result based payments tailored made for the Montado. The measures proposed are linked to result indicators, who need to cover all the relevant dimensions of the Montado. Farmers need to step out of their confort zone and adapt their management along the way so that the results to be valued, are obtained. We present the construction process and drawbacks of a bottom-up approach. We present the indicators proposed and their selection process. We discuss the potential and the limitations of such an approach for a sustainability transition in the management of the Montado.

Keywords: adaptive management, result-based payments, public goods, silvo pastoral, Montado

An evidence synthesis on farmland in urban green infrastructure for informed policymaking – the missing link?

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In 2013, the European Commission has adopted the Green Infrastructure (GI) Strategy. According to this strategy, GI is being understood as "a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services". This European GI strategy aims to promote GI in the main policy areas.
GI has been developed as a spatial planning and design concept in past decades for rural and urban areas. Benefits of multifunctional Urban Green Infrastructure (UGI) are manifold, contributing to human well-being in urban areas. They draw particular emphasis on major challenges of urbanization: (a) conservation of biodiversity; (b) climate change adaptation; (c) increasing social cohesion; and (d) promoting the transition to a green economy. Although, the understanding of UGI has matured in past decades the contributions of agricultural landscapes are rarely considered. Consequently, scientific evidence available for policymaking, addressing agricultural landscapes in UGI context is still fragmentary, revealing a missing link in the aims of the European GI strategy to promote GI in major policy areas. Therefore, it is important to know whether existing evidence can support policymaking in this regard, and if yes, how this can be addressed to European level policy areas. Thus, the following research questions emerge, to be issued:
- To what extent does scientific evidence support contributions of agricultural landscapes to UGI objectives?
- How can current research knowledge outcome policymaking?
This study aims to:
- develop a first synthesis of current research outcome,
- evaluate policies about current policy integration and further potentials for evidence based policymaking,
while putting emphasis on farmland as part of UGI considering major policy areas at European level.
Based on these findings we want to conclude further implications for UGI research and policymaking.

Keywords: urban green infrastructure, peri-urban agriculture, evidence based policymaking, EU level policies

T_8844

Innovation in land use policy for food sufficiency: insights from seven Mediterranean local case-studies

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Innovation in policy or governance for agricultural landscape can help to advance sustainability in food systems and food security. Furthermore, urban growth is acknowledged to be a factor affecting the capacities and opportunities of local agriculture to adequately respond to food demand (FAO, 2011). What is more, urban food demand affects the production and commercialisation behaviour of farmers (Vandercasteelen et al., 2018).
The aim of this communication is to identify which innovations in policy and governance related to metropolitan land use improve local self-sufficiency as a means of food security, and improve the regionalisation of food systems for shortening supply chains.
We will present the results of a comparative study of 7 urban regions, 4 in Europe (Avignon, Pisa, Madrid, Malta) and 3 in Africa (Tunis, Sétif and Annaba), representative of the Mediterranean land system diversity (project Divercrop, Arimnet 2, 2017-20). We developed an analytical framework in order to identify the determinants of local provision of some specific locally grown food products along the three major levels of the supply chain: agricultural production, food chain organisation and commercialisation. Investigation combines qualitative methods (fieldwork, interviews to key informants, grey literature analysis) with quantitative analysis (SIG database analysis, modelling).
We will present changes occurred the last 10 years in local food chains concerning the orientation of the local specific products towards local markets depending on the type of producer/farmer. Furthermore, we will highlight how urban growth has affected the local production of food and besides, how the urban demand affected its commercialization. To conclude, we will present the key aspects of policy and governance innovation of relevance for metropolitan land use and landscapes that have impacted the food sufficiency of local study-cases and we will discuss research perspectives for the Mediterranean regio

Keywords: food sufficiency, local food system, innovation, urban region, Mediterranean

Symposium 55

Assessing the patterns and drivers of land-use intensity change

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Land use and land-use changes are the major drivers of modification of ecosystems at different scales. Lately, we observe a shift of paradigm of monitoring and analyzing subtle and timing changes of land-use intensity (the extent and frequency of cultivation, inputs, and outputs) which is essential for an accurate assessment of land-use impacts on ecosystems. At the same time, the intensity of land use in a particular place is influenced by local site conditions, various inputs (technology, agrochemicals), and (global) market context which assesses land use intensity and its changes complex and difficult.
Another change of paradigm about the access to detailed and timing remotely-sensed satellite imagery, digital maps and statistics (e.g., yield data) opens opportunity to go beyond the standard land use assessment and to identify land-use intensity and its changes at very high temporal and spatial resolution. A combination of such datasets allows to understand the landscape complexity, vulnerability and resilience better, identify the precursors and triggers of landscape change. This may support the development of smart solutions for optimal allocation of land resources, assessment of suitable areas for intensification of production, consequences of potential upcoming shifts in technology, mapping agricultural land abandonment and recultivation of abandoned lands.
This session aims to determine the state-of-the-art of land use intensity assessment and identify research gaps by discussing the following questions:
- How can we measure the changes in land use intensity?
- How can we combine various datasets to study recent and historical land-use intensity change?
- What are the patterns of change in land use intensity?
- What are the driving factors of change in land use intensity?

T0921

Abandonment of agriculture on Russian steppe: spatial determinants and landscape configuration

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Abandonment of agriculture land was globally the most widespread land change in the 20th century and appeared widely in the post-socialistic countries, especially Russia. Abandonment is also widespread in the steppe region of southern Russia. This region is characterized by low precipitation, high evapotranspiration, organic soil layers and plays a major role in storing carbon.
In this study, we investigate the abandonment of agricultural lands on steppes (transformation of croplands to steppe) in the region of Orenburg (Russia).
Specifically, we:
- Identify the composition and spatial configuration of abandonment in the steppe region in last 40+ years
- Identify those factors that determine the process of abandonment of agricultural production on steppes
The result shows that 23% of the current steppe areas have once been used for crop production, i.e. are abandoned cropland. The post socialistic period (since 1989) had most widespread abandonment, contributing to 13% of current steppes. Abandonment in this period likely appeared on hardly accessible fields with poor precipitation and high temperature rates. Such occurrence differs from the earlier period (abandoned since 1975) and the later period (abandoned since 2000) when the abandonment appeared mostly likely on areas with poor soil quality and rough terrain prone to erosion.
While most of the abandoned areas complemented the existing steppes spatially, also many small isolated patches of abandonment appeared in the productive areas of Orenburg. Interestingly, the appearance of these isolated patches was much more determined by socioeconomic constraints (e.g., accessibility) than patches that complemented existing steppe.
Stratifying the configuration of steppe patches is important for modelling its dynamics and help to understand the reasons of abandonment that significantly differ between more productive and less productive regions.

Keywords: steppe, land change modelling, landscape metrics, agricultural abandonment

Landscape Modification, Livelihood Losses, and Socio-political Conflicts: A Geospatial Analysis of Coastal Aquaculture Practices in West Bengal, India

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Remarkable modifications of natural landscapes have occurred in the developing world through expansive spread of agriculture and aquaculture to meet the increasing demand of food. The eastern coast of India had been highly utilized for such intensive aquaculture in last two decades leading to widespread environmental degradation. Specifically, the Digha-Junput coastal tract of this region was identified as a thrust area for aqua farming by the local elites and socio-politically dominant groups due to the huge demands of crustacean resources in domestic and international markets. However, mushrooming of these shrimp monoculture farms had resulted into the problems of hyper salinization, habitat destruction, biodiversity losses, and socio-political conflicts among sharecroppers and farm owners. This study attempted to analyze the growth patterns of aquaculture and its resultant impact on other regional land uses through integration of landscape matrices derived from geospatial techniques and participatory appraisals. Secondly, the transforming spatial zonation of these farms with respect to their types, relative locations and extents were also assessed from the coast to inland using multispectral Landsat and Sentinel data from 1988 to 2018. Results showed that the growth of brackish water farms had intensified only during the last decade and were primarily concentrated in the near-coast areas through conversion of erstwhile farmlands and wetlands. Conversely, freshwater farms were found to be spread across the region surrounding human settlements. Notable destruction of habitats of native biota was also detected near the shrimp farms. Gradual diminution of former diversified livelihood options in the wake of this monoculture was identified as one of the major causes of slackening regional social fabric. Accordingly, several mitigating measures had been recommended towards reintroduction of sustainable agroecosystem practices in this highly humanized landscape.

Keywords: Coastal aquaculture, Ecological footprints, Land use conversion, Landscape matrix, Shrimp farming

Land system intensity change and their drivers in Mediterranean agricultural landscapes: a case study of the Vaucluse department (France)

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Mediterranean land systems are undergoing significant changes in terms of agricultural land use and its intensity. These dynamics caused in some cases environmental impact and they can affect ecosystem services fulfilment. In this work, we aim to implement a land system approach, combining land use and its management through various indicators in order to identify trajectories of land system intensity and their drivers, to propose possible future evolution and alternative scenarios. First, we classified existing land system in the study area, exploiting the agricultural census data of the two years 2000 and 2010 at farm level. Then, we assessed the recent land system trajectories, identifying areas where different change processes took place, like intensification, extensification or specialization of agricultural system. Finally, we tested a series of geographical socio-economical, topographic and planning drivers in order to understand the driving factors affecting spatial distribution of land system intensity change. We applied the methodology on the Vaucluse department (France), which is a typical Mediterranean region characterized by a strong presence of perennial crops, such as vineyards and orchards (currently around 60% of the total UAA) associated with vegetables and cereals. The results show a relevant increase on AOP vineyards and the decrease of the less specialized and rentable land systems, such as cereal cultivation and table grapes usually cultivated on the mountain areas, which progressively reduce their surface and also a decrease on fruit groves and horticulture based land systems. We classified all the assessed trajectories on three main groups: specialization, intensification and extensification and we spatialized them on the case study obtaining the distribution patterns. Moreover, we tested some possible driving factors for each type of dynamics in order to understand the process underlining the assessed dynamics.

Keywords: Mediterranean land systems, agricultural landscapes, intensification , agricultural census, trajectories

Exposure to human influence – an alternative spatial variable for land use change modelling

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Numerous studies have been focused on land use change modelling in the past two decades, most of them using spatial variables as model predictors. Close attention has been paid to the improvements of the models, concerning mostly the mathematical and statistical methodology. By contrast, relatively little effort has been put in the improvement of the spatial variables entering the models. We focus on the quantitative variables representing human activity. Most of them are routinely spatially represented as a distance to a source of human influence (settlements, roads, ports, etc.) or as a quantity per area of an administrative unit (e.g. population density). These approaches impose some limitations: distance does not reflect the quantity of human influence nor the terrain barriers; spatial resolution of density is determined by size and shape of the administrative units, therefore, it is usually coarse and biased. To overcome these limitations, we created a new spatial variable - exposure to human influence. This variable combines cost distance with population size; however, any other quantitative measure can be used. The exposure calculation algorithm simulates the dilution of human activity from settlements to landscape: exposure to a settlement is directly proportional to its population size and inversely proportional to the cost distance from the settlement. Cost distance uses the sine of slope angle as a cost raster to simulate the barrier effect of terrain. The overall exposure to human influence summates exposures to all individual settlements in a region. To demonstrate the improvements, we applied regression models to compare the prediction power of various types of density and distance variables with the prediction power of exposure. Significant improvements were observed. Based on these results and on the versatility of this concept we believe that the use of the exposure variable may be effective in many land cover change studies.

Keywords: land use change modelling, LUCC driving forces, cost distance, barrier effect, human influence extrapolation

T0637

Past and present: 60 years of land use dynamics in south-central Chile.

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The central zone of Chile, one of the 34 hotspots of global biodiversity due to the endemism of its biota and its anthropogenic impact, has undergone a process of changes in the landscape that have been very intensive for more than 300 years, and this has accelerated in the last 50 years. The main economic activities that have transformed this area have been agriculture since the seventeenth century and the forest industry that in the last century was consolidated since the seventies. The Constitución county in the Maule region has been one of the areas with the most significant landscape transformation due to exotic forest plantations, being one of the first areas of Chile where the forestry industry begins. This county has undergone a transformation of the landscape that can be used as a model to characterize the changes in the landscape experienced by Chile. This research seeks to describe the dynamics of land use and the process of replacing native forest, in addition to the loss of habitat as an ecosystem service provider. The method for obtaining the land use was by means of aerial photographs and satellite images and then processed in the IDRISI Terra-Set software, for the provision of ecosystem services, the Invest software was used. The research shows that the area covered with natural vegetation was significant in 1955 (67% Forests and Shrubs), contrary to historically maintained. Also, the rate of afforestation intensified significantly, going from 24% between 1955-1978 and 78% in the period 1978-2014. In addition, the provision of the ecosystem service of habitat quality has decreased significantly from 61,406 (ha) in 1955 to 2,537 (ha) in 2014 for high habitat quality. These results gave an account of the impact of forest plantations on the coverage of natural vegetation in Chile, which indicates the importance of moving towards a new forest model based on sustainability standards.

Keywords: Biodiversity, native forest, ecosystem service

T0944

Understanding the effect of historic mega-fires on the structure and functions of Patagonian landscape of Chilean

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In Western Patagonia (Aysén Region, 43°-48°S), the most extensive and intense forest fires (around 3,000,000 ha) were recorded in Chile within 1930 to 1950. These forests fires were caused by pioneer settlers, who opened the forests to create pasturelands for livestock and urban settlements. Although more than a half of a century since those fires, some forests have not been recovered. Despite the ecological (a hotspot of biodiversity) and economic importance (large biomass and tourism activities) of these temperate forest ecosystems, these have not been studied at the landscape level. For this reason, the goal of this work was to study the effect of forest fires on the landscape structure and functions in the western Chilean Patagonia, over last three decades (1984-2018). The Province of Coyhaique, Aysén Region (44° - 46° S) was selected as the study area, because it is a zone highly transformed by fires. Landsat satellite images were used to generate land cover and land use maps. To understand the landscape structure was selected the following commonly used metrics at landscape and class levels: Number of Patches, Mean Patch Area, Largest Patch Index, and Proximity Index. The landscape functions were evaluated through of a set ecosystem services: carbon storage, temperature regulation and water supply. The results show that after mega-fires have caused the destruction of more than 400,000 ha of undisturbed forests in the Coyhaique province (30% of the province). Despite the great losses of native forests, I found that the landscape showed a recovery over the last 34 years. However, the old-growth forests losses have been estimated in 45.000 ha. Furthermore, the fragmentation of native forests has increased since 1984. Finally, the greatest net change over the period studied was the trajectory from “arborescent shrubland” to “secondary growth forests”. However, the ecosystems services of the new regenerated forests have not shown the same functioning of the old-gro

Keywords: forest fires, dynamic landscape, spatial patterns, Patagonian, old-growth forest

T0617

Evaluating land use changes and land use planning within and around national parks – case studies from Poland

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Protected areas (PAs) are cornerstones of biodiversity conservation, but they are in danger of becoming isolated islands in human-dominated landscapes. It is thought to be related to landscape changes, especially to Land Use-Cover Changes (LUCCs). Land use changes in the vicinity of PAs may have a significant impact on their ecological functioning and biodiversity, and may cause landscape fragmentation and isolation. Despite the increasing number of studies, this issue is still not fully understood. In this research, the LUCCs between 1950 and 2015 for three selected National Parks (NPs) from different parts of Poland were analyzed. Also, future land use changes based on the analysis of spatial planning documents were evaluated. Land cover data were obtained from various databases (topographic maps, aerial photos, National Database of Topographic Objects, Land and Property Register, local planning documents). The analyses were carried out in zones of varying scope and level of protection: park area, park buffer zone, concentric ring buffers around the borders of the park, and the area outside the buffer zone and NPs, so the LUCCs in the park and in the buffer zone were assessed compared to the area not covered by any legal protection. The results have indicated an increase of land abandonment area and forest cover, as well as the intensification of human settlements around NPs border. The analysis of land use planning documents has shown the increased development pressure around NPs, which increases human activity along the edges of protected areas and thus threats their ecological integrity. The results broadens our knowledge about natural processes and human activities in areas surrounding NPs, and allow us to identify the main driving factors of LUCCs. The identification and understanding of the past, current and future LUCCs, particularly the quantification of human impact on landscape, may be a key to the effective management and monitoring of PAs.

Keywords: land use change, landscape fragmentation, spatial planning, nature conservation, national parks

P0218

Combining models with socio-ecological studies for understanding the future of agricultural landscapes in Central Europe, and options for NBS implementations.

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Agricultural lands in Poland, as well as in many other Eastern and Central European countries, have served for decades as refuges of biodiversity, simultaneously preserving numerous supporting and regulatory ecosystem services. This has been a consequence of the land use structure favouring diversified mosaic of cultivations, rooted in local tradition and empowered by market-dismantled socialist economy.
Over ten years after Poland's accession to European Union, we run a study on nutrient leakage from diverse, agricultural landscape of the Pilica River basin (Central Poland). The aim was to identify hot-spots in rural landscape to set nature-based solutions able to protect water from the impact of agriculture. The study was carried under Life+ project EKOROB and became exemplary use of SWAT model for assessment of pressures for WFD in Poland. The outcomes of the model have been confronted with results of extensive socio-ecological study carried among the farmers. The aim of the study was to understand their attitudes towards traditional landscape elements and their decisions over future land use practices, as well as forecasting impact on provision of ecohydrological regulatory services. The scenarios of catchment development have been outlined, based on a set of social, economic and ecological tradeoffs, and the key conditions for each of them to happen were defined.

Keywords: socio-economic transition, nature-based solutions, landscape changes, people attitudes, nutrient regulation

Drivers and effects of long term land use and landscape changes in the Sudety Mountains, SW Poland

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The paper presents diverse landscape changes in the Sudety Mountains resulting from two opposing trends: a long lasting depopulation and a recent revival of human activities. The depopulation was triggered by various political, socio-economic and environmental factors. Especially the shift of state borders after the World War II increased depopulation and land abandonment. In contrary, the political and socio-economic changes in Poland after 1989, and especially joining the European Union in 2004, have resulted in new trends in land use changes, especially the restoration of some of the previously abandoned agricultural areas and the increase in new buildings, mainly for tourist and recreational purposes.

These opposing trends impacted changes in landscape pattern, with areas which either ecologically benefit or suffer from the transformations. The most noteworthy landscape changes include the transition of arable lands into grasslands and forests and the conversion of grasslands into forests. While the proportion of settlement areas remained the same, the substantial qualitative changes affected this category and its spatial distribution. Secondary succession on abandoned lands resulted in an increase of landscape diversity, increase of patch boundary complexity, and decrease of landscape fragmentation.

To assess the type, extent and spatio-temporal changes in land use trajectories, and to identify drivers of changes, we combined various methods: comparative studies of cartographic sources, census data from different time periods, GIS analysis, Gi Getis-Ord local statistics, GWR modelling. The land-use statistics and landscape metrics were applied to identify the ecological effects of land use changes and their impact on the landscape pattern. These transformations are linked to diverse political, economic, demographic and natural driving forces. It allows to create a model of changes of the socio-ecological system in the European mid-mountains.

Keywords: landscape change, land abandonment, depopulation, landscape metrics, second homes

Conserving Fragmented Mangroves in an Intensely Populated Landscape: A Multi-temporal Analysis of Forest Cover Changes in Coastal Odisha, India

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The coastal stretch of Odisha, India has remained under constant threat due to rampant exploitation of its forests over the last century, making the region more susceptible to environmental hazards. As a mitigating measure, coastal plantations had been raised here under the Integrated Coastal Zone Management programme. This study emphasized on the reverberations of such plantation initiatives implemented in this region during the last few decades by integrating multi-temporal remotely sensed data and community appraisals. It also aimed at assessing the sustenance level of these efforts to bring to fruition the grails of environmental conservation and livelihood generation for the economically marginalized coastal populace. Results highlighted the perilous effects of the incessant removal of healthy mangrove patches and Pandanus tectorius stands along the back shore areas and riverbanks in the form of enhanced erosion throughout the 1990s. However, the condition ameliorated in the last decade due to the subsequent restoration efforts of Joint Forest Management and Social Forestry programmes which led to expansion of both Casuarina and mangrove plantations. Moreover, stringent measures were enforced to curb shrimp mono culture. In spite of these sporadic successes, the region still showcased alarmingly poor forest structure and species diversity. Based on the findings, identification of suitable species-specific plantation sites, bio-stabilization of relict sand dunes, controlled grazing, enhanced community emancipation and conflict resolution among stakeholder groups were suggested as the imperious measures for sustainable ecological restoration of this environmentally vulnerable region.

Keywords: Afforestation, Coastal erosion, Community forestry, Degraded mangroves, Shrimp aquaculture

Modeling agricultural land-use intensity: understanding driving forces by validating future scenarios

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Changes in agricultural intensity—driven by social, political, economic, and environmental factors—affect the provision of various ecosystem goods and services for society. However, the rationales for land use change decisions remain often intangible. As local actors decide about land use and land use change, capturing land use decisions in a model could thus help support decision-making in land use management.
To make driving forces more tangible, we used a participatory modeling approach that is based on the determination of land use drivers. These drivers were used to construct an expert based Bayesian network. The network and its output (future land use maps) were used to analyze land-use change drivers. The main agricultural land use categories were intensively an extensively used farmland, alpine meadows and pastures, intensively and extensively used farmland, vegetable gardening, orchards, viticulture and abandonment.
As a next step, the future land-use maps were validated asking farmers to judge about developments of parcels and again, asking for their rationale when agreeing or declining to the presented future change. Results show that farmers triggered with the outputs of the land-use decision model were very well able to rationalize land-use change. Furthermore, we found that by applying a second round of farmer consultation (showing the future land-use maps), statements regarding the land use drivers gained in precision.
We discuss how such participatory methods may support data-driven approaches for determining land-use intensity change.

Keywords: Participatory modeling, Land use change, Agriculture, Scenarios, Validating drivers

T0698

Land use intensity as a driving factor of semi-natural grassland management in relation to habitat type and rarity in Latvia (Eastern Baltic)

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Decline of semi-natural grasslands in Eastern Europe is directly linked to the changes in land use intensity and agricultural potential of landscape. Still, the Eastern European landscapes generally have lower average levels of land use intensity thus ensuring large areas of permanent grasslands, which are close to semi-natural condition. Most studies have focused on semi-natural habitats as a homogeneous group assuming similar response of habitat types to changes in land use intensity, which is governed by implementation of different agricultural policies. Our intention was to clarify if there are differences in responses to agri-environmental policies among habitat types in relation to rarity, land use intensity and agriculture potential. We used eight habitat types with different rarity levels. The analysis was conducted in a landscape scale with a study unit of 5 km × 5 km square grid cells. Data on habitat area and distribution were obtained from national level georeferenced EU grassland habitat maps owned by the Nature Conservation Agency. Land use data were obtained from the spatial data of Integrated Administration and Control System from Rural Support Service. We used spatial regression methodology that incorporates spatial autocorrelation into models. Agriculture potential was an important factor determining the distribution of common but not rare habitats. Rarity appeared to be a driving factor for management decisions but with different outcomes for common and rare habitats. Our findings highlight the need for regional approach to agri-environment schemes designation to maximise the uptake and thus conservation of rare grassland habitats.
The study was supported by the Latvian Council of Science Grant No.514/2013 and University of Latvia grant Nr. AAp2016/B041//Zd2016/AZ03.

Keywords: agriculture potential, semi-natural grassland, drivers of management decisions

P0207

Assessing landscape perception differences of agricultural landscapes using Google Street View and panoramic photographs

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There have been multiple methods developed for analysing landscape changes, but few studies have investigated the differences between spatial data and what is really visible to the observer. While viewing the landscape from various distances and locations one can differently perceive the same scenery. We have obtained 30 full 360° panoramic Google Street View images (GSV) of agricultural landscapes, characteristic for Wigry National Park, Poland. The images were obtained for randomly selected points accessible to visitors – along main communication routes but also where the visibility range (open spaces) from the point is at least 500m. Separately panoramic photographs (PAN) were taken inside the corresponding open spaces from locations also accessible to visitors but off the public roads, to assess the differences in perception depending on the viewing position. We used digital elevation model and panoramic photographs to spatially identify the areas visible to the viewer for each image and compared to the real vegetation maps for years 2015 and 1990. The average naturalness of the view in each of the GSV, was 3.8, while when viewed from the interior it was 4.5. Natural plant communities, contributing to high value of a landscape, were two times less visible when viewed from a road then if observed from an interior. Semi-natural vegetation, mainly meadows was 8x more seen in GSV than the observations from the road indicate, while if using PANs only 2x when compared to the real visibility. Anthropogenic plant communities dispersed across the landscape are better visible in the PANs from the interiors than in reality, but even more so when using GSV, even up 2.7x. During the 25 years the intense changes have occurred in the landscape and the size of natural and semi-natural plant communities dropped by approximately 30%. The loss will be modulated by perception and possible loss of the attractiveness of the area, which should be taken into account in management.

Keywords: landscape analysis, visibility, attractiveness, green ratio, recreation

P0162

Ecological Transformation in Institutional Landscapes: from Savannah Grassland to Urban Forest Ecosystem at JKUAT, Kenya

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Human activities alter natural landscapes resulting in either negative or positive ecological transformations. Jomo Kenyatta University of Agriculture and Technology (JKUAT), Kenya, has experienced exponential growth from an initial student population of 455 in 1978 to 20,000 today, at main campus. Consequently, there has been expansion in building and transport infrastructure accompanied with an urban forest ecosystem. However, during the 40-year transformation, there has been no assessment of the effect of human activities on the distribution of plants and animals in the institution's 200 hectare land. The study aimed at determining land use planning factors that have influenced the distribution of plant and animal habitats from 1978–2018. Aerial photographs were analyzed; construction reports and magazines reviewed; field measurements and counts were done; and interviews on people with historical knowledge were conducted. The study found that despite the general increase in both plant and animal biodiversity, native plant and animal species have reduced in numbers or disappeared. Some of the 10 native plant species are now only found in small Savannah grassland remnants covering less than 15% of the original land area. By 2018, 'sealed' surface cover was 4.2% of total area and showed a positive relationship with 247 introduced plant species. New plant species such as Cassia spectabilis have continuously died out indicating some ecological mismatch in their horticultural requirements. Data on 3-D metrics showed that areas with high building volumes positively related to plant diversity but negatively related to bird diversity. This type of assessment may be used as input for future scenarios, planning and growth in institutional landscapes so that human activities are balanced with the requirements for ecological optimization of benefits of original and introduced plant and animal species.

Keywords: institutional landscapes, ecological transformation, biodiversity, human activities, 3-D landscape metrics

Land cover patterns of wind generation infrastructure in Brazil

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Latest studies estimate land use intensity of wind-powered electricity around 0.3–1.3 m2 MWh-1. This is notably lower compared to biomass-powered electricity, which land use intensity is estimated around 450-800 m2 MWh-1. The significant contribution of biomass energy to land-use change, particularly in countries like Brazil, is widely known. In contrary, low land use intensity of wind-powered electricity suggests that contribution of its infrastructure to land-use change is minor. However, some studies point out the potential restriction of land use for human settlements, negative impact on biodiversity and occurring land conflicts due to wind-powered electricity infrastructure. Better knowledge of wind-powered electricity infrastructure impact on land use change require investigation of related land cover patterns. For discovering those patterns, we focus on two major questions:

- What land cover is favorable for VRES infrastructure deployment?
- What land-use changes follow the VRES infrastructure deployment?

Our case study focuses on wind parks deployed during past 25 years in Brazil. For spatiotemporal analysis of land cover patterns in Brazil, we combine annual land-use and land cover time series – available from 1985 to 2017 – with locations of wind generation infrastructure, transmission grids and transportation network. Land cover patterns related to wind parks deployment will improve our understanding of its role in current land use change, and allow the assessment of future land use change in case of extensive wind parks deployment.

Keywords: land cover patterns, wind parks, Brazil, land-use intensity, infrastructure deployment

The effect of external drivers on tipping-points in agricultural land-use intensity

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Changes in agricultural land-use intensity in social-ecological systems (SESs) can be caused by changes in external drivers, such as agricultural direct payments, prices for agricultural produce or climate. However, due to complex interactions in SESs, it is often challenging to predict how these drivers will influence the amount of intensive or extensive agriculture. However, such predictions can be made if one knows the equilibrium states of intensive and extensive agriculture in a SES. If the system is in equilibrium, the state of the system is constant over time (all things being equal), whereas in non-equilibrium conditions the direction of growth is either towards (i.e. stable equilibrium) or away from (i.e. unstable equilibrium) the equilibrium. Thus, by identifying equilibrium states for different values of a driver, it is possible to determine at what threshold value the SES will switch from an increase in extensive or intensive agriculture to a decrease, or vice versa (i.e. tipping-points). In this study, we identified stable and unstable equilibria in intensive and extensive agriculture in an alpine mountain region in the Canton of Valais, Switzerland. Land-use change in this SES was simulated with an agent-based, empirically derived land-use model. We tested the sensitivity of the equilibria to the above external drivers. The equilibrium states were strongly influenced by all the drivers and we were able to identify some clear tipping-points beyond which the direction of land-use intensity change would shift. We also found that a minimum amount of direct payments was necessary for agricultural extensification to take place. The developed approach is generic and provides valuable knowledge of the drivers of agricultural land-use intensity change in our SES.

Keywords: land-use change, social-ecological system, resilience, agricultural extensification, agent-based model

T0124

Land use decision making as a driver of land use intensity

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Human decision making is the key process leading to changes in land use and the intensity of land management. Land use decision making is a function of the ability and the motivation of individual actors in a specific socio-economic, biophysical and institutional context. By performing a systematic review of the land use literature we have collected a large set of case-studies that describe the key processes of land use decision making leading to alternative land use outcomes and land management intensification strategies. Results indicate decision making objectives ranging from subsistence/survival objectives to income maximization and lifestyle expression. The spatial occurrence of these alternative modes of land use decision making was related to contextual variables. Clear patterns emerged and differences in decision making could, to some extent, be explained by the contextual factors. A range of variables including landscape context, socio-economic status and institutional environment allowed us to extrapolate beyond the case study and provide a global map of the likely occurrence of alternative decision making mechanisms. Such not only increases our understanding of the motivations of alternative land use decisions but also a refinement of land use models acknowledging heterogeneity in land use decisions.

Keywords: land use intensity, human decision making, socio-ecological systems

T0267

Land use change scenarios in marginal mosaic-type landscapes and their impact on ecosystem services.

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Land use change in agriculturally marginal mosaic-type landscapes is a complex process with interlinked economic, environmental and social aspects and is often associated with social and economic problems in rural areas. Previous studies (Vinogradovs et al., 2018) have revealed drivers of farmland abandonment – solely dominant land use change in agriculturally marginal locations and have assessed ecosystem service supply potential in agro-ecosystems (Villoslada et al., 2018). Farmland abandonment leads to homogenization and polarization of landscape pattern and subsequent loss of mosaic-type landscapes, that are highly dependent on low-input agricultural practices. This process has been associated with both loss of biodiversity and change in ecosystem service supply variety. Presented research will be based on case study area in the western part of Vidzeme Uplands, Latvia, where 3 explanatory scenarios are developed – a) "business as usual" scenario where land use change is predicted based on assessed driving forces; b) "no subsidies" scenario and c) "payments for ecosystem services" where supply of wide range of services would provide subsidiary benefits for low-input agricultural practices. The story lines of scenarios "b" and "c" are based on the results of questionnaires conducted among land owners in study area. All land use change in proposed scenarios are supported by exploratory analysis of changes in ecosystem services supply potential, revealing cold/hot spots as well trade-offs and synergies among ecosystem services, thus providing additional criteria for decision support both in agricultural policy and spatial planning sectors.

Keywords: land-use change scenarios, farmland abandonment, ecosystem services

P0102

A mixed-methods approach to historical-ecological analysis of pre-Soviet, Soviet and post-Soviet steppe landscape transformations. A case study from southern Ukraine

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We present an integrated approach to long-term historical-ecological investigations on steppe landscapes and farming systems, based on an example from Beryslav District, Southern Ukraine. There are efforts to approach landscape transformations in Eastern Europe with large datasets of remote sensing data. In contrast, our methodological contribution makes use of mixed-methods – including qualitative, quantitative, and spatial data – on pre-Soviet, Soviet, and post-Soviet land transformations (from mostly steppe to mostly cultivated). We aim to situate the most recent post-Soviet transformation in a long-term environmental-historical perspective. We combine: (i) historical and contemporary land cover patterns derived from geo-referenced maps and aerial data, (ii) time-series crop yield and rotation data based on archival research, (iii) community level focus group interviews on landscape memories, and (iv) phytodiversity sampling. We seek to understand the interplay between processes driving landscape transformations, including impacts on steppe biodiversity. We highlight the importance of identification and interpretation of cultural patterns in such a way that the perspective of local people is not lost. We discuss a variety of sources used, and evaluate our approach in terms of the benefits and limitations of the procedure proposed.

Keywords: land use change, steppe, agricultural landscapes, Eastern Europe

P0194

Identifying drivers of agricultural marginality through remote sensing and statistical analysis

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Agroecosystems have been always considered primarily as sources of provisioning ecosystem services (ES), such as food, forage, fibre, bioenergy. Land-use intensity in agricultural lands is influenced by local conditions. The monitoring of its timing changes can support the identification of cultivation patterns and changes of the related land-use intensity, e.g. for the identification of agricultural abandonment or marginality leading to a decrease of providing ES, including feedstock provision.
Agricultural land marginality is a complex phenomenon depending upon different elements (e.g. biophysical, agronomic and economic factors). Due to such complexity, it is very difficult to objectively measure with some yardstick the degree of marginality. The relatively-recent open access to detailed and timing remotely-sensed satellite imagery gives new opportunities to identify and monitor land-use intensity and its temporal and spatial changes for the identification of agricultural marginality.
The scope of this study is to identify marginal agricultural lands (in terms of land-use intensity of food crops) through remote sensing data, and to analyse potential influencing factors for spatial marginality, related to different socio-economic, biophysical, and landscape metrics indicators.
The method is applied for the Province of Rovigo, located in Northern Italy. Using a GIS-based environmental modelling, after the identification of marginal agricultural lands through the analysis of multi-temporal remote sensing data, their spatial distribution is statistically analysed in relation to a set of indicators identified from different sources. Results are discussed in relation to potential emerging drivers/factors which may led to the condition of marginality, in order to understand what are the potential socio-economics and biophysical local drivers that influence the land-use intensity change in food cultivation.

Keywords: marginal agricultural lands, remote sensing , land-use intensity, food production

Symposium 56

Biodiversity spillover in fragmented landscapes and effects on ecosystem services provision and regulation

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Summary: The cross-habitat spillover - which encompass the exchange of organisms or materials between different habitat types, including both dispersal and foraging movements - is an important biological process in anthropogenic landscapes. This ecological process may proceed in both directions, from native habitat to managed matrix, or from managed matrix to native habitat. Spillover from areas of native habitat into managed matrix is expected to be common, as native vegetation often acts as a source of individuals that can disperse into recipient managed systems and it is often associated to ES provision. Both inter-habitat matrix and landscape configuration can influence spillover by controlling organismal ability to disperse, and affecting the provision of additional or supplementary resources that impact organism survival. The organismal cross-habitat spillover is often associated to positive impacts on different ES - such as pollination and pest control- given that both depend on biological fluxes connecting source areas (supply areas) and demand areas (where the service is provided). For example, the spillover of natural enemies (such as ants and birds) into coffee plantations is often associated to positive impacts on coffee-borer beetle control. Moreover, the presence of native habitat remnants along crop fields is also associated to increased spillover of pollinators and to substantial increase on pollination rates. However, the organismal spillover may also have negative impacts once it can be considered as an event in which a pathogen from one species moves into another species. Such movements can result in different devastating diseases outbreaks. For disease regulation, some studies have demonstrating that a patchy pattern of forest fragments embedded in an agricultural matrix is often associated to an increased incidence of some diseases, given that the majority of emerging infectious diseases for humans are zoonotic—originating especially from wildlife reservoirs. For Hantavirus, for example, the type of crop that surrounds forest fragments and the amount of remaining habitat in a landscape are determining factors predicting the chance of spillover to humans. For yellow fever, apparently, large amounts of edge forests combined with agricultural areas constitute a positive risk for disease emergence. Thus, identifying the key aspects of a landscape to manage in order to promote organismal movement and positive effects on ES might be a win-win strategy aiming both biodiversity conservation and ES provision and regulation. Goals and objectives: In this symposium, we will bring together speakers using a range of methods, focusing on diverse set of taxa and ecosystem services from different parts of the tropics to increase the knowledge of: (a) how landscape structure affects organismal spillover and ES provisioning and regulation; (b) how different ES are affected by organismal spillover; (c) how can we manage landscapes in order to obtain maximized spillover and ES provision and regulation?

P0224

Risk evaluation for Brazilian Spotted Fever occurrence in the Metropolitan Region of São Paulo.

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The Brazilian Spotted Fever (BSF) is a zoonotic disease caused by the bacterium Rickettsia rickettsii. In the São Paulo Metropolitan Region (SPMR), within Atlantic Rain Forest Biome, it is transmitted by Amblyomma aureolatum ticks and the lethality of the disease can reach 80%. Ticks of this species perform their cycle within the forest and in degraded areas domestic dogs can help to maintain the disease cycle by transferring infected ticks from the forest to the anthropic environment. This study aimed to analyze the risk of occurrence of BSF. For this, a multivariate analysis comparing landscape data, such as forest patch sizes and perimeters was performed in comparison whit seroprevalence in dogs, as well as the presence of vectors determined by niche analysis for the occurrence of Amblyomma aureolatum. Nine areas with different environmental patterns were selected for the study. A single blood sample was collected in thirty dogs per study area, in a total of 270 dogs sampled. All samples were submitted to an indirect immunofluorescence serological test to determine the antibodies titers against R. rickettsii. The seroprevalence ranged from 0 to 37%, and when compared to the environmental data and presence of A. aureolatum, it was possible to classify the areas into 4 risk groups (very low, low, medium and high). The results suggest that there is a relationship between the seroprevalence of R. rickettsii infection in dogs and the landscape profile of each region, especially small forest remained area and larger forest fragmentation, but not to the presence of ticks, since all nine areas were suitable to have niches compatible to presence of tick populations. This outcome shows that the Atlantic Rain Forest degradation and fragmentation is more likely to be associated to BSF human cases than the presence of tick vectors itself.

Keywords: Brazilian Spotted Fever, Amblyomma aureolatum, Rickettsia rickettsii, Rain Forest Fragmentation, dogs

P0222

Landscape structure effects on the interaction of ants and birds as providers of pest control in coffee farms

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Agricultural expansion has lead to native habitat loss and fragmentation. In Brazil, more than 2 million hectares of Atlantic Forest has been converted into coffee crops. Land-use change can disrupt the distribution and movement of species and threaten the community integrity of an ecosystem and the services they provide. In coffee farms, biological control of the primary economic pest, the coffee borer beetle (CBB), is an ecosystem service regulated by the interactions of mobile natural enemies and the native forest remnants surrounding crops. Ants and birds each benefit coffee production by predating on CBB. However, community dynamics between natural enemies may lead to trade-offs and synergies in the supply of pest control services. Our study aimed to test the effects of landscape structure on the interaction of two pest control services. We focused on CBB control by two of its main natural enemies: ants and birds. We performed exclusion experiments of ants and birds over a coffee production season in Brazil in farms with differences in landscape structure. The double-exclusion experiments allowed us to test the ability of ants alone, birds alone, the landscape, and their interaction (synergy vs. trade-offs) to regulate CBB. We also measured the community composition of ants and birds inside forest remnants around coffee crops and inside the matrix to test for cross-habitat spillover effects from native habitats to the coffee crops. Preliminary results show that both ants and birds suppress CBB populations. However, there seems to be a trade-off between higher forest cover benefiting bird community composition, and reducing ant's pest control services, probably because of bird predation pressures on ants. Better understanding the interaction of pest control services by multiple species and the landscape structure can, therefore, benefit coffee production and optimize agricultural landscape management for biodiversity conservation.

Keywords: coffea arabica, ecosystem services, conservation, community composition, spillover effects

T0619

Landscape structure as driver of avian-cross habitat spillover into agricultural matrices

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Natural habitats adjacent to agricultural areas are often considered sources of species that provide beneficial regulating ecosystem services through cross-habitat spillover. We tested the effects of landscape structure (forest cover amount, edge density, and matrix type) on avian-cross habitat spillover and resource use within agricultural landscapes in the Brazilian Atlantic forest. Field data were collected combining two methodologies: point counts across forest-matrix interfaces (paired sampling sites) in two evaluated agricultural matrices: coffee plantations (N = 40) and pastures (N = 52) and mist netting (sampling sites at forest-pasture interfaces; N = 51) for isotope analysis, in order to determine feeding sources' origin. We found that matrix type was a key factor influencing avian cross-habitat spillover, facilitating species movement into coffee plantations and acting as a barrier to spillover into pastures. Twenty-four percent of the forest-dependent species pool was capable of spillover into coffee plantations, and edge density had an additive effect with forest cover influencing avian spillover into plantations. Spillover of forest-dependent species was nearly non-existent into cattle pastures. The majority of species moving across edges into pastures were habitat generalists (63% of individuals). Even though pastures are very drastic environments for forest-dwelling species, both generalists and open-area associated species were capable of obtain a substantial proportion of its feeding resources within pastures (~ 60% and 88% of feeding sources respectively) - which make them effective ecosystem service providers in terms of pest control in pasture lands. Conservation actions that maintain forest patches adjacent to agricultural fields and manage the matrix in order to provide avian food resources, and facilitate dispersal may help to maintain both avian conservation and ecosystem services provisioning in agricultural landscapes.

Keywords: forest cover, matrix type, pest control, ecosystem services, birds

Complimentary spillover of tropical forest bees into surrounding open areas varies according to landscape context

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Bees are essential pollinators of native plant populations and crops. In the tropics, conserving bees and their pollination services directly depends on having closeby forested environments. However, spillover to open areas can occur. We analysed bee diversity in Brazilian Atlantic Forest patches and adjacent open areas within a gradient of surrounding forest cover and landscape heterogeneity to evaluate in which context bees may leave the forest to use complementary environments in heterogeneous landscapes. Our hypothesis was that bee communities would be richer and more diverse in highly forested heterogeneous landscapes when compared to areas dominated by human-made environments, but due to supplementary foraging behaviors, they would be more abundant in flower rich open areas. We sampled bees visiting flowers within Atlantic Forest patches and in surrounding open areas. We found both higher bee richness and diversity in open areas surrounded by high amount of forest than in any other context. This result is linked to a spillover effect of forest bees, which need the understory to nest but forage for complementary resources in nearby open areas with abundant flower availability. In homogeneous landscapes dominated by human-made environments, forests were too far apart, reducing overall bee diversity and richness. In regions with pressing human development and increasing agriculture needing pollination services, highly heterogeneous landscapes with enough forest cover can provide more high quality resources for bees than homogeneous croplands. The presence of forest patches interspersed by varied resourceful open areas and crops is thus critical to maintaining bee diversity in the landscape, aiding to conserve their numbers and consequent pollination services. Land management strategies to provide pollination services in tropical landscapes should seek to implement complex landscapes with alternating native and non-native environments within bees foraging ranges.

Keywords: Pollination, Landscape complementation, Brazilian Atlantic Forest, Environmental heterogeneity, Context dependent ecossystem services

Stepping into the forest: the potential for cross-habitat spillover of an emerging anthrax pathogen in West Africa

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Bacillus cereus biovar anthracis (Bcbva) is an emergent pathogen causing anthrax in West and Central African countries. Bcbva shares multiple bacteriological and genomic characteristics with Bacillus anthracis, the gram-positive bacterium responsible for anthrax in mammals worldwide. Apparent differences exist in the known distributions of Bcbva and B. anthracis in sub-Saharan Africa, with B. anthracis exhibiting a widespread distribution across dry, savanna habitats, while Bcbva has only been isolated in tropical humid forested environments. Here, we characterize the potential distribution of Bcbva and B. anthracis in sub-Saharan Africa using an ecological niche modeling framework. Additionally, we quantify environments associated with predicted distributions of each pathogen to identify possible niche differences. Our results suggest significant differences between the realized ecological niches of each pathogen, most apparent when comparing humidity and soils values. Although our Bcbva models are limited due to sample size, this exploration informs on areas that would likely be considered for further investigation of Bcbva outbreaks, with special emphasis on areas in ecological transition zones from forest to savanna, where organismal cross-habitat spillover may be prevalent, particularly as humans continue to transform native forest habitats into managed landscapes.

Keywords: co-habitat spillover, ecological gradients, emerging pathogens

T0110

A landscape perspective to optimize coffee yields through forest cover management at regional scales

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Enhancing biodiversity based ecosystem services, through ecological intensification, can generate win-win opportunities for conservation and agricultural production. Pollination and pest control are mostly provided by mobile organisms, some of which depend or benefit from green infrastructure in the local landscape. However species loss and conservation initiatives occur at larger scale, thus the need to test if the links between landscape and ecosystem service can be upscale for larger regions. We used data from 611 coffee municipalities embedded in the Atlantic Forest regions to test if landscape structure (e.g. forest, coffee amount and configuration) affects coffee productivity. Moreover, we also considered the contribution socio-environmental dimension like crop management, climatic conditions and soil characteristics, which are known to affect crop productivity. Landscape variables were more important at predicting coffee yields than socio-environmental variables. Together forest cover, coffee area and the coffee species explained 64% of the variation found in coffee yields. As expected, forest cover positively affects effect coffee productivity, the effects was stronger on Coffea canephora productivity than compared to Coffea arabica, which has lower dependence on pollinators. Highest yields were obtained at intermediate to high forest cover (> 20%) in the surrounding landscape (2 km radius), which are associated to high proximity of coffee fields to forest fragments. Landscapes with such habitat amount are known to enhance biodiversity and favour spillover processes from forest to coffee plantation. Our work provides thus a new and original regional level evidences of the landscape benefits to crop productivity, emphasizing that is possible combining landscape management at both local (i.e. within properties) and regional scale (i.e. municipality levels) to increase crop productivity via enhanced biodiversity-based ecosystem services provision.

Keywords: Atlantic Forest, Ecological Intensification, Pollination service, Pest Control

Spillover of pollinator diversity and services from forest to oil palm in Jambi, Indonesia

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Conversion to oil palm (Elaeis guineensis Jacq) is a major cause of habitat fragmentation in Southeast Asia, with negative effects for biodiversity and ecosystem functions and services. In two experiments in Jambi Province, Sumatra, Indonesia, we investigated ecological spillover of pollination services from restored and remnant forests. In one experiment, we measured pollination services within and 15 m outside of enrichment forest plots of a long-term ecological research project established in an oil palm plantation. Using chili peppers (Capasicum annuum) to indicate pollination, we compared pollinator services and insect communities over enrichment plot sizes (5, 10, 20, and 40 m squares) and richness (0, 1, 3, and 6 tree species). We hypothesized that larger, richer enrichment plots would support higher pollination services and insect diversity within and outside. In a second experiment, we examined the effect of distance to a remnant forest on pollination services to oil palm production. Using direct observation and sticky traps, we quantified pollinator diversity and visitation rate to oil palm flowers at different distances from the forest. As the well-known oil palm pollinators are small (<5mm), we used size exclusion treatments to restrict larger pollinators, such as stingless bees and moths. We hypothesized that flower visitor rate and diversity would increase with proximity to forest, and that allowing more diverse flower visitors would improve yield. Our two experiments seek to understand, on the one hand, under what conditions does spillover from forest patches moderate oil palm's impact on pollination services, and on the other hand, whether oil palm itself benefits from the spillover of these services. We find that enrichment plots appear to impact insect pollination services indirectly through the abiotic environment and herbaceous community, while increasing distance to forest and restricting flower visitors negatively affects oil palm pollination.

Keywords: ecological spillover, ecosystem services, pollination, oil palm, forest

T0866

Landscape structure affects pollinator and natural enemy spillover: a meta-analysis

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Cross-habitat spillover, defined as the movement of individuals between distinct habitat types, is an important connectivity process that can at the same time allow species to survive in fragmented landscapes and contribute in ecosystem services provision. However, the links between landscape structure characteristics and spillover movements are still poorly understood. A systematic literature revision was performed and resulted in 50 empirical papers that address this topic. General patterns, like geographical localization, publication year and crop type were evaluated. Subsequently, a quantitative meta-analysis was performed resulting in calculated 153 effect sizes for the correlations between landscape structure features and species richness and abundance of pollinators and natural enemies. It was found that landscape features affect pollinator and natural enemy spillover. Particularly, natural enemy abundance was influenced positively by annual and perennial crops, as well as native vegetation cover and distance to crop interface. Similarly, natural enemy species richness was modulated positively by annual and perennial crops and distance to crop interface. Pollinator abundance was influenced positively by crop area and distance to crop interface. Finally, pollinator richness was affected positively by annual crops and semi-natural areas. Our results suggest that landscape complementation processes, coupled to crop phenology and edge effects are relevant to explain species spillover movements. We conclude that heterogeneous landscapes, with less contrasting edges, and higher abundance of natural and semi-natural habitats are more favorable for spillover movements of service-providing organisms.

Keywords: agricultural landscape, ecosystem services, pest control, abundance, species richness

T0931

Matrix type and patch size as drivers of avian-cross habitat spillover

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Landscape structure has been proposed to affect cross-habitat spillover. We tested how matrix type surrounding forest patches and forest patch size (range 2-200 ha) affects avian abundance and species richness in forest-matrix interfaces. Data were collected in 12 paired sampling sites (N=24) in the Brazilian Atlantic forest in Southern Brazil. Each paired sampling site was composed by a forest patch surrounded by both coffee plantations and pasture matrices where mist-nets were placed at forest-matrix interfaces during three consecutive days. Overall, 559 individuals of 89 species were caught. Abundance in coffee plantations interfaces (453±16 individuals) was not different compared to abundance in pastures (495±15 individuals) (p-value=0.23) but effect size of matrix type over abundance was medium (Cohen's d=0.51). Fragment size was correlated to abundance (R=0.44, p-value=0.03) and species richness (R=0.38, p-value=0.06). Abundance of forest specialized species depended on matrix type (p-value=0.02) but not for open-area specialists (p-value=0.22). Most individuals caught at coffee interfaces were habitat generalists (52.10%), followed by forest specialized species (30.91%) and open-area specialists (16.56%). Similarly, in pasture interfaces the majority of species were habitat generalists (48.08%), followed by forest specialized (29.90%) and open-area specialist species (22.02%). Abundance and species richness of forest specialized species was not correlated with fragment size (R=0.28 and R=0.29: p-values=0.18 and 0.17 respectively). Or results show that adjacent matrix has an effect over avian abundance, especially for forest specialized species. Fragment size appears to be important for bird persistence in this agricultural area, mostly for habitat generalist species. We propose that decreasing matrix-fragment contrast and preserving medium and small forest patches can be effective measures for conserving biodiversity and ecosystem services

Keywords: Agricultural landscape, Abundance, Species richness, Coffee productive systems, Atlantic forest

P0127

Does Semi-Natural Habitat Amplify Beneficial Spider Populations in a California Organic Vineyard?

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Agricultural ecologists view "semi-natural habitats" (SNH) as areas characterized by reduced management activity and the presence of native vegetation. These zones are thought to represent a persistent reservoir of beneficial insect populations. Faced with an array of pest management challenges, the potential contribution of semi-natural habitat to biological control strategies has been researched by the organic grape wine industry. However, conclusions are often contradictory and qualitative. Various Diptera, Lepidoptera and Hemiptera including Aphids, Leafhoppers, and Mealybugs, have the potential to cause economic damage to both the wine grape crop and to vines. These pests are predated by Araneae (spiders) that overwinter in, and emigrate from, semi-natural habitat at the vineyard edges. Here, we assessed the spatial pattern and density of predatory spiders during the growing season, comparing a vineyard transect bordered by a native oak grove (the semi-natural habitat) with one bordered by an empty field in central coast California, USA. To evaluate the arthropod population densities, we collect samples from non-lethal vane traps suspended in the canopy. We found that arthropod abundance was 30% higher in the semi-natural habitat transect early in the growing season, while arthropod diversity was consistently comparable for the two transects.

Three distinct spider population clusters persisted throughout the season in both transects. Contrary to our initial expectations, we observed a reduced crab spider presence at the vineyard SNH edge. We conclude that semi-natural habitat dominated by mature oak trees likely depressed populations of the generalist spiders Thomisidae in the first 15 m of adjacent rows during the period of phenological "bloom". Thereafter, positive and negative SNH effects disappear as the crop approaches veraison.

Keywords: vineyard beneficial insects, semi-natural habitat, spiders, vane traps

Symposium 57

Green Infrastructure as a way to rethink Ecological Landscape Planning

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Green infrastructure (GI) has emerged as a way to put into practice the discourse of the sustainable city in its ecological dimension, which is also related to the vision of a resilient city. The concept is still not considered as a consensus, as there are several views depending on the point of departure of the researchers. However, it includes principles that refer to interventions associated with the formation of a set of green water-sensitive structures that would articulate sociocultural and natural interests, emphasizing their ecological potential while solving operational problems in cities. Another challenge to be faced in the implementation of the concept is the spatial translation of the green infrastructure ideology that today still predominates in the performance of specific actions associated with open space systems (SELs).

Thus, the tension among the realms that debate green infrastructure involves a discussion linked to the urban project arising from the traditional field of landscape architecture, mainly in the Ecological Landscape Design. It is also influenced by activities in the structuring of open space systems and, more recently, by the view of green infrastructure as departing from land planning, which in turn stems from environmental planning and expands its action to put urban management into practice.

Thus, the tension among the realms that debate green infrastructure involves a discussion linked to the urban project arising from the traditional field of landscape architecture. It is also influenced by activities in the structuring of open space systems and, more recently, by the view of green infrastructure as departing from land planning, which in turn stems from environmental planning and expands its action to put urban management into practice.

The proposal of greater visibility for the solutions applied to urban land planning has been made by means of a new Plan added to the existing ones, the Green Infrastructure Plan. This Plan is a way of reviewing the resistance of the practice of urban planning in incorporating an ecological dimension in its decision-making on spatial planning. These plans have been created and implemented at an international level, United Kingdom, Germany and Spain, but not in Brazil, which, on the other hand, already has several other plans with legal backing but involving some articulation difficulties for effective urban management.

A number of questions arise: What is the scope of the Green Infrastructure Plan? How does it articulate with the traditional Urban Master Plans to generate the necessary answers to produce resilient, sustainable and ecological landscapes in the cities? And, in addition to the ecological promotion of green areas, what is their contribution to ecosystem service, for example?

The symposium put together researches with different approaches in order to examines the concept of green infrastructure, identifying its relations with the concepts of ecology, as well as the strategies in different scales of planning and typology of interventions that characterize the concept. It pinpoints contributions toward the protection of urban ecosystem services, emphasizing the issue of drainage and the balance of the water cycle. It will be presented the application of plans for some cities in the international arena and the discussion of their contribution in the context of the legal framework of Brazilian urban management. These established correlations are intended to demonstrate the relevance of incorporating green infrastructure plans based on Ecological Landscape Planning. The structure of the symposia is a opening the Symposia (15 minutes; by the organizers) with six talks (15 minutes +3 questions) and, after a closing of fifteen minutes by the organizers.

Ecological Landscape Planning: An applied study of the Cantareira State Park's buffer zone

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This study discusses the issue of best land use planning from the perspective of Landscape Ecology and Green Infrastructure. It admits that the assessments of the impacts of urbanization must be considered within the landscape planning tools and methods, that accounts for the multifunctionality of open spaces – able to bring the urban, social, economic and environmental issues to the debate about green infrastructure. Regarding this context, the research argues the importance of a systemic, comprehensive and transdisciplinary approach to produce a differential analysis between conserving biodiversity, providing ecosystem services and providing places for urban housing and the correlate infrastructure. The aim is to debate how to integrate the contents of the of Ecology and Landscape Architecture into the land use planning through a study case about the characterization and conformation of a network of urban open spaces. These concepts are applied to an investigation about how environmental planning can contribute to the management of the buffer zone of Cantareira State Park in the north border of São Paulo City. The multivariate analyzes of the case study contemplate the social and environmental integration of the Park, specifically, the areas of conflict between informal urban occupation and the legal administrative protection of natural resources. The study verified that the area presents a high diversity of forms of relief, many river springs, expressive areas that are still covered by vegetation in several stages of succession, different uses of the soil and diversified cultural and leisure aspects. The surroundings of the Park are marked by a great territorial complexity that contributes to its isolation and fragmentation, in addition the south part is surrounded by densely occupied areas, quarries and sanitary landfills, while in the north part by rural areas.

Keywords: Green Infrastructure, Landscape Ecology, Environmental Planning, Ecological Landscape Planning, State parks in mega cities

Mapping the cooling capacity of existing green infrastructure to support urban planning in the city of Ghent

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Climate change is expected to increase the frequency and intensity of extreme weather events, including heavy rain, storm, floods, heat wave, and droughts. Urban heat island effect is one of the most worrisome issue in many cities across the world. The cooling effect of urban green infrastructure have increasingly attracted attention because of global climate change and urbanization trend. This study analysis the spatial distribution of urban green spaces and estimates the cooling effects of urban green infrastructure. This study focused on urban green infrastructure at a neighborhood scale. The Sentinel remote sensing image was used to analysis the characteristics (Area, Proportion, Per-capita green space area) of UGS in different Statistics sectors. The cooling effect of urban green infrastructure is assessed by estimating the surface temperature difference of green infrastructure and the impervious surface. The mapping results can be used to improve planning and decision-making to ensure urban green infrastructure to be located in the most appropriate areas.

Keywords: Ecosystem Service, Urban heat island effect, Green space, Climate adaption

Species-habitat networks: A novel approach to improve agricultural landscape management for conservation

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Agricultural intensification is massively reshaping terrestrial ecosystems worldwide, and is recognized as a key driver of biodiversity loss with negative consequences on ecosystem functioning. Understanding how species use resources across landscapes is essential for the design of effective conservation strategies. Despite recent advances in theoretical ecology, there is still a gap between theory and applied ecological science. An urgent question is to understand how to manage whole landscapes to maximize biodiversity conservation or ecosystem services delivery. We propose adapting existing bipartite network metrics to create species-habitat networks that explicitly evaluate the links between multiple species and habitat patches. Network metrics enable very powerful visualizations via a common language that defines most processes in terms of nodes and links. Most existing metrics used to study properties of bipartite ecological networks can easily be adapted to the study of species-habitat relationships. One key advantage of this approach is that the scale of the derived ecological information will match the scale of management interventions. The flexibility of the proposed approach is that it can easily be applied across a range of applied ecological fields such as species conservation, habitat restoration, and ecosystem services management. Besides the general description of the framework, we will present a case-study on the impact of landscape simplification on insect predators, pollinators and herbivores across agricultural landscapes. The results will elucidate the application of the tool to landscape management problems such as the design and implementation of effective green infrastructure to maximise biodiversity conservation. Our species-habitat network approach will also be useful for designing monitoring programs at the landscape scale as it is based on a novel multi-habitat sampling of biodiversity.

Keywords: Network ecology, Fragmentation, Agro-ecology, Land-use change, Green infrastructure

T0261

Using an ecomimicry design approach to achieve ecologically-attuned, multifunctional urban green infrastructure

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Urbanisation processes often cause ecological degradation, but cities can also harbour rich biodiversity. In the face of increasing urbanisation, conserving urban biodiversity is an urgent priority, not only to halt biodiversity loss for its intrinsic value, but also for the ecosystem services it provides and its importance for human health and well-being. Integrating innovative urban green infrastructure (UGI) solutions into urban areas should enable people and rich biodiversity to co-exist in cities, but the design of UGI must be ecologically-informed and locally-attuned to optimise its biodiversity value and produce sustainable, resilient and ecologically-functioning green-space in cities. I will present the 'ecomimicry' concept as a mechanism for designing UGI based on locally-typical, regionally important habitats. I will outline how this approach can be used to produce more locally-contextualised and ecologically-informed UGI designs that deliver positive benefits for urban biodiversity, and offer other important ecosystem services such as rainwater management and green energy production that contribute to urban ecosystem resilience and human well-being. I will present some key case studies from my research to demonstrate the ecomimicry UGI design approach in practice, and to illustrate how this could be applied in other geographical areas globally, such as cities in Brazil. I will also introduce the Horizon 2020 Connecting Nature project, a multidisciplinary partnership that will co-develop a framework for up-scaling good practice in nature-based solution/UGI implementation in cities and establish a global academy to expand the project's reach to a city network including Brazil, China and South Korea.

Keywords: urban green infrastructure, ecomimicry, locally-contextualised, ecologically-informed design, biodiversity conservation, sustainable development

T0565

Evaluation of the green infrastructure from UAV images, in the UnB Planaltina Campus area, Brasília, DF, Brazil

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The theme of urban green space is already well-discussed in several areas of science and within the urban planning process, but there is a need to evaluate several types of impacts related to the existence or implantation of green spaces in urban environments in order to understand if they meet society's needs. For example, green space accessibility and its suitability for use; impact on the urban microclimate (heat island, air quality); and whether the tree mass is coupled with open green areas, providing shading, yet also the possibility of outdoor activities. These elements can be measured from remote sensing images such as Sentinel II (spatial accuracy 10 m), or Landsat 8 (spatial accuracy 30 m), as well as through use of urban databases for evaluation of accessibility elements such as roads and bus stops. To achieve a more detailed analysis it is possible to use Unmanned Aerial Vehicle (UAV) images, which have a spatial accuracy between meters and centimeters. The proposed research aims to characterize the accessibility and ecological function of green and open spaces in UnB Planaltina Campus, and establish key parameters that could be modified or altered to enhance their accessibility and ecological function, and thus improve the overall effectiveness of these spaces in the city. We use the Green Leaf Index, this index can be used to discriminate different soil coverages. The amount of soil exposed in an urban area can be measured. It is an interesting tool for those who only have an RGB sensor, as is the case with most drones. With the use of a UAV, we can both identify, with high spatial accuracy, the current soil cover conditions, as we can repeat the survey process as many times as necessary, since the cost is very low. In this way, we can assess the conditions of the present green infrastructure, propose improvements and monitor their implementation. As well as continually evaluating its effectiveness in improving the conditions of urban quality of life.

Keywords: Green infrastructure, Unmanned Aerial Vehicle, Remote sensing Images, Green Leaf Index, urban environments

T0532

Defining ecological corridors for birds in urban landscapes using multipath model and landscape configuration analysis

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Although connectivity is fundamental for species conservation within modified regions, this topic in urban landscapes remains understudied, mainly in South American cities. Here, this research aims to assess how multipath routes contribute to define ecological corridors and functional connectivity estimation for birds between urban parks. We also intend to evaluate how different aspects of urban landscapes (such as tree density and exposure to noise) influence the taxonomic and functional characteristics of bird communities inhabiting streets and urban parks of a Neotropical city (Bauru, São Paulo, Brazil). First, we produced a land use/land cover map to characterize the urban landscape structure. The connectivity was assessed by simulating multipath routes between 10 urban parks using the LSCorridors software. With the simulation results, we selected 20 urban street points, grouped according to their preferential routes: 10 considered as preferential routes and 10 streets not crossed by multipath corridor. Currently we are performing bird surveys using the point count method in these three contexts (30 sampling points). We expect that streets nearby or considered as preferential routes will present higher diversity (species richness, number of individuals, functional richness and evenness), when compared to those points that are not part of simulated corridors. We also expect that urban parks and streets with higher tree density and lower exposure to noise will positively influence the taxonomic and functional characteristics of these urban bird communities. With these results, it will be possible to suggest guidelines for urban planning in order to create multifunctional urban ecological corridors and management strategies to assist in the conservation of bird species inhabiting Neotropical cities.

Keywords: connectivity, Neotropical birds, Urban Forests, landscape ecology, ecological corridors

T0334

Islands in the Sky: Green roofs demonstrate the problems of implementing green infrastructure without good landscape planning and ecological knowledge.

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Green infrastructure (GI) has enormous potential to transform cities by contributing to a more ecologically rich landscape. Yet, although GI is an ecological product, little research has been conducted to understand how GI fits into an urban ecological landscape.
GI systems can be relatively biologically inert when installed, with little thought beyond planting. Yet the ecosystem services GI should provide are reliant upon other species, such as soil biota, colonising this habitat. Ecological principles suggest that colonisation is reliant on having high quality source habitats, with species that are both adapted to their new habitat and able to reach this new habitat; both qualities that are impacted by the organisation and quality of the local landscape.
Implementing this to improve GI is a challenge. Our research on green roofs suggests that while some species can colonise green roofs naturally, most arrive in construction materials, and are not suited to local conditions (Rumble, Finch and Gange, 2018). Of those species that do colonise naturally, few are able to withstand the summer droughts present on green roofs (Rumble and Gange, 2013).
Is the solution better landscape planning, finding ways to connect GI together and aid species dispersal across cities? Our understanding of where in the landscape green roof organisms are colonising from, is extremely limited. Or should we intervene and look outside cities for source populations from more similar habitats, exacerbating the already anthropocentric ecological dynamic in the city? Adding biota to construction materials could improve ecology (Rumble and Gange, in preparation), but universal application of species could homogenise ecological communities.
This talk synthesises 10 years of research on green roof ecology to identify how a better understanding of local landscape ecology and biogeographical species distributions could improve GI delivery and resultant ecosystem service provision.

Keywords: Green roof, Soil biota, Colonisation, Urban planning

Evaluation of Biodiversity and Ecosystem Services of Open Space for Green Infrastructure Planning

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Evaluating ecosystem functions of open space (vacant or unused space) in urban areas has potential for playing important roles for enhancing the human well-being. The open space in Japanese urban or suburban areas is rapidly increasing along with the decrease of birthrate and increase of aging population. Therefore, it is demanded to evaluate the functions and to emphasize the value of the open spaces for sound urban planning.
In order to establish an evidence based scheme to incorporate the insight of ecosystem services into urban planning, we evaluated biodiversity and some important ecosystem functions of open spaces of residential area in Shiroi City, near Tokyo. In our study, the functions of mitigation of heat-island effect, ground-water recharging and providing playground for kids were evaluated by using GIS techniques. Furthermore, plant diversity was evaluated by a citizen participating field survey. Based on the vegetation history, i.e., the area was used as pastureland for horses, we focused on the native grassland plants.
About 1,047 open spaces were recognized in Shiroi city. The field survey revealed that the 12 open spaces with grassland vegetation kept a high plant diversity including endangered species (Cynanchum paniculatum and Patrinia scabiosifolia) in the national or local Red List. The ecosystem functions were suggested to be high in such grasslands. Therefore, appropriate conservation planning of the open spaces can be a green infrastructure plan to maximize the ecosystem services together with the biodiversity. Next, we conducted a web questionnaire survey, and examined the actual situation of use and the needs of the city area. As a result, it was statistically shown that those who were in the habit of doing outdoor activities had higher wish to pay for maintenance and willingness to participate in maintenance activities. These results will be useful to establish the green infrastructure plan to use the open spaces effectively.

Keywords: Green Infrastructure, Ecosystem services, Biodiversity

P0175

Evaluation of flood exposure risk using anticipated inundation area map and land use map in Japan.

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Due to global warming, it is estimated that rainfall will be heavier from year to year and hence risk of flooding will be raised. In a situation, it is necessary to control land-use that identification of spatial distribution of urban area and agricultural land with high risk of flooding.The aim of this study is to identify spatial pattern of land use change on flood risk areas in Japan.Land use maps (from 1976 to 2014) were obtained Digital National Land Information Japan, and used to create land use change maps at a 100m resolution. To identify increase in flood exposure risk, land use change maps were overlaid with “anticipated inundation area map”.As results of overlay analysis, almost of paddy field and farmland were converted urban area from 1976 to 2014. The spatial patterns of land use change were differed with inundation depth.Also, with increase in urban areas, financial damage of flood hazard were increased almost of cities.

Keywords: flood risk, Eco-DRR, agricultural land, land use, green infrastracure

Symposium 58

Urbanisation. Concepts, methods and spatially explicit indicators

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The global process of urbanisation is increasing anthropogenic pressures in all kinds of landscapes across the globe. The traces of urbanisation are spreading from highly urbanised megaregions to the last of the wild. Landscapes processes and patterns are undergoing profound changes under the systematic pressure of urbanisation. Urbanisation is dramatically affecting not only ecological process and patterns, but also the function of society at large, in urban cores and far beyond. New highly complex spatial configurations of urbanisation are challenging standard urban-rural assessments, making innovative concepts, methods and indicators of urbanisation highly needed in landscape and urban ecology and related disciplines.

This session will explore concepts, methods, assessments and indicators to understand, measure and analyse urbanisation and to measure its impacts on socio-ecological systems. Especially looking at new patterns and processes induced by urbanisation, such as direct and indirect anthropogenic impacts and pressures and land teleconnections, including health outcome effects from challenges related to urbanisation and how urban nature may mitigate potential negative effects, such as increasing soil sealing, Urban Heat Island, loss of green space, among others. We welcome contributions looking at urbanisation as a continuous spatiotemporal process, focusing on (but not restricted to):

- Theoretical approaches to understand, analyse and measure urbanisation;
- The impacts and pressures of urbanisation (urban land uses, anthropogenic (built) infrastructures, etc.) on landscapes;
- Spatially explicit assessments of urbanisation and its impacts;
- Urbanisation as a spatiotemporal (continuous) process;
- Socio-ecological indicators;
- The impacts of urbanisation on socio-ecological systems.

Sustainable Urban Transitions for Coastal Indian cities

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Coastal cities with their surrounding urban environment offer a unique ecological and cultural context with great potential for development. At the same time, these cities are vulnerable to natural hazards like cyclone, tsunami & climate change consequences like sea level rise & coastal subsidence which, along with unplanned urbanization exert great pressure on the coastal ecosystems. As the relationship between city and the coast is a dynamic one, involving environmental and urban processes, coastal cities in developing nations like India require an integrated approach for sustainable development.

This paper proposes an integrated methodological approach to enable strategic coastal management for sustainable transformation in dense urban agglomerations on the Eastern Coast of India. Major thrust areas for documentation & research are achieved by integrating universal sustainability goals with the objectives of ICZMP(Integrated Coastal Zone Management Plan). The proposed methodology is applied to the coastal zone of Chennai, an important metropolis in South India subject to the forces of population explosion, changing demographics & rapid spatial growth.

The findings of this research can be furthered for preparation of comprehensive interventions at three different scales of development - planning, urban design and architecture. This process can be iterative & based on global, state of the art cases to generate future scenarios promoting sustainable development of coastal cities. The generic method developed can be applied to similar cities/urban areas along the Eastern coast of India. This paper contributes to the current discourse on transformations in coastal-urban complex systems and sustainable futures for developing nations like India.

Keywords: Sustainable Coastal Management, Urban transitions, Integrated methodology, Coastal Indian cities, Climate Change

Global patterns and 40-year trends in built-up areas within and around protected areas

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Protected areas (PAs) are a key strategy in global efforts to conserve biodiversity and ecosystem services that are critical for human well-being. The majority of the more than 200,000 PAs around the world include built-up structures within their boundaries or surrounding areas, ranging from individual buildings to villages, towns and cities. While several global analyses in the past have focused on current and potential future impacts of urban growth on nearby PAs, here we present key findings from the first global analysis of global patterns and observed long-term trends in built-up areas within PAs and their immediate surroundings. We combined the multi-temporal built-up area product of the Global Human Settlement Layer (GHSL) with the World Database on Protected Areas (WDPA) to calculate for each protected area larger than 25 km2 and its 10-km unprotected buffer zone the percentage of land area covered by built-up areas for 1975, 1990, 2000, and 2014. We find that, although built-up areas covered only 0.1% of the protected land areas and 1.8% of the unprotected buffers as of 2014, there are marked differences between different regions, countries and types of PAs. On average, the proportion of built-up area within PAs and their surroundings is highest in Europe and Asia, and lowest in Africa and Oceania. While coastal and smaller PAs tend to have much higher levels of built-up area, older and stricter PAs have lower levels of built-up area. From 1975 to 2014, the annual increase in the extent of built-up areas in the 10-km unprotected buffers surrounding PAs was from five to ten times larger than within PAs. This highlights the relative effectiveness of PAs in preventing the expansion of built-up structures within their boundaries but also the increasing pressure from built-up area expansion within their immediate surroundings. Our findings have important implications for the planning, management and governance of PAs within their broader landscape context.

Keywords: Built-up areas, Protected areas, Human pressure, Landscape change, Urbanisation

Influence of socio-economic status on biodiversity patterns in an urban landscape

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Globally, local governments are considered as the key role players in the success of sustainability strategies. These strategies are closely linked to urban liveability and the provision of green infrastructure (GI) in urban areas. However, not all citizens have equal access to green spaces. Moreover, studies show that more affluent neighbourhoods tend to have higher biodiversity. These results further aggravate the division between rich and poor citizens. Equitable urban planning strategies must address and incorporate these realities in planning and managing urban GI. How this can be done should be key questions urban planners and ecologists need to address. This paper will focus on the city of Potchefstroom in South Africa as a local municipal case study. South African urban morphologies display unique spatial patterns due to past discriminatory urban laws, which results in steep socio-economic gradients. Extensive ecological studies on various biota (plants, birds, insects, amphibians) allowed a singular opportunity to test the influence of socio-economics on biodiversity. The aims of this study are: (1) to use a spatially explicit approach to determine if socio-economic gradients are visible in any of the observed biodiversity patterns, and (2) to reflect on the implications of the observed patterns for urban planning strategies.

Keywords: urban green infrastructure, equity, urban planning, sustainability

P0110

Anthropocene concept of urban environment: integrative assessment of depletion and degradation of natural forest and biodiversity to the benefit of city landscape

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The world is growing urbanized in nature which has produced expanding modification of city growth and physical landscape. Population increase is resulting to integrative initiatives to modify the natural ecosystem. Urban ecological studies generate issues of sustainable landscapes resulting to link between biodiversity and ecosystem function and landscape connectivity. Urban landscapes attract the key roles of different green areas that also provide people with ecosystem services within social and economic factors. Analyzing urban landscapes, sustainable use of ecosystem services is considered to be one aspect of sustainable cities. Urbanization expansion and facility, utility and services networks greatly affect the spatial structure of urban landscapes, especially in natural tropical forested areas. This phenomenon attracts continuous expansion and will correspondingly exert more widespread influences on the regional ecological environment. It means a complete landscape and ecological modification are mostly man made. The application of GIS technology using some spatial analysis, providing spatiotemporal physical changes of natural tropical undisturbed forest and landscape ecological risk mostly in cities like Abuja, Nigeria. This creates impacts of road and urban network expansion on ecological risk in large scale of urban modified landscape. The results confirmed the dynamic processes of change in the overall landscape pattern, changing differences in landscape indices of various landscape types with corresponding obvious modification primarily related to land-use type. It also showed the changes in road expansion with consistent extension of urban center, but depleted forest stage leaving a new urban landscape of different choices of forest of development in more of ornamental frame that produces road network expansion and city structures of anthropocene concept of most global cities.

Keywords: Urban environment modifications, Urban biodiversity, function and landscape connectivity, urban forestry, urban landscape

Asian urbanism and compact-green development: Concepts and framework for a spatially explicit indicator for transit-oriented Asian metropolis

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This paper proposes a concept of Asian urbanism and a framework for measuring compactness in high-density transit-oriented metropolis by looking at density, diversity, connectivity, accessibility (centers, transit, and Green Infrastructure/Blue Infrastructure). It focuses on the conceptual development of Asian urbanism. The proposed general framework measures compactness along the above-mentioned dimensions, emphasizing transit, green, and polycentric urban format. It will use several East/South East Asian cities such as Taipei, Shanghai, Singapore, to illustrate the concept and the framework.

Keywords: urbanization, Asia, compact, green , indicators

T0455

Functionality check of the ecological regional network (RERU) with respect to the fragmentation caused by urban pressure and infrastructural barriers in Umbria Region

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The data presented in this study have been obtained from the research carried out in the "SUNLIFE" project (LIFE13 NAT/IT/000371) under the leadership of the Umbria Region. The urban growth causes irreversible effects on many systems related, for example, to landscape, land take, human health, climate change and biodiversity loss.
The research accomplished, focused on one of these aspects, has in fact analyzed a case study applied to the Natura 2000 network in Umbria and it has tried to show how the central problem of habitat and species conservation is the fragmentation caused by urbanization. Therefore, the aim of the study was to develop a useful methodology to identify: situations of the urban pressure on each of these Sites of Community Importance and the effects on them caused by the situations of the degree of landscape fragmentation and occlusion by infrastructural barriers of the regional road network.
In the first case, a new methodology was developed to evaluate the density of historical, actual and potential urbanization within 5 buffers created around each N2000 sites.
In the second case, the work done allowed us to identify the potential ecological gaps in the main infrastructure system of the region (almost one hundred out of about 380 km of roads and highways) through the drafting of Infrastructural Occlusion Profiles (IOP). Subsequently, the Gap Efficiency (GE) index was calculated in order to verify the real functionality of the ecological regional network in Umbria (RERU), for all the identified gaps.
The results obtained highlighted critical situations and the need to introduction of mitigation actions for this intense landscape fragmentation. Issues that can be addressed through regulatory actions and use of institutional control tools, as well as through specific projects of local ecological reconnection.

Keywords: Urban pressure, Environmental fragmentation, Natura 2000 network, Landscape planning

Urban landscape metrics and heat vulnerability

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Extreme heat events are a leading weather-related killer globally. Its impacts are increasing with climate change, and are most pronounced in urban communities where the majority of the world's population resides. Heat-related morbidity and mortality are driven by 1) processes of urbanization that modify biophysical environments, 2) sensitivities of individuals, households and communities, as well as 3) people's ability to adapt to changing climate conditions. Due to variability in these physical and social factors, the impacts of heat are unevenly distributed in urban areas. Landscape indicators can help identify communities where the biophysical environment puts people at risk of heat-related illness. Due to their design, cities absorb a majority of incoming solar radiation and have less ability to moderate temperatures via ecological processes. Since thermal properties (e.g., absorption, storage, radiation) are closely linked to the composition of built and natural materials, the presence of such materials can be used to understand variation in heat exposure and the extent to which landscapes contribute to such exposures.

Although properties of outdoor landscapes contribute to people's experiences with heat, they do not fully account for them. This contribution will present studies that demonstrate a landscape-based approach for informing micro-urban heat island mitigation strategies, and approaches for validating such indicators against other measures of people's experiences with urban heat. Multiple case studies in North and South America indicate that landscape compositions have similar temperature signatures across cities. Integrating such indicators with household and individual-level risk factors enables urban communities to spatially-strategize extreme heat mitigation and adaptation efforts.

Keywords: heat vulnerability, landscape function, landscape indicators, urban heat island

Methods for monitoring patterns of urbanisation: How suitable is Shannon's entropy as a measure of urban sprawl?

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Urban sprawl is a pattern or urbanisation that has been a cause of increasing concern for among scholars, planners, and policy makers. It has been defined and measured in various ways, and scholars still do not agree on how to measure and control urban sprawl and how to prevent its many harmful effects on the natural environment and its negative socio-economic consequences. Shannon's entropy (information entropy) has been one of the most often used metrics for the measurement of urban sprawl. However, its suitability in terms of requirements for measuring urban sprawl has not yet been examined systematically. Our study addresses this need by examining the behavior and suitability of entropy as a measure of urban sprawl. We applied it to seven simple model landscapes and six real-world case studies. We also investigated the influence of the spatial choice of the city center and associated shift of zones. Finally, we assessed entropy in terms of 13 suitability criteria for measures of urban sprawl. Our results show that entropy is, in many cases, not sensitive to important differences between spatial patterns of built-up areas that represent different levels of urban sprawl, e.g., dispersed vs. compact spatial arrangement of built-up areas. In addition, the value of entropy is strongly affected by changes in the choice of zones within a landscape. Finally, entropy does not meet several important suitability criteria for measuring urban sprawl; it only meets 5 out of 13 suitability criteria. We conclude that entropy is not suitable as a measure of urban sprawl. More suitable metrics of urban sprawl are available that should be used instead. While there is ample room for future developments that may result in exciting new applications of the entropy concept and measurements in urban planning practice, our results demonstrate that Shannon's entropy is not a reliable method for the measurement of urban sprawl and produces misleading results.

Keywords: entropy, built-up areas , urbanisation, monitoring, urban growth

T0146

A multi-methods approach to study health outcome effects of urban nature in the context of urban heat

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Urbanisation and climate change are impacting on urban areas. Urbanisation puts pressure on open space with severe effects on ecosystems. Urbanisation is often threatening resident health due to increase in air pollution, noise, density and decrease in access to urban green spaces. Climate change is impacting on urban areas as well. Droughts, excessive heat or water scarcity is threatening urban residents health and well-being. In this paper we assess if a brownfield redevelopment into a public urban park can help mitigating the impacts from urbanisation and climate change. We present results of field campaign conducted during the summer heat in 2018 in the city of Leipzig where multiple methods were applied to assess the cooling function of the new park through site-based temperature measurements combined with remote sensing. In addition, we show results from a socio empirical study that assessed the recreation function of the park under heat through visitor observations, counting and a questionnaire survey. Results showed that the new park is able to provide temperature cooling under extreme heat conditions although limited due to the current park structure and compared to an old tree covered park in the vicinity. However, the relaxation function applied in the new park as visitors were using and appreciating the park even during hot temperatures.

Keywords: Urbanisation, Heat, Urban green, regulating ecosystem services, health and well-being

T0673

Mapping and assessing urban geographical systems

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The well-known approach to assess urban landscape functions and ecosystem services consists in analysis of spatial pattern of land cover units derived from remote sensing data. Rare and more sophisticated approach represents allocating and study of homogenous areas within the cities with specific combination of urban artefacts and greenery. We made an attempt to overlay homogenous urban areas and natural environment. The main objective of the research was to define a spatial unit for urban landscape assessment that better corresponds to the scale of city planning tasks. We allocated areas, named urban geosystems by analogy with natural geosystems, which included all common biophysical attributes of relief, soils and vegetation and specificity of grey infrastructure. The border between adjoining urban geosystems was lined due to either natural or artificial factor which strongly alters the conditions of mass and heat transfer. To verify our approach we studied statistical relations between chosen indicators of regulating functions of urban landscapes of Tyumen and two representations of urban landscape spatial pattern. As a first representation we used only interpretation of remote sensing information – metrics of composition and configuration of different types of land cover in a moving window. Secondly, we performed a large-scale mapping of urban geosystems of Tyumen and studied landscape properties and land cover pattern within the borders of allocated units, and their near and far neighborhood. As indicators of air quality regulation for winter and summer 2018 we used the field-measured volume of dust in melted snow and on the surface of tree leaves. Local climate regulation function was estimated using land surface temperature values derived from remote sensing data for the same seasons. The study shows that joint analysis of multiple landscape properties based on urbogeosystem mapping gives better understanding of spatial variability of chosen indicators.

Keywords: urban geosystems, landscape functions, urban planning

A multivariate approach for the classification of landscape typologies in a compact city

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Urban landscapes are highly heterogeneous, but could nevertheless possess unique distinguishable features among different typologies. Classification of urban landscape typologies (ULT) is useful, as the resulting typologies can be applied in urban planning and design to understand the socio-ecological performance of various development proposals. Past attempts to classify ULT, however, appear to mainly overlook important land features, such as land use or spatial pattern. We developed a conceptual framework for classification of ULT building on recent literature, and assessed it using Singapore, an archetypical compact city, as a case study. Sixteen variables representing five main components of urban landscapes (land cover, land use, spatial pattern, building density, and elevation) were used in a heuristic process to construct a series of models using correlation and principal component analyses, coupled with adjustment based on comparison with actual land use and land cover. Models were then tested for their performance using a range of statistical measures. The results show that there are ten distinguishable ULT in Singapore. From sixteen variables, six variables (land cover diversity, land use diversity, building density, elevation, percent landscape taken up by impervious surface and water) were shown to have equal importance in defining these typologies. Initial validation through a comparison with Google Earth showed that the ten ULT adequately correspond to distinguishable urban forms. The ten typologies were also examined for their ability to estimate land surface temperature (LST), and the results demonstrated that 42 out of the total of 45 pairs of typologies had significantly different LSTs, suggesting the suitability of the classification method to produce ULT that have ecological and environmental relevance.

Keywords: typology, urban landscape, compact city, ecosystem services, spatial pattern

P0117

Spectral indices for understanding green infrastructures – case study Bucharest Romania

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Green infrastructures (GI) are essential components of sustainable landscapes in urban settings, providing important ecosystem services by sequestering carbon, cleaning the air, recycling water, moderating extreme temperatures, increasing energy efficiency, restoring habitats, improving quality of life and offering recreation opportunities. This study aim is to determine the spectral indices usefulness to analyze the ecosystem services benefits of GI in urban environments. Some of the spectral indices we selected are Normalized Difference Vegetation Index (NDVI), Soil Adjusted Vegetation Index (SAVI), Normalized Difference Water Index (NDWI), Normalized Difference Built-Up Index (NDBI) and Land Surface Temperature (LST). Our study area is Bucharest, capital of Romania with over 2.2 million inhabitants and 5000 ha of green spaces. It was selected as study area because it offers the urban landscape complexity and diversity necessary for the study. We based our analysis on two types of data: Sentinel 2A image from Copernicus platform and Landsat 8 images. Because of the type of data the tools we used are different. For Sentinel image we used Snap 6 to process the image and extract the spectral indices, while for the Landsat 8 images we processed the thermal bands in ArcGis Pro 2.2.4. Our findings reveal that GI with high vegetation density and high values of NDWI contribute to reduce the land surfaces temperatures. From the perspective of ecosystem services, GI provide numerous benefits and the temperature regulating ones are essential to mitigate global warming risks.

Keywords: spectral indices, green infrastructure, urban landscape, remote sensing, Bucharest

T0186

Identifying and assessing indicators for quantifying urbanization gradients

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Understanding how urbanization impacts ecological patterns and processes has received great attention. Rapid urbanization is exerting pressure not only on biodiversity and the provision of ecosystem services, but also on public health. However, the large variability of measures used to characterize 'urban' hinders comparability and generalizations which is relevant if our quest is to identify a sustainable urban form. We aimed to determine a set of measures useful for quantifying the urbanization gradient of two European cities (Vienna, Austria and Amsterdam, Netherlands) and evaluated whether a common subset of measures could be identified. We also assessed their sensitivity to scale and evaluated whether the mono-centric city structure was adequate as descriptor. We calculated 17 urbanization measures identified from the literature and limited by availability and comparability. We found that although the urbanization gradient for Vienna and Amsterdam was characterized by four clusters, their spatial structure differed as indicated by their departure from the mono-centric city model. Key urbanization measures did not coincide for both cities and depended on the scale of analysis. Opting for a multivariate approach instead of using solely one measure for quantifying urbanization gradients and taking into consideration scale sensitivity would allow a better representation of the urban complexity. In addition, a multivariate approach would greatly improve the accuracy of characterized gradients and advance our understanding of the ecological impacts of urbanization and cities' potential to achieve sustainability.

Keywords: Gradient analysis, spatial patterns, urban-rural gradient

T0435

The advance of the Anthropocene - Monitoring global urbanization processes from space

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The Anthropocene is advancing. In this epoch the human influence on the ecosystem of the Earth intensifies by global population increase, increased resource needs, technologization, migration towards cities and urban sprawl, societal changes, among others. The physical transformation of the Earth's surface is the most obvious indicator of change. Although humanity is in the information age, there are large gaps in our knowledge of urban phenomena. The increasing availability of multi-source remote sensing data allows for the documentation of the current state, monitoring over time and quantitative analysis of these changes and the related processes. This presentation will show manifold physical effects of global urbanization – from urban growth in its various dynamics and patterns since the 1970s across the globe, to the evolving new dimensions of urban landscapes such as mega-regions or urban corridors, to the recording of various morphological forms such as slums or large housing estates and to related risks for built environments and societies. Furthermore, in the era of Big Data, the capability of enhancing remote data sets by the combination with other differently structured geodata, e.g. from social networks or from censuses, will be presented in order to reduce knowledge gaps on urban phenomena. The aim is to transform these measured urban patterns und morphologies into new geographical findings. As one example, it will be shown that current statistics on city sizes of the United Nations, which list Tokyo as the largest city in the world, are not correct.

Keywords: urbanization, remote sensing, urban growth, big data

T0370

The higher, the cooler? Effects of building height on temperatures in residential areas of Beijing

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Numerous studies have showed that landscape composition and configuration can significantly affect land surface temperature (LST). Most of these studies focus on the horizontal dimension of landscape structure. Few studies, however, have explored the effects of vertical dimension of urban landscape. This study aims to fill this gap. We focused on the residential landscapes in the central area of Beijing, and quantified the relationships between the vertical structure of buildings and LST. We delineated the boundaries of residential neighborhoods based on high resolution imagery, which were latterly used as the unit of statistical analysis. Building height, and proportional cover of buildings and vegetation were also mapped from high resolution imagery, with aid of digital maps. LST was retrieved from thermal band of TM imagery. We used Pearson correlation, partial correlation and ordinary least squares(OLS) regressions to quantify the relationships between these variables and LST. We found: 1) Land surface temperature varied greatly among residential neighborhoods, ranging from 53.5℃ to 37.0℃, with a mean of 44.2℃ and a standard deviation of 2.4℃. High-rise residential neighborhoods had the lowest LST, and mean LST decreased from low-rise to high-rise residential neighborhoods. 2) Building height, building density and vegetation coverage were all significantly correlated with LST. Building height and vegetation coverage has significantly negative effects on LST, but building density had a significantly positive one. 3) Among these variables, building height had greater impact on LST than the other two variables. These results have important implications for urban design and management.

Keywords: UHI, land surface temperature, vertical structure, building height, Urban Ecology

Symposium 59

Understanding the capacity of Landscape connectivity and ecosystem integrity to supply multiple ecosystem services: insights into sustainable landscapes

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Landscape connectivity is a multi-scalar concept allowing the study of how the interaction between species movement abilities and landscape structure affects species survival, gene flow and other key ecological processes in fragmented landscapes. Functional connectivity quantification necessitates also the consideration of the impacts and constraints imposed by the increasing rates of landscape and environmental change, which are ultimately driven by socioeconomic factors and are likely to continue putting more pressures on both managed and natural landscapes. Moreover, landscape connectivity including green and blue (GBI) infrastructures supports multiple ecosystem services. But still the relationships between ecosystem integrity and the capacity of GBI to supply multiple ecosystem services remain vague.

Landscape connectivity is an essential characteristic to maintain species long term viability and ecological integrity. Also, it needs to preserve ecosystem values while maintaining the multifunctionality of the landscape in order to meet the demands of the population. In this sense, it is vital to characterize in detail the functional and structural aspects of ecosystems to provide a conceptual framework for assessing the impact of human activity on biological systems and to identify impacts and practical consequences on ecosystem services stemming from this framework. Thus, connectivity is nowadays an important concern in almost any modern conservation plan around the globe. The challenge of these conservation plans is to identify the spatial scale(s) and key landscape elements needed to maintain or restore connectivity and ultimately ecological integrity. To meet these challenges operational methods are needed to monitor species viability and ecosystem diversity, but also support planning tools. They also need to convincingly demonstrate the effectiveness and benefits of connectivity investments as compared to other competing conservation alternatives. In this context, we welcome presentations considering integrated approaches offering synergies and new capabilities for connectivity conservation planning that should allow to monitor ecosystem integrity and the capacity to support multiple ecosystem services.

T0752

Modelling the connectivity of the coastal social-ecological networks subject to oceanic hazards

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Coastal risks (erosion and submersion) are significantly aggravating as a synergistic combination of the cyclone/storm intensification and sea-level rise (hazards), with the demography growth (exposure). Global changes and anthropogenic stresses entail the coastal natural barriers' loss, yet providing ecosystem services, such as food provisioning and coastal protection, thus ensuring adaptation. The understanding of the spatial patterns of both social-ecological sprawl and ecological fragmentation on the coastal risks requires to capture the fine networking of social-ecological interactions. We propose, here, to model the connectivity of the coastal social-ecological networks in French tropical overseas using the graph theory, then analyze the overall, terrestrial and marine networks. The coastal landscapes are derived from object-based image classifications, themselves developed from both high spatial resolution topobathymetric LiDAR data and multispectral spaceborne / airborne imageries, spanning the coastal fringe at risk. The spatially-explicit coastal networks are characterized by global metrics (the integral index of connectivity, the equivalent connectivity) of merged and superimposed sociological classes sorted along a vulnerability gradient, and ecological classes with an emphasis on coastal protectors (mangroves and coral reefs). Preliminary analyses show that sociological habitats are located higher or farther inland, when ecological protectors are more fragmented. The overall networks are besides more overstretched and less connected when the integrity of coastal protectors is lower. In addition to be visually meaningful, those results provide new insights for stakeholders delved into the ecosystem-based coastal risk management in the Anthropocene.

Keywords: Network, Social-ecological system, Coastal, Protection, Risk

T0362

How forest edges contribute to landscape connectivity?

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Most of the temperate landscapes mix woodland and farmland habitats that are often in contact by forest-agriculture edges. These components of the landscape are well-known for their multiple effects on biodiversity and many ecosystem services. However, less is known about their contribution to overall landscape connectivity. As linear features efficiently linking different parts of the landscapes, forest-agriculture edges play a key role in both structural and functional connectivity. Here, we analyse (i) how forest-agriculture edges may contribute to global landscape connectivity, (ii) what are their main properties, (iii) how they interact with other linear components such as hedgerows, and (iv) how they may influence some ecosystem services related to connectivity at the landscape level. Based on a literature review, we point out a lack of consensus about the contribution of forest edges to connectivity. Most of the studies deal with the transverse connections between adjacent habitats provided by edges, but few studies to date focus on how edges contribute to longitudinal connectivity at the landscape scale. We argue that forest edges can be seen as "hedgerows with single face", which plead for strong similarities and complementaries between forest-agriculture edges and hedgerow networks. We conclude by some suggestions to include these properties of forest-agriculture edges into a larger methodological framework for the evaluation of landscape connectivity and the related ecosystem services.

Keywords: forest edge, connectivity, network

T0271

Effects of wooded networks on biological control: synergy or antagonism?

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During the past 50 years, technological advances and new agricultural policies have led to a simplification of landscape structure in many agricultural ecosystems. This has resulted, inter alia, in the remove of hedgerows to facilitate harvesting. Hedges and woody elements are important to maintain connectivity between (semi)-natural habitats. Moreover, they have a direct influence on the flora and fauna of crops as they offer different resources for pests and their natural enemies and they can modify their movements through the landscape. The aim of this research is therefore to understand the relationship between the woody elements in agricultural landscape and the ecosystem services / disservices that can be provided by an increase of the amount of natural enemies / pests. Two biological models of natural enemies were investigated: generalist predators with slow numerical response (carabid beetles) and specialist (aphid parasitoids) with high numerical response. Both are important component of biological control services. Additionally, two potential pests (slugs and aphids) were considered. The fieldwork consisted of pitfall trapping of slugs and carabid beetles as well as counting of aphids and mummies in winter wheat field bordered by a hedge. The studied fields were divided into three different landscapes in Belgium with high, medium and low-hedge density. This experimental set up makes it possible to analyse the landscape and the field scales. This study was carried out at five and three sampling periods respectively in 2017 and 2018.
Our results show a high difference between years for the different groups of species studied. No influence of hedges was observed on aphids at field and landscape scales. On carabids, hedges seem to have a favourable impact on species richness and a negative impact on abundance. Slugs are as well impact positively by hedges at the field scale.

Keywords: hedgerows, landscape, ecosystem services/ disservices, natural enemies, pests

T0245

Combining connectivity and habitat suitability models as decision-making tools: a case study in the south of France

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Landscape connectivity, the degree to which a landscape impedes or promotes flows among resource patches, is an essential characteristic to maintain species long-term viability. Connectivity results from the interaction between landscape characteristics (composition and spatial organization of landscape elements) and the capacity of movements of the organisms considered. The spatial elements that influence the landscape connectivity is a central question in conservation ecology with direct implications for land planning. From broad-scale to fine-scale, movements across the landscape matrix are a key ecological process that influences the distribution, the survival, and maintenance of animal populations, especially in fragmented and heterogeneous anthropo-ecological systems. Here, we present preliminary results of spatially explicit habitat connectivity analysis. We analyzed the habitat suitability and the connectivity of the landscape using a set of species selected based on their relation to structural and functional connectivity. Outputs will be presented from Species Distribution Models (SDMs) in combination with graph theory based connectivity analysis. The spatial outputs from SDMs were validated by a combination of statistical assessment and expert knowledge. Least-cost corridor analysis was used to develop a resistance maps in relation to weighted distance and the probability of connectivity index used to measure the level of connectivity in the landscape matrix. The methodology was applied in a study site located in the south of France. This site is of particular ecological interest due to the presence of several protected areas, that are under pressure from suburban-sprawl. The work serves to support planning implementation within the framework of a territorial coherence program at the National level in France. The landscape-based approach proposed represents an operational framework and associated.

Keywords: Species Distribution Models, Connectivity, Graph theory

Mapping ecological connectivity in the European Alps

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Nature and landscape conservation in Central Europe may primarily take place where there are few or no conflicts of use. It is therefore hardly surprising that the last decades have been marked by the loss of important habitat patches of sufficiently large size. In order to preserve biodiversity and thus ecosystem services, species-rich areas must be large enough and smaller areas ecologically connected. As it is impossible to evaluate this for all species, we assessed the complete landscape with regard to its suitability as a functioning ecosystem. A toolkit for the analysis and evaluation of the landscape as an ecological continuum has been developed and applied to the European Alpine macro-region. It consists of five individual and homogeneous indicators (CSI): land use (LAN), population pressure (POP), fragmentation (FRA), topography (TOP) and environmental protection (ENV). The individual indicators, which are based on scientific literature and experts' knowledge, were analysed and evaluated over the entire landscape. For this purpose, extensive geodata analyses were carried out. For a test region (lower Engadine, Switzerland), the results of the individual indicators were checked for their plausibility using selected species-based approaches. A comparison of indicators of the distribution of 259 red-listed species (precise data of different taxa) with those from the entire test region showed significantly higher average values for LAN, TOP and ENV. The comparison with precise distribution data for ground nesting birds showed significantly higher values for FRA and TOP than for the entire test region. Thus, both approaches support the plausibility of the CSI. In general, the results revealed high Alpine areas as most suitable for functioning ecosystems, but marked obstacles in the inner Alpine valleys and the areas surrounding the Alps. These results form the basis for tactical considerations, since different landscape qualities require different measures.

Keywords: ecological indicators, landscape conservation, Continuum Suitability Index, Eusalp

Planning tools for landscape connectivity and threatened species conservation in a forestry context

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Without careful assessment and planning, forest practices including timber harvesting can have a substantial impact on biodiversity and habitat connectivity across the landscape. In order to support the maintenance of threatened species across the landscape in the long term, planning for forest practices must consider the risk presented to each relevant species and incorporate mitigation strategies based on preserving key functional and structural habitat elements at all spatial scales. In Tasmania, Australia, it is a legislative and policy requirement to consider biodiversity in forest practices planning, and specifically to consider landscape connectivity and enhance opportunities for recolonisation following forest disturbance. Forest practices planners need information to understand these risks and how to mitigate them. Good science communication, education and ongoing support for forest planners is therefore vital for good conservation outcomes. The Forest Practices Authority as the industry regulator have developed a series of training courses and online planning tools to help achieve this. Elements include statewide species range boundary maps and specific habitat descriptions, which help forest planners to identify areas of the state where the risk to a species is highest, and highlight critical habitat elements for successful landscape connectivity. This information feeds into an online decision support system to deliver practical, on-ground habitat management recommendations for forest planners and harvesting contractors. Management recommendations are designed to be applied at multiple spatial scales, from coupe-level to the broader landscape, and are reviewed whenever new research findings are released. Importantly, implementation and effectiveness monitoring are carried out to evaluate the success or otherwise of this risk based conservation management approach.

Keywords: Planning tools, threatened species, habitat connectivity, forestry, biodiversity management

P0169

Conceptual framework and uncertainty analysis for large-scale, species-agnostic models of landscape connectivity: the case study of Alberta, Canada

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Sustainable land use planning should consider large-scale landscape connectivity. For instance, Alberta's Land Use Framework defines the provincial strategy for managing land and natural resources to achieve a balance between the population's economic, environmental and social demands. To support this goal, the Alberta Biodiversity Monitoring Institute (ABMI) has established a detailed, vector-based geospatial data base of human footprint features across the entire province and their changes since 2000. We used this database to create wall-to-wall maps of landscape connectivity based on the degree of naturalness and intensity of use of 101 human footprint categories. Here we discuss the conceptual and methodological decision involved in such connectivity models and their relative contribution to uncertainty. While the scaling of resistance values is known to have a large effect on connectivity models, we found that the decision whether or not to consider water as a barrier to movement was of similar importance. In comparison, the conceptual decision whether to define landscape resistance to movement of organisms based on degree of naturalness or intensity of use, had a much smaller effect on the identification areas that contribute to large-scale connectivity. Future research will capitalize on ABMI's biodiversity monitoring data to test which parameter combination best explains provincial-scale biodiversity across a diverse range of taxa.

Keywords: Landscape connectivity, Circuit theory, Alberta, GFlow, Species-agnostic

Coming back home: recolonization of abandoned dens by crested porcupines and Eurasian badgers after wood-cutting and riparian vegetation mowing events

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Semifossorial species are widely considered as landscape engineers, often responsible for soil oxygenation, as well as for landslides and floods. The crested porcupine and the Eurasian badger are medium-sized mammals, who share their den systems. Both species localize their setts in densely vegetated areas, providing them with cover and protection from predators and poachers. Camera-trapping showed that wood-cutting and mowing of riparian vegetation surrounding den setts force both porcupines and badgers to leave burrows. We evaluated the probability of den re-occupancy following the vegetation removal, through intensive camera-trapping at 16 den setts monitored for 9 years. We performed GLMMs to test the annual probability of sett occupancy after vegetation disturbance, taking into account interspecific competition. The probability of re-occupying the burrow by porcupines increased with increasing time from the cessation of the disturbance. A similar pattern was also observed for the badger, which probability of den occupancy was also correlated with the porcupine presence at the same den, confirming the aggressive behaviour of this large rodent. Furthermore, we tested whether, since the first year after vegetation removal, the proportion of years of occupation by porcupines on the total of years is affected by the repetition of the disturbance in those years. This effect was found to be statistically significant (and negative) only for the Eurasian badger.
Apparently, the crested porcupine, strictly protected by international and national laws, is more sensitive than the badger to vegetation removal around the den entrance. A single mowing or wood-cutting event is sufficient to force it to abandon the den sett, followed by a very slow recolonization process with growing vegetation. Conversely, the Eurasian badger is sensitive to continuous vegetation removal whereas, it can colonize porcupine dens abandoned after single disturbance events.

Keywords: Wood-cutting, Mowing of riparian vegetation, Crested porcupine, Eurasian badger, Den recolonisation

P0180

A SWOT analysis of the ecosystem services at the local scale in specific protected area – Vlkolínec (Slovakia)

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Ecosystem services is a framework that is intended to capture the benefits of nature to society and human wellbeing through assessing monetary and non-monetary values of ecosystem functions. An ecosystem services-based SWOT analysis is proposed in order to identify and quantify internal and external factors supporting or threatening the conservation effectiveness of specific protected area. The applied approach concerns both the ecological and the social perspective of the UNESCO locality Vlkolínec which is situated in Slovakia. Based on the national legislative, Vlkolínec as a vivid open-air museum was declared a Reserve of Folk Architecture and the locality is also registered on the List of UNESCO World Heritage as the last inhabited settlement in the Carpathian region preserved as a part of original folk architecture. Strengths and weaknesses, opportunities and threats were evaluated based on selected environmental and socio-economic indicators for reserve of folk architecture, belonging to the List of UNESCO World Heritage, and for its protected zone. The indicators, used as criteria within a multi-criteria assessment, include changes in land use, urbanization and recreational and cultural use of the territory. The results call attention to where landuse changes may have strong influence on protected priorities and for defining management strategies to assure biodiversity conservation and ecosystem services provision.

Keywords: ecosystem services, SWOT, UNESCO, protected area, landscape

T0903

A Landscape level approach of green infrastructure multifunctionality: from species conservation to ecosystem services producing areas

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Green infrastructures (GI) are composed of natural and semi-natural landscape elements that are in interactions with more heavily managed and/or urbanised areas. Sustainable territorial management of GI requires an understanding of the different functions provided by GI and the links between their ecological integrity and the capacity to maintain those functions. GI provides natural habitats to wild species, thereby supporting ecological processes such as e.g. primary productivity, nutrient cycling or biotic interactions and the ecosystem services (ES) capacity depending on them. We defined three main GI characteristics to be assessed for an integrative analysis of their multifunctionality: 1. GI connectivity, ie the capacity for providing roaming areas for wild species at the landscape level, 2. GI ecological integrity, ie the conservation state of the GI elements that is linked to natural levels of ecosystem functioning and 3. The GI elements ES Capacity, ie. The capacity to potentially provide ES supporting human well-being. Based on 3 case study sites (CSS) in Belgium, France and Norway, we evaluated using a common methodology those 3 main components (Connectivity, Ecosystem Integrity and ES capacity) in order to analyse the spatial patterns of multifunctionality and their relation to the location of human settlements. Our results illustrate that GI elements provide different functions depending on their spatial interaction with other land covers and their levels of EI. Based on the results, policies and management options would be spatially adapted according to the specific functions targeted for the different GI elements. This study is part of the research project IMAGINE supported by BIODIVERSA.

Keywords: ecological integrity, multifunctionality, Biodiversa, Connectivity

T0324

Global trends in protected area connectivity from 2010 to 2018

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Connectivity of protected areas (PAs) is crucial for meeting conservation goals and for allowing biodiversity to adapt to climate change. For this reason, the Parties to the United Nations Convention on Biological Diversity agreed in 2010, in the current Strategic Plan for Biodiversity, to have 17% of the land covered by well-connected PA systems by 2020 (Aichi Target 11). Here we assess the progress of the world´s countries towards this target since its adoption in 2010 to date. For this purpose, we use the recently proposed Protected Connected (ProtConn) indicator, which evaluates how well designed PA systems are to support connectivity, and the information provided by the World Database on Protected Areas for years 2010, 2012, 2014, 2016 and 2018. We show that there has been a notable global increase in the connectivity of PAs as measured by ProtConn, but that this increase has significantly slowed down in recent years. We highlight examples of countries with clear improvements in the design of their PA systems for connectivity, but suggest that the current trends question that global connectivity targets may be met by 2020. The detailed results of the updated ProtConn indicator will be made available through the Digital Observatory for Protected Areas (DOPA) of the Joint Research Centre of the European Commission, which can be accessed at http://dopa.jrc.ec.europa.eu/. We conclude summarizing planned directions for further development of the ProtConn indicator and related global PA connectivity assessments.

Keywords: Protected areas, Connectivity indicators, Aichi Targets, Ecological networks

Effects of network conductivity of linear landscape elements on arthropod and plant communities in agricultural landscapes modelled with circuit theory

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In agricultural landscapes, the dispersal of organisms that occur in semi-natural habitats may be impeded by the arable landscape matrix. Yet linear landscape elements (LLE), such as grassy margins and hedgerows, might facilitate dispersal of species through providing habitat corridors and enabling multi-generational migration. We hypothesized that facilitation of dispersal depends on the degree of connectivity of the networks of LLE and tested this on vascular plants and arthropods (carabids and spiders). This study was conducted in intensively used agricultural landscapes of lowland Germany where we established eight study areas of 2 x 2 km and sampled arthropod and plant communities on 100 plots. We used Circuitscape 4.0 to assess the connectivity, or rather conductivity, of LLE networks based on land-cover rasters of the study areas. For this purpose, we assigned non-zero local conductivity values to LLE, but zero conductivity to the landscape matrix. Then, we calculated landscape-level resistance (the reciprocal of conductivity) between pairs of plots as well as within circular buffers around single plots. In order to model effects of resistance on dispersal, we used community similarity as a proxy of dispersal or migration events among plots. Similarities were calculated separately for different subsets of the arthropod and plant communities according to habitat preferences and dispersal syndromes. We found that LLE networks facilitate dispersal of plants that are confined to semi-natural grasslands and that lack mechanisms of long-distance dispersal, whereas ruderal as well as long-distance dispersed species showed little response. Further, we could show that the LLE network had a true connectivity effect, rather than an indirect area effect, because plant species diversity within single plots decreased with resistance, but did not respond to LLE area. Modelling of arthropods is in progress and results will be presented at the congress for the first time.

Keywords: circuitscape, corridor, dispersal, migration, resistance distance

T0385

A trait-based approach to unravel the effects of habitat connectivity and habitat amount on weeds

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The recent essay of Fahrig (2019) has revived the debate about the relative influence of two major components of landscape structure, i.e. habitat connectivity and habitat amount, on biodiversity. In plants, these two components may act as a filter on dispersal and establishment trait values (response trait). These trait values should, in turn, shape plant diversity and abundance (effect trait).
In agricultural landscapes, weeds play a dual role. They support important ecosystem functions (e.g. pollination, limitation of soil erosion) but also represent a major problem for farmers through the competition with the crop. Unraveling the effects of habitat connectivity and habitat amount on weed traits should then help to understand the mechanisms behind their maintenance and growth in fields.
Here, we investigated the relative effects of habitat connectivity and habitat amount on i) five dispersal and establishment trait values and on ii) weed richness, diversity and cover, as proxies of their colonization ability. We sampled 27 cereal fields in the LSTER-ZA Armorique. We assessed habitat connectivity and habitat amount provided by wooded, grassland and cropland elements at three spatial scales: 250m, 500m and 750m.
Habitat connectivity provided by cropland elements impacted decreased values of seed germination rate. Habitat amount provided by wooded, grassland and cropland elements impacted aggregated values of plant height vegetative, seed mass, seed germination rate and seed number per plant. Changes in trait values of seed germination rate and seed mass, in turn, drove weed cover and diversity. Our results demonstrated hence that landscape structure shapes the colonization ability and establishment of weeds through its filtering effect on functional traits. This study emphasizes that using the response-effect trait framework provides a better understanding of weed assembly rules and a key to combine the maintenance of weeds without jeopardizing crop production.

Keywords: Agricultural landscapes, Response-effect trait framework, Dispersal traits, Establishment traits, Weed cover and diversity

P0188

Ecological network in spatial planning in the countries of the Carpathians

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The main objectives of ConnectGreen project is to restore and manage ecological corridors in Carpathian Mountains while minimizing the conflicts between regional development and nature conservation. The partners intend to elaborate a common methodology to identify ecological corridors in the Carpathians by using large carnivores as umbrella species. The project covers the Czech Republic, Hungary, Romania, Serbia and Slovakia. One of the basic research objectives are to explore how deep is the integration of ecological network identification and planning in the spatial planning process and carry out a gap analysis on the identification of the needs for improving the planning processes and tools. In our study we would like to present our first results.

Slovakia has a long landscape ecological planning tradition. The Terrestrial System of Ecological Stability, which is a basic part of the spatial planning process defines the distribution of the elements of ecological network.

In Serbia the problem is that legislation for the spatial planning and construction sector does not provide regulations and ecological corridors are indirectly covered by the provisions related to nature protection.

In Hungary the National Ecologic Network represents all the ecologically valuable areas in the spatial plans covering 36% of the country's territory including core, buffer areas and ecologic corridors.

In Romania the content of the plans is not always clearly defined stronger integration of the plans goals would be necessary with the development priorities of public and private stakeholders.

In all countries, spatial planning is an important tool for landscape protection, improving landscape permeability. The integration of ecological network planning is on different levels in the partner countries.

ConnectGreen project is co-funded by the Danube Transnational Programme (DTP), the European Regional Development Fund (ERDF), the European Union and the State of Hungary.

Keywords: ecological network, Carpathian Mountains, spatial planning, nature conservation

T0247

Quantifying simultaneously habitat loss and fragmentation for mobile species in continuous landscapes through Habitat Functionality - applied to Norwegian reindeer

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Anthropogenic habitat loss and fragmentation are key drivers of biodiversity loss and present major challenges globally for conservation planning and ecosystem management. Although habitat loss and fragmentation are distinct phenomena, they often occur together, and their total impact depends largely on their spatial configurations, magnitude, and interacting effects. Unfortunately, common approaches to quantify habitat loss and fragmentation originate from different theoretical frameworks, and only recently landscape ecologists started focusing on their synthesis.

We build upon recent advances in landscape ecology, animal movement ecology and computer science to synthesize the quality, abundance, and connectivity of each landscape unit into a single Habitat Functionality metric, HF. HF generalizes previous metrics, and overcomes the dichotomy between 'links' and 'nodes' in graph theoretical approaches by operating on continuous spaces. Furthermore, HF estimates connectivity through the Randomized Shortest Path algorithm, which allows modelling the continuum between fully optimal (as in Least Cost Path) and fully random (as in Circuit Theory) animal movements. The efficient closed-form algorithm allows fast computation of HF over large, high-resolution landscapes.

We demonstrated the response of HF to habitat loss and fragmentation on both artificial and real landscapes, the latter we parameterized using GPS-tracking data from individual wild reindeer (N=245; Rangifer tarandus) in Norway. As expected, HF decreased in response to both habitat loss and fragmentation, but their combined effect was dependent on spatial configuration, and higher than each one separately. An important application is the use of HF to assess the environmental impact of different land-use scenarios. Thanks to its strong theoretical foundations, HF represents an important step towards an integrative theory of anthropogenic impacts on ecosystems.

Keywords: connectivity, habitat loss, fragmentation, reindeer

T0373

Study on ecological route selection of subtropical mountain expressway in China.

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Subtropical mountains area Landsat8 satellite Tm images were used as information sources, RS technology was used to extract vegetation coverage, soil erosion and land use type for the evaluation of ecological background condition, and the GIS software was utilized to extract indices of terrain slope and water environment. Based on the indicators above, with GIS analysis techniques, calculated the visual - landscape - aesthetics index to evaluate and analysis of the ecological background of the ecological background of the subtropical mountains area. Subtropical mountains ecological background conditions could be classified as excellent, good, fair, poor and very poor level. Based on the overall distribution and evaluation route corridors with relatively some feasible routes, and possible route options were compared to ultimately determine the best route with environmental coordination. The results show that the method overcomes the limitations of traditional line selection method which is too dependent on designers experience and subjective judgments.

Keywords: Mountain area, Expressway, Route selection, Ecological, Visual aesthetics

Location of Biological Corridor of Fragmented Habitat by Roads and its Effect Evaluation on the Giant Panda Migration Based on Agent Based Model - Case Study of the Wolong Natural Reserve in Chi

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The integrity and connectivity of landscape are critical to promote gene exchange and maintain population diversity. However, the development of infrastructures like roads and dams fragmented primary landscape, blocked species and material flows, and threatened the survival of species. Biological corridor, as an effective tool to connect fragmented landscape and foster population communications, is being used more and more widely in biological conservation and habitat restoration. It's still a key issue that where to decide the corridor location and how to evaluate the effects of these corridors at the design stage, in which time is without the monitoring data. The Wolong Natural Reserve is the distribution center of the Giant Panda and one of the most important biodiversity hotspots in the world. The road G350 runs crossing protected areas and divides the Giant Panda population into two sub-populations. Based on habitat suitability assessment which considers natural condition and human activity, a least-cost path model was used to simulate the Giant Panda mitigation corridors. An agent based model (ABM), which was built according to the Giant Panda's behavioral characteristics, was introduced to compare several corridor schemas with the mitigation rate as the index. The result shows that the road decreases the mitigation opportunity of the Giant Panda and the built corridors contribute to the population communication, although different corridor schemas have different contributions. This study will help to the management and conservation of the Wolong Nature Reserve and beyond with the biological corridor construction and effect evaluation.

Keywords: Biological Corridor, Fragmented Habitat, Landscape Connectivity, Agent Based Model, the Giant Panda

P0106

Wetlands connectivity matters for maintenance of amphibian populations in different wetland network configurations

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Wetland habitats are important ecosystems as they provide several functions and services and constitute an important source of biodiversity. Land-use changes and urbanisation threaten wetland landscape integrity and cause wetland habitat loss and fragmentation, which, in turn, results in the decline of many wetland-dependent species populations. Many conservation efforts are based on protection of individual wetland site; however, fluxes of energy, materials and organisms exist among wetlands and creates important structural and functional connections upon which several species depend. We propose a modelling framework that aims at sustaining policies for managing wetlands not as independent object, but as objects integrated with other wetlands and the rest of the landscape.

We develop a theoretical model coupling a virtual wetland landscape and amphibian population dynamics to investigate how the spatial distribution of wetlands and their connectivity may impact amphibian population persistence.

The model (1) describes a wetland landscape through a network where nodes are wetlands and links are amphibian flows and (2) integrates an amphibian population dynamic model within the wetland network. Then, we examine the relationships between wetland's connectivity and amphibians population size under different wetland management strategies. Our results suggest that is possible to classify wetlands according to their connectivity into sinks (where local mortality exceeds birth rate), sources (where local birth rate exceeds mortality), and pseudo-sinks (where excessive immigration maintains the population above the carrying capacity). Moreover, management interventions in wetlands have different impacts on amphibian abundance depending on wetland connectivity.

Keywords: Connectivity, Ecological network, Wetland configuration, Amphibian population dynamic model, Graph theory

T_9011

Stochastic geometry and graph-based modeling of agricultural landscapes: towards better understanding of population dynamics in biological control

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The structure of agricultural landscapes affects diversity, abundance and trophic cascades within the community of pests and their predators, and it therefore plays a key role for biological control. Indeed, the configuration of cultivated area and semi-natural elements determines the resources and habitat connectivity for different species, influencing their dynamics and spill-over to the crop. This work aims at: 1) designing a novel agricultural landscape generator, based on stochastic models defined over a graphical representation of the landscape and controlled by a moderate number of interpretable parameters; 2) drawing statistical inferences on models and their parameters from real landscapes. The generative stochastic model of agricultural landscapes we developed simulates virtual but realistic agricultural scenarios featuring different spatial patterns (e.g. geometry, connectivity) and temporal patterns (e.g. crop-rotation). In particular we focus on linear elements in landscapes composed of agricultural fields, such elements being crucial in determining the spread of populations through corridor/barrier effects. Patterns of this landscape geometry are simulated by an iterative algorithm. We first define a T-tessellation model of Gibbs type, then, each field is allocated with one of two habitat types (crops or seminatural habitat), and a proportion of edges surrounding fields is allocated with hedges. Broadly speaking, the parameter configuration controls proportions and interaction (e.g. clustering, connectivity) of fields and edges. We use this framework to conduct sensitivity analyses for assessing the effects of ecological landscape metrics on pest-predator population dynamics such as species persistence and dispersal among different patterns of crops and semi-natural habitats. This provides new insights into functional and structural aspects of the agro-ecosystems, which may aid to identify key elements to maintain the agricultural ecological integrity.

Keywords: Agricultural connectivity, Agricultural stochastic landscape generator, Biological control, Acro-ecological integrity

Symposium 60

Implementing the Green Infrastructure Approach in Central Europe and beyond

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The concept of Green (and Blue) Infrastructure raises more and more attention as an alternative draft of the often technical infrastructure-oriented planning system. The concept follows the ecosystem services approach and incorporates the multiple social, economic and environmental benefits provided by green infrastructure. It underpins human well-being and quality of life. The concept has been widely used in the urban environment. With the EU Strategy on Green Infrastructure that was implemented in 2013 this concept has spread also to the wider landscape to cope with the major future challenges like halting the biodiversity loss, sustainable growth or climate change mitigation and adaptation. Several European countries adopted own strategies, programmes or action plans to promote and implement the concept of Green Infrastructure, e.g. France (2011), Poland (2014), Lower Austria (2015) and Germany (2017). The most developed implementation approach can be found in United Kingdom, where Green Infrastructure is part of the National Planning Policy Framework since 2012. In other countries its implementation is somewhat lacking. One of the causes may be quite a lot of existing understandings or definitions explaining what Green (and Blue) Infrastructure is and also a lack of guidelines how to map it and analyse its functions. In addition, transferable practical implementation strategies are missing currently. The inter-link of the green infrastructure concept with other existing concepts like ecological networks (e.g. territorial system of ecological stability in the CZ and SK) may help to force this process. Therefore, recent challenges are to develop unified, easy-to-use methods for mapping, evaluating and assessing green infrastructure, its functions, and public benefits. Furthermore, methods how to identify the specific local needs for green infrastructure and its benefits are necessary. Finally, strategies and action plans for the practical implementation of green infrastructure and where to best invest into green infrastructure need to be developed.

T0582

Green Infrastructure at regional and local scale – Assessing connectivity and functionality through stakeholder involvement

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Green Infrastructure (GI) is a key strategy in the European conservation and restoration policy aimed at reconnecting vital natural areas to urban hubs and restoring and improving their functional roles. MaGICLandscapes (ML) will operationalize the GI concept in Central Europe (CE) providing land-managers, policy makers and communities with the tools and the knowledge they need to ensure the persistence of GI functionality and consequent benefits to society, at different spatial levels.

Among nine multi-scale and multi-thematic case studies, the Austrian region "Eastern Waldviertel and Western Weinviertel" serves as a testing ground for our trans-disciplinary partner consortium to identify and feedback best practice for assessment, thus creating transnational added value.

In this work we develop and demonstrate GI assessment methods that focus on functionality in terms of connectivity and provision of landscape services and furthermore communicate and facilitate the adoption of those assessment methods by institutions through stakeholder involvement and participatory approaches.

Through a number of multi-thematic surveys the type and quality of GI elements was mapped exemplarily in the case study area in cooperation with regionally active institutions. Subsequently we combined morphological analysis of spatial patterns and distance to identify priority areas for interventions. The additional analysis of the landscape services (LS) supply offered by these GI elements may therefore complement the information basis for the sustainable planning of GI in the case study area.

The results will provide these planning and environmentally oriented institutions with information and methods with which planning policies and strategies can be produced that recognise landscape ecological functions and landscape services and identify opportunities for enhanced multifunctionality.

Keywords: Landscape services, Green Infrastructure functionality, Waldviertel, Weinviertel, Green infrastructure mapping

T0125

Assessing landscape services as foundation for Green Infrastructure functionality: the case of the Biosphere Reserve Wienerwald.

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Biosphere Reserves are considered as means for the people who live and work within them to attain a balanced relationship with the natural and semi-natural environment. Moreover, they contribute to the needs of society by showing a way to a more sustainable future. The Biosphere Reserve Wienerwald partly surrounds the city of Vienna and other minor settlements, representing an example of Green Infrastructure (GI) of great cultural and natural value. The heterogeneous landscape of Wienerwald offers a variety of landscape services (LS). The analysis of the services supply offered by the open land GI elements of Wienerwald may therefore represent a well-founded basis for the sustainable planning of GI in the peri-urban and rural areas around Vienna.
In this work we quantify and map the supply of LS offered by the open land GI elements of Wienerwald. Starting from a high-resolution dataset, we select suitable GI classes, and we build on expert-based assessments to score each ecological and socio-cultural service through a capacity matrix. The LS are then spatialized, through an analysis focused on intensity and density of "LS potentials". First, each landscape element is converted into a point, whose LS potential is represented by an outer buffer linked to the scores from the capacity matrix. Then, touching or overlapping buffers are merged, obtaining dissolved shapes representing the cumulative intensity of LS potential. Spatial trade-offs among LS are explored, to get an overview on the main trends of GI multi-functionality.
The work provides an easy-to-use method for mapping GI functionality, effective in monitoring the Reserve's both ecological and socio-cultural sustainability performance. It also allows detecting resilient areas, by taking into account both the spatial distribution and the LS of GI elements. The proposed method can also provide insights for building management scenarios to adequately inform planners (e.g. effects of abandonment of pastures).

Keywords: landscape services, open land, Green Infrastructure functionality, Wienerwald

T_0998

Methodological geospatial guidance to support strategic deployment of Green Infrastructure

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Green infrastructure (GI) is defined as a strategically planned network of natural and semi-natural areas with other environmental features that are designed or managed to deliver a wide range of ecosystem services. The EU Biodiversity Strategy to 2020 and more particularly the EU Strategy on Green Infrastructure calls for the strategic deployment of GI and improved information.
This presentation aims at informing the range of European-wide datasets, geospatial methods, and tools available for GI mapping. It shows how two complementary mapping approaches (physical and ecosystem based) and the three key GI principles of connectivity, multifunctionality and spatial planning are used in case studies selected in urban and rural landscapes in Europe. GI mapping is demonstrated to enhance nature protection and biodiversity beyond protected areas, to deliver ecosystem services such as climate change mitigation and recreation, to prioritise measures for defragmentation and restoration in the agri-environment and regional development context, and to find land allocation trade-offs and possible scenarios involving all sectors. Lessons learnt and guidance are provided for the strategic design of a well-connected, multi-functional, and cross-border GI. Current gaps in knowledge and challenges are identified ; a list of on-going European projects to be monitored for addressing those gaps is provided.
This knowledge base promotes consistent data collection and use, consistent and reproducible approaches, the coordination of decision-making across regions and countries, and the prioritisation of conservation and restoration efforts. As such, it can benefit Member States and other stakeholders to support their efforts in strategically deploying GI and feed into relevant EU and national policy processes.

Keywords: green infrastructure, geospatial methods, ecosystem services, connectivity, landscape planning

The knowledge about the term Green Infrastructure in the public and general needs for a Green Infrastructure assessment

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Within the five partner countries of the project MaGICLandscapes - Managing Green Infrastructure in Central European Landscapes, we asked stakeholders of different target groups "What is Green Infrastructure?" The diverse answers reached from a list of single green elements, via networks sometimes considering the functional connectivity as well, up to an approach suitable for sustainable spatial planning. Green Infrastructure (GI) as a network of institutions working in the field of nature conservation and environmental protection was also mentioned.
Therefore, one major need for a GI assessment is to improve the knowledge about the term and to promote the GI approach first. This means to raise the awareness of the multifunctionality and the benefits GI can provide. If people are well informed about GI, its multifunctionality and potential benefits they are able to name further GI assessment needs. Our stakeholder consultations resulted in six further general needs for a GI assessment in Central Europe. These needs are:
- Educational tools for all kinds of stakeholders to increase the awareness of the importance of GI
- Simple, understandable and easily usable tools for assessing GI by a broad variety of different stakeholders, but with a compatible format to implement results in different common planning documents
- Cooperation/coordination of GI assessment and targets with communities, planning authorities, managers of grey infrastructure, local GI-projects, etc.
- Planning and assessing the GI network independently of administrative boundaries
- Thinking the GI approach even more in conjunction with grey infrastructure
- Improvement of the network of urban green itself and its ecosystem services and connecting urban green with the surrounding landscape
They form the guidelines for the assessment of GI, its functions and benefits within our project and will be integrated into handbooks/manuals, available to a wide public, to use them for own GI projects/planning.

Keywords: Green and Blue Infrastructure , Multyfunctionality, Ecosystem Services, Benefits, Spatial Planning

Strategic Alpine Connectivity Areas (SACA): a tool for targeting nature conservation interventions in the European Alps

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Ecological connectivity is fundamental to alpine and global species conservation and thus for the functioning of ecosystems and the provisioning of ecosystem services. However, limited financial resources require prioritization when it comes to the concrete planning of measures to improve ecological connectivity. Therefore three types of strategic connectivity areas with different required measures have been developed and applied to the perimeter of the Alpine Macroregional Strategy (EUSALP). The Strategic Alpine Connectivity Areas (SACA) consist of Ecological Conservation Areas (ECA), Ecological Intervention Areas (EIA) and Connectivity Restoration areas (CRA). ECA and CRA have been derived from the combination of a set of five existing spatial indicators depicting relevant anthropogenic aspects of the integrity of ecosystems. For this purpose, landscape quality and size criteria have been applied. For the evaluation of EIA electrical circuit-based simulations have been conducted with the simulator Circuitscape using ECA as source areas.
The resulting pan-Alpine mapping of SACA offers a basis for the identification of large-scale corridors as well as main physical barriers to connectivity, especially on the transition area between the mountain zones and the flatlands. It may serve as a decision-supporting system for the restoration of ecological connectivity between the Alps and their surroundings.

Keywords: ecological connectivity, land use policy, EUSALP

T0895

Applying socio-ecological lens to blue-green solutions in the city under the multiple social-ecological transitions. The case study of Lodz (Poland).

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Since the beginning of the 1990s, cities in Central and Eastern Europe have been experiencing a socio-economic transition from a centrally-planned to a market economy, and a management shift from entirely top-down to participatory one. The transition brought economic growth and consumption into the focus of city planning and management. Urban landscapes reflect the imbalance between increasing awareness of dedicated groups, and growing expectations of improved well-being, with nature and its services becoming paradoxically the secondary issue. In this new context, building city's sustainability on ecosystem services and blue-green infrastructure became a challenge of reconciliation of conflicting priorities under numerous constraints.

The study explores the situation of the post-industrial cities in the region, using the City of Lodz – the third largest city of Poland – as a case. The City is recognized for its human capital, technologies and innovation, and visionary thinking about blue-green future (e.g. The City Vision 2038: Lodz uses water wisely, blue-green network for ecosystem service transfer). Its authorities, encouraged by researchers and NGOs, adopted an integrated development strategy and a set of accompanying sectoral policies, which opened the way to green growth. It has also been one of the first places in the world applying nature-based solutions since 1990's, far before they entered political realm. The societal recognition and support for NBS is rapidly growing together with local bottom-up initiatives. However the study reveals fourfold challenges being a bottleneck to incorporation of ecosystem and landscape services into planning: 1. rigidity of governance structure and institutional legacies, 2. deficit of stewardship and sense of place, 3. absence of natural capital assessment in spatial and temporal planning, 4. citizens' passiveness as an effect of both post-communistic legacies and deficiencies of civil society.

Keywords: socio-economic transition, nature-based solutions, best practices in NBS, planning bottlenecks, post-communistic social, institutional and ecological legacies

Transnational Mapping of Green Infrastructure in Central Europe

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This talk provides the lessons learned mapping the green (including blue) infrastructure (GI) in Central Europe within the framework of the Interreg Central Europe project MaGICLandscapes (Managing Green Infrastructure in Central European Landscapes). The process of generating a transnational mapping of GI started with an evaluation of available data, for example data provided by the European Copernicus programme, and their suitability for assessing GI in Central Europe. General data needs for the transnational mapping were a) data comparable for all countries involved, b) classification systems applicable to all Central European countries, and c) free/open data access and usability. Using suitable datasets a draft map of GI in the Central-European area covering nine countries was produced as discussion basis. The content of this first draft was than adapted according to further specific needs of some partner countries. Based on this draft GI dataset a detailed ground-truthing was applied to the nine case study areas of the project. The ground-truthing results were discussed amongst the project partners and conclusions for generating a final transnational GI map and a coordinated GI classification scheme were drawn. After this decision process GI maps on transnational scale for whole Central Europe as well as for all case study areas were generated.

Due to some shortcomings regarding transnational data (spatial resolution, accuracy, classified elements) the mapping was refined on national/regional level using available detailed data (e.g. biotope maps). This is especially important for subsequent tasks within the project and beyond.

The coordinated GI classification scheme for the transnational and regional maps presented here is based on CORINE land cover (CLC).

Process and methods of mapping GI have been published in a project derived manual, available to a wide public, to use for other GI maps and planning.

Keywords: Green and Blue Infrastructure, Mapping, Central Europe, Spatial Data, Classification Scheme

A Federal Green Infrastructure Concept for Germany

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In 2017 the German Federal Agency for Nature Conservation (Bundesamt für Naturschutz) published the Federal Green Infrastructure Concept („Bundeskonzept Grüne Infrastruktur") as a nationwide concept for green infrastructure (www.bfn.de/bkgi.html). It is a spatially comprehensive informal concept that bundles existing concepts of nature conservation at the federal level. It refers to the Green Infrastructure Strategy of the European Commission and also put in concrete terms the numerous goals of the National Strategy on Biological Diversity, which can be spatially operationalized. This results in important areas of nature conservation at the federal level, like protected areas, ecological networks, floodplains and peatlands. The focus of the Federal Green Infrastructure Concept is on the preservation and promotion of biodiversity as the basis of an intact green infrastructure. As far as the available data bases permit, references are made to the other target dimensions of nature conservation, such as natural resources like soil, water or the landscape.

The Federal Green Infrastructure Concept primarily targets planning by the federal government, such as federal transport infrastructure planning, the expansion of electricity grids or spatial planning. These plans have to be improved from an environmental point of view. Therefore, an improved and nationwide date set for the Green Infrastructure is now available to take the interests of nature and landscape into account at an early stage and at strategic planning levels.

Keywords: green infrastructure, nature conservation , landscape planning

T0710

Ecological networking assessment to evaluate ecosystem services and improve green infrastructure

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The Italian Agency for Energy, New Technologies and Sustainable Development (ENEA) and Metropolitan City of Turin (CMT) developed, as a tool for the Provincial Plan for Land Management, a methodology for the characterization and improvement of ecological networking finalized to the classification of land uses in different ecological functionality levels through the definition and combination of specific values for Naturalness, Relevance for conservation, Fragility, Pressure on surroundings, Use irreversibility.
The first applications were carried out using a cartography based on a hierarchical structure deriving from Corine Land Cover and containing 97 land use types (Land Cover Piemonte); the same approach was used also with different levels of detail and in Lombardy.
In addition, to provide useful advices in terms of protection and planning of ecological networks, the studies followed an approach for biophysical evaluation of Ecosystem Services (ESs). In particular, the use of the open-source Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) platform was tested with regards to the evaluation module "Habitat Quality".
Results of the applications carried out during the Interreg Central Europe Project" "MaGICLandscapes" are presented here. In the Italian case study areas (Po vercellese-alessandrino Park and Chieri Hill area), starting from the construction of land use maps, ecological networking map and Habitat Quality map were realized. Applications of monetary evaluation methods for Habitat Quality were tested.
The reliability of Land Use data (thematic and geometric detail) proved to be a crucial issue for the application of methodologies for ecological networking and the evaluation of provided ESs.
At the same time, the usefulness of the biophysical assessment of ESs (Habitat Quality in particular) was verified and, on the other hand, the strong limits of monetary assessments of some ESs were pointed out.

Keywords: Ecological networking, Ecosystems Services, Land Use, GIS

T0672

Planning Green Infrastructure: strategies and action plans.

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The Interreg Central Europe Project "MaGICLandscapes" aims to draw up a strategy and / or an action plan for each study area, in order to implement green infrastructure in the pilot study territories. The strategy will be set on the basis of the analysis of the current situation of green infrastructure on a transnational, regional and local scale, and on the evaluation of their functionality, also taking into account the results of the public benefit assessment (thus including specific needs, threats, strengths and weaknesses, opportunities on a local scale). Each strategy will then be organized hierarchically into general objectives, detailed objectives and targets, possibly differentiated by specific areas (if necessary). In the cases in which the study area identifies an entity that can play the role of manager (Park Authority, Local Administration, Territorial Consortium), it will be possible to proceed with the drafting of a real Action Plan, starting from each detailed objective or goal defined in the strategy, might define methods, times and resources to be used for its implementation. Strategies must take into account all relevant national and regional regulations and strategies, while action plans must consider funding sources , partnerships and timing, as well as identify the responsible subject for the implementation of single actions. The drafting of Strategies and Action Plans will be guided by a scheme shared among project partners in order to produce comparable tools even if they refer to very different territories. The critical analysis of the work carried out in very different realities will therefore make it possible to draft a Handbook for the creation of evidence-based strategies and action plans, which aims to be a support tool for local planning.

Keywords: Green Infrastructure, Planning, Management, Strategies, Action plan

Territorial system of ecological stability as a regional example for Green Infrastructure planning in the Czech Republic

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The concept of Green Infrastructure (GI) is still relatively new in the Czech Republic despite the fact that on the EU level it was already introduced in 2013. The term of GI is tough to adopt and fully understand for local people because of overlaying with concept already being used. When looking at the definition of GI, one can recognize some relation to Czech Territorial System of Ecological Stability (TSES) which is defined as "an interconnected system of natural as well as modified but near natural ecosystems keeping the natural balance". TSES is a designed system and is an integral part of territorial plans. Its "backbone" consists of existing valuable landscape elements (called bio-centres) that ensure permanent existence of ecosystems. These bio-centres should be physically interconnected by so called bio-corridors which then enable migration of organisms among bio-centres. Third group of elements in the TSES concept is represented by so called interactive elements – these can be seen as stepping stones for migration as well as permanent existence of organisms. In the present agricultural landscape, there is a lack of ecologically valuable ecosystems, therefore individual parts of TSES must be first designed (based on a prescribed set of rules) and then created/planted. At the end of the process, TSES represents an interconnected functional network.

At an example of a case study in South Moravia, we will show current state of TSES in the territory. Our research is based on existing territorial plans from which we derived TSES layer and present aerial photos where GI elements are depicted. We will focus namely on the ratio of existing and non-existing elements and their relation to existing landscape elements which are not part of TSES but can be considered as GI. We will also look at other issues connected with the TSES and their design, mainly connectivity and functionality.

Keywords: Green Infrastructure, Territorial System of Ecological Stability, South Moravia

Symposium 62

The European Landscape Convention 20 years after: Achievements, Progresses, and Opportunities

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Over the last decades, the protection and sustainable use of landscapes have become a prominent and widely practiced policy objective in Europe. One of the main issues in this regard has been the need to assess landscapes to implement suitable national legislative safeguards and to identify adequate interventions for landscape management and rehabilitation. Safeguards have been intertwined with more robust practices to protect isolated cultural heritage items, including archaeological sites or historical buildings and monuments. The study of landscapes has thereby experienced a paradigm shift, evolving from conventional reductionistic and mechanistic approaches to more integrated approaches based on wholeness, connectedness and ordered complexity. These new visions have been proposed by landscape ecology, but they are now shared by other researchers and have recently permeated landscape protection legislation. The European Landscape Convention (ELC), signed in Florence in 2000 and since then ratified by 39 Council of Europe member states, provided a major milestone in this evolution of landscape protection, study and policy. The ELC innovated not only the shared definition of the landscape but also the approach to landscape preservation, protection, and management. The ELC applies to all types of landscape and represents a holistic view of the sites and their surroundings. It emphasizes how people experience the landscape and highlights its social significance. It underlines the democratic aspect, i.e. the importance of giving people the opportunity to participate actively in the evaluation and management of the landscape. The ELC is designed to be applied at two levels: adhesion of the states and the construction of common regional policies, strategies, and practices that share the values of local societies. A variety of national policies and planning processes are used to implement the ELC due to the different types of European landscapes, which cannot be planned in the same way at the various administrative levels. In some European countries, ELC has pushed legislation toward the promulgation of new measures for landscape protection. This represents the latest relevant evolution of the national normative for the landscape. From a planning perspective, the introduction of the new legislation for cultural heritage and landscape protection has produced a new generation of landscape plans with an increased attention to environmental issues of landscape conservation and integrated safeguard rather than conservation of individual historical sites or monuments. However, in the last years claims have been raised on moving beyond the rhetoric of the ELC and to bring landscape more firmly and coherently into the spatial planning discourse. This requires more research to promote and champion landscape governance in order to overcome its inherent ‘fuzziness’ and elitism which still pervades many practices of landscape planning. Against this background, the proposed symposium intends to bring together European experiences of implementation of ELC at different levels and including different cross-cutting fields and disciplines. Contributors are requested to provide reflections on one or more of the following topics/aspects related to the implementation and impacts of the ELC:

- How does the practical implementation of the ELC differe across European countries?
- Has the ELC been effective in improving the protection and sustainable use of European landscapes?
- Which indicators and methods can be used to measure this effectiveness?
- Which have been the main impacts of the ELC on the coupled socio-ecological landscape systems?
- Which have been constraints, possibilities and positive outcomes of implementation of the ELC in the different European planning systems?
- Is a revision of the ELC needed after 20 years, and which reform opportunities exist?

The Big Hope. Landscape discourse and landscape policies in Italy after the European Landscape Convention

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The ELC was signed in Italy in 2000. In the last 20 years, the ELC deeply impacted on the legislative framework, governance processes, and planning tools. Moreover, it also gave impulse to new training programmes and to bottom-up initiatives, such as the rise of local and regional "landscape observatories".
The Italian traditional approach to landscape issues puts emphasis on cultural and historical values, with a consequent focus on heritage preservation, a top-down and expert-based approach. The Italian planning community put much hope on the ELC approach as a way for innovating traditional practices, jointly managing cultural, natural and perceptual values, shifting attention towards forward-looking actions, and introducing participatory approaches.
The aim of the proposed paper is to provide an overview of the ELC implementation process in Italy, with a particular focus on landscape governance, planning and preservation, which were deeply renewed, but also taking into account the influences on sectoral policies. The recent attempts to assess and monitor the state of the landscape and the related policies at National and regional level are relevant steps forward.
In a way, the landscape discourse has been "normalized". And, also thanks to the continuous action of the Council of Europe, it has been "internationalized", looking at foreign models and practices.
Nevertheless, some difficulties in implementing the ELC principles – particularly due to the Italian planning "cascade" model - cannot be hidden. Moreover, 20 years after the Convention, landscape processes are affected by current demographic and economic shrinkage, plus environmental changes, so challenging current landscape policies. If the past goal was to shift from mere preservation to planning, nowadays the big issue is landscape management. Probably the more uncertain and less discussed concept in the ELC.

Keywords: Landscape governance, Landscape planning and preservation, Assessment of policies, Landscape management

Typisation of the Slovak Landscape

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In October 2000 the European Landscape Convention - also known as the Florence Convention was adopted. The aims of this Convention are to promote landscape protection, management and planning, and to organise European co-operation on landscape issues. Contracting states ought to analyse the landscape types on the whole area of their countries, to analyse their features, record their changes, specify motive power and pressure forming them and assess selected types with respect to special values attributed by engaged participants and inhabitants. Slovakia signed ELC in 2005 and became an active participant in its implementation. The Institute of the Landscape Ecology of Slovak Academy of Sciences elaborated methodology for specification and evaluation of the representative landscape types of Slovakia (RLTS).

RLTS are defined as homogeneous units considering the landscape character, functions and current land-use. Each landscape type represents unique combination of land-use in different abiotic conditions and gives the unique environment for nature development. In the second stage typing rare and unique landscape types of Slovakia have been marked. For evaluation of the individual representative landscape types we utilised following criteria

• specification of the key drivers
• degree and character of the representative landscape types changes
• degree of the protection of representative landscape types
• degree of the degradation of representative landscape types

The basic results of the evaluation was proposal of the sustainable management of the representative landscape types of Slovakia. The key stakeholders were involved in the preparation to the management plan.

The paper will present methodology of the landscape typisation and its application in the Slovakia.

Keywords: Typisation of the Landscape, European Landscape Convention, Slovakia, representative landscape types

T9NN8

The European Landscape Convention at 20 – Reflections and opportunities from landscape planning processes in Italy

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The European Landscape Convention (ELC), signed in Florence in 2000 and since then ratified by 39 Council of Europe member states, represents a major milestone in the evolving protection, study and policy for European landscapes. The ELC not only established a now widely shared definition of landscape, but also put forward new approaches to landscape preservation, protection, and management. The ratification of the ELC led to a significant boost in the protection and sustainable use of landscapes, now representing a prominent and widely practiced policy objective in Europe. The study of landscapes has thereby experienced a paradigm shift, evolving from conventional reductionistic and mechanistic approaches to more integrated approaches based on wholeness, connectedness and complexity. By proposing a concept of landscape as an interaction of different socio-ecological systems, the ELC has embraced landscape ecology theories and its manifold approach to landscape assessment, with the result of having also influenced a reform in national landscape protection legislations.

In Italy, the most relevant consequence of ELC at landscape planning level has been the generation of landscape plans with an increased attention to environmental issues of landscape conservation and integrated safeguard rather than conservation of individual historical sites or monuments. This paper presents some examples of landscape planning in Italy, underlines how the implementation of the ELC has been actually translated both scientifically and practically into landscape planning processes. The paper also reflects on new possible revisions and development of the ELC after 20 years from its adoption.

Symposium 64

Deciphering environmental gradients in landscapes for a better understanding of biodiversity dynamics

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For quantifying and modelling of landscape patterns, the patch matrix model (PMM) and the gradient model (GM) are the fundamental concepts of landscape ecology. While the PMM model has been the backbone for our advances in landscape ecology, the GM represents a continuous landscape characteristic, which provides crucial insights into pattern-process-functionality interactions.

For the patch/matrix representations to mosaic and to the current state of mapping gradients from different sources, Remote sensing (RS) images, from satellites, planes or drones, are a main source of information, complemented by field surveys and spatial statistics. The information from aerial photos or satellite images differ widely in terms of spatial, spectral, temporal, and directional resolution. The information is produced by biotic and abiotic attributes at any relevant scale, like landscape features (trees, forest, any land cover, land use intensity) as well as by the influence of these features on the overall landscape (climate, propagules etc.). Gradients may be spatially continuous or split into patches due to disturbances, differential management practices (land-use intensities), and phenology, as in the case of crop or vegetation type phenology or greeness where the same crop vegetation type can be at different development stages in a landscape.

As gradients do exist in space as well as in time, plant phenology, food resources, water and nutrient flows change at different rates, this implies that land cover (habitat) "quality" dynamics proceeds according to complex spatio/temporal domains.

The objective of the symposium is to present and discuss such diversity of gradients, how their increase our knowledge of biodiversity patterns and processes across space and over time. Questions as "what are the relationships between the scale of behaviour of species, the status, the influences of stress and disturbances, in relation to the characteristics of RS information ?" or "are gradient based analysis more robust than mosaic based ones?" need to be addressed. Furthermore, we want to discuss the future methodological requirements for a better understanding of patterns-processes-functionality interactions in landscapes.

T0466

Assessing the wheat and rapeseed vegetation structure in space and time from local to landscape scale using Sentinel-1 and 2 time series and their use in ecology

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Heterogeneous agricultural landscapes are beneficial for biodiversity conservation. However, the study of cropland remains challenging due to their dynamics at different spatial scales (plot, landscape and region) and temporal scales (intra- and inter-annual dynamics). Most of the studies have focused on wooded and semi-natural elements rather than crops in connectivity and habitat models, or kept crop characteristics are static. The recent synthetic aperture radar (SAR) Sentinel-1 (S-1) and optical Sentinel-2 (S-2) time series offer a great opportunity to monitor cropland characteristics (structure, phenology, biomass) thanks to their high spatial and temporal resolutions. These are key factors to understand the ecological functioning of the agricultural mosaic. In this study, we assessed the structural changes of wheat and rapeseed crops using S-1 & 2 time series in northen France and Brittany. These two French temperate agricultural landscapes, present a gradient from open field to wooded landscapes. Firstly, we assessed the potential of single S-1 data, single S-2 data and their joint use to characterize rapeseed and wheat crops (biomass, LAI and phenological stages) using field data sampling. Random Forest (RF) algorithm has been used to identify phenological stages of wheat and rapeseed crops from the Sentinel images and general linear models (GLM) to predict biomass, LAI and height. Secondly, we studied the influence of landscapes patterns on crops characteristics using GLM. The first results show that the Sentinel time series have a good potential to identify phenological stages of wheat and rapeseed. S-1 was better than S-2 to identify phenological stages of wheat, whereas S-2 was better than S-1 to identify phenological stages of rapeseed. A significant correlation (r^2=0.64) was found between the dry and wet biomass of wheat and VH polarization of S-1. Finally, we will present how a carabid species involved in pest regulation respond to these dynamics.

Keywords: Biocontrol, Remote sensing, optical and SAR satellites images, carabid beetles, Landscape patterns

T0237

From threshold-based methods to functional windows to characterize relations between landscape variables and biological responses

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Landscape variables are often measured using buffers or rings centered on sampling sites. The aim of this kind of method is to characterize the relationship between biological responses at a site (e.g. abundance, species richness) and landscape variables to find at which scale landscape variables and biological responses are the most related. This threshold-based method assumes that the effect of the landscape is consistent up to a threshold distance. However, it seems more likely that the landscape effect declines with increasing distance from the biological point. Recent studies used then weighted distance functions to integrate this hypothesis. The distance functions describes the relative weight of a given distance of the landscape as a function of distance from the ecological response. Moreover, based on species preferences, each landscape elements can modulate (e.g. as barrier) the relation between landscape variables and biological response. We can therefore couple weighted distance functions with functional traits of species by using functional windows. In the context of the Woodnet project and using data on three carabid's species, we analyze the relations between different landscape variables using three methodologies (threshold-based methods, weighted distance functions and functional windows). We then analyze the relevance of each methodology by comparing the strength of the relations between landscape variables and biological responses to provide insights in the better choice to made for our target species.

Keywords: Landscape variables, Threshold-based method, Weighted distance functions, Functional windows

T0889

Two statistical approaches to infer multiscale effects of Landscape : Modelling effects of landscape variables using buffers or spatial influence functions

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Landscape affects the entire dynamics of populations and communities, interacting with local characteristics of habitats and potentially shapes their structure for generations. Knowledge about the biological traits of the species studied are often not sufficient to determine precise scales of effect for each landscape variable. These scales are commonly inferred by measuring the proportion of the landscape variables around each site in circular buffers which size are a priori chosen. The buffer sizes best explaining the response variable in a regression model are the estimated scale of effects. However, this approach increases the number and the correlation of the explanatory variables. Consequently, the potential scales chosen are often too few and their ranges are too limited.

This contrasts with the increase in the extent and accuracy of landscape data now available through new remote sensing methods (satellite image, drones,...). The development of efficient statistical methods to process these data as efficiently as possible is therefore necessary.

We propose two methods for simultaneously estimating different scales of landscape variables effects. Both are based on Maximum Likelihood Estimation. They do not need to define a priori range of scales, but integrate the total information of the landscape in a continuous way over the whole space. The first one automates searching for the best buffer sizes. The second estimates the spatial influence functions of landscape variables using the framework proposed by Chandler et al. 2016.

We implemented these methods in the R package SILand. We compare and discuss the results obtained from the two methods on a case study : the analysis of the effect of landscape and local variables on the abundance and richness of weeds in annual crops.

Keywords: Data science , scale of effect, kernel smoothing, landscape variable

T0372

The response of biodiversity of urban ecological corridor to urbanization in Beijing

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The development of modern urbanization has led to the fragmentation of urban green space patches, which has had a severe blow on regional biodiversity. As a species migration channel, urban ecological corridors can intuitively reflect the impact of human activities on the pattern of biodiversity.

Using landset8 remote sensing images of Beijing from 2013 to 2017, we divided the gradients of urbanization in Beijing built-up areas and extracted the spatial pattern of biodiversity of Beijing's urban ecological corridor.

In terms of spatial scale, we studied the spatial pattern of biodiversity of Beijing's urban ecological corridors under different urbanization levels. On the time scale, we analyzed the evolution process of biodiversity of ecological corridor with the progress of urbanization by selecting typical sections.

By analyzing the correlation between urban biodiversity and urbanization, we hope to understand the role of ecological corridors in the protection of biodiversity in the urban environment, and explore the ways to protect biodiversity in the construction of urban ecological corridors through the means of landscape planning.

Keywords: biodiversity, urbanization, ecological corridor

Satellite remote sensing of ecosystem functions for the assessment of ecosystems conservation status

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The Habitats Directive (HD) and the IUCN Red List of Ecosystems (RLE) represent the most relevant frameworks to report conservation status of ecosystems at continental or global levels. Despite their different operative approaches, both procedures define protocols and criteria for such an assessment at different jurisdictional (national/continental/global) and ecological (ecosystem/landscape) levels. Given the importance of maintaining ecosystem functions as conservation goal, both procedures include the functional dimension of ecosystems among the key aspects for conservation status assessment. However, in practice such assessments usually rely on categorical (spatial distribution and structural) rather than continuous (functional) indicators, which makes it difficult to monitor the (non-linear) response of ecosystems to environmental changes and to establish links between their conservation status and their resistance/resilience capacity and their ability to deliver ecosystem services. Despite the well-known potential of satellite remote sensing (SRS) for the assessment and monitoring of ecosystem functions, the implementation of consistent resilience/thresholds evaluation protocols for both HD and RLE, is still hampered by challenges relating to the specificity (by habitat and ecosystem type) of ecosystem functions and spatial/temporal scales relevant to their status, to the overwhelming offer of new sensors and products, to the difficulties of knowledge and technology transfer from researchers to managers/administrators. This review has explored how such potential has been harnessed in research studies related to HD and IUCN_RLE reporting. We reviewed the literature indexed in ISI-WOS and Scopus since 1990 and evaluated how SRS has operationally contributed to the evaluation of ecosystem functions in practice, the limitations that its application may have in connection with the specificity of the functions to be considered for different types of ecosystems.

Keywords: Habitats Directive, IUCN Red List of Ecosystems, Functional indicators, Resilience, Risk of collapse

T0888

Spatial and temporal stationarity of inter-component relationships in boreal forest landscapes of Russia

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One of the urgent tasks of landscape ecology is the forecast of possible chains of changes in landscape components as a result of global changes or disturbances. For this, it is required to identify the spatial and temporal limitations of such a prediction, i.e. to determine whether more or less universal structure of inter-component relationships persists in different spatial areas of a landscape and at different temporal stages of its development.

The focus of our research is the stationarity of landscape inter-component relationships in space and time. By stationarity we mean the invariance of the composition of correlation groups, linkage density and type of interdependency between landscape properties. We compared quality of multiregression and correlation models for several samples of landscape units selected along ecological, spatial or temporal gradients.

To study temporal stationarity we examined the variation in the relationships between vegetation, soils and landforms on different stages of secondary vegetation succession in middle taiga landscapes of Eastern European Plain and Western Siberia. The differences in the average age of the forests of the two taiga regions made it possible to study the changes in the structure of inter-component relationships with different temporal steps of analysis. We revealed the difference in interdependency of landscape properties at the various stages of succession and the change of the leading factor that determines the properties of vegetation.

To study spatial stationarity we considered landscape linkages of two types – intra-level and inter-level. The results show that composition of correlation groups of components properties varies within the landscape which is the evidence that inter-component relationships are non-stationary. Decrease in diversity of landscape-forming drivers at the lower hierarchical level also results in changes of correlation groups and linkages density.

Keywords: stationarity, landscape inter-component relationships, forest landscapes, multiple regression models, hierarchy

Remote sensing of forest mast seeding

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Mast seeding is the variable and synchronous production of abundant seed crop by plant populations. Mast seeding results from multi-annual interactions among resource availability, weather cues and internal plant processes. As an ecological process, masting underpins ecosystem functions and services, especially in forests, and has also cascade effects at ecosystem levels, including forest carbon and nutrient cycling, food-webs, human allergies and disease carrying vector populations.
The aim of this study is to assess whether environmental gradients of seed production could be detected by spatio-temporal remotely-sensed information. We used annual seed-trap data collected in the last 15 years in both conifer and broadleaf forests in Italy, and a corresponding LANDSAT time series to build parametric and non-parametric models of seed production as a function of spectral vegetation indices as proxies for primary productivity weather, forest structure, and site characteristics. Our main hypothesis is that changes in resource availability needed for masting in the years preceding seed maturation could be associated with changes in forest structure and physiology, directly/indirectly captured by optical information available from remotely-sensed data.
Preliminary results indicate that vegetation indices, as proxies for biophysical vegetation properties, can provide inferences on seed production. This supports the use of remotely-sensed information as a means to improve the understanding of the correspondence between environmental drivers and the physiological processes leading to mast crops, which are likely to affect forest successional dynamic at the landscape level and to plan forest management activities. Such knowledge is also critical for the development of predictive mast seeding models in the context of climate change for the forest cover types analysed herein.

Keywords: temporal gradients, ecosystem functions, forest ecosystems, time series, seed traps

Symposium 65

Innovating teaching and learning landscape ecology to address the challenges of the Anthropocene

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Living in a fast-changing environment and society is challenging, for all species. Especially in the era of the Anthropocene, with an almost irreversible human influence on the environment, societal responses to environmental change are crucial. Worldwide in different geographical contexts (from urban to rural areas, from areas specialised in agriculture or densely populated to remote areas), there is an urgent need for a more sustainable attitude to environment and society. The interest in the topic of the Anthropocene is also increasing in different disciplines. Central to the different approaches is the coupling of the human and biophysical system in one holistic system, which is in line with the core of the discipline of landscape ecology. Dealing with the changes and challenges of the Anthropocene is also demanding different exceptions of the current and future researchers, policy makers, teachers, practitioners, among others. They have an important task in the raising awareness of the need for a more sustainable way of dealing with space and people. Hence, landscape ecology research, education and teaching in the era of the Anthropocene are challenging for both teachers and students and important to formulate solutions to the challenges ahead. This symposium is questioning how teaching and learning landscape ecology can address these challenges. What do we have to teach? Are we using the appropriate concepts and teaching methods? How can we get students more interested in landscape ecological related topics? What are the societal demands towards landscape ecology teaching? What kind of teaching innovations can contribute to building up the knowledge and competencies of the future generations?

We particularly encourage submissions about:

- how to develop learning lines for teaching landscape ecology in the curricula of students;
- how to cross the bridges between different levels of education;
- how to go beyond traditional teaching methods from different perspectives;
- how to integrating different approaches to understanding the holistic landscape;
- how to integrate different knowledge on real-life examples;
- how to use innovative technologies that contribute to the understanding of the socio-ecological relations in the landscape;
- how landscape can be used as a living lab to build up the social skills of students;
- how to evaluate the landscape ecological knowledge, skills and attitudes necessary to understand and tackle the fast-changing environment and society;
- how to prepare the future teachers to teach landscape ecology.

Of particular interest are approaches that bring together different disciplines and promote interaction within those disciplines as well as with the 'real world', the society. Also encouraged are educational approaches that arise from the different landscape ecology perspectives such as the more holistic, humanistic, and society-centred views, grounded approaches as well as the more analytical and biological ecology-centred approaches. Both presentation of landscape education (as the continuous process of learning about the landscape, environment and society) and teaching (as the formal, planned and organised activity to transfer knowledge, skills and attitudes with a specific purpose in mind) are welcomed. To enhance the coherence of the symposium, the submitted papers will be organised according to subthemes such as (1) level of teaching – from to schools over under- and graduate level to PhD level, (2) didactic and pedagogical aspects of teaching and learning landscape ecology, (3) teaching methods, (4) exchange of good practices among others. This symposium will be organised by IALE-Europe working group 'Education in landscape ecology' in collaboration with the working group 'Landscape Ecology in Schools' of IALE International.

Growing roots: using data to connect people to the trees in their communities

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The Chicago Region Trees Initiative (CRTI) is a multi-disciplinary partnership of organizations and agencies from across the metropolitan area working for coordinated action on key issues facing trees. Our mission is to ensure that trees are healthier and more abundant, diverse, and equitably distributed to benefit all people of the Chicago region. CRTI's efforts are based in analysis of LiDAR, tree census, and a community capacity survey data that together provide canopy reports specific to each of the 284 municipalities around Chicago. This analysis and its comparison to demographic data yields two significant results: that 70% of trees are on private property and that our vulnerable and under-represented populations often live in areas of low or unhealthy canopy. These results inform our strategy to engage residents and municipal staff, and provide targeted outreach to our diverse audience. This site-specific and novel approach requires innovation, flexibility, and interpreting urban forestry processes at both landscape and hyper-local scales. Similar to more formalized teaching, we evaluate the level of tree-related knowledge of a group, establish participation goals, and finally develop and implement a curriculum. These curricula can be formal workshops with education credits, but they are more often two-hour events: walking tours, tree plantings, library talks. Topics can include the benefits of trees, advocacy, and managing trees with free technology. These methods evolve as engagement progresses – peers from our extensive network of partner organizations provide expertise for eager audiences. CRTI's outreach adheres to the tenets of community conservation, but our methodology is unique. By integrating sophisticated data analyses with personalized, engaging education we have succeeded in improving access to tree conservation resources for previously excluded communities. These successes can seem small, but are meaningful to the people and trees they benefit.

Keywords: Teaching, Stewardship, Data interpretation, Community conservation, Advocacy

P0184

In search of Nature: Teaching ecosystem services concept into primary school

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Respect Earth and life in all its diversity and protect and restore the integrity of Earth's ecological systems are two of the fundamental ethical principles that are declared in the Earth Charter (2000), a document that proposes to build a right, peaceful and sustainable global society. It makes reflect how much important is to begin with teachers and children project of environmental education. Ecosystem services are not yet teach in primary school, but some of the principles contained in the concept can be used to project environmental education activities. We developed a project in a school with a class of 17 children of 9 years old. In order to get them familiar with the topic, we introduce the topic of ecosystem services through a story, to make children reflect on their emotions when they think about nature. Successively, they are bring to short educational trips in which they see natural, anthropic and degraded places of their own territory. Children are asked to observe, describe and map them on a map. All their reflections will be support from a questionnaire appropriate on their age and level of comprehension. The project has the goal to introduce the ecosystem services concept into a class of a primary school by using both narration and experience and help them in knowing better how is their territory where they live and which environmental problems exists. A result expected is to make children able of critical sense, by knowing natural balances of our world and to develop in them a good social and civic competence. We expect that from this project children learn how to recognize problems about safeguard and protection of natural and cultural heritage, and may propose solutions for their life context, thinking and acting like real world's citizen. In order to make children to have respect and take care of their territory and to be more conscious of its natural possibilities and benefits. It's necessary to do that for their future and for our future.

Keywords: education, primary school, ecosystem services, teaching

Between theory and practice - New training formats against the background of changing needs

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The Anthropocene as a new age requires new training approaches. The need for ever more specific qualifications is to be met by new training courses in the fields of protected area management and nature conservation.
New technologies, changing social needs and a progressive specialisation and differentiation of economic activities are constantly creating new jobs. This is also evident in the dynamic field of nature conservation.
In a larger context, this growing demand is easily recognisable and explainable: nature conservation can be traced back to the 19th century across all ideas and institutions. With the increasing effectiveness of this social concern, increasing professionalisation began in the middle of the 20th century. The need for nature conservation and nature conservation expertise has risen sharply, especially in the private sector, the development of new organisations, job profiles and tasks.
In particular, the Sustainable Development Goals demand new training formats. A distinction can be made between formal learning and non-formal learning. The first refers to learning formats such as courses, master programmes, etc. Non-formal learning formats include acquired knowledge in the context of a project and outside seminars, universities and other institutions.
In this contribution, we examine three educational formats (MMCA – Master of Management of Conservation Areas, NSFK – Nature Conservation Operator, Wahlfachmodul Nachhaltigkeit – Elective Subject Sustainability) as examples of how didactic methods, learning settings and the interweaving of theory and practice are further developed. The handling of inter- and transdisciplinary approaches plays a central role here. As a didactic frame, the concept of "constructive alignment" will be presented and discussed.
After analysing several formal trainings, the necessity of a differentiation of training formats in the field of nature conservation and protected area management will be discussed.

Keywords: Education and Training, Nature Conservation, Protected Areas, Formal Training, Teaching Methods

P0134

Perceiving landscape as a special place through total immersive experiences.

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The activities we propose to study different landscapes required to set up educational environments in which it is possible to acquire sensations and personal observations of the landscape and discuss on both. The activities that we have proposed are listed below. In a kindergarten school: we propose going to green spaces and freely observe the surroundings while experiencing them us; not from a window of a classroom or sitting down on a bench. In primary schools we allow the students to observe microorganisms that live in water: a natural environment shaped by us, not only throughout microscope observations but also by conserving or contaminating the ponds.
Another activity for high school students is to use natural history museums' dioramas, either directly in the museums or by means of digital dioramas, an interactive multimedia interface that leads the students to various crossover topics of ecology and biology: the virtual level (museum representations) followed by another one (digitalized representations). The landscapes that we usually have in mind are mostly those in which we are living. These could be urban, dirty and polluted and we surely aren't motivated to study them but simply cancel their perception in everyday life. On the other hand, landscape that media information (internet, videos, photos, etc.) give us are untouched, beautiful and generally far from us. To study these types of landscapes appreciating their differences, knowing their different stories and understanding our role (or non-role) in their specific development we need an immersive experience. Only from this, can our knowledge be improved, only from this our sense of place emerges and, perhaps, our ability to set up strategies to protect our planet.

Keywords: environmental education, sense of place, future responsibility

Teaching and learning landscape ecology to landscape architects in Italy toward protective, adaptative, redundant landscape design

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Some words are more and more used by different disciplines to focus on contemporary challenges, for exampe “sustainability” and “resilience”, becoming trendy slogans, but the real understanding of these concepts in Landscape Ecology is necessary to avoid their loss of significance, and to add effectiveness to ecological based projects and actions.
The collaborative partnership between Landscape Ecology and Landscape Architecture is a fundamental opportunity. Landscape Ecology is a necessary topic for landscape architects' education and its application becomes a tool for landscape projects. A good landscape architect can play a significative role in the promotion of people's appreciation of landscape in terms of resources (cfr. Almo Farina " theory of resources").
Starting from the experience, of more than 30 years, by the Genoese Landscape Architecture School, from the theoric teaching by Almo Farina and Vittorio Ingegnoli (see Ecofield theory, spatial configuration of functional elements , shifting mosaic, BTC measurement, Landscape Bionomics), to the applicative courses and experimental design of landscapes at different dimensions, the discipline of Landscape Ecology is a clear guide to the understanding of landscape configuration, and of its critical actual aspects.
In the actual main Italian Schools of Landscape Architecture (Genoa/Turin/Milan, Florence, Rome, Milan) a fundamental role is given to Landscape Ecology education.
Particularly in the Genoa/Turin/Milan Master Degree in Landscape Architecture, the experimental applicative approach to design by Landscape Ecology (in the brilliant courses of Applied Landscape Ecology by Gioia Gibelli and Luigino Pirola, with the help of Applied Botany), gives necessary tools to face the challenges of contemporary society, with particular reference to resources and needs, such as water, food production, ecosystemic services, socio-ecological relations, safetiness of everyday landscapes.

Keywords: Landscape Ecology Education, Landscape Ecology Application, Tools for Landscape Architects, Landscape Planning and Design, Partecipative Process and Adaptative Projects

Supporting learning on the ecosystem services approach through role playing game simulation in secondary schools

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The ecosystem service (ES) approach has gained importance because of the capacity to connect the functions that the ecosystems and landscapes can provide, with the end users that benefit from them, as well as with the multiple actors that can affect the delivery of the ES flow. Education about ES could be an effective means of communicating the importance of mantaining and managing the ecosystems for the multiple benefits they provide. Traditional learning methodologies, as frontal courses, can fail to produce the understanding and support learning on the complex relationships embedded in the management of natural resources, and landscape management, such as the connections between landscape functionality, the capacity of the ecosystems and landscapes to provide benefits for the civil society and multiple beneficiaries, and the stakeholders involved in the decision-making process. This study applies a role-playing simulation approach to the learning process of students of different secondary schools. We tested the validity of the approach by means of pre- and post-survey comparisons. We replicated the experiment on a series of schools of different scientific subjects to verify the influence of previous knowledge and learning on the comprehension of ES arguments.
The learning approach was effective in producing learning, especially with respect to the series of learning objectives specified for the experiment, related to the understanding of the capacity of landscapes to provide ES, the relationship between ES supply and demand, and the interactions between actors in ES management. Such innovative learning methods, as role playing game simulations, has the potential to support learning-by-doing for the benefit of landscape protection and management, where environmental and socio-economic factors influence the decision-making process.

Keywords: ecosystem services approach, education and learning, role playing simulation, secondary schools

P0084

From Rochester to Malmö: An international cross-institutional urban ecology course

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The cities of Rochester, NY and Malmö, Sweden share many features, including a parallel industrial history that declined in the late 20th century and geographic proximity to ecologically sensitive international waters. Malmö is transforming into an urban center for technology and green infrastructure and sustainability. Through a university partnership, we created an urban ecology course that compares the two cities and culminates in a study abroad experience pairing students from Malmö University and Rochester Institute of Technology. The course focuses on: natural ecosystem services; how humans have impacted those systems through development; and how impacts can be mitigated by using the natural systems as templates to influence smart development and maintain ecological functions and services.

The course has been taught three times in a workshop format, blending lectures, in-class exercises, and field trips to local problem areas and sustainable solutions. The study abroad experience allowed RIT students to work collaboratively with international students and faculty, strengthening global understanding and cultural awareness. Students created projects that emphasized key urban ecology initiatives found in the host country and were presented/disseminated through the use of ESRI Storymaps (https://storymaps.arcgis.com/en/).

Urban Ecology examples used in Storymaps found in both Rochester and Malmö included:

1) Enhancing biodiversity by integrating natural landscapes into the built environment (pollinator gardens, permaculture, restoration ecology/refugia, land use/land cover analyses and urban planning);

2) Reducing stormwater runoff and flooding that result from increases in impervious area through green infrastructure (rain gardens, eco swales, vegetative roofs, wetlands restoration for flood control, water supply, and nutrient/waste management systems);

2) Management and reduction of waste, including educational components for K-12 students

Keywords: urban ecology, education, study abroad, storymaps

P0146

Landscape metrics: introducing a new R tool to characterise landscapes

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Landscape metrics are well-established tools to describe the composition and configuration of landscapes, mainly with the purpose of linking landscape patterns to ecological processes. Advantages of landscape metrics include the simplification of complex landscape structures into meaningful metrics that can be easily interpreted and communicated. However, existing software capable of landscape metrics calculation is usually limited to only selected operating systems, is not open-source and laborious to include into reproducible workflows. These constraints limit the use of existing landscape metrics and the development of future ones. Therefore, we introduce the R package "landscapemetrics". It runs on all operating systems that run R and is open-source software. The package includes the most common used landscape metrics and has several advantages over existing software. "landscapemetrics" is based on well-established spatial frameworks in R and follows the “tidyverse” principles. This allows an easy integration into reproducible workflows such as pre-processing of input data or analysis of results. Additionally, the package includes utility functions, for example to visualize or sample landscape metrics. Also, several “building-blocks” are included in the package to support development of new metrics. All this simplifies the application and development of landscape metrics for future ecological research.

Keywords: R software, open-source software, landscape analysis, landscape indices, patch mosaic model

T0838

Landscape ecology in environmental education in Russian universities: is there a need for change in a changing environment?

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Environmental education in Russia is carried out within the several directions of preparation as a part of geographical, biological, chemical, pedagogical and engineering specialties. Training of specialists within geographical specialties is the closest to a field of landscape ecology but also within this direction the landscape ecology as independent discipline is not obligatory for studying, only in a number of the universities it is offered as a part of disciplines of specialization or disciplines for choice.

At the same time theoretical and practical questions of landscape ecology are included in programs of disciplines obligatory according to Federal Standard of Education such as landscape studies and geoecology.

The first of them is based on the russian landscape tradition considering a landscape, first of all, as the natural and territorial complex without special attention to its cultural and aesthetic value. Geoecology in turn includes knowledge of global and regional environmental changes and environmental impact assessment.

The data source for conducted research was the specially made database on environmental education by more than 100 universities that allowed to compare the representation, contents and applied orientation of both disciplines – landscape studies and geoecology - in curricula and programs of training of bachelors and masters. The critical analysis of the special content directed to forming of holistic idea of a landscape is carried out. The most common forms and ways of training directed to forming of practical skills in the field of landscape ecology are defined.

Results of a research include evaluation of the "strong" and "weak" moments in learning techniques and theoretical approach to teach landscape ecology within environmental education. Potential solutions to improve the level of landscape ecology teaching within geoecology is provided, the template version of the contents and practical works for this block on the basis of scope

Keywords: environmental education, landscape ecology, curricula, university

T0025

LIFE “Sic2Sic - In bici attraverso la Rete Natura 2000 italiana” – creative writing in primary schools to increase knowledge on the importance and role of the Natura 2000 Network

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A network of connections among 169 Italian Natura 2000 Sites by cycling around 6000 km in 7 regions and directly involving 2000 students through creative writing: this is the Life project whose main purpose is to increase the knowledge of the meaning and role of the Nature 2000 Network through a sustainable means (the bicycle) and conveying to students the importance of the environment. During each meeting between Sic2Sic project representatives and students, the key concepts of the project are explained (biodiversity, landscape, conservation, sustainability) and each child is given a sheet with an ad hoc text; the student circles 10-15 words chosen according to "instinct" and uses them to build a short poem to which he assigns a title. The experience gained so far has revealed that the approach to nature through an instinctive use of printed words highlights a sensitivity to environmental issues that, with the help of the teaching staff, can represent a great opportunity for a different and effective way to approach the boys to the basic concepts of landscape ecology

Keywords: biodiversity, sustainability, knowledge, landscape, education

T0887

Bringing Landscape closer to biologists: teamwork for facing Anthropocene challenges in real life socioecosystems

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During most of their graduate curriculum, Biology students at Universidad Autónoma de Madrid receive teaching mostly centered in species or communities. Only in the last year they get the chance to open towards more interdisciplinary issues. The "Environmental Systems" course has become a highly valued subject after being improved through a teaching innovation project.

Aiming to bring students closer to social-ecological processes the course goal is to analyze local landscapes through a transdisciplinary approach, problem-based learning and collaborative teamwork in real-life cases. Sierra Nevada and Cabo de Gata (Spain) is the study area and student teams select one local landscape within it to analyze biophysical processes, ecosystem services, land use patterns, stakeholders' perceptions and landscape related institutions and governance. The high regional heterogeneity ensures that each group investigates quite different landscape patterns, processes and perceptions, facing very different problems and solutions.

Complex thinking, Earth system science and planetary boundaries are introduced by flipped classroom techniques. As the first step of an autonomous learning process, student teams analyze the socioecological history of places and identify the main drivers of change. Using a step by step DPSIR methodology, students tackle the whole social-ecological circle from landscape to institutions and governance and vice versa, that ends in an interactive session designed to discover regional relationships between places. Students and teachers plan a 5-days field trip to the study area, aiming to face real-world situations through deep interaction with landscape and selected experts and stakeholders, who give students interpretations and thoughtful discussions about their visions for the future. The course evaluation depends on a final dossier developed after assimilating all the feedback gathered during the visit, which includes concrete landscape management proposals

Keywords: Landscape ecology education and teaching for biologists, teaching methods, social-ecological systems framework, landscape services

Landscape' / 'Architecture' | 'Seeing'/ 'Acting' Structuring disciplinary dichotomies for ecological learning

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Historically landscape architecture has drawn from practices of 'seeing' for example, landscape painting, mapping and GIS. At the same time forms of action have been modified from gardening, architecture, painting and other fields. Taking this idea of multiple lineages as a starting point, a teaching practice was developed that actively used the tension between processes of seeing and acting in landscape architecture to establish a dynamic frame of reference for analysis and positioning, in which the act of positioning is always in motion and capable of producing multiple threads of connection. This oscillating framing of seeing and acting became a way for students to explore ideas using multiple intelligences and establish a suite of tools for students to position their own work and the work of others.

In the Discipline of Landscape Architecture creative forms of intelligence are discussed in teaching and learning environments, however rather than arguing for an either-or-model, in this paper we suggest that multiple forms of intelligence may be engaged, which we title as a 'practice-based model' for teaching and learning. This is explored as a model to enable multiple forms of engagement and learning capacity which is inherent in the process of learning for the discipline.

This paper aims to discuss how three dynamic ' design research-based teaching' models; 'the conference', 'the design laboratory' and 'the expedition' were developed for the purpose of engaging multiple intelligences in order to develop both lateral and linear thinking. This is an expansion of what is commonly understood as the 'studio learning model', into a 'collaborative and cooperative' learning model which suggests a pedagogical structure customised to various types of disciplinary learning and doing.

Keywords: creative ecologies, landscape pedagogy, ecological thinking, research methods, research techniques

T0942

Going beyond traditional teaching methods with Inquiry Based Science Learning (IBSE)

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The aim of my presentation is to share my experience, and the experience of all my ANISN group of Teachers, in the Inquiry based teaching method, which lets the students acquire more than just the knowledge of the matter of study, it gives them the ability to build their own Learning experience.
Students who experience IBSE have a more active role in their classrooms, materializing a bidirectional and closer relationship between them and with their teachers, a greater involvement in decisions and collective work with effective repercussions on student outcomes. The students became more autonomous, intervener, reflexive, critical, dynamic and able to be actors on their own process of learning construction.
This means going beyond traditional teaching methods, and also helping fill the gap between different levels of education.
Inquiry method helps to get a well succeeded continuous professional development, and to get life skills such as: better values and visions, mutual trust, respect, support and openness, collective responsibilities for student learning, collaboration focused on learning (the group as well as the individuals). In a word, a better World

Keywords: Teaching techniques, IBSE, Inquiry

Learning landscape ecology in the landscape: Educative tools in the context of a landscape observatory

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Raising awareness for the landscape is one of the aims of the European Landscape Convention in order to promote the quality of landscape planning and management. Thus, the creation settings and tools for the motivation and involvement of people in landscape issues is pivotal. Investing in education fosters a transgenerational perspective. It is acknowledged as one of the most efficient tools to prepare for a future sustainable and responsible society. Landscape ecology concepts can be incorporated throughout the various levels of education. In this context, landscape observatories (LOs) as fora for the collection, co-production and sharing of landscape knowledge, act as meeting points and catalyzers for landscape action, involving communities, stakeholders and interest groups.
Observatório da Paisagem da Charneca (OPC) is a local landscape observatory located in the municipality of Chamusca (Portugal), focused on networking with local communities for educational purposes. It has stablished partnerships with local primary and secondary school, as well as, with higher education to develop special training tools based on a landscape ecology approach, incorporating ecological and social dimensions. This communication reports on the research and application of tools to incorporate landscape ecology into teaching activities, using innovative approaches, such as the 'classroom in the landscape', where students benefit from an immersive landscape experience, in order to achieve an integrated vision of the landscape. This approach intends to be a 'real-life' landscape experiment for the students, developing their perceptions and knowledge about the landscape in holistic terms, and thereby reinforcing the role landscape observatories in creating links with the community.

Keywords: Education, Rural landscape, Immersive, Agro-forestry system, Trails

Impactful partnerships among graduate students and managers for regenerative landscape design

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New models of student-university-society partnerships are needed to find solutions to pressing food-energy-water problems at landscape scales. We are developing a graduate training program, Landscape-U, that provides interdisciplinary training opportunities in ecology, human dimensions of natural resource management, and agriculture and development, while training the next generation of scholar-practitioners to deftly cross disciplinary boundaries and work in partnership with stakeholders to co-create solutions to these challenges. Through an orientation, foundational coursework, science communication training, internships, lab rotations, and community-building and outreach events, carefully aligned along existing intercollege graduate degree programs, trainees will have the confidence, skills, and professional networks necessary to have an impact on pressing societal challenges at landscape scales. We anticipate training sixty (60) MS and PhD students, including thirty-five (35) funded doctoral trainees from ecology, natural resources, agriculture and development, and related disciplines. Student-research case studies will explore landscape change across time, and may include: (1) the influence of critical zone processes (including the geological template) on hydrology patterns and subsequent decisions about food and energy systems, (2) the deep history of human entanglements in intertidal systems, based on archaeological evidence, that indicates sustainable oyster harvesting by Native Americans in the Chesapeake Bay, thus providing important baselines for sustainable restoration, and (3) energy transformations, many of which originated in the Chesapeake Bay watershed. The traineeship focuses on transdisciplinary competencies for graduate education through an emphasis on regenerative solutions, ecological design and planning, and landscapes as the unit of analysis for linking food-energy-water systems across scales.

Keywords: food-energy-water nexus, education and teaching, geography, transdisciplinary, planning

T0683

Experiencing ecosystem services in the landscape

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Ecosystem services (ES) describe goods and benefits humans receive from ecosystems and landscapes. The ecosystem service framework can also be an advantageous concept to promote the societal relevance of landscape ecology in specific and basic research principals in general. To divulgate the concept and its applications as well as to support policy making applications, efficient and smart educational activities are needed t. To support this goal, we developed and implemented the first educational walk dealing with ES (https://www.oekosystemleistung.org/en/index.html). The content is based on the results of research projects and was developed by applying a participatory and iterative approach involving both, landscape ecologists and end users. The educational walk allows local population as well as tourists to become familiar with the ES concept in general and the most relevant ES in the European Alps in specific. A stationary trail, which can be explored individually using a freely available audio guide for smartphones, includes 11 different stations dealing with landscape ecology in general, and relevant ecosystem services in the European Alps in specific. It is complemented by a guided tour offered for school classes and other interested groups. This tour is conducted by trained nature guides using a specially developed tool-kit and can be done nearly everywhere in the cultural landscape of the European Alps. In both, the stationary trail and the guided tour, the content is presented using interactive and experience-oriented methods and allows addressing and reaching very different target groups (stakeholder, multipliers, residents, tourists, students and pupils) in an effective and cost saving way. Cooperation with a regional environmental education organisation, the tourism association, and regional environmental authorities guarantees the sustainable and long lasting use of the developed materials and tours.

Keywords: Teaching social-ecological relations in the landscape, 1st educational walk dealing with Ecosystem Services

Interdisciplinary training through a distributed graduate course: DGS Landscape Genetics

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In order to address the challenges of the Anthropocene, a new generation of scientists needs to be trained to bridge between disciplines both conceptually and methodologically, and to collaborate in a new research community. The Distributed Graduate Seminar (DGS) Landscape Genetics may serve as a model for such training. This course provides interdisciplinary training for graduate students in the developing research field of landscape genetics that integrates landscape ecology, population genetics and spatial statistics. With funding from the National Center for Ecological Analysis and Synthesis (NCEAS), we started with 8 participating institutions and provided taped lectures as well as opportunities for inter-institution group research projects and a synthesis meeting for faculty and students. While the graduate course was the original focal product of our effort, the DGS has allowed us to build a community among participating faculty across disciplines and to integrate young scientists into a dynamic and inclusive scientific community. Since 2010, we have taught the DGS four additional times reaching a total of over 1200 students and professionals. Here we discuss six aspects of ongoing innovation in the DGS and their impact on interdisciplinary training and community development: (1) access for a diversity of participants through online access to individuals and institutions around the world, (2) integration of interdisciplinary knowledge though a new textbook, (3) development of quantitative research skills through a course R package, (4) hands-on training in online collaborative research through group projects, (5) networking for faculty and students through the biannual synthesis meeting, and (6) career development for faculty and students through mentoring and opportunities to take on new roles in the DGS course.

Keywords: Interdisciplinary training, Hybrid course, Postgraduate, Online collaboration, R package

P0234

Mobartech: experiencing local heritage and cultural landscape in a Unesco site.

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Our work explores educational experiences to improve the use of landscape and heritage in a Unesco site, Mantua and Sabbioneta, within an Italian research project named MOBARTECH funded by the European Union, Lombardy Region (FSR). This was inspired by "Cultural landscapes. The research and the proposal of a didactic of the heritage between art and science. New forms of valorisation", financed in 2014 - 2015 by the Lombardy Region (FSeR) and aiming at developing educational paths to valorize Isola comacina, Lorenzo Rota's botanical garden and Villa Carlotta. While listening to visiting public and cultural operators, great importance was given to educational activities aimed at the school. The result was an empirical kit (Dewey 1954) to be used by different visiting publics. A new project was born from this successful research, MOBARTECH . With a similar multidisciplinary approach, we aim at co-building knowledge to encourage the creation of new creative processes to enhance cultural landscape from a local community perspective. This study will discuss data collected during school work alternance actions' in February and April 2019 in Mantua and Sabbioneta. Thanks to the collaboration of a groups of 15 students of Pitentino Institute, we have reflected on the relationship between heritage, landscape and local stories. Attention will be paid to how school-work alternance activities may have promoted personal and collective identity in young citizens of a Unesco site. As cultural geography argue cultural landscape is not just the expression of a domination single perspective, rather a complex multifaceted construction laden with symbolic power (Olwing, 1996). In the light of this, an exploratory and experiential kit will be created by the students themselves as a tool for participatory activities in the Unesco site involving different types of audience (senior visitors, families, foreign tourists, city users, pupils of any age etc.) in the near future.Without heritage

Keywords: cultural landscape, education, unesco site, heritage

Symposium 66

The landscape approach - key to enhance sustainable land use in Europe and North-America as well?

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According to the Global Landscapes Forum "the landscape represents an ideal scale at which to implement strategies and evaluate progress of initiatives designed towards more sustainable outcomes for both people and nature. As such, landscape approaches are increasingly acknowledged within global environmental policy discourse and have generated discussion and debate within the scientific and practitioner communities" (GLF 2017). This is followed up by Reed and Sunderland (2018), who describe the background for the wide appeal of the concept being based on a recognition of a need to overcome sectorial silos if we are to find sustainable development pathways. Also Freeman et al. (2015) emphasise that the concept is increasingly applied within the international environmental community, in general for addressing multiple objectives, usually related to both environmental and social goals, especially social equity. However, in Europe and Northern America landscape is not often considered as an integrating concept in cross-sectoral strategies and policies for the mentioned purposes.

A landscape approach is "a framework to integrate policy and practice for multiple land uses, within a given area, to ensure equitable and sustainable use of land while strengthening measures to mitigate and adapt to climate change" (Reed et al. 2015). FAO (2012) defines a landscape approach as "…dealing with large-scale processes in an integrated and multidisciplinary manner, combining natural resource management with environmental and livelihood considerations." FAO further underlines that the landscape approach also factors in human activities and their institutions, viewing them as an integral part of the system rather than as external agents." According to Sunderland (2014), the landscape approach "…as it relates to conservation, agriculture and other land uses seeks to address the increasingly complex and widespread environmental, social and political challenges that transcend traditional management boundaries."

"The landscape approach" is currently being propagated as useful in a wide range of contexts, including rural land use (FAO 2017), forest land use (Reed & Sunderland 2018) and urban heritage landscapes (Bandarin & Van Oers 2012). The Center for International Forestry Research (CIFOR) and partner institutions describe ten principles they consider characterise such an approach (Sunderland, 2014). These 10 principles emphasise adaptive management, stakeholder engagement and dialogue, and multiple objectives (Sayer et al., 2013). FAO (2017, p.6) forward the usefulness of a landscape approach and state; "Landscape approaches are essential to support sustainable food and agriculture and build resilient and productive social-ecological systems. These approaches protect vital ecosystem services and sustain livelihoods, tackling food security challenges while adapting to the likely future impacts of climate change."

While being propagated by FAO, UNESCO and The Global Landscapes Forum, interestingly the landscape approach at present appears to be mainly seen as relevant to development cooperation, e.g. REDD and other land use projects, required by the donors to be sustainable and equitable. The landscape approach is much less well recognised in e.g. European and North-American policies. Landscape ecology has a considerable potential to play a crucial role in this "landscape approach", although it is rarely mentioned explicitly as being relevant in this context. In this symposium we will explore why this is the case, and how this could change.

T0402

Moving from rhetoric to reality: Operationalising the landscape approach in practice

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Integrated landscape approaches are now central in international dialogues related to biodiversity conservation, livelihoods of marginalized groups, food security and broader development issues. The concept has also entered discussions around the new climate agenda and Sustainable Development Goals. Any landscape approach to development that integrates policy and practice for competing land uses faces national level challenges of balancing demands for domestic growth and food security with global commitments to curb biodiversity losses and achieve emissions reductions targets.

In addition, in recent years, and as part of zero deforestation commitments, the private sector has also expressed a strong interest in working at a broader landscape scale but requires guidance and advice as to the most effective means of implementation and measurement of progress. Thus, this broad constituency suggests that achieving more satisfactory environmental and development outcomes by focusing at the scale of the landscape, rather than at the sectorial level, will have considerably more impact.

While strong conceptual frameworks and principles for landscape-scale implementation exist, assessment of progress on the ground remains incomplete. This is especially exacerbated by the limited reporting of the actual implementation of landscape-focused projects in the current scientific literature and the "how to" in terms of actually managing landscapes more holistically. Recent research has begun to assess the constraints in operationalizing landscape approaches and identifies issues of legislation, governance, institutional power relations, external drivers of change, lack of adequate metrics for monitoring and inadequate stakeholder engagement as hinderances to effectively scaling up to landscape level implementation. Here we present these constraints in the context of current efforts in three tropical countries: Burkina Faso, Zambia and Indonesia.

Keywords: Landscape approaches, Operationalise, implementation, monitoring, integration

T_8922

Multiple aims - one landscape

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The Norwegian Government has a bioeconomy strategy entitled "Familiar resources – undreamt of possibilities». The aim outlined in the strategy is ambitious; "National focus on the bioeconomy should lead to increased value creation and employment, reduced emission of climate gasses, as well as more efficient, profitable and sustainable use of renewable biological resources." The idea being that a bioeconomy can be key in a transformation towards a more environmentally friendly low emission economy.

The resources concerned are to a large extent terrestrial renewable biological resources. In general, they have in common that they are (physically) rooted at a location. They thus occupy a certain spatial extent. If we are to increase one of these, e.g. forest, it will require reducing the spatial extent of something else, e.g. agriculture. This understanding is not well incorporated in Norwegian policy documents however, and aims are often potentially (spatially) conflicting. One such conflict is between this efficient and increased resource use and preserving biodiversity, as the same renewable biological resources that are to be used in a more efficient and profitable way also represent different habitats. For example, approximately half of the Norwegian threatened or near-threatened species are found in forests. Forestry related activities are considered negative for 1400 of these. Land use is a threat to a majority of Norwegian red-listed species, in line with how fragmentation and habitat loss are affecting species worldwide.

One possible way forward, we believe, is through the use of GIS and spatial analysis. By assessing the spatiality of different resources, qualities, and in fact the aims, in a way inspired by McHarg, locations of potential conflicts and locations without apparent conflicts can be identified at an early stage. These analyses could then provide a foundation for a management based on a place-based landscape approach.

Keywords: landscape approach, sustainable land use, GIS, conflicting aims

T0589

40 years of environmental activism in the province of Girona, Catalonia – from case advocacy to regional planning, a story of success.

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The province of Girona, in Catalonia, is located in one of the most dynamic geographical spots of the Iberian Peninsula. With the Pyrenees bordering with France on the north, the "wild" Costa Brava seaside to the east and the vicinity of Barcelona to the south, this little region receives more than 5.5 million tourists per year. A pressure combined to high industrial and logistic potential, with the main international infrastructures corridor between Spain and Europe and the port of Barcelona. Alas, in Girona, landscape is at once diverse and beautiful (from 2.900 m to sea level in less than a 2h drive) yet always at stake. Hence, since the 70s a myriad of environmentalist groups advocate for landscape and ecosystems conservation.

In a citizen science collaborative experience, the Geography Department of UdG has produced a dataset and a map of more than 60 places in the province of Girona, where plans and projects of high environmental impact have been stopped after civil society mobilization. What would the region look like if all these roads, urbanizations, massive campsites, waste and power facilities, quarries, intensive livestock farms, ports, etc. had been built? In the transition to sustainable societies and for the maintenance of ecosystem services, reaction and resistance are perhaps as relevant as regeneration and rewilding. Nonetheless, a shift from case advocacy to regional planning is needed; reason why the pressure of environmentalist groups in Girona is currently fueling the development of an ambitious regional urban declassification plan, aiming at cancelling growth prospects for up to 30.000 detached housing units on fragile coastal areas. It is a story of success, in a territory of excess.

Keywords: landscape and quality of life, environmental activism, socioecological resilience, land planning and management, governance

T0739

Wrapping it up? How does landscape approach work in marginal areas?

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Landscape can be understood as common good, which is influenced by different stakeholders (Antrop & van Eetvelde 2017). The landscape approach, as defined by Shuttleworth (2017), should offer a mechanism for reconciling top-down objectives and needs with bottom-up perspectives and priorities. The problem, however, as Hernandez Morcillo et al (2017) show is that the priorities of different stake holders do not coincide too much. How would this approach work in marginal areas with minimal (and declining) human populations where landscape changes are becoming dependent on individual decisions of a very small number of people? There are areas with minimal – and declining – rural populations which fall in the gap pf interest between traditional management sectors, such as agriculture, forestry, or nature conservation. In cases like this the development of a landscape becomes dependent on everyday practices of a small group of people (Palang et al forthcoming). How are these decisions made? What is the role of landscape here? We will use multiple cases in Estonia to study how concepts like stewardship and seasonality might in fact help maintaining the cultural landscapes.

Keywords: Landscape approach, stewardship, seasonality, marginal areas

T0403

Engaging multiple stakeholders in landscape approaches that reconcile climate, conservation and development objectives

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Achieving equitable and sustainable development that supports climate change mitigation and avoids biodiversity loss remains a leading challenge for developing countries. Sectorial thinking – focusing on just one aspect of the problem or system – is increasingly perceived as inadequate to address the complexity of linked social-ecological challenges. Consequently, holistic approaches that incorporate diverse stakeholders across scales, sectors, and knowledge systems, are gaining prominence. Such 'integrated landscape approaches' have recently received new momentum and interest from the research, donor and practitioner communities, and have been subsumed in international conventions related to climate, biodiversity, and sustainable development. Despite this new impetus, implementation efforts and the evaluation of progress remains lacking. Failure of landscape approaches to adequately engage (e.g. in design, implementation and evaluation) diverse user groups relevant to the landscapes being managed is a key factor contributing to their sustainability. Here we draw from our collective experience, consultation workshops, and advances in the literature to identify key constraints and opportunities to better engaging stakeholders in landscape decision-making. Specifically, we ask: (1) what are the key challenges related to effective engagement of multiple stakeholders in landscape approaches for conservation, climate change mitigation and development and (2) what lessons can be learned from practitioners, and how can these serve as opportunities to avoid duplicating future research effort or repeating past underperformance. We present our findings within three broad categories: (i) navigating complexity, (ii) overcoming siloed thinking, and (iii) incentivizing behavioral change, which we hope provides a useful starting point for overcoming inherent implementation challenges associated with engaging multiple stakeholders in landscape approaches.

Keywords: Landscape approach, Landscape governance, Biodiversity conservation, Integrated conservation and development, Sustainability

From integrated landscape approach to new European commons - about stakeholders, participatory processes and social learning

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The landscape approach has been widely applied in various regions in the world. Still its use in European landscape planning so far has been limited. The question is what the landscape approach has to offer for the European landscape planning.
In this paper we revisit the internationally coined landscape approach, we define and describe it, and explore its practical implications for planning. We will assess the similarities and differences with comparable approaches that are being used in Europe to do justice to multifunctionality and community-based development, such as 'integrated nature and landscape management', 'Living Labs', the 'Çittà Slow' movement, various 'rewilding initiatives', the 'commonland approach'.
Although generally not promoted as such, 'new commons' are being practiced in many places in Europe, partly on the basis of the historical commons, but also in specific new forms of public-private partnerships, enhanced by citizens' commitment and landscape stewardship. Integrating such landscape approach in European landscape planning requires case-specific solutions. Joint learning, deep democracy, and new models of social value creation are among the novel approaches that are being applied, using landscape ecological knowledge and insights to ascertain credibility.
In this sense the landscape approach – just as much as in development cooperation – could form an avenue towards a more just and sustainable land use, with shared user rights instead of exploitation based on the underlying system of land ownership, which results in overexploitation, beyond sustainability limits. The landscape approach, through the consideration of functional relationships, would offer opportunities which avoid land degradation, but it could offer also opportunities for social rehabilitation of communities, enhancing biodiversity, integrating newcomers, strengthening relationships with the land, and thus developing 'new commons'.

Keywords: landscsape planning, social value, use rights, landscape justice, biodiversity

Landscape approaches for implementing green infrastructure in local planning practice: a review

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Though increasingly acknowledged and propagated as a framework to deal with processes in an integrative, transdisciplinary and multiscale way, landscape approaches do not seem to be widely adopted within the European context. The Green Infrastructure (GI) concept, on the other hand, has received much attention in Europe. It even became part of European policy when the European Commission launched its strategy ‘‘Green Infrastructure—Enhancing Europe’s Natural Capital’’. GI is seen as a promising strategy for the development of green networks and their implementation on the ground to meet a range of policy objectives. Nevertheless, the implementation of GI in local planning practice, like in the pilot projects of the EU Interreg project LOS_DAMA!, seems often hampered by dealing with the complexity of its processes. GI and landscape approaches share many underlying principles, such as an integrative approach and the importance of the landscape scale for implementation. Yet, are landscape approaches more fit to deal with the complexity of implementation processes? Our aim is to explore whether landscape approaches could benefit the implementation of the GI strategy in local planning practice. Through a qualitative content analysis on literature, we juxtapose landscape approaches and their underlying principles with GI strategies. We aim to identify how landscape approaches and GI share common theoretical ground and where they differ. Moreover, we try to determine the potentials and limitations of landscape approaches to support GI implementation. Next to an increased understanding on the link between landscape approaches and the GI strategy, we aim to develop landscape approaches as a framework for supporting and evaluating GI implementation processes. In a follow-up study, we then apply this framework to analyse seven local planning practice cases within the EU Interreg project LOS_DAMA!

Keywords: landscape approaches, green infrastructure, local implementation, planning practice

Symposium 67

Towards visionary peri-urban landscapes? Environmental governance mixes for sustainable peri-urbanization.

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Recent research highlights that peri-urbanization processes, described as well as peri-urban transformations, are massive, intensive, often taking place beyond any regulations, threatening performance of ecosystems and thus unsustainable. The main driving forces behind peri-urbanization are related to increasing commercial demand for building-up open spaces, different kinds of newly developed infrastructures, or search for better quality of live by urban dwellers. Those transformations lead to emerging of peri-urban landscapes (PULs), which are transition territories connecting cities with their surrounding environment, where urban, forest and rural characteristics are mixed. Thus PUL is understood as a territory, which is located beyond administrative boundary of the main city, or several cities in the frame of a conurbation, and covers fully or partially several urban and non-urban municipalities. It is characterized by low settlement and inhabitants density, by a mixture of diverse land-uses, by material and energy flows, which are encouraged by dynamically emerging urban land-uses. PULs remain under continuous, or even rising urban influence, which is represented by: increasing presence of typical urban forms, industrial / commercial areas, diminishing of natural habitats, high ecosystem fragmentation and increasing stress factors like noise, or light smog. Under the sociological perspective, PULs are characterized by e.g. mixture of old and new residents (often urban commuters), degradation of social relations among PULs inhabitants, or a mixture of different live styles. All that make PULs to suffer from different conflicts. Vertically and horizontally fragmented management, increasing pressure of market forces over the landscape, velocity of peri-urbanization, lack of awareness about threats of peri-urbanization are just a few different types of obstacles related to governance of PULs. Environmental governance of PULs relates to concepts such as metropolitan areas, conurbations, or functional urban areas. Thus environmental governance of PULs needs to address urban, regional and national development goals such as air pollution reduction, integrated watershed-management, transport-management, economy, the provision and accessibility to ecosystem services. We argue that to achieve the sustainable development of PULs a governance mix tailored specifically for PULs are needed. The term governance mix is frequently used in political or management sciences and means a collection of specific for the particular context governance approaches, which allow to create and implement on site different policies. Environmental governance mix do not refers to the particular type of governance, but is rather a thoughtful mix of different policy instruments and other top-down and bottom-up governance approaches, introduced at diverse levels of administration, bringing different formal and informal outcomes, discussed and implemented by the wide range of governance actors (citizens, stakeholders and experts). The notion of governance mix is similar to "policy mix" as a "combination of different policy instruments" (p.17, Ring and Schröter-Schlaack, 2011). We hypothesize that PULs are an emerging new type of dynamically changing landscapes, which requires visionary approaches, implemented by more innovative governance tools and instruments. Thus we encourage the session participants to think critically about possible visions for the PULs and the ways how to implement those visions in a sustainable way. Our symposium will be open for scientists, practitioners and diverse stakeholders related to PULs. We welcome highly innovative theoretical research concerning to environmental governance mixes for PULs and examples of practical implementation of governance mixes aiming to achieve the sustainable development of diverse PULs.

T0357

Neglected urban open spaces as a potential cultural ecosystem services provisioning areas in peri-urban context

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One of the main drivers of peri-urbanization processes is the need for improving the quality of life of urban dwellers, by providing accessible and diverse cultural ecosystem services (CES). Thus a frequent ecosystem services (ES) trade-off emerges in peri-urban contexts between the need of protecting of green areas or protecting of food production areas and providing to urban inhabitants the good accessibility to CES to increase their quality of life. In our research, we will focus on neglected urban open spaces (NUOS) as potential CES provisioning areas located in the vicinity of urban inhabitants. We hypothesize that NOUS could be abandoned green spaces (e.g. unused parks, playgrounds or other green spaces without clear land use), brown-fields, vacant spaces, non-developed built areas, fully or partially sealed areas.

Our study aims to provide a quantitative approach to delimitate areas which are potential NUOS. Those areas have a high potential to provide CES, are located in the peri-urban landscapes, close to the settlements with the high CES demand. We focus on areas which are publically owned and offer transformation possibilities to increase their potential to provide CES.

The research is implemented in the sample of peri-urban landscape located in the vicinity of Ostrava city, Czech Republic. To fulfil the research aims we propose a quantitative methodology based on spatially explicit indicators (Technomass, Normalized Difference Vegetation Index, ES Deficit Factor) and calculation of the accessibility over the road network. The calculations are provided for the hexagonal cells, distributed in the form of a grid over the case study area. The method allows delimitating hexagons, which fulfil the criteria of NUOS.

The research method creates an analytical governance approach to assess the ES trade-offs in diverse peri-urban contexts and to prioritize NUOS with highest potential and demand for conversion.

Keywords: Ecosystem services, Governance, Peri-urban landscapes, Trade-offs, Urban open spaces

It takes a region: weaving a strong partnership to grow a healthier urban forest

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In the Chicago Region of the United States, the urban forest is in a state of transition. There is a significant presence of invasive woody plants; eight percent of the canopy was recently lost to the invasive pest, emerald ash borer; the recent recession reduced funding significantly for the growing, planting, and care of trees; native oak trees are not regenerating at a sufficient rate to sustain healthy oak woodlands; there is limited species and age diversity of trees across the region; and climate change is intensifying many of these problems. The Chicago Region Trees Initiative is a broad collaboration committed to addressing these challenges.

The Chicago Region Trees Initiative focuses on the City of Chicago as well as the surrounding region, which includes seven counties, 284 municipalities, 123 townships, more than 160 park districts, and seven forest preserve districts. Each government body represents constituents with different values and attitudes, yet the trees in this region do not recognize the political boundaries. The Chicago Region Trees Initiative has brought together public, private, and nonprofit partners across the region from myriad sectors and government levels to work collaboratively on improving the urban forest.

When collaboration is done well, partners can push an initiative further and achieve greater goals. Our lofty goals for the region's trees, which include inspiring people to value trees, increasing the canopy cover by 4 percent, improving connectivity of oak ecosystems, and reducing risks to trees, have been vetted and supported by numerous stakeholders across the region. We have developed tools and resources to help individual partners assess their capacity to reach these goals and to help them build stronger programs. In this talk, attendees will hear about challenges and successes in one of the world's biggest urban forest initiatives, with examples they can enact in their own communities.

Keywords: urban forest, community forest, collaboration, operational capacity

Research on the Integration Strategy of Suburban Fragmentation Landscape- Taking the Planning of Country Park Ring in Beijing Plain area as an Example

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Since the 1990s, with the gradual increase in construction land and the gradual reduction of cultivated land, Beijing has entered a typical suburbanization process. In this process, even though the landscape patch number in suburban regions is increasing, it has not been able to avoid the fragmentation of suburban regions due to the reduction of landscape patch area, which has caused great damage to the suburban landscape.Taking suburban regions of the plain area in Beijing as an example, according to the planning of the national land space by the Ministry of Natural Resources, we will mainly divide the research area into urban space, agricultural space and ecological space. Through the assessment of the sensitivity of ecological environment and the importance of ecological functions, the ecological space is adjusted and the relationship between the three types of space is coordinated to rectify the suburban landscape of the plain area.On this basis, taking into account the landscape resource advantages, ecological restoration needs, and tourist recreation needs of the region, the location of the country parks is selected in the ecological space and connected in series to control the spread of the city, improve biodiversity and integrate broken suburban landscapes.

Keywords: suburban landscapes, fragmentation, country park

P_8196

Long-term land use changes driven by urbanization and their environmental influences

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The development of cities is linked to qualitative changes of the landscape aimed at strengthening economic, administrative and cultural-social functions, which are associated with ever-increasing pressures on ecosystems and their individual components of the surrounding area. These pressures are subject to various factors – socio-economic, political, environmental, etc. Like many post-communist countries, Slovakia has undergone significant changes. The transformation of central planning into a market economy was the basis of these changes, which conditioned following strong pressure of investors on the landscape, construction of technological parks, shopping and logistics centers, transport infrastructure, but also construction of residential complexes, etc. The conversion of natural and semi-natural ecosystems into building lands represents activities with significant negative ecological impacts (e. g. habitat destruction due to the reduction of forest and urban vegetation, occupation top-quality soils for non-agricultural activities, increasing of anthropisation of the area, the reduction of spatial ecological stability,etc.). These trends negatively reflect not only on the ecosystem changes and as threats of ecosystem services, but also on the deterioration of the quality of the environment. The poster willl present:

• the changes to land use in the peri-urban area Trnava in connection with urban development trends
• negative impacts of changes on the landscape, their components and also on the quality of the environment
• the main driving forces of these changes
• the main tools that can be used to guide the spatial development of the area according to the principles and criteria of sustainable development.

Ecological and environmental assessments may indicate both land-use and planning inefficiencies, and can help to identify negative urban development issues and to direct urban development towards a sense of sustainable development principles and criteria

Keywords: land use changes, landscape-ecological planning, urbanisation, sustainable development

T0114

Where houses and wildland vegetation meet – meta-analysis of criterions and methods of Wildland–Urban Interface determination

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Wildland–Urban Interface (WUI) is an area where human settlements and wildland vegetation meet or intermingle. This is an area mainly associated with wildfire context globally, however, in last years, the researchers indicate that WUI is important also as a space, where exotic species introductions, disease transfers or conflicts between predators and humans may happen more often than elsewhere. While researchers report that WUI plays important role in landscape governance of rural or peri-urban areas, little is known if they understand WUI in similar way?

In this work I have analyzed 716 scientific papers from Web of Science Core Collection, published between 2010 and 2018, where WUI or Wildland-Urban Interface was found in the text. As the second step only non-fire related papers (72 in total) were selected. For these, I have conducted the in-depth analysis focusing on differences in WUI definitions, main topics of the study and geographical scope of the works. The results showed that although WUI is analyzed globally, 79% of the papers refer to the research conducted in the US. The main topic studied in the selected papers was related to wild animals activity near settlements (36%), while land use change, invasive species and recreation activities were also found relatively often.

The results show that there is a need to use WUI as a useful and meaningful concept of landscape governance and an important spatial determinant of socio-ecological process. However, more cohesion in defining WUI is needed.

Keywords: Wildland–Urban Interface, WUI, settlements, forest cover

Beyond boundaries, collaborative governance in periurban landscapes. Evidences from Alpine metropolitan areas

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Periurban spaces are hybrid areas where built and non-built patterns are mixed, and various functions of urban and rural ambiances are threatened by urban sprawl and fragmentation. Urban cores and surrounding municipalities need therefore to find innovative context-specific tools to tackle the increasing pressure on periurban landscapes. The analysis of GI and landscape-related policies within seven pilot projects of the EU Interreg project LOS_DAMA! reveals that intermunicipal and local levels remain quite overlooked in spite of the common awareness on the need to address these issues at the FUA level.
Landscape governance refers to an inclusive multilevel, multi-actor and multi-sectoral approach to foster public action. In the particular case of developing GI processes in periurban areas we claim that an approach through "collaborative governance" could enhance mutual understanding and foster local and regional knowledge to reach a more effective adaptive management of landscape. We aim to answer the following questions:
• Which stakeholder constellations can typical be found in the planning of open spaces in peri-urban areas?
• How to include various stakeholders beyond administrative and sectoral boundaries?
• To what extent does collaborative governance play an important role in planning open spaces within periurban areas?
Our methodological approach will be based on content analysis of project documents (Pilot Action Plans) designed by local communities involved in the INTERREG Alpine Space Programme LOS_DAMA!. Pilot projects developed within LOS_DAMA tend to answer this problem; this will result in a typology of stakeholder constellations, and methods and tools to promote cross-boundary collaboration.

Keywords: Periurban landscape, Governance, Stakeholders, Intermunicipal

Analysis of Changes in Rural Landscape Interiors with the Use of Sectoral Analysis of Landscape Interiors (SALI, SAWK in Polish) - an Example from the Peri-Urban Zone of Wroclaw (Poland)

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The aim of the article is to present the changes taking place in the landscape of villages situated in the zone of the influence of a large city. The research area includes villages located in the urban fringe of Wrocław, within the green infrastructure system of the Wrocław Functional Area (GI WFA), which was planned in 2016. For this reason, any investment activities within them may result in the interruption of the planned system. The villages under study (Psary, Szymanów, Krzyżanowice), however, are now subjected to high investment pressure mainly in the form of housing development, zones of economic activity and road infrastructure. What is also noticeable is the disappearance of open spaces between them and the fragmentation of ecosystems.

The studies carried out with the use of the sectoral analysis of landscape interiors (SALI, SAWK in Polish) find negative spatial changes that have occurred in the landscape of the analyzed villages and their surroundings over the last decade: (1) reduction in the percentage share of greenery in individual village landscape interiors (2) differences in the type of the existing greenery, depending on the type of buildings, lack of high greenery in the areas where new buildings are present, primarily new housing estates, (3) blurring clear boundaries between individual villages and fragmentation of open spaces. Research results - justify the necessity to implement the GI WFA project at the local level, introduce standards and guidelines, and to undertake various types of bottom-up activities in order to increase the share and use of greenery in the peri-urban landscapes (PULs).

Keywords: landscape interior, village, evaluation method, system of greenery

Types of suburban neighbourhoods in Warsaw agglomeration in the perspective of spatial and social integrity

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The aim of the presented research was to distinguish types of the suburbs that appear in the peri-urban zone of Warsaw metropolitan area. The identified variety of suburban forms is typical for post-socialist European countries. The suburbs are organized in a typology based on six criteria: (1) the size level of neighbourhood (spatial scale), (2) the time when the neighbourhood was erected, (3) spatial interaction with the nearest town/city, (4) the prevailing type of investment, (5) street layout, (6) access to the city centre by public transport. The typology classifies the neighbourhoods according to the degree to which they favour the creation of public spaces, or the access to such spaces in the city or nearby town. The neighbourhoods which are planned, compact in form, densely populated and based on street grid are most preferable from the point of view of spatial order and prevention of fragmentation of peri-urban landscape. They are also the most preferred type from the perspective of building social capital, especially in case they comprise individual housing, not predominantly developers' investments. Urban tissue continuity with the adjacent town or city, or at least, good public transport connections to the town or city, foster spatial and social cohesion. The 'new suburbs' may be compared with 'old suburbs'. One example are satellite 'garden city' settlements – the old ones make use of planned green public areas and railway connections with the central city; the contemporary ones are lacking public spaces and social facilities, as well as proper public transport connections with the neighbouring towns and the central city. However, examples of interventions intended to improve social and spatial integrity in contemporary suburban neighbourhoods will be also given.

Keywords: suburban neighbourhoods, typology of suburbs, peri-urban zone, garden city, public spaces

P0072

Spatial modeling of environmental risk of shallow groundwater in a typical urbanizing area, northeast China

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Taking Shenbei area of Shenyang city as an example, which is a typical area of urban expansion and intensive agricultural development, on the basis of shallow groundwater pollution assessment and hydro-geological and socioeconomic data collecting and processing, referencing to the theory of natural disaster risk, we established groundwater environmental risk assessment model, in which four kinds indicators of vulnerability, stress, functionality and adaptability were selected. The groundwater environmental risk gradients and spatial pattern characteristics are evaluated by means of data statistics and spatial analysis functions of ArcGIS and other software.

Further, the correlation between the evaluation results and land use and socioeconomic characteristics was analyzed. The results showed that (1) Spatial distribution of groundwater environmental risk is similar to that of groundwater vulnerability in Shenbei Area; geological conditions are still the main influencing factors of groundwater environmental risk in this area. (2) Urbanization and agricultural intensive development have shown obvious potential risks to groundwater environment. (3) Paddy fields in this area have higher protection value and should be further protected by safe production. (4) In the process of urbanization, natural vegetation protection, afforestation, sewage treatment facilities establishment have active effects on maintaining the quality of groundwater. （5）Finding out the spatial distribution pattern of regional environmental risks, accordingly, to adapt to natural geological conditions, to plan reasonably land use, to strengthen environmental management is one of the effective ways to coordinate economic development and groundwater environmental protection.

Keywords: Environmental risk modeling, Groundwater, Urban expansion, Agricultural intensification development

T0035

Linking land use pattern to soil antibiotic contamination in a peri-urban area

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As a result of intensive use and continuous release of antibiotics, there were high persistence concentrations in soils worldwide, which indicated severe antibiotic contamination and elevated exposure risks to soil ecosystems and humans. Although numerous studies have focused on occurrence and spatial distribution of antibiotic residues in soil matrices, little is known about the linkage between land use pattern and soil antibiotic concentrations, especially in peri-urban areas with intensive influence by human activity. Estimation of antibiotic concentrations in soils is also complex because of the limited available information of antibiotic use. In this study, we linked land use pattern and soil antibiotic contamination in peri-urban areas in different seasons, and established a modeling approach based land use parameters for estimating the spatially explicit concentration of antibiotics in soils. It has been demonstrated that surrounding land use pattern in buffer zones with radius of 350 m determines the concentrations of antibiotics in soils, and agricultural activities were the main sources of antibiotics entering into soils in this study area. A statistical model describing the linkage between land use pattern and soil antibiotic concentrations was developed with good performance ($R2 > 0.7$). Model evaluation suggests that our model can successfully simulate the concentrations of antibiotics in soils. Finally, the model was extrapolated to exhibit detailed distribution of antibiotics in soils, and we observed obviously spatial and seasonal dynamic of antibiotics in soils. To our knowledge, this is the first endeavor to explore this land use dominated relationship for estimating spatially explicit distribution of antibiotics in soils. This research provided an modeling approach based land use as a reference for prevention and control of soil antibiotic contamination in the future.

Keywords: modeling, land use, antibiotics, spatial distribution, seasonal varaition

Symposium 69

Satellite and UAV (Drone) systems for assessing and monitoring of ecological landscapes of Africa

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The goal of this full-day special session is to address the advances and challenges to using satellite and Unmanned Aerial Vehicles (UAVs) or drones derived imagery to effectively characterize, assess and monitor ecological landscapes of Africa, with view of supporting sustainable development in African countries. The landscapes include agricultural areas, peri-urban areas, watersheds and the fate of natural environment. As the human population of Africa grows, the growing demand for land to increase food production and urban development poses serious challenge to ecosystems integrity in the Anthropocene across the continent. Improved agricultural productivity is considered vital to achieving the 2030 SDGs and 2063 African Union agenda for socio-economic transformation of the continent, and to sustain the 2 billion people expected on the continent by 2050. However, agricultural and urban landscapes are expanding at the expense of natural habitats, thereby limiting the ability of the latter to provide vital ecosystem services, including biodiversity, food, drinking water, and fisheries. These change processes are taking place across varying spatial and temporal scales, from farmlands to regions. Furthermore, land cover changes and fragmentation of natural habitats need to be monitored at the appropriate spatial scale.

The availability of timely information on crop condition at the appropriate scale is indispensable to sustainable agricultural production in Africa. Recent advances in high-resolution Earth Observation satellites, coupled with the reduced cost of building and launching the Unmanned Aerial Vehicles (UAVs) or drones, have opened up great potential for enhanced capacity in African countries to integrate remotely sensed data to characterize and assess agricultural landscapes such as crop condition, as well as environmental conditions including watershed and habitat degradation. However, no single sensor meets all the requirements for assessment and monitoring of diverse ecological landscapes in Africa because of the varying spatial, spectral and temporal resolutions of these sensors. Therefore, there is the need to develop remote sensing data integration protocols to effectively characterize the changing human–environment interactions and support sustainable development and agricultural productivity in rapidly urbanizing landscapes of Africa.

We will like to propose a full day special session (morning symposium and afternoon panel session) at the 10th International Association of Landscape Ecologists (IALE) World Congress in Milano, Italy in July 2019. This proposal is supported by the Africa Regional Chapter of International Association for Landscape Ecology (Africa-IALE). We will invite scholars, researchers, environmental and resources managers from within and outside Africa to join us to discuss recent advances in integrating satellite and done data applications to landscape assessments to characterize human-environment interactions, including land use and land cover change (LULCC) at multi-scales. We are particularly interested in women, early career scientists, and graduate students.

Setting up unmanned aerial system (UAS) or drone services for agriculture in Uganda

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In Uganda and in most sub Saharan African countries, there is increasing interest for small holder farmers to improve productivity and marketing but they lack appropriate data and information. Since 2014, ESIPPS International Ltd started establishing a system for farmers in Uganda to obtain real time remote sensing data by use of drones and ground data on farms. The need was informed by a survey of existing and potential users of the remote sensing products including drones. ESIPPS established that about 144 institutions had potential to use the products for prediction and forecasting models, suitability, Unmanned Arial System (UAS), Agriculture, Spatial farms, Databases, Real-time remote sensing data farm location, crop acreage, crop statistics, crop growth monitoring, soil monitoring, mapping irregular crop plots and intercropping as well as climate forecasts for risk assessment for agricultural insurance and loans. With support from ACP-EU Technical Centre for Agricultural and Rural Co-operation (CTA), ESIPPS has since April 2017 initiated a program on "Setting up Unmanned Aerial System for Agriculture in Uganda". The program supports farmers and their agribusiness associations to establish spatial farm databases for traceability, farm area, location and crop condition through indices to help monitoring and managing of farm inputs. Two agribusinesses have been supported to establish the spatial data bases and enabled profiling of over 10,000 of tea and coffee farms, respectively. The system can be used to set up so called spatial farms in Uganda and beyond for coffee, tea, bananas, sugarcane, Irish potato, maize, tree forest cover, oil palm and pasture as well as fragile aggro-ecosystems.

Keywords: Unmanned Arial System (UAS), Agriculture, Spatial farms, Databases, Real-time remote sensing data

P0036

Application of NDVI and aerial imaging for land use classification and plant disease diagnosis

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In recent years, the development of unmanned aerial vehicle (UAV) imaging technology widely used in numerous applications including hazard investigation, agricultural survey, crop disease and pest monitoring, and agricultural land use inventory. The purpose of this study was to use an UAV to capture high-resolution aerial images of crop fields. We conducted normalized difference vegetation index (NDVI) image analysis for land use classification and plant disease diagnosis to help relevant agencies in the use of aerial imaging for agricultural production management.

Rice is an essential food crop accounting for the largest harvested area for crops in Taiwan, and the largest rice production area is the Chianan Plain. This study selected 5 townships in Chiayi County: Minxiong, Xingang, Lucao, Budai, and Yizhu. Approximately 100 ha of farmland was selected in each township as sample area, and a quadcopter (DJI Phantom 4 PRO) and a handheld fixed-wing drone (Parrot DISCO AG) were used to capture visible-light images and multispectral images. The survey was conducted from April to October 2018 and aerial photographs were captured under clear and dry weather conditions. The aerial images were processed using Pix4DMapper and ArcGIS 10.0 for land use classification and plant disease diagnosis.

The results showed that UAV imaging was extensively applicable in land use classification and plant disease diagnosis. For land use classification, the software-based interpretation results were highly consistent with the actual land use status. For plant disease diagnosis, the software-based interpretation results of sampling areas with rice blast disease were highly consistent with the results of an actual sample survey. Although this study applied UAV imaging technology to agricultural surveys, the technology can be applied to surveys of the landscape environment in the future. The technology can save costs associated with

Keywords: Unmanned aerial vehicle, Agricultural survey, Crop disease and pest management, Land use

T0956

Digital Image Classification with Machine Learning: Application to Unmanned Aerial Vehicles (UAVs)

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Recent developments in computer science have made available new techniques such as artificial intelligence (AI) to analyze big data and derive the patterns that naturally occur in them. AI techniques such as machine learning are a branch of computer science that group the methods where computer learn from data, observe and evaluate patterns to make decisions without or with minimal human intervention. In parallel, the development of low cost unmanned aerial systems (drones) has also eased data collection through aerial surveys. A major constraint posed by drones is the limitation of the existing techniques to analyze the large volume of image. Making sense of these big data will provide valuable information that can be used to address critical issues faced by communities especially in developing countries.

Satellite data are commonly used for this task. However, to what extent can drones replaced satellite data? This study assesses the performance of supervised classification conducted on drones data and compares them to the performance using satellite data. Using data collected in Benin from October 21-24, 2018, results of our analysis show that drones can serve as a proxy for satellite data. They are also easily accessible to local communities provided they have the necessary equipment measing the adoption of this technology and its use to reach development goals.

Keywords: UAV, Satellite, Machine Learning

Characterising Spatial and Temporal Heterogeneity of Vulnerable Miombo Woodlands of the Copperbelt Province of Zambia using Remote Sensing and Landscape Metrics

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Assessing ecosystem responses to land use land cover (LULC) changes and its impacts on human well-being are priority areas for the scientific community. This paper aims to demonstrate the potential of integrating remote sensing and landscape metrics into ecological research through a study on the Copperbelt province of Zambia. This integration would enhance the understanding on the mechanisms shaping the current and future changes in landscape pattern. The Miombo ecosystem on the Copperbelt is home to about 8,500 species of higher plants with 54% being endemic. In Africa, Miombo supports the livelihoods of over 100 million people. In recent year, human activities have disturbed the structural integrity of the landscape and negatively affected the ecological flows. The objectives of this study were to: (i) quantify the spatial and temporal variations in landscape fragmentation, and (ii) quantify forest fragmentation in the Copperbelt Province from 1984 to 2016. Land Use Land Cover change was determined using the supervised classification in ENVI software, computing Landscape metrics using Fragstats at grain scale determined by the Minimum Legible Area (MLA) concept. The results showed that the Province landscape exhibited increasing fragmentation because the Shannon Diversity Index (SHDI) increased from 1.18 to 1.46. At class level, forestland was highly fragmented with the Number of Patches (NP) increasing from 137,415 in 1984 to 250,205 in 2016. The Largest Patch Index (LPI) reduced from 47.73 to 20.48. Croplands on the other hand were major contributors to forest fragmentation with increasing Percent of Landscape (PLAND) of 6.43% in 1984 and 18.40% in 2016. The central, southern and eastern portions of the Province were highly fragmented. Fragmentation had caused widespread degradation to the integrity of the Miombo ecosystem hampering delivery of ecosystem services. Increasing requirement for agriculture to feed a growing population leads to ecosystem degradation

Keywords: Landscape metrics, Miombo, Heterogeneity and fragmentation, Indices, Satellite Imagery

T0196

Geospatial analysis of vegetative drought impacts on southern African biomes (1998-2017)

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Within southern African biomes, droughts are recurrent with devastating impacts on ecological, economic and social security. As southern African rainfall continues to decline, there is a high risk of drought-induced vegetation decline. In this context, understanding drought impacts on vegetation are of extreme importance for effective mitigation measures. Information on the impacts of drought on natural vegetation at the biome level is scanty and remains poorly understood. Most studies on the impacts of drought on vegetation have focused on crops, largely ignoring natural vegetation. The few existing studies on natural vegetation are based on experiments and measurements at individual tree level which are not representative of the biomes. In this study, we have analyzed and quantified the impacts of drought on southern African biomes using the vegetation condition index (VCI). The main objectives of this study are to: (i) analyse the space-time trends of vegetative drought impacts across the southern African biomes over the last 20 years (1998-2017), and (ii) to determine vegetative drought hotspots across the biomes, i.e. identification of biomes with high frequency of vegetative drought impacts. VCI was computed from SPOT VGT & Proba-V data for the period 1998-2017. VCI values range from 0 to 100, with VCI < 30 indicative of moderate to extreme drought. Results from the VCI time-series images show that the rainfall seasons 1998-1999, 2002-2003, 2003-2004 and recently the 2015-2016 season have severe drought impacts on vegetation. Our results also showed a significant ($p<0.05$) decrease in both the drought intensity and the percentage area of vegetation affected by drought over the last 20 years (1998-2017). The vegetation drought impact frequency analysis showed that the nama karoo biome has the highest vegetation drought impact frequency (17%). The results of this study provide information on vegetation resilience and ecosystem conservation restoration programs.

Keywords: Vegetation monitoring, Remote sensing, drought, biomes, Southern Africa

Multi - season biomass estimation as an indicator of rangeland quantity using MODIS imagery

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Vegetation condition assessment is critical for environmental monitoring beyond protected areas. Herbaceous biomass (g/m2 or kg/ha) is one of the indicator for assessing vegetation condition. It determine the amount of food available and movement a patterns of herbivores. Today, global change including land use or cover and climate change impact on the availability of grass resources. Climate change causes high frequency of droughts and erratic nature of rainfall. Again, increasing carbon dioxide (CO2) fertilizes trees as compared to grasses, and this exhibit a phenomenon called bush encroachment. The latter reduces grass resource availability. To understand an extent to which grazing resources are affected by plethora of these cumulative effects, there is a need to monitor them. Traditional methods for assessing vegetation are tedious, laborious and often cost-ineffective. Remote sensing provides an alternative monitoring approach that covers wider areas in a timely and cost effective manner. There is a notable progress in the estimation of biomass using remote sensing through spectral bands and vegetation indices, but limited studies focused on seasonal estimation of biomass using leaf area index (LAI). The objective of this study is to predict herbaceous biomass using field-measured LAI collected in 2009, 2013 and 2014 and upscale it using MODIS to create multi-seasonal biomass maps. Herbaceous biomass was predicted using field collected LAI for respective years and combined or pooled data sets (all years). The data was collected in Kruger National Park and surrounding areas. The results showed that LAI explained 50-80% of biomass variation, with bootstrapped relative error ranging from 24 to 34%. The study showed a potential to map time series biomass data which is critical for determining carrying capacity models; understanding impacts of climate and land use change; land degradation and bush encroachment.

Keywords: biomass, leaf area index, remote sensing, herbivory, rangeland ecology

T0620

Modelling land use/cover transitions and vegetation dynamics in the fragile Rwizi catchment, Lake Victoria Basin

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Vegetative cover is a key indicator of the ecosystem health and its resilience for stressors, while land use transitions signify a key pathway in the sustainability domain. Whilst Rwizi catchment of the Lake Victoria Basin (LVB) is fragile and considered highly degraded, there is paucity of knowledge on land use transitions and spatio-temporal vegetation dynamics. In this study, we determined land use transitions for a period spanning 30years i.e. 1985 to 2015 and modelled future land use/cover to the year 2030. Multi-temporal Landsat images (30m) were subjected to standard procedures and used in land use/cover transition assessment. Markovian processes were employed to analyse the pattern and trend of change, while neural network analysis was implemented to simulate future land use/cover. Vegetation dynamics were interrogated on seasonal and annual trajectories using MODIS NDVI imagery data of 250-meter resolution. Between 1985 -2000, vivid transitions are conversion from woodland to built-up (51%) and farmland to built-up area (31%). For the period 2000-2015, the transitions entailed conversion of woodland to built-up, woodland to farmland and forest to farmland by 87%, 73% and 69% respectively. Future predictions indicate increase in built up areas (21%) and farmlands (43%) while forested area and woodlands will decrease slightly (<1%). Seasonal vegetative analysis based on NDVI reveals a stronger second season of September to November (SON) vis-à-vis the first season of March to May (MAM) for the cropland and grassland classes. However, the rate of vegetative greening in SON is observed to be lower than that observed on MAM. Vegetation phenology is tele-connected with rainfall and topography owing to a positive and significant correlation detected ($p<0.05$). Increasing farmland and built up area will require integration of sustainable conservation practises such as agro-forestry to attain ecosystem and catchment resilience.

Keywords: Land use/cover transitions, Vegetation dynamics, Modelling, MODIS, Lake Victoria Basin

Symposium 70

Seascape Ecology

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While landscape ecology studies have been developed for and applied in terrestrial systems for nearly 50 years, the description of spatial patterns in marine contexts has only recently emerged. Developments in seascape ecology have been also closely linked to technological developments that strongly improved our capability in investigating the physical characteristics of marine environments at multiple scales, including geographic heterogeneity and chemical properties all along the water column and down to the seafloor. Such investigation revealed that the seascape rarely appears uniform. Instead, an intermixed multiple patches of the same or different habitat is often representative of the marine environment. In the last decade an increased attention has been given indeed to the application of tools, models, and methods to estimate the spatial properties and connectivity of most marine ecosystems like seagrass meadows, salt marshes, coral reefs, mangrove forests, but also deep-water and pelagic habitats. For instance, since seascapes can also be used to describe variation in chemical composition throughout the water column, chemical 'landscapes' play now huge and influential roles in the ecology of pelagic organisms, some of which never encounter benthic geography. Yet, sound plays a relevant role in the ecological processes like recruitment, and it acts as an orientational cue towards suitable settlement habitat. The sea is heterogeneously filled with varying sounds forming an underwater 'soundscape' that could be as familiar to marine animals as the visual landscape is to humans. This session aims at collecting contributes that can amplify the perspective of seascape ecology research and also document how a sound knowledge of seascape ecology is key to management practices in marine environment (i.e. marine spatial planning). The Anthropocene represents indeed an epoch of dramatic impacts on marine life (coastal-land exploitation, marine transport, pollution, overfishing, climate changes). Seascape studies can deeply contribute both a better understanding of the effects produced by anthropogenic pressures and a more efficient implementation of environmental monitoring programmes (such as the Marine Strategy Framework Directive).

P0165

Assessing the delivery of ecosystem services in a climate change context: using ecological reasonable indicators

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Every European Member State has been asked to deliver before 2021 an exhaustive Maritime Spatial Planning (MSP). The Ecosystem-Based Approach (EBA) required by MSP can be achieved with the Ecosystem Service (ES) assessment. In this context, multiple ES in the 3-dimensional scale of the marine environment (sea surface, water column, seabed) should be modelled together taking into account side-effects and feedbacks. The pitfall not to consider these externalities can give a rather blurry picture of the reality of ecosystem functioning. Furthermore, ES assessment is developing fast and in an even more difficult scenario to define: climate change.
My PhD project will focus on the marine coastal ES (up to 12miles from the shore) evaluation as support at the Italian MSP. A Petri net model (even if the decision of the model to use is still ongoing) has already been implemented in the Venice lagoon case-study as a dynamic operation tool for exploring how ES interacts among each-others and how they behave under different scenarios of Business-As-Usual (BAU), Climate Change (CC) and different management options up to the end of the 21st century. Georeferenced ES, within MSP context, allows stakeholders to identify priority area of conservation and suitable indices can summarize conflicts between uses and sustainability. The best alternatives in the management of natural resources, explored in the operational model above cited, at the sea can support environmental policies at the national level for natural capital conservation.

Keywords: marine ecosystem services

T_0988

Mediterranean shelf shaped by algal reef (coralligenous)

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Marine bioengineers are organisms able to create rigid biostructures at the seafloor. Such organisms consequently literally shape the seascape. The most famous are hermatypic corals forming the coral reefs, where their growing not only develop a very special marine habitat, but also drives the geomorphological development of coasts and atolls.
Outside the tropics, no analogues are reported for shallow water, but it does not mean that the same phenomenon is not in act. In fact, large areas are dominated by mobile and hard substrates of biological origin. No more hermatypic corals, but coralline algae act as bioengineers. They are sciaphilous algae with skeletal thalli. They encrust hard and mobile substrates, or generate new ones. They request dim-light conditions, and consequently colonize both shallow water with low level of irradiance, and relatively deep bathymetric interval. In relatively shallow water (continental shelf), the Mediterranean Sea hosts abundant coralline algae forming algal reefs, referred to as coralligenous.
BIOMAP project was one pioneer project aimed at the mapping of the coralligenous within 100 m of water depth along the Apulia region coasts. The main outcome of this project is that coralligenous dominates the Apulia shelf (38% of seascape cover). It develops diverse morphotypes, ranging from discrete reliefs, made of small isolated build-ups with a thickness up to 50 cm, up to tabular reliefs, several kilometers large and with a thickness up to 4 m, depending on diverse bathymetric intervals or type of substrate. Therefore, the seascape has been literally drawn by the activity of coralline algae, primary bioengineers of these monumental structures. Algal reef is a very important topic, as biodiversity hotspot in the framework of European Community Directives. Moreover, its carbonate hard structure contributes to the geomorphological development and protection of the coasts, becoming relevant under the scenario of marine acidifica

Keywords: Marine bioengineers, Seascape, Hard framework, Submarine geomorphology, Coralline algae

T0880

Using photogrammetry to quantify the movement rate and pattern of Culcita sp. (Echinodermata: Asteroidea).

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The ability of movement, in terms of direction and velocity, has multiple implications on the biology and ecology of organisms. Thus, studies on the movement of organisms are important for understanding population and individuals dynamics and the interactions and impacts on the environment. Coral-eating seastars may have an important role in influencing coral cover, especially in the aftermath of a coral mortality event. The cushion-seastars of the genus Culcita is a non-obligate corallivorous with possible role in delaying coral reef recovery. In particular, the Republic of Maldives was severly affected by the coral bleaching events in 2016 and outbreaks of Acanthaster planci in 2014-2016. In this context, knowing movement patterns may reveal key aspects on the impact of the seastars on the recovery of the Maldivian coral reef. Thus, the present study aims to quantify the rate and pattern of movement of the cushion-seastar Culcita sp.. A new approach has been used by the involvement of Unmanned Aerial Vehicle (UAV), or drone, to spot and obtain a rate of movement of specimens of the cushion-seastar. We followed 12 individuals on a sandy lagoon of Magoodhoo island, Faafu Atoll, Republic of Maldives. Photogrammetry was obtained by flying a commercial drone and ≈ 600 pics were collected. The specimens moved an average 1,7 m/h during the night, while little movement has been observed during the daylight. The path chosen by the specimens showed a significant directionality. Currents did not influence the movement path suggesting that specimens choose the direction independently from environmental conditions. The direction was constantly pointed towards the reef suggesting that specimens may detect cues from the reef where they can hide. Furthermore, the use of drone and photogrammetry reveal an excellent tool for studying movement and path without influencing the individuals.

Keywords: Photogrammetry, Drone, Culcita, Maldives, Coral Reefs

T0882

Seascape-scale factors modulate sea urchin predation in macrophyte ecosystems

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Top-down control regulates the shallow macrophyte communities, where habitat structuring is heavily dependent on the ability of predators to control populations of herbivorous sea urchins. In Mediterranean Sea, while Posidonia oceanica seagrass is less dramatically affected, top-down processes still play critical roles in mediating trophic interactions in algae benthic mosaic. There has been considerable attention paid to understanding the role of the habitat structural attributes, such as crevices, holes, algae cover in influencing the strength of predator-prey interactions. However, how the nearshore habitats are distributed in space and their aggregation patterns have also strong effects on predators and prey migration. In this study, we compare relative rates of predation on sea urchin Paracentrotus lividus across a gradient of increasing habitat structure across macrophyte communities (turf and macroalgal habitats, low and high structured seagrass) and their spatial distribution. Results show that the edges are less structurally complex than the interior of the habitats allowing greater access to roving predatory fish. Typical Mediterranean patch mosaic of Posidonia oceanica can generate lumpiness in the distribution of trophic function, with cold- and hot-spots of predation dependent on area-perimeter relationships, the presence of rocky substrates or the degree of habitat clumping in space. However, sea urchin predation risk can change across the habitats due to the variation of local predator composition. Although fishes strongly affect sea urchin population structure in patchy habitats, homogeneous habitats such as continuous' seagrass meadows can be a 'death trap' by the hand of the bottom predators. Given the importance of predator-urchin dynamics to the functioning of nearshore macrophyte habitats, we need much more understanding of habitat characteristics at seascape-scale to be able to effectively manage these systems and the functions they embody.

Keywords: patch dynamics, predation risk, predator-prey interactions, seascape

T0382

Integrated multi-level strategy to incorporate biodiversity conservation in marine spatial planning of the Northern Adriatic Sea

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Marine/maritime spatial planning (MSP) is the public process to allocate maritime uses in space and time while managing synergies and conflicts between uses as well as between uses and the marine environment. MSP can support the conservation of marine biodiversity in multiple ways. However, the design process – from the definition of the conservation targets to the elaboration and implementation of the measures to achieve those targets – is still not explicitly formulated. In this study, we propose an integrated multi-level strategy to incorporate biodiversity conservation within a testing process of MSP in the Northern Adriatic Sea (NA). Firstly, we established the general goal of the plan, to comply with the 10% AICHI targets and with the European Biodiversity Strategy at 2020. We articulated the general goal in specific objectives related to the multiple features of conservation along the multi-spatial dimensions of seascapes (benthic and pelagic). The strategy proposes to achieve the targets through the identification of multiple measures, as i) spatial measures for conservation as new marine protected areas (MPAs), ii) actions for the identification of other effective area-based conservation measures, and of iii) management measures to control threats from specific maritime activities, iv) monitoring measures to for the strategy implementation. Following the criteria of the Convention of Biological Diversity on well-connected network of MPAs, we developed a methodology based on marine spatial prioritization (through Marxan) and cumulative effects assessment, in order to inform the decisions on priority areas for conservation. We discuss the applied methodology with respect to the knowledge gaps and needs in order to support the implementation of the strategy. We finally address the multiple bottlenecks and trade-offs encountered in the design process.

Keywords: biodiversity conservation, marine spatial planning, design process, marine protected areas, integrated modelling approach

T0573

Risk caused by plastic pollution on marine ecosystems: a seascape-driven approach

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Plastic pollution is cause of increasing scientific and social concern due to its pervasiveness and persistence, in particular in the marine environment. The Mediterranean Sea (MS), one of the ecoregions most impacted by human activities worldwide, is affected by marine litter, with measured plastic concentrations comparable with those typically found in oceanic gyres. At the same time, the MS is a semi-enclosed basin hosting about 7% of the world's marine biodiversity, including several endangered species. In our work, we propose a methodology to assess risk of pollution from plastic waste within the largest marine protected area of the MS (the Pelagos International Sanctuary for the Protection of Mediterranean Marine Mammals, North-Western Mediterranean), which includes the most important feeding grounds of the fin whale Balaenoptera physalus, an endangered species that is heavily impacted by microplastic ingestion. Using a quantitative and data-driven approach, we modelled a decade (2000-2010) of marine plastic litter advection patterns released from different sources (i.e. coastlines, major rivers and maritime shipping routes). Risk of exposure of fin whales to plastic pollution has been evaluated by interlacing litter distribution maps, generated from oceanographic modelling, with maps of suitable habitats by elaborating seascape data, i.e. satellite chlorophyll data and bathymetry, within species-specific visited areas. Our modelling results show that all the three main sources of plastic litter clearly contribute to impacting cetaceans in the Sanctuary, yet in a quantifiable different manner. The proposed procedure can potentially be extended to assess the risk caused by plastic pollution in other areas or on other taxa, thus informing targeted actions to tackle marine litter.

Keywords: plastic pollution, Mediterranean Sea, marine ecosystems, seascape, microplastics

Habitat alteration increases consumer pressure across diverse marine ecosystems

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Anthropogenic habitat changes occurring worldwide can have major impacts on food-webs. Meta-analyses of terrestrial studies demonstrate that habitat alteration routinely weakens consumer-resource interactions. To test the generality of these findings, we conducted a meta-analysis with 166 marine studies. Contrary to terrestrial patterns, we found that habitat loss, fragmentation, and structural degradation all strongly increased resource consumption by marine predators and herbivores. The only exception to this pattern was loss of connectivity between different ecosystems, which reduced resource consumption. Broad ecological traits and latitude underlied marine consumer responses to habitat alteration. Increased resource consumption following habitat change occurred in habitat generalist but not specialists and was most pronounced at higher trophic levels and in higher latitude regions (i.e., temperate, subtropical). These results reveal a divergent effect of habitat change in marine vs. terrestrial consumer-resource interactions, one that might be explained by the greater prevalence of habitat generalists in the marine realm. The revelation of this general ecological pattern warns that marine ecosystems maybe more vulnerable to intensified top-down forcing following habitat alteration.

Keywords: Consumer-resource interaction, Marine ecosystem, Habitat fragmentation, Degradation

P0217

Landscape study of "Utrish" reserve marine area

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Protected areas – one of the main tools, which helps to save landscapes and its biodiversity on the land and in the sea as well. Only small part of protected areas includes marine areas in Russian Federation, although the country washed by 13 seas. Most studies focus on marine flora and fauna, hydrological parameters, but not on the underwater landscapes. Study area is located in "Utrish" reserve between cities Anapa and Novorossiysk on the Black Sea coast. Reserve includes two marine areas (783 ha totally), research was conducted in the northern one.

We used a set of methods: bathymetric survey (multibeam echo sounder Garmin), side scan sonar survey (Klein System 3900). We studied coastal zone on 300-meter marine transects, which were oriented perpendicular to coastline. We described relief, bottom sediments, main algae species at 5m interval along the transect. Underwater studies were conducted using diving to the 30m depth and using GNOM Underwater Remotely Operated Vehicle deeper than 30m.

We compiled landscape map for northern marine area. Classification features for it were relief form and depth range, which determine hydrodynamics, sediments, light, and benthos composition. We determine 5 landscapes: beach, bench, landslide, upper and lower parts of marine accumulative plain. Each of them has its own morphological structure and landscape pattern. Also we made recommendations for improvement of protection, monitoring, science and environmental education, ecological tourism.

Our study allowed to test and to improve technique of underwater studies, to reveal the main regularities of landscape structure. Furthermore, it provided opportunity to offer solutions for main reserve functions development based on landscape studies materials.

Keywords: coastal zone, Black Sea, landscape structure, seascape

Convergence research on landscape and seascape resilience in the Anthropocene

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We live in a time of widespread human impact that has tipped Earth into a new epoch called the Anthropocene. In this new epoch, ecosystems worldwide are contending with anthropogenic and environmental changes that are shifting disturbance severity, timing, and frequency. As a result, ecologists are concerned that shifts will exceed natural disturbance variability, threatening the long-term sustainability of ecosystems and their services to society. To maintain services at broad spatial scales, ecologists are interested in enhancing resilience of landscapes and seascapes on Earth. Resilience describes the capacity of a system to 'spring back' after being disturbed and maintain its functioning by absorbing or adapting to change. Accomplishing this goal at the landscape and seascape level requires understanding interactions among pattern, process, scale, and complexity. Equally relevant is disturbance, as disturbances are critical drivers of composition, structure, and function in both terrestrial and marine ecosystems. Despite these shared goals and drivers, often research on landscape and seascape resilience is siloed in separate disciplines: terrestrial ecology and marine ecology, respectively. We propose that integrating the two disciplines through convergence research will produce collaborations that successfully cross ecosystem boundaries, better support resilience at broad spatial scales, and elevate a long history of knowledge exchange in ecology.

Keywords: Disturbance, Forests, Coral reefs, Anthropocene

P0130

Exploring the joint application of seascape ecology, food-web modeling and ecosystem services for the implementation of the Water Framework directive in the Venice lagoon (Italy)

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The implementation of the Water Framework Directive (WFD) is a major challenge at the EU level, its overall target not being yet achieved in about half of EU surface waters. In the Venice lagoon (north-eastern Italy), the directive's implementation is currently facing a standstill due to the contrasting response of the selected biological quality elements to changes of the system, which make it extremely difficult to define management strategies capable to improve the overall ecological status. This work aims at exploring how the application of different approaches, namely seascape ecology, food-web modeling and ecosystem services, can contribute to foster the WFD implementation. These three approaches capture different aspects of the Venice lagoon social-ecological system, that is, the habitat structure, the ecosystem functioning in terms of trophic interactions among species, and the benefits delivered to people, respectively. The seascape ecology application characterizes the spatial configuration of the lagoon's submerged habitats, the food-web approach is used to assess the dynamics of ecological processes and the ecosystem services quantify the multiple contributions of the lagoon ecosystem to the well-being of society. The results, analyzed in relation to the biological quality elements that determine the ecological status of the lagoon, could offer new perspectives for the WFD implementation policies.

Keywords: seascape ecology, food-web model, ecosystem services, coastal lagoon, integrated management

Symposium 71

Synergistic Effects of Climate and Management on Biodiversity

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Although recent studies have estimated the interacting effects of land management and climate on plant and animal populations, there are still very few tests of the degree to which such interactions occur in nature and mechanisms for such effects are poorly understood. This research gap is due to the fact that vegetation data must be at sufficiently fine resolutions to match the spatial scales experienced by species, but such data are rarely available at the broad spatial scales associated with species' ranges and climate data. Second, climatic conditions and management tend to be highly correlated at broad spatial scales; climate is well known to influence vegetation, which makes it challenging to attribute proximate cause of species distributions to either climate change or land-use. It is only when climate and land management vary independently that the opportunity exists to identify interactive or additive effects (Sirami et al. 2016, Betts et al. 2018). Presenters in this symposium will provide a summary of leading-edge research that examines (1) the mechanistic bases for climate–management synergisms, (2) empirical studies on ecological responses to climate and management, (3) predicted (modeled) responses by organisms to climate–management synergisms.

T0391

Synergistic effects of climate and land-cover chenge on long-term bird population trend of the western USA: a test of modeled predictions

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Climate and land-use change are predicted to lead to widespread changes in population dynamics, but quantitative predictions on the relative effects of these stressors have not yet been tested empirically. We analyzed historical abundance data of 110 terrestrial bird species sampled from 1983 to 2010 along 406 Breeding Bird Survey (BBS) across the northwestern USA. Using boosted-regression trees, we modeled bird abundance at the beginning of this interval as a function of (1) climate variables, (2) Landsat-derived landcover data, (3) the additive and interactive effects of climate and land-cover variables. We evaluated the capacity of each model set to predict observed 27-year bird population trends. On average, 45 species significantly declined over the period observed and only 8 increased (mean trend = -0.84%/year). Climate change alone significantly predicted observed abundance trends for 44/108 species (mean 0.37 ± 0.09 [SD]), land-cover changes alone predicted trends for 47/108 species (mean r = 0.36 ±0.09), and the synergistic effects predicted 59/108 species (mean r = 0.37 ±0.11). However, for 37 of these species, including information on land-cover change increased prediction success over climate data alone. Across stressors, species with trends that were predicted accurately were more likely to be in decline across the western USA. For instance, species with high correlations between predicted and observed abundances (> r = 0.6) were declining at rates that were on average >2%/ year. This indicates that abundance models have the capacity to predict the species most likely to be at risk from climate and land-use change, but for many species there were substantial discrepancies between modeled and observed trends. Nevertheless, our results highlight that climate change is already influencing bird populations of the western U.S. and that such effects often operate synergistically with land-cover change to affect population declines.

Keywords: Climate, Land-cover, Birds, Synergistic

T0407

Extinction filters mediate the global effects of fragmentation

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Habitat loss is the primary driver of biodiversity decline worldwide, but the effects of fragmentation (i.e., the spatial arrangement of remaining habitat) has been much debated – perhaps due to high variation in species' fragmentation sensitivity globally. We tested the hypothesis that fragmentation sensitivity (edge avoidance) should be driven by historical exposure and therefore species' evolutionary response to disturbance. Using a database containing 109 datasets worldwide and 9003 unique species, we found that the proportion of forest fragmentation sensitive species five times higher in regions with low versus high rates of historical disturbance (i.e., fires, glaciation, hurricanes, anthropogenic deforestation). These disturbances coincide with a latitudinal gradient in which fragmentation sensitivity is amplified by three fold at low (tropical) versus high latitudes. These results indicate that conservation efforts to limit fragmentation effects will be most effective in tropical forests of the world.

Keywords: Forest fragmentation, Biodiversity, Extinction filters, Global ecology, Biogeography

Maintaining longleaf pine habitat for red-cockaded woodpeckers under climate change

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Over the past century, the distribution of longleaf has been constricted to a mere three percent of its original 92 million acre range due to development and land-use change. This has led to the listing of endangered red-cockaded woodpecker, which relies on old (>80 years old), live longleaf pine trees for nesting. The Department of Defense at Fort Bragg, NC, maintains one of the last strongholds of longleaf pine and red-cockaded woodpecker habitat in the U.S., but faces challenges in optimizing management for longleaf pine in the face of disturbances and climate change, while meeting economic, social, and other environmental goals. We used a widely-used forest landscape model (LANDIS-II) to project how the spatial pattern in tree species composition at Fort Bragg will change under multiple climate change scenarios. Preliminary results suggest that rising temperatures associated with climate change will reduce burn windows, limit the prescription burning necessary to maintain longleaf pine, and hardwoods will increase. These results will inform long-term forest planning efforts in the southeastern U.S. by providing guidance on the sustainability of longleaf pine and the habitat of the endangered red-cockaded woodpecker.

Keywords: management, forestry, LANDIS-II

T0723

Using robust decision-making and virtual reality to evaluate management tradeoffs under climate change

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Managing forest ecosystems is challenging because there are trade-offs among a complex suite of management goals and strategies. Also projections are deeply uncertain, especially under climate change. Current decision-support tools for forest management address some but not all of these challenges. Here we used LANDIS-II to simulate different intensities of forest harvesting and prescription burning on multiple ecosystem services in the Nicolet National Forest in Wisconsin under alternative climate change scenarios. We used an iterative, robust decision-making approach to evaluate the model output by exploring shifts in the Pareto front. We also developed a workflow to translate these outputs into virtual reality to allow users to more fully experience how different scenarios affect forests. We hope this will allow managers to make more informed decisions benefiting from a fuller set of cognitive reactions than traditional modelling outputs would allow. Our work demonstrates the utility of using new and innovative techniques for comparing trade-offs in management practices under climate change.

Keywords: forests, virtual reality, climate change, modeling, LANDIS-II

T0173

Managing forest landscapes as functional complex networks to increase resilience: a simulation study

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Our ability to assess future forest growth and dynamics and to develop efficient strategies for managing forest ecosystems is obstructed by increasing uncertainties due to global changes. An integrated and dynamic landscape management approach can ensure that individual decisions are aligned in a territorial strategy aimed at tackling risks related to global change so to maintain the desire level and diversity of ecosystem goods and services, including biodiversity. Therefore, a multi-scale perspective is needed for predicting ecological responses to changing climate, biotic disturbances and management under increasing socio-ecological changes and uncertainties. We applied an ecophysiologically-based forest landscape model (LANDIS-II with PnET-Succession) to a large fragmented forested landscape in Southern Quebec to evaluate future landscape scenarios and ecological resilience to global change stressors. PnET captures the changing drivers of local competition and integrate them in the LANDIS framework to account for landscape-scale spatial interactions and disturbances. We coupled this multi-scale approach with functional diversity and network theory indicators to represent the landscape as an interconnected complex spatial network of forest patches. We simulated forest dynamics and landscape development over a 100 years period under different climate, disturbances (biological outbreaks) and management scenarios. Our results show that an integrated landscape management approach based on network properties can more efficiently maximize landscape resilience to broad-scale disturbances. Increasing both forest structural and functional diversity in centrally connected forest patches and enhancing landscape structural modularity by strategically adding patches can positively affect overall resilience. Our study demonstrates the value of upscaling forest management at the landscape level using a functional complex network approach to increase resilience to global changes

Keywords: climate change, management, resilience, landscape modeling, network theory

T_9006

Applying climate-adaptive forest management principles to a mixed-conifer landscape in Colorado, USA

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Under increasing uncertainty, climate-adaptive forest management strategies are critical for sustaining ecosystem services to society. Three common adaptive silviculture options discussed in the context of climate change are: (1) resistance – maintaining relatively unchanged conditions over time; (2) resilience – encouraging an eventual return to reference conditions while permitting limited short-term changes; and (3) transition – actively facilitating change to encourage adaptive responses. However, there is a lack of on-the-ground research to indicate what adaptation measures might be effective in preparing forested landscapes to cope with climate change impacts, posing barriers to widely deploying adaptive forest management practices. The Adaptive Silviculture for Climate Change (ASCC) project is translating these adaptation concepts into on-the-ground, operational-scale research through a network of replicated sites testing ecosystem-specific climate change treatments across this gradient of adaptive approaches. Here we use forest growth-and-yield modeling to extend ASCC-developed adaptation strategies to a landscape setting under different climate change scenarios. We apply the Climate-Forest Vegetation Simulator extension to compare the efficacy of these adaptive management approaches for sustaining fire-adapted, mixed-conifer forests in Colorado, USA. Our results will inform the potential management of these diverse forests for carbon storage, wildfire risk reduction, and overall forest health.

Keywords: adaptive management, silviculture, climate change, resilience, adaptation

Landscape trajectories of ecosystem services under climate change and climate adapted management

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Concern over climate change and altered disturbance regimes has prompted debate about whether it is possible to accelerate the ability of forests to adapt to novel conditions (through managing for adaptive capacity) in order to continue the provision of ecosystem services, such as biodiversity. We developed and applied a novel framework that quantifies patterns of ecosystem response to disturbance and climate change and then applied the framework to develop management strategies to sustain the provisioning of critical habitat under global change. There are four expected responses to disturbances: resistance, resilience, adaptation, and decline, and by generating trajectories of ecosystem services through time we can investigate the capacity for 'climate smart' management strategies to ensure the desired level of provision of ecosystem goods and services in an uncertain future. We applied our framework to the Lake Tahoe Basin, in California and Nevada, a montane landscape expected to experience climate-change induced increases in wildfire and insect mortality, and reduced regeneration of extant tree species. We quantified how disturbance-induced changes in ecosystem structure and composition are correlated with the provision of habitat through time. Under our climate change scenarios, the four expected responses were spatially distributed across the landscape; climate adaptive management reduced – but did not eliminate – the decline response.

Keywords: climate change, trajectory, management, biodiversity, habitat

P0149

Abundance of submerged aquatic vegetation and water quality as drivers of waterfowl distribution across an oligohaline bay and coastal wetland system

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Temperate coastlines and their associated wetland and bay ecosystems are facing increased environmental pressure due to sea level rise and extreme weather in the age of the Anthropocene. Utilized as a stopover point by a myriad of migratory birds, a network of such areas has been identified along the eastern coastline of the United States and protected under the country's National Wildlife Refuge (NWR) System since the early 1900s. Back Bay NWR, Virginia, and the adjacent Back Bay system have together served as a key link along the Atlantic Flyway for wintering waterfowl such as American black duck (Anas rubripes), American widgeon (Anas rubripes), and tundra swan (Cygnus columbianus). This unique system, which features an oligohaline, wind-driven bay separated from the Atlantic Ocean by the refuge's ten impoundment pools, provides an interesting opportunity for assessing the movement of waterfowl across differently managed habitats. A Poisson regression incorporating 30 years of aerial and transect survey data as well as quantitative water quality samples was used to quantify the relationship between waterfowl abundance and three environmental drivers: salinity, turbidity (an indicator of sediment runoff), and density of submerged aquatic vegetation (SAV). Implications of the patterns discovered were reviewed with key informants including members of the U.S. Fish and Wildlife Service as well as the Virginia State Department of Game and Inland Fisheries. The model and interview responses were then used as a basis to explore collaborative land and water management strategies aimed at providing the most appropriate habitat conditions for migratory waterfowl. A fundamental understanding of the dependencies between environmental conditions and the distribution of waterfowl derived from this ecological model therefore supports managers in their mission to conserve biodiversity in a unique landscape at high risk under the impacts of climate change.

Keywords: Ecological model, Migratory birds, Biodiversity, Water quality, Submerged aquatic vegetation

Symposium 72

Theoretical and practical challenges for planning landscape restoration

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At present, diverse global and national initiatives and agreements seek to promote and support ecological restoration of degraded ecosystems at orders of magnitude greater scale than was envisioned in the past. To be effective, these initiatives must address the challenge of scaling up and adapting the knowledge and know-how developed over the past 30 years from the well-known ecosystem level to landscape level, and to do so across the full range of landscape types. However, little consensus exists on the definition and methodological approaches needed for landscape restoration. This symposium will gather scientists and practitioners to discuss and agree general concepts and principles of landscape ecology that me be instrumental for planning landscape restoration. This new perspective should incorporate ecosystem service mapping and assessment, conservation science, and spatially explicit analyses in site and landscape prioritization, as well as multi-criteria participatory planning. Finally, ample time will be reserved to exchange knowledge and experiences of on-going plans and programs of landscape restoration in varying biomes, in order to identify challenges and recommendations.

T0772

Theoretical approaches and practical challenges for landscape restoration planning from the landscape sustainability science.

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Landscape ecology and, in particular, landscape sustainability science (LSS), can make a profound contribution to a better understanding of the concept of landscape restoration (LR) and its application. Diverse global and national initiatives and agreements seek to promote ecological restoration at landscape scale. The Global Partnership on Forest and Landscape Restoration is a network based on a landscape approach and responds to the Bonn Challenge to restore 150 million hectares. However, we believe that little consensus exists on the definition and methodological approaches needed to apply LR. The objective of this work is to discuss a definition of LR from landscape ecology perspective and discuss some implications and practical challenges. LR can be defined as the planned process of recovering the capacity of a landscape to consistently provide long-term, ecosystem services essential for improving human well-being. In other words, LR seeks to improve key attributes of a landscape including composition, configuration and dynamics that are spatially interacting with ecosystem processes, biodiversity (at different levels of organization) and ecosystem services. We present a case study to discuss implications of this definition and exemplify practical challenges of how dealing with LR by integrating these key attributes. The study landscape is located in the core of a biodiversity hotspot in Chile, with a substantial loss of natural ecosystems, a landscape profoundly transformed by economical drivers, and an explicit need from local community and relevant stakeholders to recover essential ecosystem services in order to improve their well-being

Keywords: Restoration, Ecosystem services, Landscape planning, Spatal prioritization

P0076

Significance of spatial interactions between patches of ecosystems with different ecological maturity and spatial position in the functioning of the landscape

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It is assumed that the functioning of the landscape, i.e., the flows of matter and energy between different patches in space, depend on two factors: a) the degree of ecological maturity of the patches-ecosystems that make it up (more mature as more advanced successional state) and b) its spatial pattern, according to the relative position of the patches-ecosystems with respect to topographic gradients.
Thus, the flows between a more mature ecosystem, as an oak grove, and a less mature one, as a pasture, will be of different intensity if the oak grove is topographically above or below the pasture. Accordingly, it is expected that the difference in maturity between the two patches will tend to be smaller or larger, respectively.
In order to test this hypothesis, pairs of ecosystems patches with different degrees of maturity (oak groves, pastures with scattered scrubs and pastures) spatially connected by a common boundary in the two relative spatial positions (above or below) were sampled. Maturity has been estimated based on biomass turnover rate (P/B, P: net primary production, B: standing biomass) through the relationship between photosynthetic and structural biomass in the different patches sampled.
Results show that less mature patches (pastures) below more mature ones (oak groves) are more mature that less mature patches (pastures) below intermediate matures ones (pastures with scattered scrubs). This indicates that the stated hypothesis could help in understanding landscape ecological functioning and could be useful in its management.

Keywords: Landscape ecological organization, Landscape ecological functioning, boundaries, spatial pattern, landscape management

T0865

Guidelines for defining the decision space for landscape-scale ecosystem restoration

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Given the immediate need to meet global restoration targets (e.g., UN Aichi Targets and Sustainable Development Goals), the restoration community is ramping up efforts to develop national and regional restoration plans and to develop monitoring and assessment frameworks. Central to these efforts is the need to ensure that activities that are planned and implemented under restoration initiatives are restorative and have the potential for both strong biodiversity conservation and human wellbeing outcomes. For example, ecological restoration by definition aims to repair degraded ecosystems and, therefore, restoration planning at the landscape scale should focus on identifying degraded landscapes. In addition, restoration plans must consider biodiversity conservation and ecological complexity and sustainability, in addition to the ecosystems goods and services of interest to stakeholders. Despite widespread agreement on these principles, the international community lacks comprehensive and widely endorsed guidelines for landscape-scale restoration. In this presentation, case studies of assessments of priority areas for landscape restoration will be used to explore the need for landscape-level guidelines. In addition, a framework for defining the decision space for ecological restoration planning will be proposed. The framework and guidelines will provide a tool for decision-makers, stakeholders and scientists to use in both restoration planning and assessment, and will assist with separating ecological restoration and restorative activities from other areas of ecosystem management.

Keywords: ecological restoration, prioritization, guidelines, standards

T0252

Understanding ecological restoration effectiveness in southwestern China

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Understanding the impacts of different sectors on the effectiveness of ecological restoration projects could support for planning restoration implementation. The Karst eco-fragile area of southwestern China is of great ecological importance with boasting biodiversity and high levels of endemism. However, intensive exploitation of nature under population and poverty pressure in this vast limestone plateau-canyon landscape has caused serious rocky desertification. In order to restore the widespread forest landscape, Chinese government has implemented Grain for Green Program (GFGP) since 2001. The increased vegetation growth in this area have been reported, but the mechanisms behind them remain unclear. Here integrating multi-resource data (i.e. satellite observation, socio-economic statistics and meteorological data), structural equation model (SEM) was used to analyze the interactions across restoration efforts, environmental factors, socio-economic dynamics and climate changes on regional ecological restoration effects from 2001 to 2015. Our study aims to explore the socio-ecological feedbacks and socio-economic changes on forest expansions and provide evidence-based policy suggestions for ecological restoration.

Keywords: ecological restoration projects, forest expansion, landscape planning , structural equation model

T0640

Restoring riparian forests according to existing regulations could greatly improve habitat connectivity for forest fauna in Chile

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Habitat connectivity is essential to facilitate species movement across fragmented landscapes, but is hard to achieve at a broad-scale and where adequate land use policies are lacking. Evaluation of existing land use policies could help set restoration goals to improve connectivity that have support from related agencies to secure funding and enforcement, even when the policies were not design to increase habitat connectivity. Our goal was to evaluate the potential effect of restoring forest according to a riparian buffer regulation on forest connectivity. Specifically, we simulated the restoration of riparian forests within 30 and 200 m of rivers in 98 watersheds in Chile, following an existing regulation. We mapped habitat for two forest-specialist species that require different minimum-size patches (10ha and 25ha). For each species, we identified core habitat and structural corridors with image morphology analysis, and quantified forest connectivity using a network graph index, the Equivalent Connected Area. Our scenarios of riparian forest restoration increased the connectivity between existing habitats, but it did not increase the amount of new core habitat, as expected. We found that forest connectivity could increase the most (~ 77% increase in ECA) with our 200-m buffer in watersheds with 20-40% forest cover. The 30-m buffer could increase connectivity the most (~ 46% increase in ECA) in watersheds with 40-60% forest cover. In watersheds with >60% forests, restoring riparian forests did not improve connectivity. Restoration effects were similar for both species, suggesting that effective implementation of exiting riparian forest regulation could improve connectivity for forest fauna with varying habitat requirements. Overall, restoration plans that targets riparian ecosystems can help increase habitat connectivity in landscape with medium to low amounts of forest, where fragmentation is more pervasive.

Keywords: Fragmentation, Land use policy, Watershed, Scenarios, Buffer regulation

P0136

Landscape restoration based on ecosystem services and historical recollections after the Great East Japan Earthquake of 2011

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This research focuses on recovery and restoration in the region of severely damaged by the Great East Japan Earthquake and Tsunami of 2011. The approach applies concepts of Ecosystem-based Disaster Risk Reduction (Eco-DRR) and historic recollections to restoration and conservation of sustainable landscapes with high resilience to future disturbances. In recent years, earthquakes and extreme weather events have occurred in Japan and around the world. At the same time, Japan is faced with an aging and declining population, increasing the need for sustainable highly resilient landscapes. Severe disaster disturbance frequently occurs in mountainous and coastal regions where farming and fishing are the major livelihoods. Landscape restoration and future risk reduction programs in these areas should concentrate on preserving natural habitats and biodiversity, which support the local livelihoods by providing a wide range of essential ecosystem services. This research presents concepts for restoration and future risk reduction programs that are not limited to civil engineering projects, but also include Eco-DRR concepts, such as multi-functional green infrastructures and connectivity among habitats, that focus on preserving and restoring the vital ecosystem services. Traditional knowledge, experience and historical recollections are also incorporated into these plans.

Keywords: Landscape restoration, Ecosystem services, Eco-DRR, Sustainability, Resilience

P_8220

Fluvial morphotypes for basin planning

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This study proposes the introduction of a fluvial invariant in the Territorial Planning tools through the definition of an abacus of river morphotypes (or territorial morpho-typologies of fluvial and perifluvial contexts) to which multiscalar guidelines should be applied. On the basis of this graphic and geographical analysis, it will be possible to identify good risk-management practices related to the different territorial morphologies. In this context, the morphotypes must therefore be understood as abstract models to be applied to the various river contexts: their reconstruction starts from the analysis of the basin (or sub-basin), identifying the hierarchy of the streams of its hydrographic network, continues with a typological classification (and identification of patterns) of the network as a function of the geomorphological characters and ends, through a morpho-typological framework of the patterns, with a definition of the morphotypes with which to classify the recurrent forms of the river systems in relation to the distribution of the settlement system. The analyzes were carried out starting from the open data published on the site of the District of the Northern Apennines and the Basin Authority.

Keywords: river planning, rivers management, landplanning, river restoration, basins planning

Symposium 73

Adaptive barrier management at times of climate change: delivering Europe's first Atlas of river barriers

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Rivers are some of the most threatened ecosystems in the world and a major focus of restoration programmes in Europe and elsewhere. A major challenge to achieving good ecological status, as required under the EU Water Framework Directive, is the reduction of fragmentation of river habitats caused by many thousands of barriers. Strikingly, the real number and location of barriers in Europe is currently unknown. Extrapolation from detailed national and regional surveys suggest there may be as many as 1 barrier for every 2 river km. In that context the H2020 AMBER project addresses the issue of river fragmentation in European rivers and seeks to apply adaptive management of barriers at multiple scales to achieve more efficient restoration of river connectivity. AMBER is building the first pan-European barrier database collating and harmonising existing institutional data at national and regional scales.

We present here some preliminary data on the distribution and typology of barriers at the pan-European scale. From the 48 national and regional barrier databases collated >260,000 barriers were identified. Of these, 60% of barriers could be attributed to one of six common barrier types whilst the remaining 40% were of unknown type; 62% were without height attributes; <30% were without barrier, river or basin name and only 7% included information about installed fish passes. We show how the integration of barrier data with datasets on climate, stressors and socio-economic can be used to derive meaningful drivers of barrier density, from which barrier distribution can be inferred in countries and regions where data are scarce.

This approach allows the generation of a more realistic picture of river fragmentation at national and European scales and will provide a better assessment of barrier impacts on sediment, water and biota at times of climate change.

Unified science, landscape management, and the Viewpoint of Complementarity

Steen Brock[1]

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The field of landscape research harbors a long standing ambition to sustain a balanced, integrative perspective on cultural landscapes able to support analysis efforts which are not restricted by boundaries between what is otherwise delineated as either social, natural, cultural or political phenomena. Accordingly, landscape researchers have accommodated an increasingly broad array of perspectives on landscape. However, this approach has not added to the internal consistency of landscape research, which in some respects has become an arena of "translation" or "integration" of diverse perspectives of particularist and monodisciplinary origin. This paper argues that if one follows Niels Bohr´s "Viewpoint of Complementarity" one might succeed in producing a systematic, holistic account within landscape research. Bohr´s Viewpoint was originally formulated within Quantum Mechanics. However, Bohr generalized the Viewpoint and formulated a new encyclopedic understanding of human experience, stressing that different kinds of reality are associated with different forms of observational practices, which are complementary to each other. In that sense, it is possible to integrate all sorts of expertise. Importantly, this integration concerns the variety of naturally grounded affordances that comes with each observational practice. As such, I am not pointing to the integration of experience as such, but to the integration of a variety of possible phenomena, that nature itself offers in relation to different human practices. Accordingly, the Viewpoint of Complementarity leads to the revelation of a unified landscape. I thus recommend abandoning the idea of integrative research in favor of a more comprehensive perspective. I argue: Stop asking how to synthesize different conceptions of landscapes, ask instead how to let, precisely, landscapes emerge in the first place, by developing a sufficiently sophisticated set of complementary observational practices.

Keywords: Synthesis, Explanation, Complementarity

Exploring the concept of problem framing as a basis to understand actors' preparedness to implement landscape management decisions

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Actors' implementation of landscape management decisions depend on their acceptance of the selected solutions. Different actors using shared landscape resources, however, often do not agree in their perception of problems related to landscape development and their attitude towards management strategies. These discrepancies can be explained with the concept of problem framing (e.g. Kolkman et al., 2007) according to which actors' problem perspectives are not mainly shaped by their knowledge but rather by their interest positions. Solutions widely accepted among actors accordingly only be found, if actors become aware of shared (e.g. regional) interests and initiate social learning processes by discussing and exchanging their problem perspectives. A recent study basing on this concept of problem framing aimed to reveal actors' problem perspectives in a real decision situation and the potential to find shared solutions. In the initial stage of a participatory process designed to identify shared solutions for an integrated water catchment management in a Swiss Alpine valley, the problem perspectives of involved and not involved members of regional actor groups were elicited using both qualitative interviews (N=28) and standardized questionnaires (N=250), and focusing on meanings, measures and beliefs related to regional waters. The analysis of both data sources concordantly revealed considerable differences in actor groups' problem perspectives regarding the river catchment management and preferred measures, but also considerable area of agreement, in particular the shared goal to ensure the protection against natural hazards, which provides a good basis for finding shared solutions. These findings allow for sharpening the concept of problem framing as a basis to understanding landscape management conflicts as well as to finding shared solutions.

Keywords: Problem perspectives, Social learning, actors, landscape management, empirical

Comparative approaches to theory formulation from case study evidence - Examples from studies of decision making in European and post-colonial agricultural landscapes

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Landscape management is an inherently complex phenomenon, which mediates between social and ecological sides of human existence. It is also a globalized and cross-scalar phenomenon, meaning that decision making at landscape scales is embedded within socioeconomic, ecological and cultural contexts linking landscapes together in flows of mutual structuration. Events in one landscape affect and are affected by events in a multitude of other landscapes, making it complex to identify a relevant scale and locus of analysis. Landscape research has accumulated a rich record of case studies documenting this complexity. However, only few general concepts and insights have been derived from the wealth of unique cases available. In many respects this is due to the fact that the field is lacking a systematic method to accumulate, appraise and differentiate knowledge as it is transferred from one context to others and distilled into middle-range or general theory. Landscape research may be in need of a new approach to derive socio-ecological knowledge of general interest (theory) from case study material. In this paper a range of possible approaches to solving this challenge are presented, discussed and illustrated with empirical examples from a diverse dataset of case studies comprising farm units set within modern agricultural landscapes in Denmark and New Zealand. The dataset consists of land use inventories and interview material focusing on the decision making practice of landscape managers. On this basis it is explored how general analytical concepts can be derived from diverse examples of flows of landscape management practices within landscapes organized based on similar cultures, institutions and technologies. Results of these experiments indicate a potential within landscape research to formulate analytical concepts and theory using a hierarchical, pragmatic method similar in some respects to approaches used in comparative sociology and anthropology.

Keywords: socio-ecological theory, complexity, globalization, middle range theory, social theory

Deriving more generally applicable knowledge from multiple-case data: an example from strategic spatial planning processes

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Processes of landscape management and planning are hard to grasp as they are highly context dependent and embedded in sociopolitical and institutional complexity. Strategic spatial planning is typical in this regard. When addressing planning processes empirical research usually examines single case studies whereas cross-case comparisons and consolidated mid-range theories are largely lacking. Although we recognize the importance of contextual specificity in spatial planning, we argue that a comprehensive conceptualization is nevertheless necessary and possible. In this paper, we present an approach to synthesize empirical material from multiple case studies to design a comprehensive framework which is subsequently operationalized to facilitate quantitative comparative research. First, we employed a grounded-theory approach to synthesize material from 21 cases studies on strategic spatial planning in European urban regions into an empirically-based framework that reflects current planning practices. In a second step we developed a method to quantifying the transformative capacity of strategic planning based on the decomposition of the planning process with the Analytical Hierarchy Process. For data collection we employed expert-questionnaires. Specifically, we investigated to what degree governance processes of plan-making and -implementation as well as external events facilitate or hinder the implementation of development strategies. The method has been tested in Lyon, France and Copenhagen, Denmark. Overall our findings reveal that strategic spatial planning has a higher transformative potential in Lyon than in Copenhagen due to the role and power of the regional planning authority. The employed research methods, useful for synthesizing case study knowledge into a framework and for operationalizing the framework for comparative research, is suitable to critically discussing issues on deriving generally applicable knowledge from multiple-case data.

Keywords: spatial planning, mid-range theory, governance, grounded theory, urban regions

Inscape/Landscape Concept by P. M. Dansereau: synthesis for landscape management

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In the era of the Anthropocene, we as human beings transformed existing landscape into Human dominated landscape with a power similar to geological processes. On the other hand, we are not sure how to integrate natural and social sciences into the landscape concept. Middle-range theory sensu Merton is still missing in landscape ecology.
There were attempts in contemporary history of science to build synthesis of ecology and sociology. One of the great attempt, mentioned by the fathers of landscape ecology (Naveh), but nearly lost, is Inscape and Landscape of Pierre Dansereau (1975). Far away from former spiritual as well as poetic Inscape concept, he established system for landscape integration and landscape management based on the complementary categories Inscape and Landscape (I/L). I/L builds system. Inscape is always selective. Inscape is the result of human perception of landscape – the way of understanding landscape. Inscape is result of processing: Perception, Training, Education, Research, Energy for changes, Power, Planning and Management. „I view the inscape/landscape process as a cycle“ says Dansereau in his work which become very popular in 70th through Massey lectures of Canadian Broadcasting.
Research questions for every landscape projects occurs in I/L concept: What energy transfers, what system of values, what is the present perception, what changes can we foresee? „Inscape is so strong in recourses distribution like an earthquake, flood and dieses" Dansereau (1975).
Concept of reality and reality perception like a two different thing is not completely new, but what is new and full of inspiration is the application into the landscape concept. This is open door to the re-defining of landscape in terms of I/L system and Nature-Culture-Continuity and Discontinuity process. (N-C-C).
Some practical examples how to read and interpret land-art public actions as N-C-C and Landscape-Inscape system will be presented from the area of CR.

Keywords: Inscape/Landscape, Pierre Dansereau, system, concept, Anthropocene

Politics of Nature – Development of a participatory framework for water allocation, -trade and -ethics in the Western Cape Province, South Africa

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The South African water crisis is affected by and in turn affects all aspects of society. There is no single solution to the crisis, and thus it can be classified as a wicked problem. A new and sustainable operating system for water, integrating governance-, market-, and social mechanisms is demanded by businesses, government, and civil society. Water scarcity necessitates new allocation principles, rules governing its trade, and a shared regard of water as an asset by all actors. The stakes are high and lobbying is at full steam. Uncoordinated and conflicting solutions risk creating ecological degredation, social unrest and economic instability.

We aim to investigate: How Politics of Nature (PoN) – a participatory research and collaboration platform – can inform the development of a framework for water allocation, -trade and -ethics in the Western Cape, ensuring water for sustenance of humans and non-humans alike, while incentivizing innovation and frugality. PoN has been applied and refined in Copenhagen, Amsterdam and Brazil: http://www.politicsofnature.org/events/.

PoN takes its name from the eponymous book by Bruno Latour. The central element is a game-like meeting format inspired by the Cratic Platform. Actor-Network Theory, Life Cycle Assessment and Life Cycle Costing are merged to enable a turn-based participatory mapping of social, ecological and economic aspects respectively. The platform empowers actors in a collective, either directly or through spokespersons, to express their needs and wishes for future scenarios. Following Rittel and Webber, wishes constitutes concerns. Supported by the Danish Water Tech cluster, solutions will be proposed, thus crystalizing problems. Consent is the democratic principle, and a biophysical, a social and an economic consent shall be given if solutions do not compromise these aspects.

At IALE, we present the first results from PoN South Africa, and discuss integration with landscape ecology and landscape planning.

Keywords: Actor-Network Theory, Life Cycle Assessment, Ecological Economics, Wicked Problems, Deliberative Democracy

T_1018

Landscape ecological theory building in an interdisciplinary context – learning from the past towards the future

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Landscape ecology, as conceived by Troll in the 1930s and reintroduced in the 1980s, is considered as an interdisciplinary science with a renewed interest in holism and systems theory. Theories can be built on empirical research, which also formed the core of the systematic descriptions of landscapes during the exploration age, such as the ones made by Alexander von Humbolt. The data and methods used were synthesised to be able to understand the system of landscape as a holistic phenomenon. Since then, different models and concepts were (re)introduced in landscape ecology. What concepts do we use to learn from these empirical landscape studies and to build on a general theory that is useful and applicable across a range of landscape? Do they really contribute to a fundamental theory building in landscape ecology? How do we accumulate knowledge of landscapes in general, based on knowledge derived from specific landscapes? Is there a certain way in which landscape knowledge is traditionally generated, accumulated and conceptualized? If scientific theories should give scientist a context to make predictions of for example landscapes patterns and processes that have not yet been observed in space and time, how can those theories be formulated in landscape ecology? This contribution will look to historical developments of knowledge of landscapes, how they contributed to a general landscape theory and how they shifted through time. It will also reflect on the current existing theories used in different landscape perspectives and articulate if they are situated in the core of landscape ecology, contribute to a landscape ecological theory building or if they were rather borrowed or influenced by theories from other disciplines such as ecology, communication science, social geography, environmental psychology.

Keywords: history of landscape ecology, knowledge creation, concepts or theory, interdisciplinarity

Explaining environmental changes in the landscape: Do we need more theory or better methodology?

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Theorizing complex phenomena like human-environment relationships is difficult. Efforts to achieve conceptual synthesis rarely get beyond analytic heuristics and, when they do, tend to over-simplify in the abstract and encourage confirmation bias. Many social scientists use approaches like Process Tracing, Historical Ecology and Landscape History to better account for contextual complexity and historical contingency. Yet, these more ideographic approaches are not always satisfactory for causal analysis. If our goal is to understand causal interactions between people and the land and to explain environmental changes in the landscape, the more pressing need is for better causal-analytic methodology, not for more or better theory per se. Specifically, we need interdisciplinary methodology that enables researchers to clearly identify and rigorously assess causal interactions between land use and environmental change. I present such a methodology, Abductive Causal Eventism (ACE), and illustrate its application to recent research on reforestation and land use change in Saint Lucia, West Indies. This study revealed a variety of insights that inform (and are informed by) general theory in the social sciences as well as theory specific to explaining land use and forest change (i.e., Forest Transition Theory). While some findings were consistent with established theory, many important discoveries were not. The lesson is we should be careful not to rush-in to fill an apparent void in theory about human-land interactions with theories that may be ill-suited or too rigid or simplistic for the task. Instead, we should accept that human-land interactions are enormously varied and usually changing over time and employ a methodological approach that accounts for general and contingent causes and embraces the possibility of unexpected findings that do not conform to theoretical expectations. Theories that may eventually emerge from this work will be the richer for it.

Keywords: research methodology, causal-historical explanation, reforestation, Saint Lucia

Symposium 74

Biocultural Landscapes During the Anthropocene

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This symposium is designed to convene researchers and graduate students in landscape ecology, conservation biology, ecology, natural resource management and environmental education and communication, to stimulate fruitful discussions on the current trend of ecosystem service degradation of biocultural landscapes in the world. Current challenges, linked to the anthropic pressure or to climate change (as examples), will be discussed and papers can give insights in addressing such challenges. Emphasis will be on the exploration of the underlying ecological processes affected by anthropogenic activities that are driving ecosystem and landscape patterns in a given area. Research presented at this session may consider plant and animal species diversity, forests, shrub communities, grasslands and wetlands. These may involve field measurements, observation, experiments, modeling, and environmental education and communication within the context of the biocultural landscape in the era of the Anthropocene. The symposium will be a great venue to develop future cooperation among researchers and graduate students working on biocultural landscapes.

Malay Community Perspective towards the Conservation of the Traditional Houses Landscape in Langkawi

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A Malay traditional house landscape spatial structure which divided into three main areas that are front's compound, side compound, and rear compound. These landscapes spatial structure are partly influenced by ethnicity belief of the resident in general which it consists of vernacular timber houses laid in a garden of fruit trees, edible shrubs, herbs, flowering and fragrant plants in their landscape. These features make one of the unique identity of Malay identity. However, due to rapid development and redevelopment project being done especially in rural areas of a traditional village it was given potential to damage and extinct the value and originality of Malayness. Therefore, this research aims to explore the communities' perceptions towards Malay traditional house landscape spatial structure compound and element towards the conservation. This study is conducted to advance fundamental knowledge about landscape characteristics conservation in the rural area. The Malay traditional house landscape spatial structure was examined and divided into two (2) components, spatial structure compound and spatial structure element. A total of 60 residents were interviewed in Kampung Mawat to elicit their preference for traditional rural development, their perceptions and preferences of rural character, and their attitudes toward rural living in general. The statistical analysis shows that are very significant perception towards element existing in Malay traditional house landscape spatial structure between the community aged. The Malay traditional house landscape spatial structure compound and feature that still exists at the Malay traditional village especially at Kampung Mawat, however, there are on the verge of destruction. Therefore, the preservation of the Malay traditional house landscape spatial structure components as its giving a positive impact on the sustainability of unique identity and originality of Malay traditional house landscape.

Keywords: Malay traditional house, landscape spatial, conservation, Langkawi

P0041

Local festival as a key for sustaining coastal pine forest of biocultural landscape

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The coastal pine forest, man-made ecosystem, is an important component of landscape, which gives beautiful scenery to tourists as well as local people. People had planted pine trees to protect village and crop field from storm and surge in its origin, then used to gather shrubs and fallen leaves for fuel and mushroom for food in the matured forest. Use of forest products for daily life used to be the system for keeping the forest in an early successional stage. However the structure has drastically changed due to progressive succession; energy change from firewood to petroleum/electricity, and decreases of workers/population in the counties are the drivers of change of biocultural landscape in Japan.

Even in the situation, pine forest at Osato coast in Tokushima Prefecture, has been kept at good condition by voluntary activities of local people. Our study clarified that local festival, which is hold every autumn at the forested area for preying good harvest and catch, is a key incentive for keeping pine forest; people have a picnic with family/friends in the forest, and hence the forest must be cleaned up. The system installed in the society is essential to keep biocultural landscape.

Keywords: Ecosystem management, Ecosystem services, Coastal area, Social-ecological system, Tradition

T0305

An Assessment of a Biocultural Landscape using Community Wellbeing Approaches

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During the anthropocene, landscape disturbances led to domino of disruptions. Landslides are rampant leading to loss of soil nutrients and eventually to reduced ecosystem services and food production. There is a cascading effect especially with the disadvantaged populace. Therefore, it is important to address this concern. This paper is an assessment of biocultural landscape using the 5 dimensions of community capitals. A community consultation through a focus group discussion (FGD) with diverse sectors' participation was the first step. The unique voices of each sector were documented for a relevant and successful community planning. The participation of local government, education, business, people's organizations, and socio-civic sectors is a necessity so that multiple perspectives on the state of the community capitals can be determined. This resulted to a well identified holistic determinants of community wellbeing index (CWBi). Spearman's rho correlation analysis was used to assess highly correlated variables from different indicators and sub-indicators. The Analytic Hierarchy Process (AHP) calculation technique was chosen to determine the weights for each indicator and dimension as well.

Results showed themes attached to the meanings of CWB, depending on sectoral roles. The themes centered on security, beginning with the individual's stability and eventually encompassing a community's stability. CWB indicators categorized as built, financial, political, sociocultural and natural, were determined and confirmed with each sector. CWBi provided a scientific evidence for sound decision making on the part of the local policy makers to enhance CWB and immediate recovery from disturbances of a biocultural landscape. This study, demonstrated that trust is the overarching indicator of the sociocultural capital. Others include, good governance, functional literacy, and a healthy natural environment.

Keywords: biocultural landscape, community wellbeing (CWB), community capitals, disaster, sustainability

Pattern of vegetation structure along elevational gradients in a tropical biocultural landscape

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Many tropical mountain forests landscapes are beset with human disturbances affecting the vegetation structure and dynamics and hence, ecosystem services for the human communities in the vicinities. Field investigations in selected Philippine mountains were done using standard methods of vegetation sampling and analysis. Results showed nontypical zonation pattern of vegetation structure, unlike the usual trend in the tropics. Lower elevation dominants ascended in higher altitudes, replacing original dominants destroyed by farming. Pinus kesiya of northern Philippines (Mount Pulag and Mount Akiki), replaced the Lithocarpus and other oaks. The Diplodiscus of Mount Makiling in southern Luzon colonized the niche of Dipterocarpus destroyed by logging in the 1940s. The Astronia of the volcanic Mount Mayon in southern Luzon and Artocarpus of Mount Tabunan on Cebu island, central Philippines and that of the Aborlan Guba System in Palawan island are ascending to higher altitudes. Species of Gmelina and Swietenia dominated in lower altitudes in Mount Ilong, Halcon range (Mindoro Island) and in Mount Bfu-lak, Nagchayan and Munchipfichib (Chaya, Mayoyao, Ifugao). Multivariate regression analysis showed that elevation, temperature, pH, moisture, water holding capacity and human disturbance, significantly influenced the distribution of tree species. In northern Luzon island, Pinus becomes a topo-edaphic climax displacing the oaks. The case of Diplodiscus could be a temporary stage of a long succession process initiated by logging and swidden agriculture, drastically changing the edaphic and microclimatic conditions, favorable for the lower dominants during the Anthropocene. There is a need to understand the dynamics in these biocultural landscapes so that appropriate conservation and management strategy can be formulated.

Keywords: altitudinal vegetation zones, biodiversity conservation, patterns of vegetation structure, terrestrial ecosystem, tropical mountain forest

T0036

Identification of the dynamics of change in the historical- ecological characteristics of the rural territory in the Northern Apennines: Val Tidone and Val di Nizza in the Oltrepò Pavese

Anita Calegari

The present work aims to trace the dynamics of landscape change in the area of the Northern Apennines of the Province of Pavia, in the Region of Lombardy (Italy).
The field of investigation is located between the regions of Emilia Romagna and Piedmont. This vast area covers about 45 Km², and includes the municipalities of Val di Nizza, and Valverde. Data were elaborated in order to examine the dynamics of the modifications of land use and of settlement through different periods, and to calculate the BTC (Biological Territorial Capacity) index.
The data used have been taken from recent and archival documents, such as: the data of the land holdings of the Monastery of San Colombano di Bobbio from the 9th to the 10th centuries, the Cadastre (or land registry) of Charles V of 1550, the Teresian Cadastre of 1723, the Historical Use of the Soil map of 1954, the Use of the Soil map of 1980, the DUSAF 5 map of 2015, and vintage images. For the elaboration of the documentation, a DB has been structured for the implementation of a GIS territorial information system.
The information gathered and processed highlight the characteristics of permanence in the rural settlement, of the use of the land, and of the forms of farming and of 'appoderamenti'. In particular, a substantial presence of cultivated areas in the lower hills emerged in the 16th century, predominantly featuring a type of vine cultivation called "avidato" (literally, "I grow in rows"), while in the historical relief of 1954, in the high hilly and mountainous area, the mixed cultivations are mainly represented by "seminativo arborato" (arable land with trees). Knowledge of the changes in land use, of the distribution of farming, and of the BTC are considered to be important elements for the identification of the historical-biological characteristics of the landscape, useful for the purposes of territorial-landscape planning and for the recognition and enhancement of ecosystem services (MA 2005).

Keywords: Landscape Ecology, Biological Territorial Capacity

Malevolence or Benevolence: The Nocturnal Urban Forest in the 21st Century, The Case of Seoul Forest and North Seoul Dream Forest, Seoul, South Korea

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Nyctohylophobia, an excessive irrational fear of forests at night or dark wooded areas. Fear as a semantic syntax in landscapes have not been often viewed as an aberrant argument primarily because landscapes and its features such as trees or city forests are surrounded with multitude anthropogenic attitudes. Albeit trees and city forests are recreational destinations in the rise of Anthropocene, the rerouting from archaic ecologies to modern homogenized landscape features of today have opened up new angles that depart concepts of primeval "forests of fear" into designed landscapes that harbor associations of recreational and physical space where meaning and aesthetics interpretation are devalued. Thus, social and cultural constructs decouple from radical understanding of forests. The axioms of urban forests as venues for menace, confusion, danger, mystery, curiosity and wonder should be re-investigated in the 21st century as such could still pose important attitudes that guide planning and design, safety and security, interpretation and solution-based design; these factors could even equate to the importance of urban forests as ecological pivot and place-making niche. These new understandings should be addressed if practicing nature-human societal relations are to be pursued in the modern age. This research paper attempts to qualify the exploration of perceptive "forests of fear" that answer the malevolent or benevolent interpretation of meanings from the features of an urban forest. The study involved over 200 participants within the months of October-December, 2018, that visited Seoul Forest and North Seoul Dream Forest, prominent two urban city forests in Seoul, South Korea that are distinctive in features.

Keywords: Cultural landscape, Ecology and Interpretation , Urban Forest, City forest, Landscape architecture and design

P0017

Let's Democratize Drones! Using the Ryze Tello Drone as a Tool for Ecological Farm Design & Landscape Ecology Research

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The use of drones in agriculture is becoming popular nowadays. From analyzing plant growth to determining the water holding capacity of soils, the opportunities for drones are endless. However, the high cost and risk of damaging high-end drones continue to be the major hindrance for researchers and farmers to access the benefits of drone technology. Ryze Robotics, a startup tech company, addresses these challenges by democratizing the use of drones to the masses with its first product, the Ryze Tello. The powerful mini drone's built-in camera captured photos and videos of twelve permaculture sites across the Philippine flying in both ideal and extreme outdoor conditions. The visual data collected provided both the researchers and the farmers a unique perspective on how the practice of permaculture design can shape the overall landscape of agroecosystems. Images from the drone can also be used as a powerful science communication tool for environmental information dissemination and education.

Keywords: drones, agroecosystems, communication, socioecological, permaculture

T0086

Creating a Network Model of System Component Connectivity to Visualize Agroecosystem Interactions in Ecologically Designed Permaculture Landscapes in the Philippines

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Permaculture is a design philosophy and framework for a regenerative culture based on ethics and socio-ecological design principles. Visualizing a farm design as a graphical model, the research aims to study the network structure of agroecosystems and shed light on the multidimensional and complex web of relations found in farm system interactions. In the study, system components were documented, mapped, and identified in twelve permaculture projects of varying scales and social contexts all over the Philippines. In the model, system components are treated as actors or 'nodes' while relationships between components are represented as links or 'edges.' Data on the intrinsic characteristics of individual components and functional relationships between them were collected using rapid rural appraisal, ecological profiling, field inventory, biodiversity and social surveys, focus group discussions, key informant interviews, and literature review. The data is embedded into each component and then classified into six categories: biotic, abiotic, manmade, technological socio-economic, cultural to create a network model. Graphical modelling, network visualization, and data analysis will be performed using Social Network Visualizer (SocNetV) Version 2.4 (2018), a free software application for social network analysis. A network model of a permaculture landscape will help identify biocultural patterns of interaction that could play crucial roles in ecosystem sustainability, resilience, biodiversity conservation, and food security in the household and the community.

Keywords: network, system, model, graph, visualization

P0208

Evaluation of Bio-Cultural Landscape in Tsushima Island, Nagasaki, Japan

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"Cultural landscape" is defined as the cultural properties represent the combined works of nature and of man. That is also one category of Cultural Property, as defined under the Japanese cultural protection system. Certain cultural scenery properties have steps for protection set aside, and on the basis of a request from the local municipality are chosen as "Important Cultural Landscape." Being landscapes, protection of these areas calls for adaptive protection that allows for change, and is thus distinct from other types of preservation that keep things exactly as they are. While the essential criteria for designating Important Cultural Landscapes are set, differences in each landscape's qualities lead to diverse selection processes. Although determining these criteria is closely related to the problem of demarcating cultural landscape, as of yet the relationship between selection criteria and the range of protection has not been discussed.

Storehouse architectures in Tsushima, Japan has a close relationship with local climate, natural features, and peoples' livelihoods, and comprises part of the landscape of rural villages. Their form one unit with a property's main building, stable, farmland, and uphill forests, and thus make the shape of a settlement's shape. These Storehouses and the landscape they define are distributed throughout Tsushima, but there has been no effort under the current system to assess them as one biocultural landscape, nor is there any precedent for doing so.

We focused at problems with Japan's cultural property preservation system, we approached this issue through an analysis of landscapes selected thus far as Important Cultural Landscapes, with particular attention to examples. Finally, we argued that farm villages in Tsushima constitute a bio-cultural landscape, and puts this in conversation with other examples.

Keywords: cultural landscape, warehouse, Tsushima Island, farm village

Striving for a Balance Between Sprawl and Bio-cultural Landscapes: The Case of the Ifugao Rice Terraces in the Philippines

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The Ifugao Rice Terraces of the Philippine Cordillera mountain range is listed among UNESCO's World Heritage Sites and has been described as an outstanding example of an evolved, living cultural landscape that can be traced as far back as two millennia ago in the pre-colonial Philippines. The rice terraces were carved out by the Ifugao, an ethnic minority group of indigenous people who have lived in these remote mountains for hundreds of years. Using age-old farming practices and planting traditional rice varieties, the hardy Ifugao people to this day have tilled and sustained the rice terraces as part of their cultural heritage. Fittingly, the Ifugao Rice Terraces has been recognized as a Globally Important Agricultural Heritage Site by the Food and Agriculture Organization of the United Nations. However, the FAO has currently drawn attention to the "very critical stage of deterioration" of the rice terraces. The continued survival of this important biocultural landscape is threatened by combined economic and tourism growth, environmental degradation, unregulated housing development and neglect.

Use of geospatial technology tools like Geographic Information System (GIS) and Remote Sensing (RS) can make a significant contribution to decision-making and management of cultural heritage sites. This study used digitized thematic maps and satellite images from different time periods since 1968 to document and analyze changes in land use in the Ifugao Rice Terraces. Non-spatial data was also part of the analysis, which included quantitative and qualitative information on community needs and possible gaps in the management of the heritage sites. Ultimately, the analysis and results of this study can be used by national and local government officials and planners in cultural heritage protection and management.

Keywords: sprawl, biocultural , landscape, Ifugao, terraces

Recommendations for Sustainable Cultivation of Organic Rice Farming in Malang East Java Indonesia

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Indonesia continues to strive the organic rice production. This effort is also carried out in the Malang District. This study aims to prepare recommendations for sustainable management of organic rice cultivation in Gondanglegi, Malang District, East Java, Indonesia. Data collection was carried out through direct observation of farming systems, interviews and filling out a list of questions. A series of deep interviews was conducted in order to identify knowledge, attitude and preferences of farmer on organic farming system. The interviews were conducted with five key persons. Recommendations were constructed based on farmers' choices and then determined through focused group discussion. The scope of cultivation includes nurseries, pest control and fertilization. This study indicated that the process of seed selection must be done thoroughly. Seeds must originate from organic farming systems. For organic farming system beginner, it was recommended to use standardized seeds available on the market. Pest control techniques must emphasize environmentally friendly efforts through conservation of natural enemies. Types of natural enemies known to farmers included snakes, dragonflies and spiders. Conservation of natural enemies was carried out by maintaining the existence of natural enemies and increasing the biodiversity of refugia plants. These refugia were planted alongside small dike. The farmers determined the refugia plants were the wild cosmos (Cosmos caudatus), the chili (Capsicum frutescens), tomatoes (Solanum sp.), Aster spp. and Zinnia sp. The existence of refugia plants has known to increase the biodiversity of Arthropod, which lead to improve the balance of agricultural ecosystems. In addition, farmers were also recommended to use liquid organic fertilizer combined with pesticides that are a mix of local plants. The pesticides consists of extract from the coconut fiber and shell, the stone apple fruit, Asiatic bitter yam tuber, sour soup seeds and leaves.

KeywordS: biodiversity, organic farming, refugia, liquid organic fertilizer

T0123

Water and Nutrient Dynamics in Muyong Forest and Rice Terraces (muyong-payoh system) in Banaue, Philippines

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The Ifugao Rice Terraces, also known as the Eighth Wonder of the World, was inscribed in the UNESCO World Heritage List in 1995. However, it was included in the 1999 World Monument Watch's list of 100 most endangered sites and the 2001 UNESCO List of World Heritage in Danger due to its deterioration.

The muyong-payoh system is a unique agroforest management strategy ingrained in the culture of Ifugao people. Muyong forest is the source of irrigation water and litter and nutrients for organic fertilizer for the rice terraces (payoh).

The nutrient and water dynamics in the muyong-payoh system in Banaue, Ifugao was determined by quantifying the essential nutrients present in the soil and water run-off from the muyong forest; the changes in soil fertility level of payoh throughout the length of rice growing season; and to quantify the rice plant nutrient content (leaves, stalks, grain) at harvest.

Water and soil samples were collected during different stages of rice growing season in the muyong and payoh located in different elevation. Water parameters evaluated included nitrogen, phosphorus, potassium and nitrate concentrations. Soil parameters assessed were organic matter content, pH, levels of phosphorus and potassium.

There were no general patterns in water chemistry values with cropping stages and distance of payoh from muyong indicating a very dynamic and open system. The soil fertility is generally highest in the upstream payoh and decreases as the distance from the muyong forest increases. Soil nutrients also generally decrease through the cropping season.

In Brgy. Amganad, the rice biomass yield is highest in the downstream payoh while in Brgy. Poitan, the highest biomass yield is in the midstream payoh. The most favorable grain harvest based on the proximate analysis is from the downstream payoh.

Management of the muyong forest is thus critical in the sustainability of rice production in the rice terraces.

Keywords: Ifugao rice terraces, muyong-payoh system, water and nutrient dynamics, soil fertility, rice yield

Vegetation stand structure analysis using quadrat method and auto-cad in a tropical forest ecosystem in Banaue, Ifugao, Northern Luzon, Philippines

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The Ifugao Rice Terraces of the Philippines is one of the most famous cultural landscapes in the Asia-Pacific Region and also included in the UNESCO World Heritage List. At least five land uses can be found across the landscape namely community forest (inalahan), privately-owned forest (muyong), rice terraces (payoh), human settlement areas (boble), swidden farms (uma) and grasslands (magulon). The establishment and conservation of these land-uses including traditional resource management by the local people contributed to the continuous existence and viability of the heritage site. Meanwhile, muyong has a significant role within the landscape. It serves primarily as a water recharge zone for the rice terraces found below it. Conservation of its biodiversity could sustain its ecological function and even its socio-cultural value. This study aimed to evaluate the vegetation composition and structure of the muyong. A total of 52 woody plant species were recorded in the ten 10m x 10m quadrats established in Brgy. Kinakin, Banaue, Ifugao, Northern Luzon, Philippines. The most represented family is Euphorbiaceae (11%) and the most represented genera are Macaranga and Ficus. The results on floral composition showed close affinity of the muyong to the lower montane forest formation of the Philippines. Moreover, 20% of the woody species are Philippine endemics and pioneer tree species. These species are used by the local people as important biological resources for socio-cultural and economic purposes which lead to their protection and conservation. However, the present study on horizontal and vertical structure generated from Auto-CAD showed that more than 50% of the stands are on very early stage of succession as shown by the abundance of short stature (<10 m) and low DBH trees (<10 cm), low species richness and Shannon's index of diversity and the presence of less than 60% canopy closure. Thus, there is a possible threat on the sustainability of the muyong possibly due

Keywords: vegetation stands, canopy closure, plant diversity, cultural forest, Auto-CAD

P0026

Enhancing coping mechanisms to hydrometeorological hazards of Manamoc Island, Cuyo, Palawan, Philippines

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Low lying small islands like Manamoc are vulnerable to hydrometeorological hazards such as typhoons and storm surges. These storm hazards caused coastal retreat in the island. To mitigate this, hard engineering was employed but then it was proven to be temporary and costly both financially and ecologically. Alternative measure is therefore imperative, hence, this study. The present study determined the coping mechanisms of community residents to hydrometeorological hazards; and attempted to enhance these coping mechanisms using sustainable and environment friendly measures. From key informant interview (KII), the following coping mechanisms to hydrometeorological hazards were determined: mangrove planting, riprapping, regulating sand and rock extraction, and seawall construction. However, these were not enough and therefore coping mechanisms should be enhanced. Using systems thinking approach, a schematic diagram of the underlying factors contributing to coastal retreat and strategies to address these factors was generated. These resulted to the determination of the following coping mechanisms: establishment of mangrove corridors; reforestation and planting of local beach forest species along the coastline. Vegetation analysis of mangrove areas in the island and mapping using remote sensing technique were employed in laying out mangrove corridors and reforestation sites. It is critical that local leaders and policy makers adopt these coping mechanisms to reduce disaster risk.

Keywords: coping mechanisms, hydrometeorological hazards, mangrove corridors network, Small Island

P0040

Finding potentially suitable sites for restoring endangered lily (Lilium japonicum) in Ishima island, Tokushima, Japan

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Lilium japonicum grows at grassland and/or forest edge where has been continuously managed by local people, so-called "Satoyama". However the plant has been endangered in Japan. In case of Tokushima Prefecture, Shikoku, they only grow in Ishima island, ca. 4km apart from mainland, and its population has decreased due to abandonment of Satoyama management, and it has ranked as IA in the Red List of Tokushima Pref. People living in Ishima have shared memory; when they were junior high school students, they collected and sold the lilies for getting money to compensate cost of school-trip. Therefore they are regretting the current situation and wishing for recover of the lily-population, and have started restoration works with volunteers outside the island.

In order to support the activities, we clarified environmental factors necessitating for the lily to grow and flower from multi-scale perspectives, and temporal change of distribution through interview with local people. And then sites with high potential for recovering are selected and mapped. Information on "what kind of activities are ongoing at where and by whom" was added on a map, and finally a zoning map was made to propose what kind of works should be carried out in each area.

Keywords: Co-production of research, Potential habitat map, Satoyama, Zoning, Lilium japonicum

Biocultural landscape of Carpinus tschonoskii var. torta, a national natural monument in Japan

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Tengu-shide means the long-nosed goblin hornbeam. The academic name of this tree species is Carpinus tschonoskii Maxim. var. torta Horikawa and identified by Prof. Y. Horikawa in 1942. Its original species distributes widely in temperate East Asia including Japan, however this variety only distributes in one site of Ohasa area, Kita-Hiroshima town in western Japan. There are no other habitats of the variety in East Asia. Its tree architecture is very unique showing hanging branches. The variety has been conserved by the local society in Ohasa for a long time. From 2000 to 2002, we conducted a genetic research on the variety trough a molecular biological study using 4 taxonomical groups namely Carpinus tschonoskii var. torta, C. tschonoskii, C. laxiflora and C. japonica taken from natural forests in the same region. The introduced research method is AFLP marking method. This genetic study shows a standard species level among three species. Fine statistics analysis shows the variety is able to be identified as a variety among C. tschnoskii population. The Cultural Agency designated this unique plant population as a national natural monument in 2000: administrative registration name is "Carpinus tschonoskii var. torta community in Ohasa." Carpinus tschonoskii is an important tree in Satoyama coppice forest in temperate western Japan including. The wood of hornbeam is a good material for fuel charcoal because its hardness. The habitat of the variety locates in deep valley near steep slopes. The residential people afraid a landslide often caused by heavy rain fall and typhoon after clear cutting of coppice forest due to the dangerous topography of valley. The legend of Tengu raised after such situations. Trees are cut and Tengu will get angry and punish the people caused by landslides. These ecological and biological facts show a typical biocultural landscaping in Anthropocene. This biocultural landscape is a good example of co-existence between human and nature.

Keywords: biocultural landscape, Japanese culture, Legend, tree population, Satoyama

P0173

Ritual plant utilization in Balinese ceremonial facilities

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Plant utilization can be used as an indicator of biocultural diversity. Plant utilization by ethnic groups is strongly influenced by local cultural practices. Balinese people used various types of plants for offering ceremonies. This ceremonial activity is based on the beliefs of the Balinese Hindu community. The community uses plant parts from seed, stems, leaves, flowers, and fruit. The plants used for offering ceremony means are known as ritual plants. This study will reveal the diversity of plant species used in ceremonial facilities such as Canang Sari, Kwangen, Segehan, Daksina, Pejati, Peras, Ajuman, Sesayut, and Penjor. At the past time, the existence of ancient ritual plants is easy to find in the natural environment of Bali. However, the rapid development of tourism led to the conversion of land from agriculture into a built-in space, enabling the loss of the diversity of ritual plant species. Changes in the components of ritual means can occur due to the loss of ritual diversity. Educating the community regarding the importance of the existence of ritual plants is essential to maintain and preserve ritual plants. This study aims to identify plants found in ritual ceremonies. Literary studies were carried out to identify the types of plants contained in each ceremonial facility. Descriptive and quantitative analysis of plant species was carried out to determine the value of these plants both functionally and aesthetically. This study revealed that there were 16 plant species in Canang Sari, 13 plant species in Kwangen, 18 plant species in Segehan, 30 plant species in Daksina, 43 plant species in Pejati, 15 plant species in Peras, 23 plant species in Ajuman, 21 species plants in Sesayut, and 16 plant species at Penjor. Several species such as Cocos nucifera, Areca cathecu, Piper betle and Musa pardisiaca are used in 9 types of ritual facilities. Ritual plants utilization proves the diversity of plants on Balinese ceremony facilities.

Keywords: biocultural diversity, ritual plants, plants diversity, bali

P0119

Ecological restoration of a quarry and spiritual landscapes in motion for a Buddhist monastery

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The Contemplation Park in Pomaia (Pisa) is much more than a linear path between the future Buddhist monastery called Lhungtok Choekhorling ("Place where teachings are transmitted and realized") that will arise in the old serpentinite quarry and Lama Tzong Khapa Institute. If it is a geometric and geographic line, the flow of energy from the monks positively invest the site, seemingly degraded by the abuse of extraction, thus giving a spirituality to the NBS to be implemented.Thus, the ecological restoration merges with the construction of the monastery, as if wanting to purge and correct the karma of such anthropocene abuses.It is no coincidence that links the new site and the Institute through areas of mature Mediterranean scrub with high naturalness from which to start, even reinforce and stabilize, the nature already present in the quarry. Not neo-nature then, but re-nature, that is recovery of what was tending to the original climax enriched by the energies of the monastic settlement and not depleted, as before, by quarrying.The approach to quarry bioremediation is well depicted by butterflies gently alighting on the flowers of the endemic species.Like the walk, it is almost a flight, fast and decisive, but light, almost floating on the nature of the spontaneously settled garrigue and that already tends to the more stable Mediterranean scrub.Soft times, then. Actions dictated by the observation of the pioneer species for the base of the grassing and absolute respect to the nature that has already resumed, without help, its own course and that wants only to integrate its own energy of plants and animals with the spiritual one.The bioremediation of asbestos by Alyssum bertolonii is thus mind-remediation in a landscape "in motion" supported by the monks during their walking meditation. Work began with educational works for university students and with the symbolic joint planting of myrtle by children together with the Dalai Lama. New generations for new approaches.

Keywords: Bioremediation & Mindremediation, Walking meditation, Green stones quarries, Asbestos contamination, Mediterranean maquis

Re(Connecting) with the Ifugao Rice Terraces as a Biocultural Landscape through a Youth Capacity Building and Exchange Program: A Conservation and Sustainable Development Approach

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The Ifugao Rice Terraces (IRT) in the Philippines has been declared by the United Nations Educational, Scientific and Cultural Organization (UNESCO) as a World Heritage Site in 1996. In 2004, the Food and Agriculture Organization (FAO) also declared the IRT as the only Globally Important Agricultural Heritage Systems (GIAHS) site in the Philippines. However, despite these designations, the IRT is faced with various challenges. This paper aims to investigate and examine the youth capacity building and exchange program that generally aims to reconnect Ifugao youths and connect urban youths with the IRT as a biocultural landscape. The youth capacity building and exchange program was implemented to address the extensive anthropogenic problems that confront the IRT such as terrace erosion, poor maintenance, unregulated tourism activities, loss of indigenous knowledge, and out-migration of young Ifugaos which result to the lack of succession in the farming of IRT. The youth capacity building and exchange program was conducted through a conservation and sustainable development approach done in four phases: needs analysis through youth exchange discussion; development of tablet-based training modules; youth training and exchange program, and contextualization of the training modules. Based on the needs analysis, tablet-based training modules were developed by experts from collaborating universities on the following topics: IRT as a Satoyama Landscape; Ecosystem Services of the IRT Landscape; Sustainable Development in the IRT; My Culture, My Nature and My Heritage; and, IRT as a Satoyama Landscape in the 21st Century. The following were the insights of the youths: tablet-based modules were comprehensible learning tools in imparting knowledge about the IRT; there is an interest to be part of the sustainable development of the IRT as a satoyama landscape; and there is a need for various stakeholders to work together to sustain these kinds of interests from the youths.

Keywords: Ifugao Rice Terraces, capacity building, conservation, sustainable development, youth

Impacts of Oil Palm Plantation to the People of Barangay Sagpangan, Aborlan, Palawan, Philippines

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Economic development such as oil palm plantation is seen as booster for the economy that will help improve the lives of the community. However, several studies have already proved otherwise. This study aimed to explain one of the sensitive issues in the locality and to provide data for policy implication. Using purposive sampling, key informants were interviewed. Data were analyzed using thematic analysis. Results show that oil palm plantation did not actually help in the development of the community but rather contributed to the suffering of the landowners, especially the Tagbanua indigenous peoples. Land conversion to oil palm plantation did not only negatively affect the community but also the biodiversity.

Keywords: Indigenous peoples, debt, decreased biodiversity

T0015

Fragmentation drivers in Polillo Islands key biodiversity area, Polillo Quezon, Philippines

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The Polillo Island Key Biodiversity Area (KBA) is one of the designated priority sites for conservation in the Philippines. The forest habitats in this area are threatened by fragmentation and forest loss. However, there is an absence of a study that focuses on the drivers of fragmentation and declining forest cover. To close this gap, spatial analysis, model development, and participatory research were employed to: (1) analyze the extent and potential drivers of fragmentation and forest loss within the KBA; (2) model and predict land use change for the Polillo KBA for the year 2032 and 2047 and describe fragmentation status and coverage in total area; and (3) analyze institutional mechanisms in-place and develop recommendations to address forest fragmentation and forest loss within the KBAs. 2002, 2006 and 2017 Landsat imageries of the study site show differences in degree of fragmentation. Land Use Land Cover Change (LULCC) drives these changes, where the pattern in the mainland KBA shows a degrading forest while conversion of forest to coconut predominates in Patnanungan. The change in landscape is explained by socio-economic, institutional, governance mechanism and spatial pattern drivers. Projection result for the year 2032 and 2047 shows a decreasing forest for both mainland and Patnanungan. Among the recommendations to improve management of the KBA include strengthening Local Conservation Area (LCA) through program continuity, as well as establishing inter-Local Government alliance among the municipalities of Polillo Islands. Sustainability in existing community-based protection particularly of forest guards has likewise been identified as an efficient management response to forest loss and should be continued. Lastly, responding to economic need of communities by developing a coconut-based agroforestry system could be strengthened to respond lessen, if not totally arrest conversion practices.

Keywords: Forest fragmentation drivers, Polillo Island KBA, spatial analysis, governance, institutions

P0062

Threshold interactions in socio-ecological systems across spatial scales. Rural landscape development in Poland.

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The complexity of the agricultural landscape is one of the important aspects of preserving biodiversity and reducing the negative impact of agricultural activities on the environment. For decades traditional, mosaic agricultural landscape in Poland served as a source of wide set of ecosystem services available for society. The rural areas are currently under varying pressures, caused by the intensification and the abandonment of plant and animal production. Those processes lead to loss of biodiversity, ecological functions and critical ecosystem services in rural areas. In order to understand the changes we conducted a number of surveys, based on which we prepared conceptual model of alternative states of the socio-ecological systems (cascading thresholds approach) for the rural river catchment (Pilica River, Central Poland). The model served for understanding and forecasting the effects of society and nature interaction on ecosystem services, based on the identification of social, cultural and economic drivers of landscape changes. The study enabled formulation of the three scenarios of change: industrial, extensive and multifunctional agriculture. These scenarios are an integral part of the created conceptual model which is the basis for determining the consequences of the approach of farmers to nature, the present agricultural policy and the structure of agriculture for ecosystem services in rural areas.

Keywords: agricultural landscape structure, regulatory ecosystem services, cascading thresholds, tradeoffs

T0486

Bio-cultural landscape values as perceived at community level – a case of disappearing steppe landscapes, southern Ukraine

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Due to agricultural expansion, the steppe habitats are among the most degraded across Europe and beyond. In this study we aim to examine local peoples' knowledge, perceptions and attitudes to remnant steppe habitats, to evaluate and map what landscape (ecosystem) services and disservices local people attribute to bio-cultural landscape features and steppe habitats, and to determine factors that can encourage them to either support or oppose conservation and management actions aiming at restoration of steppe biodiversity around their properties. We made use of community scale focus groups interviews, and surveyed the actual phytodiversity of the area. The results show that people primarily reflect services related to everyday concerns about agricultural productivity, environmental hazards and family well-being. Nonetheless, the non-monetary value of nature was expressed strongly in their relationship with the land, and the aesthetic and recreational capacities that it offers (though not necessarily in terms of nature protection as understood by biodiversity agendas and strategies; the perceived and actual phytodiversity of the area also differs). The services reported show spatial-temporal patterns related to land use transformations of the area. Our results give insights into social landscape values at community level, and underline the necessity of integrated land management in creating public awareness for high conservation value habitats located beyond ecological networks.

Keywords: socio-cultural perception, ecosystem services, nature conservation, steppe, bio-cultural heritage

Session Dynamic and disturbances in landscapes

T0211

Does land use change influence human well-being and development in the Amazon's agriculture frontier?

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Regional land use change is normally studied in a context in which human actions are the proximate cause of landscape change. However, how changes in land use relate to human social and economic development is uncertain. For example, higher income is expected when replacing natural land cover with agricultural land use, but human well-being associated with natural resources (environmental quality) can also decline. Here, we evaluated how land use change affects the human welfare in the Amazon's agriculture frontier from 1990 to 2010. Human welfare were represented by indicators for income and inequality, human development index, children mortality, schooling, housing, and employment, among others. We modelled these indicators as a function of land used for cropland and pastureland (considering both extensification and intensification) as well as deforested and forested land using econometric models. Using the Akaike Information Criterion, we compared these land use models among themselves and with a null model, and models exploring municipality area and/or population as the only factors explaining variation in indicators. Our results show that large spatial and temporal differences both within and among municipalities. Variation within municipalities overtime plays a dominant whole on models results. When controlling for temporal variation, cropland expansion and intensification are positively correlated to indicators of improved well-being such as general human development, education, longevity, and equality. Still, pastureland expansion does not explain socioeconomic indicators better than null models. These results offer an interesting perspective on agricultural frontier development by showing that different trajectories - such as deforestation followed by pastureland introduction (characteristic of government programs) and agricultural expansion (characteristic of nonstate institutions) – may present different outcomes for population welfare.

Keywords: Well-being, Development, Expansion, Intensification

Integrating vegetation suitability into the ecological restoration in the Loess Plateau, China

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China's Loess Plateau is one of seriously eroded areas in the world and large-scale restoration project (Grain for Green, GFG) has been implemented since 1999 to control soil erosion. GFG involves working to return cropland on steep slopes to forest and grassland, while the irational distribution of forest and grassland affected the local water and energy budget, and caused significantly negative consequences, such as soil drying and streamflow declining. The rational distribution of forest and grassland should be solved in the landscape restoration planning and vegetation suitability research would be quite instrumental. Thus, we developed individual species fitness equation to quantify vegetation suitability of two common restoration species (*Robinia pseudoacacia* and *Stipa bungeana*). The equation was based on the optimality trade-off hypothesis stating that dryland vegetation patterns are constrained by maximization of water use and simultaneous minimization of water stress. Then the water stress and water use efficiency were modeled for both the species. Results showed that the water stress *Robinia pseudoacacia* suffered has reached the maximum in the majority of the region, and *Robinia pseudoacacia* generally suffered greater water stress than the *Stipa bungeana*. The water use efficiency for both species mainly varied along the precipitation gradient, and *Stipa bungeana* generally has greater water use efficiency than *Robinia pseudoacacia*. In most regions of Loess Plateau, vegetation suitability of *Stipa bungeana* is higher than *Robinia pseudoacaci*a. And the suitable regions for *Robinia pseudoacacia* planting are identified, the northeast part of Loess Plateau and a small part of the southwest regions. Our findings indicate that species selection should be applied in the landscape restoration planning.

Keywords: Loess Plateau, Vegetation restoration, optimality trade-off hypothesis

T_9003

Amazon deforestation drives malaria transmission, and malaria burden reduces forest clearing

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Deforestation and other forms of land use change are among the most pressing anthropogenic impacts on the environment, eliminating species and ecosystem services, and potentially causing disease emergence. In Brazil, a resurgence of malaria starting in the 1970s has paralleled rapid deforestation and settlement in the Amazon basin, yet empirical evidence of a deforestation-driven increase in malaria remains surprisingly equivocal. We hypothesize an underlying cause of this ambiguity is that deforestation and malaria influence each other in bi-directional causal relationships, where deforestation increases malaria through ecological mechanisms and malaria simultaneously reduces deforestation through socio-economic mechanisms. Here, we test these hypotheses with an unprecedented geospatial dataset encompassing 807 municipalities across 13 years and show that deforestation has a strong positive effect on human malaria incidence when controlling for variation over space and time and across stages of land use intensification. Using regression-based methods from econometrics, we estimate that a 10% increase in deforestation would lead to ~3.7% increase in Plasmodium falciparum malaria cases (~1,730 additional cases in 2008). The effect is larger in the interior and absent on the fringe of the Amazon where little forest remains. However, this strong effect is only detectable after controlling for a feedback of malaria burden on forest loss, possibly mediated by human behavior, economic development, or long-term socioeconomic change. Using instrumental variable regression, we estimate that for a 1% increase in P. falciparum malaria, we expect ~1.5% decrease in forest area cleared (~235 fewer km2 lost in 2008). This bi-directional socio-ecological feedback between deforestation and malaria, which attenuates as land use intensifies, illustrates the intimate ties between environmental change and human health.

Keywords: Deforestation, malaria, Brazilian Amazon, coupled natural-human systems, econometrics

T0292

Landscape Approach Methodology for Islands Environmental Monitoring

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The information base of safe life activity of the population is based on the fact that when studying the environment, it is necessary to apply the methodology of an integrated approach to the problem inherent in the geographic community. Such a scientific basis considers landscape geography and, in general, a landscape approach using landscape indication and monitoring of geosystems as part of the study of environmentally safe development of territories. In the context of the growing role of the environmental factor and the study of environmental risks, the landscape method serves as the basis for choosing the main direction or even the management strategy.

Study of landscapes using component, morphological, areal, multi-scale landscape-ecological monitoring will allow cartographically using modern digital computer technologies to proceed to the consideration of scientific and practical tools for planning and forecasting economic, social, environmental and other geosystems that are harmonized with nature. Structuring will be conducive to solving problems of environmentally friendly land development and is relevant.

The need and usefulness of landscape-ecological analysis is manifested, for example, in the design and selection of construction sites. The choice of which is based on the assessment of the landscape space and its internal content (height, slope angle, the dynamics of the erosion-denudation system, the development of physical-geographical and other processes). They require special attention to themselves, because quite often, after the construction of a building, these processes change dramatically due to the additional load, and disrupt the functioning of landscape-ecological systems. That, in turn, gives significant deviations from the planning and environmental standards, and this leads to the appearance of negative consequences of construction.

Keywords: Landscape, ecology, planning, method, practice

Transboundary Climate Adaptation Strategies Are Needed For East Asian Temperate Forests.

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The impacts of climate change on forest ecosystems traverse administrative borders and new paradigms are needed for developing climate change management strategies. Temperate forests in the countries of East Asia include many biodiversity hotspots, but forecasts of climate change impacts to these forests have been limited compared with some other regions. Here we assess the level of climate change exposure to the Temperate Broadleaf and Mixed Forests Biome of East Asia by 2070. These temperate forests occupy 18 ecoregions, five countries (China; North and South Korea; Japan; and the Russian Federation) and 102 provinces. We used mean annual minimum temperature and total annual precipitation to describe the climate conditions in these forests. We categorize climate change exposure by measuring the level of change from baseline (1960-1990) climate conditions for the current geographic distribution of five temperate forest types (Evergreen Needleleaf Forests; Evergreen Broadleaf Forests; Deciduous Needleleaf Forests; Deciduous Broadleaf Forests; and Mixed Forests) in each ecoregion and across the biome. Under the RCP8.5 business-as-usual emissions, 24.5-65.7% of forests enter the most marginal one percent or non-analog climates of baseline climate conditions by 2070. These results suggest the need for extensive transboundary governmental coordination including forest preservation actions for 51 of 54 provinces containing climatically stable, or low climate exposure, forest areas that span provincial administrative boundaries; and forest climate adaptation strategies for 90 of 96 provinces containing forests at high climate change exposure, that include the border areas of China, the Russian Federation, and North Korea. As a place-based approach, this study is easily replicable and provides useful insight for developing proactive management and institutional coordination to address the long-term impacts of climate change on a large forest ecosystem.

Keywords: Climate Change Risk, Temperate Forests, Ecoregion, Transboundary Coordination, Climate Adaptation Strategies

The effect of the invasive species Buddleja davidii on plant–pollinator networks is mediated by honeybee abundance

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Buddleja davidii is a highly invasive perennial shrub native from China that is invading several low elevation areas of the Alps. Its reproduction depends on insects for pollination, and it is therefore very attractive for several pollinator species. Honeybee (Apis mellifera) is considered the main pollinator in many natural and agricultural ecosystem. However, its effect on wild pollinators is controversial. We explored how the alien species B. davidii impacted plant–pollinator networks over its elevational range distribution in Northern Italy, and how this relationship is modulated honeybee abundance.

We observed plant–pollinator networks over a 5 months period (June-September 2018) in 18 sites over an elevation gradient of 1000 m ca in the Veneto and Trentino-Alto Adige regions. Structural equation models were used to evaluate the relationships between network topology, honeybee abundance, B. davidii abundance and elevation.

In each site, we identified all flowering plants and the entire pollinator community (i.e. all the hymenopterans, dipterans and lepidopterans touching the reproductive parts of flowers). In total, the network consisted of 175 species of flowering plants visited by 9 563 insect pollinators (370 species). Honeybee was the most abundant species, representing the 43.3% of the whole community.

Honeybee abundance was significantly higher is sites with high cover of B. davidii. In turn, the abundance of honeybee influenced network modularity, with networks becoming less compartmentalized as honeybee abundance increases. Our results provide experimental evidence that honeybee deconstructs the interactions between flowering plants and their pollinators, as many insects species probably switch to other plants in order to avoid honeybee competition. The observed effects were not affected by temperature. The potential impacts of exotic plant invasions on native pollinators are complex and require the consideration of multiple concomitant factors.

Keywords: alien species, polinators, networks, honeybee, elevational gradient

Responses of Spring Phenology to Preseason Warming and Temperature Sensitivity Changes in High Latitudes of China

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Plant phenology is sensitive to climate change. In particular, spring phenology has a complex response to preseason temperature. We selected a mid-high latitude area (44°N-52°N) with stronger warming magnitude relative to other regions in China to examine the effects of winter (Dec to Feb) vs. spring (Mar to Apr) warming on changes in six spring phenological phases (bud burst to end of flowering) using a daily mean temperature dataset of 0.5° grid-box and in situ observed phenology data during 1980-2010. The correlation between temperature and spring phenology and the temperature sensitivity (expressed as the date of phenology change per °C warming) were also analyzed for Populus simonii, Ulmus pumila, Syringa oblata. The results showed that winter warming (0.28-0.87 °C/decade) was higher than spring warming (0.04-0.42 °C/decade) in this region. The responses of phenology to warming are different among different species, as well as among different phenological phases for a given species. We found the phenological phases of Ulmus pumila have delayed with winter and spring warming, while other plants have advanced. The spring phenology is mainly affected by the temperature in April, rather than in the last winter. The average temperature sensitivity of budburst of these three species became stronger from 0.64 days/°C during 1980-1994 to 2.04 days/°C during 1996-2010. The temperature sensitivity of leaf unfolding and flowering phases of Populus simonii became weaker, however, that of Ulmus pumila became stronger. These results illustrate that, temperature in pre-growing season has a more important effect on spring phenology than that of winter. However, spring phenology does not advance with early spring warming for all species in mid-high latitudes. Therefore, further phenological sequence with ongoing warming will be more complex due to the differences in temperature sensitivity among species and phenological phases.

Keywords: Climate change, Northeast China, Spring phenology, Temperature sensitivity, Winter warming

T0844

Urbanization and black locust dominance effects on understory plant biodiversity in three European cities compared

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The worldwide city growth is increasing the number of people who benefit from the provision of services by semi-natural urban ecosystems. The plant species living in semi-natural "wild" urban woodlands, is one of the main structural component giving ecosystem complexity and stability. Plant biodiversity is mainly affected by anthropogenic disturbances like habitat modification, destruction and fragmentation. Alien plants are shaping their plant composition. Urban woodland canopy is rich in alien trees. To assess whether this is resulting in the development of novel ecosystems, comparisons of plant communities between ecosystems and cities with different levels of invasion are needed. The aim of this study is to disentangle the effects of urbanization, plant invasion, and climate, on urban woodland plant communities. We present their similarity patterns in three European cities distributed along a latitudinal gradient. Sampling relied on a paired comparison design through which seventy-six 100 m2 paired plots in stands invaded and not invaded by the alien black locust tree (Robinia pseudoacacia) were identified in Berlin, Padua and Rome. A relative high proportion of alien species was recorded. This abundance may be interpreted both as a driver of and a response to anthropogenic disturbances. Differences in plant communities were explained by different levels of urbanization and landscape components of the urban matrix. The understory composition among different cities showed higher homogeneity within woodlands dominated by black locust than within native woodlands. This research enabled us to explore joint impacts of urban matrix components and dominance of black locust tree on alpha and beta diversity and confirmed the importance of multiple-scale studies to better understand how effects on plant biodiversity can be modulated by multiple factors.

Keywords: Robinia pseudoacacia, invasive alien species, biodiversity, urbanization, urban woodlands

T0871

Ecosystem changes induced by Robinia pseudoacacia: results from invaded landscapes in the Veneto Region

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Invasive alien species are one of main threats to biodiversity conservation worldwide. Indeed, widely spread species can become an important feature of a landscape and can have strong impacts over large areas. Investigating the role and impact of invasive alien species is fundamental to tackle this issue through appropriate landscape management and planning. Here we present results from a number of studies investigating the potential ecosystem changes induced by the presence of black locust (Robinia pseudoacacia L.) in forest habitats, as well as the potential influence of forest management on these dynamics at the landscape scale. Black locust, a N-fixing tree, is the most widely spread alien woody species in Europe and has an impact on many natural and semi-natural habitats. We selected several forest sites in hilly and riparian landscapes in the Veneto region (northern Italy) within and outside the Natura 2000 European network of protected sites. We considered the effects of this species on ecosystems after its invasion of fields and other abandoned areas, but also in managed coppice and high forests. We surveyed vascular plant species and soil features in nearby paired plots dominated by black locust, invaded, and by native tree specie, non-invaded. Results show that plant diversity is not influenced by the alien tree species. Invaded plots are rich in nitrophilous and alien species. Black locust showed compositionally heterogeneous plant communities, but species composition clearly differed between invaded and non-invaded plots. Furthermore, the effects on functional plant trait composition were substantial and can be linked to differences in soil conditions with native stands. Further research will investigate the presence of nitrogen fixing archaea in invaded and non-invaded forest soils. Management and conservation decisions should consider these impacts, the landscape context and specific environmental features in which black locust forests develop.

Keywords: invasive alien species, Natura 2000, biological invasion, protected areas

Session Antropogenic landscapes

Technomass: building a bridge between urban ecology, metabolism and planning

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Urban systems are one of the most complex systems built by humans, posing a tremendous challenge towards sustainability. To deal with the non-linearity and high complexity of urban systems requires novel and interdisciplinary approaches. In this contribution we develop an operational approach using the background of three scientific disciplines: 1) ecology that understands the city as an ecosystem, 2) urban metabolism focusing on stocks and fluxes of matter and energy, and 3) urban planning, a discipline designing forms of social control over the urban development to guide its morphological and functional evolution. We use the technomass indicator to build a bridge between these disciplines. Technomass is based on an innovative classification of urban stocks that overcomes the current conceptual and operational limitations of other classifications such as EUROSTAT. The operationalisation of technomass considers the three spatial and one temporal dimension and has been fully implemented in GIS, overcoming the limitations of two-dimensional land cover-based indicators. We present four different case studies, from urban ecology, urbanisation, ecosystem services and energy demand in buildings, applied in one European region, one European city and five Latin American cities, respectively. These case studies demonstrate that technomass is a powerful indicator able to synthesise the complexity of the urban environment to measure its impacts on different dimensions, in one simple, spatially explicit elegant metric, allowing the robust comparison of different urban systems across the globe. It is a versatile, holistic and conceptually robust indicator that articulates the fundamental principles of urban ecology with the study of urban metabolism, providing urban planning with empirical evidence of the impacts of urbanisation, opening new paths in the search for the elusive urban sustainability.

Keywords: urban ecology, urban metabolism, urban planning, GIS, spatially explicit indicators

T_7777

Remote sensing in a landscape planning perspective: a multi-scale analysis for mismatches between regulating and provisioning Ecosystem Services

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Increase in world population and urbanization, as well as ongoing climate change represent important threats for human wellbeing. To cope with such challenges, a scientifically sound landscape planning, which take in consideration Ecosystem Services (ES) and human wellbeing is required. UN Sustainable Development Goals (SDGs) also push toward a landscape planning aimed to protect, restore and promote sustainable use of terrestrial ecosystems and to make cities and human settlements inclusive, safe and resilient. Many studies have shown that some landscape configurations are more effective in the delivery of a specific ES, thus enhancing human wellbeing, while some others can be detrimental. For example, urban and peri-urban forests are strongly associated to the provision of Regulating ES like air quality improvement whereas agricultural lands enhance Provisioning Services. Nevertheless, scientific evidence alone is not sufficient in order to produce a sustainable landscape design: dialog with stakeholders is also necessary. The ES management approach at landscape scale requires good quality, spatially explicit data; In this framework, Remote Sensing (RS) has increasingly been used in landscape planning as well as ES management. In this work we performed a land cover analysis based on Sentinel-2 RS data to assess eventual discrepancies between the delivery of Regulating and Provisioning ES in Latium Region (Italy) at different scales. Almost 30% of the Region is covered by forested areas; agricultural, herbaceous and bare soil surfaces occupy more than 60% of the total area; artificial surfaces covers approximately 7.6%. Land cover analysis was also conducted for the 5 provinces of Latium Region . We therefore identified areas where imbalance between Regulating and Provisioning ES production occur as those areas where a sustainable landscape planning is more required.

Keywords: Remote Sensing, Ecosystem mapping, Ecosystem Services, Natural and agroecosystems, Landscape planning

T0112

Contribution of living landscapes on ecosystem services in small-holder farming systems

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While the role of insects in supporting pollination and natural pest suppression is widely acknowledged, we still lack understanding how pollinator and natural enemy communities, pollination and biocontrol services are influenced by landscape factors in smallholder agroecosystems. We conducted a study in fields with an oilseed rape-rice rotation in 20 landscapes with proportions of small-holder farming ranging from 10% to 70% in southern China. In a pollination study in oilseed rape we assessed pollinator communities with pan traps and quantified pollination services by pollinator-exclusion experiment. In a biocontrol study in rice we assessed pest and natural enemy communities, crop injury, yield and economic performance in plots that were treated with insecticides or not.
The abundance of wild pollinators was positively associated with the proportion of cultivated land, while the diversity showed an opposite pattern. Pollination services were positively associated with the abundance of wild pollinators. In rice, natural enemies suppressed brown planthopper population growth in unsprayed plots, irrespective of landscape composition. Pesticide applications were only profitable for less than half of the cases when only costs for pesticides were considered, and less than 1/3 of the cases when costs for pesticides and labour were considered.
Our findings indicate that landscape had an inconsistent influence on pollination and biocontrol services. Crop dominated landscapes with numerous small fields supported an abundant, but relatively species poor bee community that delivered pollination services to oilseed rape. Conservation of (semi-)natural habitats, however, is important for maintaining the diversity of wild pollinators. In contrast, crop injury and biocontrol are largely independent from the landscape context. To maintain high levels of biocontrol, conserving this small-scale character appears more important than increasing the proportion of semi-natural habit

Keywords: biocontrol, pollination, yield, rice, oilseed rape

Agricultural Landscapes of Densification. The Case of Luxembourg.

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Luxembourg's increasing attractiveness as a place for working and living puts the development of urban and agricultural territory under high pressure, often prioritising economic viability over environmental sustainability. Urbanisation threatens food productivity of agricultural land and reducing the capacity of the hinterland to support the growing urban population. Understanding how the agricultural landscape can be transformed to accommodate intensive population and commuting growth without losing productivity in a sustainable manner is a crucial and difficult challenge. The exploration of alternative development trajectories offering both spatial and adaptable alternatives is necessary. This paper will present first results for prospective land use scenarios accommodating a population growth of one million inhabitants in Luxembourg by 2060. It explores alternative model developments, responding to (i) the country's intensive population and economic patterns and (ii) its unsustainable spatial materialisations that affect the agricultural landscape. The research accentuates a multi-scalar nature by articulating three components: (1) The development of a hybrid landscape classification through the investigation of geospatial analysis and modelling, urban design and agricultural landscapes typologies. (2) The identification of sustainable and ecological criteria that go beyond conventional dichotomies of existing fabrics. Based on that, Luxembourg will be re-mapped in order to uncover new potential areas for optimised urban development without giving up productive agricultural land. (3) Eventually, the research will explore future land use scenarios of agricultural landscapes of densification with alternative typologies for future growth projections.

The benefit of this research will provide sound spatial planning guidance on productive agricultural landscapes in Luxembourg.

Keywords: Luxembourg, Land-use Scenarios, Typologies, Sustainability, Peri-Urban

Can private property increase land degradation in pastoralist systems? The tragedy of the commons in the North-Eastern Qinghai-Tibetan Plateau in China.

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Land degradation in the North-Eastern Qinghai-Tibetan Plateau in China has been a source of concern for more than two decades and has been attributed to biophysical factors such as increasing temperatures, increased grazing, and increasing pressure from small mammals. Given the widely recognized importance of institutional arrangements such as land tenure in the management of natural resources and the empirical evidence showing an increased degradation following fencing in the 1990s in this region, we investigate the ecological impact of fencing in terms of optimal herd movement across the landscape using an agent-based model (ABM). The novelty of this approach lies in its ability to produce macro-scale patterns from the behaviour of micro-scale heterogeneous constitutional elements. Due to these traits, ABMs have become one of the most relevant tools in the investigation of complex human-natural systems (CHANS), i.e. systems characterized by heterogeneity, nonlinearity, feedbacks and emergence resulting from human-environmental interactions. Framing the pastoralist system in the North-Eastern Qinghai-Tibetan Plateau as a CHANS, we develop an ABM of an alpine pasture in which grass, individual yaks and herders are represented and tracked daily. Simulations show the emergence of a dynamic equilibrium between yaks and grassland that closely mirrors well-known predator-prey dynamics. While fencing appears to be beneficial on low-density landscapes preventing herds to randomly graze next to each other, it reduces the overall carrying capacity and productivity and increases the probability of herds entirely disappearing on high-density landscapes. These results suggest that landscapes with high animal density are negatively impacted by land tenure systems that promote fencing. Further research investigating interactions among herders will examine the role of management practices and behaviour on the environmental sustainability of herding under alternative land tenures.

Keywords: agent-based modelling, spatial simulation, CHANS, grassland degradation, land tenure

Place-Participation, Place-Alienation and Place-Production in Vernacular Landscape

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The vernacular landscape is a place where people change and transform according to their own interests. Therefore we can define the vernacular landscape as a partnership between human and geography. Human's partnership with geography can be associate with the feelings and demands of land, property, nature, labor, work, feeling, memory, origin, belonging, home.

Together with the transformation of this partnership, the interaction of people with the vernacular landscape may vary depending on the physical distance (living another place) and proximity. In Turkey, Vernacular landscape is a place both missed and not preferred for living. From all reasons above, in this study, the vernacular landscapes is evaluated within the context of place making, place-participation and place-alienation. Understanding the causes and the forces that lead to alienation and participation has embarked on as a way of determining the relationship between vernacular landscape and human pragmatism. This argument and evaluation have been realized in Onar and Ormansırtı Village which which are important settlements since the Roman Period, derelicted since 1980 and preferred due to tourism sector in recent years. Based on this argument new space/place production and social construction have been examined tourism sector and increase of alineation and how local spatial tactics are localized in the vernacular landscape.

Keywords: Vernacular landscape , Place-alienation, Place-making, Place production

T0517

Landscape ecology and tourism research - intangible risks and tangible rewards

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The paper aims to discuss theoretical and methodological issues of linking landscape ecology and tourism research. Close relation between landscape and tourism seems obvious, as diverse landscapes and its elements are fundamental tourists attractions. Amazingly, although theoretical models and frameworks of both disciplines share many common points, until recently they have been developed in isolation each from the other. Consequently, however both natural and social scientists declare the need of mutual cooperation, interdisciplinary studies are rarely realized. Lack of common theoretical framework, general unwillingness to go out beyond the main body of one's discipline and incompatibility of the interdisciplinary approaches with existing dissemination and implementation schemes are the main impediments to link social and ecological research. These problems are, however, worth to overcome, as combining social and ecological approaches offers a chance for deeper understanding of ongoing processes and can be an important step forward in sustainable tourism management. The risks and rewards of combining social and landscape ecology methods and theories will be discussed on the example of the 3 year research project on nature based tourism realized in a lakeland area of northern Poland.

Keywords: landscape, tourism, socio-ecological system

T0666

Identifying and supporting High Nature Value farmlands: lessons learned and future needs

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About 40 per cent of the world's terrestrial surface is used for farming. In many parts of the world, particularly in Europe, regionally adapted farming systems have shaped the landscape for centuries, and sometimes millennia, and are associated with diverse cultural and natural heritage. Known as High Nature Value farmlands (HNV farmlands), these farmlands and their underlying farming systems evolved as tightly coupled social-ecological systems, and are essential to biodiversity conservation and the delivery of ecosystem services to society. However, HNV farmlands are currently under threat from abandonment of agricultural management, intensification of production, and socio-economic decline. Past and current policy measures within the Common Agricultural Policy have mainly failed to safeguard HNV farmlands and the respective farming systems. Here, we discuss the concept of HNV farmlands as an integrative landscape-level approach to define areas in Europe where agricultural activities support and are associated with high biodiversity. We then show how this concept is related to existing concepts aimed at biodiversity conservation in agricultural landscapes and present results from a modelling approach applied to Germany to map the spatial distribution of potential HNV farmlands at the national level. Finally, we outline and discuss steps to be taken to maintain and support HNV farmlands and respective farming systems in the future so that so that their inherent biodiversity and ecosystem service delivery is assured.

Keywords: Agricultural landscapes, biodiversity conservation, cultural landscapes, ecosystem services, social-ecological systems

Green seawall: challenge to conversion from gray to green infrastructure.

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After the Tsunami disaster attacked the coastal area of east Japan, especially on the pacific side of Tohoku region in 2011, our government built seawalls of 400km length along the coastline to protect inland area from Tsunami disaster. Although this seawall secured a certain level of safety at these coastal areas, it has been pointed out that the seawall will prevent the connectivity of eco-tone (gradation of ecosystem in coastal sand dune system) and degrade the resilience of dune system. We aimed to regenerate the eco-tone of coastal ecosystem using the dune plants by greening the seawall project. This presentation will be reported the survival rate of planted dune plants on the seawall and vegetation change of study area for a year.

Our study sites of coastal area were located on Yuriage coast at Miyagi prefecture, where were attacked by Tsunami disaster in 2011 and built seawall along the coastal line. We observed the dune vegetation were completely different between seaside beach and landside beach of seawall. To regenerate the eco-tone, we planted the seven species of dune plants on the seawall in 2017. As a result, planted dune plants were survived around 80% or more on the seaside seawall. But the survival rates were decreased around 70% on the landside seawall because of dried out by soil loss. Comparison between natural recovered seaside seawall and planted seaside seawall, the dominant species Ischaemum anthephoroides were similar. But Ixeris repens were less survived on the planted seaside seawall, in spite of one of the dominant species on the natural recovered seaside seawall. On the other hand, species of landside seawall were completely different with natural recovered landside seawall. This results shows that the greening on the seawall, especially on the landside seawall, were important for regeneration of coastal dune eco-tone.

Keywords: green infrastructure, eco-tone, coastal dune system, ecosystem services, dune plants

Session Biodiversity conservation

T_0991

Movements and habitat use of river dolphins (Cetartiodactyla: Iniiidae) in the Amazon and Orinoco river basins, determined from satellite tagging

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The South American river dolphins have evolved in the continental aquatic ecosystems of the Amazon, Araguaia-Tocantis and Orinoco rivers. The spatial and temporal distribution and the habitat use of these cetaceans are determined by distinct environmental characteristics and geomorphological accidents, have emerged as barriers that biogeographycaly, promoting processes of speciation. These processes have generated the greatest diversity of river dolphins on the planet is it so currently threatened by the construction of hydroelectric projects. Satellite telemetry is a valuable method to help identify the movement patterns and habitat of fauna specially in remote areas or species of high home ranges.The objective of this study was to identify patterns of movement and habitat use of I.g.geoffrensis, I.g. humboldtiana and I.g.boliviensis. To achieve the goal we used A total of 15 dolphins of the genus Inia were tagged in the rivers Tapajós (Brazil), Amazon and Orinoco (Colombia) and San Martín (Bolivia) with transmitters Spot 299A, connected by Argos satellite (Wildlife Computers, Redmond, WA, USA).The results show that the largest displacements were presented by I.g. boliviensis, where a male individual managed to move up to 333.7 km between the rivers San Martín and Iténez in Bolivia, followed by one male of I.g.geoffrensis, marked in the Tapajós river, a female I.g.geoffrensis tagged in the Colombian Amazon and finally an I.g. humboldtiana with a displacement of 48.8 km. These results show long differential transboundary movements between the subspecies studied as a result of spatial heterogeneity, water types, system productivity, biomass, and a differential use of habitats. Finally, the importance of the confluences, small tributaries and wetland complex within the protected areas such as the national and departmental natural parks Juruena (Brazil), Iténez (Bolivia), Amacayacú and the Tarapoto Ramsar site (Colombia) is highlighted.

Keywords: Conservation, Distribution, Human impact, Satellite-linked telemetry, River dolphins

T_9010

Importance of habitat landscape heterogeneity to big mammal species: taking giant panda as the case

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With continuously developing of human's socio-economics, the features and patterns of the natural earth surface are all changing. With overlaying effects from global climate change, this has impacted the wildlife's home and their populations, specifically to the big wild animals. According to physic-ecological principles, the big wild animals consume high energy, require more daily food, and has a great mobility, therefore they need larger habitat space for survival in order to gain enough food resources and better mating resources, etc.. Even some wild animals need the different habitat space in the various seasons. So, the rich habitat heterogeneity is necessary to the big wild animals, which play the multi-roles in their survival. This presentation is taking the giant panda (Ailuropoda melanoleuca) as the case to show the heterogeneous habitat landscape and its role on the species.

The giant pandas are distributed in the median and high mountainous areas surrounding the Sichuan Basin in Sichuan, Gansu and Shaanxi Provinces with a large span over latitude and elevation. The giant panda areas owe the various climate conditions, and grow the different bamboo species and forest types from south to north (latitude effect) and from low elevation to high elevation (altitude effect). This naturally forms the giant pandas' heterogeneous macro habitat. Meanwhile, the giant pandas' long-term evolutionarized diverse physiological behaviors also happens in various micro habitats. This presentation will display the needs of habitat landscape heterogeneity by big wild animals from the following aspects: (1) landscape for seasonal migration; (2) landscape for looking for the sexual partner and territory information; (3) landscape for mating; (4) landscape for giving birth. Understanding these will benefit us to provide a good habitat management for species conservation.

Keywords: giant panda, landscape heterogenity, big wild animal, habitat

T0757

Managing fire and fauna Down Under – spatially explicit solutions to understand bird distributions in disparate ecosystems

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Uncontrolled fire poses a risk to human life and property, and biota, in fire-prone regions globally. Landscapes are managed to reduce the risk of catastrophic fire. To manage fire and conserve species within natural landscapes, we need to understand the complex relationships between fire and biota. This will enable predictions of how species distributions will change due to altered fire regimes under climate change and human management, which can be used to inform management and reduce negative impacts. We used Atlas and survey data to explore the relationships between birds, fire and climate in two fire-prone ecosystems in SE Australia: semi-arid Mallee woodlands and temperate eucalypt forests. Together, these two broad ecosystem-types constitute a major portion of the remaining native vegetation of SE Australia and are of high biodiversity value. They are eucalypt-dominated, but differ in climate, topography, vegetation and fire-response syndrome. We modelled species responses to fire, including novel aspects of fire regime (diversity, configuration and amount of vegetation age-classes in an area), temperature, rainfall and topography across two large study areas (MW=100000 km2; TEF=75000km2) to compare the influence of drivers of bird distributions between and within ecosystems. In both systems climate was important, but fire played different roles in each ecosystem. Fire regime had a greater influence on species in Mallee compared to temperate forests, where topography was more influential. Species responses to fire regime also varied within ecosystems. Our findings show that not only do fire-responses vary between species, but the role of fire regimes can differ between disparate ecosystems, emphasising the need for nuanced approaches to fire-management to facilitate bird conservation in fire-prone landscapes. Spatially explicit models will help predict the impacts of climate change and management on birds in some of the most fire-prone landscapes in the world

Keywords: Fire, species distribution model, birds, ecosystem, climate

Monitoring and Mapping of Avifauna Diversity towards Assessment of Wetland Ecosystem Health: A Study of Ichhamati Floodplains in West Bengal, India

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Avifauna diversity is widely considered as a potent ecological indicator to comprehend wetland vitality. Along with high biological productivity, wetlands also contribute substantially towards livelihood provisioning of millions. However, exploitative anthropogenic activities have resulted into continuous fragmentation and degradation of these landscape units thereby deteriorating their ecological health throughout India. Consequently, the avifauna community thriving in these wetlands have become highly vulnerable as they are exposed to the augmented magnitudes of aquatic pollution, forage loss, habitat obliteration, and micro-climatic changes. In this context, the present study had been conducted to evaluate the changing status of avifauna diversity and habitat conditions of seven floodplain wetlands of River Ichhamati, India during the last decade. Relevant ecological indicators of avifauna distribution, diversity, and habitat suitability had been applied for this purpose. Among the native species, Dendrocygna javanica was of highest abundance followed by Phalacrocorax fuscicollis whereas Ixobrychus sinensis was of the least presence. Similarly, Nettapus coromandelianus was of highest abundance and Ardea purpurea was of least presence among the migratory variants. In general, native avifauna diversity was significantly higher ($p < 0.05$) than those of migratory ones even in the post-monsoon months and their numbers were found to be gradually decreasing. Furthermore, few wetlands were identified with alarmingly dwindling values of diversity index indicating towards their dismal state of ecological vitality and geographical extent. Intense humanization of the regional landscape in the form of multi-cropping, commercial fishing, built-up expansion, hunting, and eutrophication were inferred as the prime causes of these depletions. Accordingly, few holistic management strategies had been developed towards sustainable ecological restoration of these fragile wetlands.

Keywords: Anthropogenic stress, Bio-indicator , Bird community, Habitat fragmentation, Species diversity

T0843

Species traits and landscape changes as drivers of time lags in population decline and recovery

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Population declines may lag following habitat destruction, resulting in extinction debt. Similarly, colonisation credit describes the lag before restoration benefits become evident. Species traits and the nature of the habitat change are important drivers of time lags. However, the impact of these drivers has not been well quantified, making it difficult to set realistic conservation targets.

We built a spatio-temporal model to describe how species abundance and distribution respond to habitat change. We measured lags in species response, and explored how this depends upon the timing, rate, and scale of habitat loss and gain, and differing dispersal ability and life history speed.

Species with fast life histories track changes in habitat closely, and benefits of habitat restoration are more immediately evident. Whereas, for species which respond more slowly, extinction debt and colonisation credit are not easily distinguishable. The influence of dispersal on time lags changes depending on life history speed and the scale of habitat change.

We conclude that trends in species abundance and distribution alone are not always good predictors of the effectiveness of habitat restoration efforts. Therefore, while setting conservation targets and evaluating progress, the population should be monitored in the context of species traits and the nature of habitat change.

Keywords: Colonisation credit, Extinction debt, Habitat change, Spatio-temporal model, Species traits

T0931

Matrix type and patch size as drivers of avian-cross habitat spillover

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Landscape structure has been proposed to affect cross-habitat spillover. We tested how matrix type surrounding forest patches and forest patch size (range 2-200 ha) affects avian abundance and species richness in forest-matrix interfaces. Data were collected in 12 paired sampling sites (N=24) in the Brazilian Atlantic forest in Southern Brazil. Each paired sampling site was composed by a forest patch surrounded by both coffee plantations and pasture matrices where mist-nets were placed at forest-matrix interfaces during three consecutive days. Overall, 559 individuals of 89 species were caught. Abundance in coffee plantations interfaces (453±16 individuals) was not different compared to abundance in pastures (495±15 individuals) (p-value=0.23) but effect size of matrix type over abundance was medium (Cohen's d=0.51). Fragment size was correlated to abundance (R=0.44, p-value=0.03) and species richness (R=0.38, p-value=0.06). Abundance of forest specialized species depended on matrix type (p-value=0.02) but not for open-area specialists (p-value=0.22). Most individuals caught at coffee interfaces were habitat generalists (52.10%), followed by forest specialized species (30.91%) and open-area specialists (16.56%). Similarly, in pasture interfaces the majority of species were habitat generalists (48.08%), followed by forest specialized (29.90%) and open-area specialist species (22.02%). Abundance and species richness of forest specialized species was not correlated with fragment size (R=0.28 and R=0.29: p-values=0.18 and 0.17 respectively). Or results show that adjacent matrix has an effect over avian abundance, especially for forest specialized species. Fragment size appears to be important for bird persistence in this agricultural area, mostly for habitat generalist species. We propose that decreasing matrix-fragment contrast and preserving medium and small forest patches can be effective measures for conserving biodiversity and ecosystem services

Keywords: Agricultural landscape, Abundance, Species richness, Coffee productive systems, Atlantic forest

Session Habitat fragmentation and landscape connectivity

T0661

Ecological connectivity along the Tiber River: a GIS based study linking land use changes and habitats availability

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Among the ecological restoration interventions that have taken impulse from the Water Framework Directive, the river restoration is one of the most important. As many species survival is strictly dependent on the presence of continuous and ecologically functional riparian areas, reducing the human-induced pressure on the watercourses represents one of the minimum requirements supporting the biodiversity conservation in the Mediterranean ecoregion. This study is based on the basin of the Tiber River (Rome) and aims to evaluate the links between the land use changes and a specific ecosystem service (habitat function) applying a multi-temporal, quantitative and spatial study. A GIS based analysis, supported by four land use transition categories derived by land use data (1960-2012) has been realized. Linking pattern and processes on one hand, the urbanization and agricultural intensification processes have been considered as a threat to the wildlife movements and to the ecological status of the basin; on the other hand, the processes of natural succession and evolution towards heterogeneous agricultural systems have been positively evaluated for their contribution in sustaining the habitat function of the river landscape. A spatial analysis including a large set of landscape metrics has been carried out in order to evaluate the modifications of the connectivity conditions. Our study reveals: the emergence of new barriers impacting on the ecological connectivity; an important conversion and intensification in the use of the lands with different degrees along the watercourse; a weak and discontinuous improvement in the habitats availability (increased forests and heterogeneous agricultural areas); a rising contact between natural and human-dominated patches; a reduced connectivity reflected by the landscape metrics. Finally, in the light of the results, the importance of habitats regeneration along the basin is highlighted and several restoration scenario are discussed.

Keywords: habitat function, river connectivity restoration, GIS analysis, landscape metrics, scenario analysis

The impacts of roads on sub-Saharan African ecosystems: a systematic review

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Roads are essential for development, but also represent one of the most extensive forms of land use that lead to natural land cover transformation. Emerging road infrastructure across Africa is expected to have major implications for future development and conservation at local to continental scales. In terms of environmental costs of road development, the impacts on ecosystems remain unclear for Africa as a whole. To address this knowledge gap, we conducted a systematic review using the RepOrting standards for Systematic Evidence Syntheses (ROSES) methodology. The main aim is to conduct an integrated assessment and synthesis on the current state of knowledge on the impact of roads on sub-Saharan African (SSA) ecosystems. This review is the first to assess the state of this knowledge across SSA ecosystems.

Preliminary findings indicate that, in general, roads have varied impacts across African ecosystems. Despite roads not being the primary focus of most reviewed articles, approximately 100 published scientific papers have tested a specific impact of a road on an ecosystem. Most studies were conducted in South Africa and The Congo Basin in savanna and forest ecosystems, respectively. Additionally, short-term studies usually focus on species richness and abundance impact, whereas long-term work (>7 years) focus on land cover/land use change impact. The road effect zone across African ecosystems varied with impact type. For instance, roads appear to negatively influence species richness and abundance within 15km of a road, while promoting agricultural expansion within 50km from a road. To address SDG's in Africa, while minimising environmental costs, we require effective and informed infrastructure planning. This requires a comprehensive empirical understanding of the extent of available knowledge on the impacts of roads on ecosystems unique to Africa.

Keywords: roads, sub-Saharan Africa, ecosystems

T0064

Accounting for landscape connectivity uncertainties in predicting roadkills: a comparative approach between path selection functions and habitat suitability models

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Landscape connectivity modelling is increasingly being used to predict wildlife movements. This tool requires estimation of resistance surfaces, ideally modelled with animal movement data which are costly to obtain. An alternative is to use occurrence data within species distribution models to infer movement, although this remains a controversial issue. The aim of this study was: (i) to compare the performance of resistance surfaces derived from path versus occurrence data in identifying road crossing locations of a forest carnivore; and (ii) to assess the influence of movement type (daily vs. dispersal) on this performance. Resistance surfaces were built for genet (Genetta genetta) in South Portugal using 1) path selection functions with telemetry data, and 2) species distribution models with occurrence data. An independent roadkill dataset was used to evaluate the performance of each connectivity model. Results show that models derived from occurrence data are as suitable in predicting roadkills as are path data. When dispersal movement was simulated, we found no significant differences in performance between models based on daily movements and models based on dispersal. Our results suggest that species distribution models are a cost-effective tool to build connectivity models for road mitigation plans when movement data are not available.

Keywords: Movement models, Species distribution models, Roadkill, Mitigation, Dispersal period

T0128

Analysing gene flow in heterogeneous landscapes: why and how to use genetic graphs?

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In heterogeneous landscapes, when species occupy discrete habitat patches, ecological connectivity is influenced by populations' topology. Graph-theoretic methods constitute a relevant tool to reveal this topology and better analyse gene flow. Despite growing interest in genetic graphs, a better understanding of when and how to use them is lacking. To fill this gap, we simulated gene flow between 50 populations in different landscape configurations and constructed genetic graphs using various genetic distances and pruning (link selection) methods. We then compared metrics derived from these graphs to analogous metrics describing the topology and connectivity of the dispersal network driving gene flow during the simulation.
Genetic graphs consistently reflected the dispersal pattern. Pruning methods had more influence on the results than genetic distances, highlighting the crucial role of populations' topology. Link selection based on maximal dispersal distances was more accurate to analyse ecological connectivity than when based on statistical inference of direct gene flow. Taking into account the pattern of population genetic structure is key to relevant analyses. Besides, graphs construction parameters should be closely tied to prior knowledge on species dispersal traits, when available. This study lays down a new framework to use genetic graphs in landscape genetics.

Keywords: graph theory, lanscape genetics, ecological connectivity, simulation, dispersal

T0270

Contribution of functional connectivity to fragment occupancy by carnivores in a Mediterranean agroecosystem

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Due to their simplicity and small data demands, patch-matrix models are widely employed to describe the occupancy of habitat remnants by species and communities. These models provide limited insight about the processes involved in the distribution of organisms in fragmented landscapes due to their simplifying assumptions about habitat homogeneity and also because regional processes such as functional connectivity are neglected. Moreover, the relevance of these processes is expected to vary across landscapes featuring a heterogeneous structure. Here, we relax several assumptions of the patch-matrix model to compare the relative importance of local, landscape and regional processes for forest fragment occupancy by three carnivores in a Mediterranean agroecosystem.

At the landscape level, we distinguished two different structures within the agroecosystem. In the mosaic landscape, the occupancy of the three species was mostly determined by the internal quality of fragments. Conversely, patterns of occupancy in the simplified landscape revealed that each species was highly sensitive to processes occurring at different spatial scales. The distribution of the Eurasian badger responded only to the configuration of patches. The Egyptian mongoose proved sensitive to a favourable placement of patches along regional connectivity pathways linking the fragment network. Finally, the common genet was restricted to fragments with a relatively high proportion of forest in their vicinity but not necessarily well-connected at the regional level.

Considering regional connectivity provides insight into the species-specific factors affecting occupancy which seem to show up only at high levels of habitat loss and fragmentation. The identification of landscapes with quite different structure within the heterogeneous study agroecosystem revealed these contrasting responses that would pass unnoticed if the whole agroecosystem had been considered as a homogeneous entity.

Keywords: Landscape heterogeneity, Landscape structure, Spatial scales, Processes

T0520

Habitat configuration matters when evaluating habitat-area effects on host-parasitoid interactions

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Higher trophic levels tend to be more sensitive to habitat fragmentation than lower trophic levels, which is why parasitism rates should decline in fragmented landscapes. Habitat loss and fragmentation (the subdivision of habitat) are typically interrelated processes, and thus their effects are confounded in most studies. To address this, we quantified parasitism rates in pea aphids (Acyrthosiphon pisum) within an experimental model landscape system, in which we independently controlled the amount versus the fragmentation of habitat (red clover, Trifolium pratense) within individual landscape-plots (16 m x 16 m). Aphid densities were generally unaffected by landscape pattern, except at the local scale for interior habitat cells within fragmented landscapes, which had significantly lower aphid densities than all other cell types. Aphid parasitism rates averaged about 40% and were significantly—albeit weakly—correlated with aphid density. Habitat amount had the greatest overall effect on parasitism rates, but fragmentation effects were evident in a shift in parasitism at intermediate habitat levels: parasitism rates were higher in fragmented landscapes <50% habitat, but higher in clumped landscapes >50% habitat. Edge effects alone did not explain this shift in parasitism rates. Parasitism rates were uniformly high within edge habitat and fragmented landscapes, and thus the shift in parasitism at intermediate habitat levels was driven by increasing parasitism rates within interior cells and clumped landscapes at higher habitat amounts. Habitat configuration is thus important for evaluating habitat-area effects on species interactions, as habitat amount only affected parasitism rates within less-fragmented landscapes at this scale in this system.

Keywords: habitat fragmentation, habitat amount, edge effects, biological control, insects

T0725

Contrasted responses of carabid (Coleoptera: Carabidae) communities' functional structure to local and landscape characteristics in forest fragments and hedgerows

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Forest loss and hedgerow destruction have become common in temperate agricultural regions. Such fragmentation of woody habitats is a threat in intensively cultivated landscape matrix, to gene and species fluxes, especially for forest species. Among affected species, carabids (Coleoptera: Carabidae) are recognized as a major, highly diversified guild of predator and granivorous species which render important ecosystem services in forest and agricultural ecosystems. Previous studies have shown that land use intensification is likely to reduce taxonomical and functional diversities of carabid communities, to select species with similar traits, reducing the breadth of community trophic niches, and potentially the efficiency of rendered biocontrol.

Using the complementarity of taxonomical and functional trait-based approaches, we evaluated the influence of landscape fragmentation of forest fragments and hedgerows in European agroecosystems and their internal characteristics on taxonomical and functional diversities and structures of carabid communities.

We observed influence of the isolation and size reduction of habitat patches, both forest fragments and hedgerows, on alpha (within-) and beta (between-) taxonomical and functional carabid community diversity. Habitat fragmentation mainly explained the contribution of non-forest species to local communities, these patches being less suitable for forest specialists. Local carabid ground beetle communities appear as random assemblages of mostly non-forest species that are typically patterned by dispersal filters and chance, but incorporate a number of forest species which increases with fragment size and forest connectivity.

Keywords: European gradient, Functional ecology, Forest connectivity

Estimating parameters of landscape resistance using spatial autoregressive models

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An understanding of how landscape characteristics (e.g. elevation or roads) create resistance to organisms' movement and gene flow is vital for conservation science and management. Yet, there are challenges associated with validating resistance parameters representing landscape-connectivity because independent data are often lacking and combinations of biotic and abiotic processes may produce similar resistance. Spatial autoregressive (SA) models provide a natural approach for modelling landscape-genetic structure, but are rarely used for this purpose. We demonstrate how resistance parameters can be estimated within a SA model and use individual-based simulations to validate the approach. The SA models correctly identify the ecological and evolutionary processes (i.e. isolation by distance, resistance, and/or barrier) used to generate the underlying genetic structures in every case. There are numerous advantages to using a SA approach. Predictors representing multiple evolutionary-process hypotheses can be assessed within a single model, which produces interpretable parameter estimates, with uncertainty estimates, so that inferences can be made about their relative influence on resistance between populations and individuals. Information-theoretic-based approaches may be used for model selection and predictions, with estimates of uncertainty, can be made at unobserved locations or under different land-use or climate scenarios. The ability to account for missing data within the SA model means that a contiguous data model can be used; thus, a priori assumptions about the spatial location of unobserved movement corridors are avoided. The SA methods have been implemented in the rwc package for R, so that others can explore landscape-genetic structure in their data; providing new insights into the evolutionary processes that generated spatial genetic structure and valuable information about the optimal characteristics of conservation corridors.

Keywords: connectivity modelling, spatial statistics, landscape genetics, conservation corridors

Session Landscape Metrics

T_4444

Connecting Ecosystem Functions to Landscape Structure at Right Scales: Beyond Correlation Analysis

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One of the conceptual foundations of landscape studies is that land mosaics, or patterns, matter for ecological processes and ecosystem functions at various scales. Regardless of significant recent progresses made for this topic, there remains apparent mismatches between patterns and ecosystem processes. Ecosystem research remains mostly on explorations of underlying processes responsible for functional changes at 'homogeneous patches" (e.g., forcing mechanisms for changes in production), while landscape studies continue their interests in patch patterns as well as the causes and consequences. We reason that the discrepancies are due partially to the lack of high resolution satellite data that can be used to quantify both landscape structure and ecosystem processes. MODIS and Landsat products, for example, have been applied to describe the spatiotemporal changes of land cover, NPP, ET and other properties, yet ecosystem ecologists found it difficult to connect their experimental data due to course pixel sizes of 30+ m and/or pseudo-replications. Promising new remote sensing technology and data, computational power, modeling, statistical tools in recent years provide us with renewed opportunities to make the connections. Here we present a few frontiers in connecting ecosystem functions with landscape heterogeneity: (1) direct references of ecosystem functions by measuring high-resolution landscape structure such as LiDAR; (2) spatiotemporal changes of ecosystem functions such as albedo, production, and ET across heterogeneous landscapes through an innovative down-scaling approach; (3) statistical inferences of patch interactions in fragmented landscapes; and (4) influences of ecosystem structure (e.g., canopies) on net exchanges of CO2, H2O and energy within "homogeneous" footprint of eddy covariance flux towers. These examples are selected evidences showing the emergence of long-waited research need: integration ecosystem science and landscape ecology.

Keywords: Ecosystem functions, Landscape structure, Scale

T0069

From empirical to theoretical descriptors of landscapes complexity

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Landscape metrics are the most often used numerical descriptors of the observed patterns in landscapes. The overall complexity of landscape pattern is the single most important metric, but the standard set of landscape metrics lacks the bona fide indicator of complexity. Additionally, a large number of landscape metrics are highly correlated, which makes their interpretation difficult. Our goal was to find a minimal number of metrics which are able to describe landscape complexity. Firstly, we approached that issue from an empirical standpoint. We calculated a set of traditional landscape metrics on a global dataset of landscapes and next, we performed principal components analysis (PCA) on their correlation matrix to uncover latent variables. This allowed us to demonstrate that variability of geometric configurations of landscape patterns worldwide can be captured in terms of only two metrics – complexity and aggregation – as they explain 70% of the variability. While this approach gave a satisfactory result, it requires recalculation of the principal components for each new dataset. Therefore, in a continuing effort, we analytically derived four theoretical metrics of landscape complexity using the information theory. Two of these theoretical metrics, which can also be interpreted as complexity and aggregation, are sufficient to organize landscape types in a fashion analogical to the empirically-obtained metrics. This demonstrates that the information theory provides a natural framework for a systematic analysis of landscape complexity.

Keywords: landscape metrics, complexity, aggregation, landscape complexity, information theory

T0388

Plot-level variability in phytosociological and structural characterization of tropical herbaceous vegetation in West Africa

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Primary information on vegetation are often obtained from methods that solely rely on ground plots. The size of inventory plots has been identified as one source of uncertainty. In this study we analyzed the plot-level variability in phytosociological structure for herbaceous vegetation inventory designs. Using a phytosociological dataset collected from 11 1ha randomly established larger plots, we explored how different sets of plot shape, size and direction affect the structure of herbaceous vegetation in West Africa. Each 1 ha plot was demarcated into 400 quadrats of 25 m2, with 28 types of subplots of different size, shape and direction being identified. The effect of subplot shape, size and direction was evaluated by modeling the variability in the relative loss of accuracy in phytosociological characterization and herbaceous density estimation error. Both plot size and direction showed significant effects on phytosociological characterization of herbaceous vegetation, while plot shape did not. More specifically, the Relative Loss of Accuracy decreased as plot size increased. For inventory in herbaceous vegetation, the rectangular plot of size 2700 m2 is suggested as a minimum efficient size for phytosociological characterization. We also found that plot size and shape don't have a significant effects on the estimation error of the plant density. It was suggested that rectangular plot of 60 m x 20 m would be more efficient to accurately estimate the plant density of herbaceous vegetation.

Keywords: plot shape , size, direction, accuracy, savannah

Promoting Landscape Performance Assessment: A Guideline on Performance Baseline Collection

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Landscape architecture and planning is an evidence-based discipline, which advocates using credible evidence to guide decisions. Landscape performance, initiated by Landscape Architecture Foundation (LAF) in 2010, is a research effort to "evaluate performance, show value of and make the case for sustainable landscape solution" (LAF, 2019). Unlike rating systems such as Leadership in Energy and Environmental Design and Sustainable Sites Initiative, landscape performance assesses landscapes after they are built and occupied for three years. As a backward evaluation system, it quantifies and compares a landscape's pre- and post-performance. However, when conducting this comparison, one difficulty research teams encounter is lacking baseline data as exemplified by site images, water quality, soil fertility, noise level, and user satisfaction. These data are hard to obtain once a project is built. Lacking baseline data not only hinders performance assessment, but it also undermines the assessment's credibility.

Landscape performance is quantified through a collaboration between researchers and practitioners, in which practitioners report sustainable solutions used in their projects and researchers develop metrics and methods to quantify these solutions' performance. Since the collaboration does not form until a project is built, researchers are not involved in baseline data collection. This study attempts to 1) explore the relationships between sustainable solutions and performance metrics and methods, and 2) summarize metrics and methods to help collect baseline data.

In this study, we use LAF's 148 published case studies to 1) identify sustainable solutions used in each case, 2) link sustainable solutions with their performance benefits and create guidelines to help practitioners select metrics and methods to collect baseline data for landscape performance assessment.

This study expects to promote landscape performance assessment and sustainable development.

Keywords: Baseline data, metric, method, performance, sustainable solution

T0726

Scale and scaling in space: Top 10 rules for landscape ecologists

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Scale is about size and detail in space and speed and frequency in time. Scaling is not just power laws, but also refers broadly to the translation of information and relationship across scales. Modern landscape ecology is fundamentally a science of ecologically relevant geospatial heterogeneity defined by intertwining patchiness and gradients. Emphasizing heterogeneity leads to, of necessity, the paramount importance of scale because heterogeneity is inherently scale-dependent. In other words, scale determines what heterogeneity manifests itself and how. Scale may act as a magnifier or a shrinker and a revealer or a concealer. Scale can help simplify complexity to seek order out of disorder, but it can also muddle waters and confuse matters. No wonder, therefore, landscape ecology has been on the cutting edge of spatial scale and scaling research. Then, what does landscape ecology contribute to the science of spatial scale and scaling? What should landscape ecologists know about spatial scale and scaling? Here I address these two questions by presenting my top 10 rules for landscape ecologists.

Keywords: Scale, Scaling, Landscape ecology theory

T0920

Land cover proportion and heterogeneity can help predict the accuracy of spatial pattern metrics after downscaling

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It is widely known that translating information across scales can have adverse effects on analyses. Nonetheless, researchers are often compelled to change either the support or extent of datasets to match the characteristic scale of complementary datasets when integrating multiple datasets for spatial analysis. This approach is particularly common when categorical land cover datasets, such as the National Land Cover Database, are incorporated into models of climate change, earth processes, and coupled human and natural systems. However, categorical land cover data present a unique challenge for scaling because of the limited ways in which they can be statistically recombined. As a result, both upscaling and downscaling lead to data loss and uncertainty. Disaggregating land cover datasets is particularly challenging because there is limited information from which to make predictions about land cover distribution at the sub-pixel scale. However, researchers in landscape ecology have found that certain spatial pattern metrics exhibit consistent and robust scaling relationships across resolutions opening a potential pathway toward the characterization of data loss and the improvement of downscaling accuracy. This study examines how two fundamental characteristics of landscape pattern, heterogeneity and land cover proportion, affect our ability to extrapolate scaling relationships to unknown scales to make predictions about the spatial patterns in the landscape. We develop this understanding from a set of 20,000 generated neutral landscape models in which we control for land cover composition and configuration. We then test our experimental findings against a set of 700 real world landscapes representing forested land covers in seven ecoregions of the U.S. We hypothesize that matched by heterogeneity and land cover proportion, neutral model results can be predictive of the accuracy of spatial pattern predictions in real world landscapes.

Keywords: Landscape Metrics, Scale, Landscape Composition and Configuration, Downscaling, Forested Landscapes

T0927

How do ecological equivalence metrics incorporate landscape parameters in a biodiversity offset context?

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Biodiversity offsets have been largely adopted in environmental policies and private sector in the last 15 years, with a high public acceptance and adherence by governments. They are a more strict compensation that aims to achieve no net loss (NNL) in biodiversity, seeking for ecological equivalence between impacted and offset areas. The real effectiveness of offsets has often been questioned; one of its strongest criticisms is the lack of landscape perspective: as landscape parameters influence biodiversity dynamics, they should be accounted for in measuring equivalence and selecting offset locations. We made a literature review on how these parameters are being incorporated in ecological equivalence metrics (EEM). On May 2018, we used the term ("ecolog* offset*" OR "biological offset*" OR "environmental offset*" OR "biodiversity offset*") AND (metric* OR measure* OR index OR indices OR calculation* OR variabl*) to search for papers in Science Direct, JSTOR, Scopus and Web of Science. We only selected papers that mentioned EEM, and searched for metrics that incorporate the landscape parameters of composition and configuration either categorical or quantitatively. We found a total of 121 papers; only 25 mentioned at least one EEM. From the 21 considered EEM, solely 9 included some landscape parameter. Most metrics (5) included composition and configuration dimensions, alternating between categorical or quantitative assessments. Two metrics considered solely configuration, one included exclusively composition and only one included composition and configuration both categorical and quantitatively. The wider incorporation of landscape parameters in EEM remains as an urgent demand, since they are paramount to achieve NNL at larger scales, and other offset measures may lead to lower connectivity in the landscape, either through a decrease in vegetated area (trading-up), or in the quality of habitat available - low functional connectivity (multipliers).

Keywords: Biodiversity offset, Ecological equivalence, Landscape ecology, Public policies

Session Public Participation

T0191

Co-producing urban meadows as a nature-based solution: Land manager perceptions of the opportunities and challenges.

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The growing evidence base for the benefits for people and wildlife of nature-based solutions to managing urban green infrastructure lacks research investigating land manager perspectives on their implementation. To address this gap, we explored UK local authority manager perceptions of the challenges and opportunities of introducing perennial urban meadows to prioritise biodiversity and aesthetics. This was co-produced as an experiment in urban greenspaces with Luton Parks Service and Bedford Borough Council 2013-15. We conducted semi-structured interviews with the eight stakeholder managers involved to identify key factors impacting on the perceived feasibility of future urban meadow establishment in other areas. All managers identified three dominant factors (aesthetics and public reaction, locational context, and human resources and economic sustainability). Additional factors (local politics, communication, biodiversity and existing habitat and physical factors) varied in importance according to personal values and managerial role. Support for future meadow introduction and a desire to overcome the economic challenge of the disposal of meadow arisings were related to manager biocentricity. Managers were aware of changing public values leading to increasing acceptance of a messier urban aesthetic. They perceived perennial meadows as a realistic alternative to amenity mown grass that in specific contexts could increase local biodiversity and enhance aesthetics if implemented in consultation with the public and local councillors. Our findings have relevance for the wider implementation of such nature-based solutions to urban GI management: Changes in management practice such as the introduction of perennial meadows have significant political, strategic, economic and practical implications and cannot be viewed purely as a technical challenge.

Keywords: nature-based solutions, stakeholder landmanager, aesthetics, biodiversity, ecosystem services

T0561

Management and Perception of metropolitan Natura 2000 sites: the case study of La Mandria Park (Turin, Italy)

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In Europe the Natura 2000 sites, that ensure a long-term survival of species and habitats listed under both the Birds Directive (2009/147/EC) and the Habitats Directive (92/43/EEC), cover about 1,150,000 km2 in different Countries. In Italy there are 2613 Natura 2000 sites of which 221 sites located in 73 metropolitan areas. The European Commission (EC) guides the local Authorities in developing and promoting good management practices aimed at conserving habitat biodiversity, agriculture and human well-being, requiring the involvement of stakeholders and users. In order to respond to these requests, a research has been set up on the La Mandria Park (Turin metropolitan area, Italy) with the objectives of collect the needs and the perception of the users and understand, from stakeholders, which management strategies could be adopted in the future. To understand the user's perceptions about the La Mandria Park, a questionnaire was administered at different places within the park. In order to understand which future management strategies could be adopted, a focus group with stakeholders was carried out. The results of the focus group show that park management strategies can be implemented, such as: defining permanent sample plots to monitor the state of the soil, flora and fauna over time; setting up an in situ nursery for the seed gene conservation and setting up a long-term management plan. The statistical analysis of the questionnaires administered (232) shows: about 50% perceive the agricultural activities well integrated in the park; in general the grasslands, the woodlands and the paths are well managed. The lack of information about the park in different languages is highlighted, and educational/cultural activities could be further expanded. The information acquired through this study could be useful to set up a management plan of the Park appreciated by the community. The same methodology could be useful to monitor over time any socio-ecological changes.

Keywords: ecosystem services, management plan, stakeholder, questionnaires

T0625

Landscape preferences as predictor for social acceptance of the energy turnaround. How the perceived change of landscape quality contributes to the development of sustainable energy policies.

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Supported by the development of energy strategies on different levels (EU, national, regional, local) renewable energies play an important role in contributing to the challenges of global warming as they help to shift our societies from a fossil to a renewable energy system. As a consequence, the implementation of suitable infrastructures for the harvest of wind- and solar energy has become highly relevant in bringing those strategies to the ground.
New Renewable Energy Infrastructures (nREI) show impacts on landscape aesthetics and therefore have effects on the perceived landscape quality. Experiences within the last two decades of research show that people even if they do support the energy turnaround, often do not support renewable energy projects when they come to local implementation (NIMBY effect). Researchers identified major lacks of planning, participation and/or communication as a trigger for that behavior.
However, fundamental information in the landscape relevant component is lacking. Accompanying to those mentioned aspects, meanings people assign to both landscapes and nREI seem to be crucial in understanding people's attitude as an indicator for the social acceptance of the energy turnaround.
Knowledge of this opens potential opportunities for integration in strategical decision-making processes like monitoring-, planning-, communication- and policy issues.
Based on a representative online panel survey in Switzerland (n > 1'000), this presentation provides insight into a choice experiment based on representative alpine landscapes and both wind- and photovoltaic energy infrastructures as well as high-voltage overhead lines, each in different levels of impact. Beside peoples preference to scenarios, we also focused on meanings people assign to those landscapes and nREI implemented within. Results indicate that people do see the opportunities of energy developments in some landscapes but also do want to protect other landscapes from such scenarios.

Keywords: Landscape preferences, perceived landscape change, renewable energy infrastructures, place meanings, renewable energy meanings

Potentials and issues in involving peri-urban agricultural stakeholders to enhance landscape multifunctionality. A selection of cases from "Los_Dama!" and the Alpine metropolitan areas.

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Peri-urban areas host a heterogeneous and complex mosaic of land uses. These fringes feature important agricultural activities at very different scales; from plots for personal use to professional farming activities connected with global food chains. This rural dimension of peri-urban areas is particularly strong around Alpine cities due to the inherited socio-economic background and to the specific topographic conditions. As the demand for spaces for development and recreational activities is growing, urban and rural features of fringes often come into a clash. The need to reconcile these conflicts makes urban fringes as very challenging territories to implement planning policies for landscape multifunctionality or ecological connectivity. In spite of the recognized importance of agricultural stakeholders in preserving and enhancing the mentioned landscape values, planning processes still fail to properly acknowledge their role and struggle in reaching involvement of farmers or breeders. Sustainable landscape management processes can benefit from their knowledge and capacity to put actions in place. This contribution will investigate how peri-urban agriculture is considered in actual planning frameworks and its role in shaping territorial identity. In particular, the potentials and barriers of involving farming-related stakeholders into planning processes are studied. The research is developed within EU Interreg Alpine Space project "Los_Dama!", in which local actors work closely to enhance and develop peri-urban green infrastructure within seven pilot projects. For each of them we assess both the planning framework and the involvement of stakeholders from the agricultural sector through interviews and content analysis of pilot action plans. The outcomes will help to understand the issues related to farmers' involvement. Moreover, they will provide suggestions to get agricultural stakeholders involved in policy processes to enhance landscape multifunctionality.

Keywords: peri-urban areas, rural-urban multifunctionality, landscape governance, agriculture , stakeholders

Urban Green Infrastructure for Children's Ecological Learning : Design and Collaborative Management of an Urban Park in Kitakyushu City, Fukuoka, Japan.

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Developing urban natural environment is an important issue for both conservation of biodiversity and providing natural experiences for children. This study describes the design and management process of an urban park which was designed and used for ecological learning for school children. The study site, Megurizaka pond park is located in Kitakyushu city, the southern part of Japan. The park has a pond in the middle the area and the area is 4,400 square meters. The restoration project of the park started in 2008 with a corporation between Kitakyushu City government, a primary school which is located beside the park, and Keitaro ITO's Laboratory, Kyushu Institute of Technology. The project aimed to conserve regional biodiversity and create a space for children's play and learning in nature that can simultaneously enhance the local ecological network and provide a variety of activities. The children have participated in the planning workshops.The construction was completed in 2010. As a result of the restoration, a number of the species of herbaceous vegetation and insect species were observed in the park. The workshops with children have been continued as an ecological learning program after the restoration. 186 children and 7 teachers in all were participated in the program from 2011 to 2014. The natural environment provided a variety of learning for the children. Particularly, the experience of the vegetation management in the park supported children to establish their ecological thinking. Therefore, "learnscape" that children can learn from natural envrionment should be considered as an essential quality of green infrastructure. The field of urban green infrastructure for children will be a meaningful challenge for a wide range of stakeholders such as planners, scientists, educators, and children to contribute to establish sustainable cities.

Keywords: Urban Green Infrastructure, Children, Ecological learning, Urban park, Collaborative management

Session Remote Sensing and Landscape Ecology

T0189

Remote sensing data for the assessment of condition dynamics of river basins vegetation cover in European Russia

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One of the key parameters of ecologic monitoring is vegetation productivity. This characteristic depends on soil condition, which forms the basis of landscape production potential.
The research objective is to study productivity and structure of land use of river basin landscapes of European Russia applying remote and surface data. Several basic river basins reflecting the landscape variety of the area have been chosen for the research. The data used for the research: space images MODIS from 2005 to 2017 and climatic data. The applied methods are geo-informational analysis of remote sensing data based on ArcGIS. To assess vegetation cover condition the following indices have been applied LAI (leaf area index) and FPAR (fraction of photosynthetically active radiation). The surface studies within the key areas included geo-botanic descriptions and determination of herbaceous vegetation phytomass.
It has been revealed, that river basins ecosystems located in various nature-climatic zones differently react to the changes of climatic parameters. The production potential can be assumed to continue growing in the future only in areas, where the sum of biologically active temperatures served as a limiting factor, that is, within the mixed forest basins. Over the 10-year period, we have observed a slight increase in vegetation productivity in the area. The most favorable conditions for the phytomass accumulation are formed in the southern taiga zone.
Phytoproductivity of the overgrown agricultural and natural lands in the basin of the Klyazma river has been analyzed. Post-agrarian phytocenoses are stated to gradually restore the production potential of natural phytocenoses, but to differ in species variety. The agricultural lands overgrowing causes the reduction of the communities biodiversity, since overgrowing of different landscapes areas with varied soil cover follows general successions. It results in the leveling of phytocenoses landscape features.

Keywords: river basin landscapes, vegetation productivity, land use structure, remote sensing data, climatic data

Landscape patterns of forest types using object-based classification method based on GF-1 remote sensing data in the Qinling Mountains, China

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The extraction of forest vegetation types has been the difficulty and focus on information extraction in the field of remote sensing. This study used GF-1 remote sensing image as base data, and according to the characteristics of GF-1 data for atmospheric correction, geometric correction, and image fusion for image preprocessing. Object-oriented classification method was adopted to extract forest information in Changqing National Nature Reserve, the Qinling Mountains, giving full considerations to the spectrum and texture, geometry and to join the information such as vegetation index. Use multi-scale segmentation technology, along with decision tree classification method and adjacent classification method for classification process, finally the purpose of classification of forest types was completed. Classification results of forest types in the Changqing National Nature Reserve could distinguish to six types very well. And compared to a single level of adjacent classification method, the practical conclusion proves that application of multi-level segmentation model of decision tree classification accuracy is 84.1%, the Kappa coefficient is 0.815, while the single level of adjacent classification method accuracy reached to 66.2%, the Kappa coefficient of 0.603. Landscape patterns of forest types showed that mixed broadleaf-conifer forest (dominated by oak) occupied 36.7% of the whole region, followed by Larix kaempferi, Picea asperata, and Abies chensiensis. It proved that multi-level multi-scale method is more effective for forest types classification and recognition for high resolution remote sensing image classification processing, it also provides reliable evidence for extracting information of forest types.

Keywords: Forest types, GF-1 image, Object-oriented classification method, Qinling Mountains

T0449

3-D beach metrics: an instrument to inform resilience on Mediterranean beaches.

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Mediterranean beaches are characterized by three main aspects: microtidal regime, lack of sand, and intensive exploitation of its cultural ecosystem services. Thus conferring high levels of exposition and vulnerability to climate change.
Currently, the most widely-used information sources are numerical models that simulate the hydrodynamic and morphodynamic processes that govern sediment availability and predict the impacts produced by storms and coastal structures. But those models need long-term data provided by expensive sensors and are unable to see some relevant factors like aeolian sand transport and the human-induced impacts on dune build-up, vegetation cover, and beach profile.
Two beach cells at Catalonia, NE Spain, with contrasting grain size and morphodynamic states were analysed using LIDAR data. Each beach cell was divided in a sequence of 100 meter long tiles. So each beach cell (15,6 and 14,4 km) could be transformed in a sequence of georeferenced points containing information of emerged sand volume, slope, width, average height, and azimuth.
This method provided the following outcomes:
• The analysis of average width, slope and volume for each tile showed characteristic patterns that change with sand grain diameter.
• The analysis of outliers led to rapid identification of dysfunctional hot-spots and its causal processes.
• Emerged sand volume assessment also led to the definition of the minimum requirement of dry beach to withstand storm impacts and support the demand for social use.
• Those data provide base for comparisons over time within each beach cell, and between different beaches.
• Clustering methods can provide objective differentiation of beach stretches, thus facilitating customized management strategies.
So, this 3-D information system is a new cost effective way to support a shared evidence-based management system to assess beach resilience and design adaptation strategies to sea level rise.

Keywords: LIDAR, Seascape, Ecosystem services, Climate change, Coastal governance

T0636

Thermal fields invariants in the southern taiga landscape using Landsat images

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Radiation measurements from the atmosphere and the earth surface from satellites provide spatio-temporal information about fundamental planetary physical processes in different scales. Temperature and heat flow are the most informative indicators of these processes. They affect the intensity of photosynthesis, transpiration, plant and soil respiration and etc. Researchers consider temperature changes using a large number of images but it is difficult to analyze, so the goal of our scientific work is to develop a new method for processing temperature data using invariants, also to reveal the influence of vegetation cover and relief on them.

Study area is Central Forest Nature Reserve in Russsia. The selection of invariants and the identification of their physical meaning were carried out by regression, principal components, correlation and dispersion methods.

Two invariants describe about 60% of temperature variations from 1984 to 2017. The first invariant represents the structure of thermal fields in winter, and the second in summer. Morphometric relief indicators describe 22% of the temperature in winter and 26% in summer. The cross and maximum curves are the most important indicators for the winter invariant, and the elevation and the slope are most affect the summer invariant. Vegetation cover determines 54% of the temperature in winter and 68% in summer. The parameters of trees (height, diameter, age) and the projective cover of mosses and grasses are the most informative indicators of the invariant structure of thermal fields.

The results showed that the new method using invariants is successful for processing a large number of Landsat images. Analysis of the vegetation and relief influence indicates the presence of the physical meaning of invariants. This method was first used for the southern taiga landscape and requires verification for other landscapes.

Keywords: Landsat thermal channel, temperature in spruce forests, data processing method

T0764

Anthropogenic gap dynamics in forest landscapes of Northeastern Europe during recent history

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Human influence augmentation on forests via clear-cuts and other anthropogenic activities threatens biodiversity and services provided by forest. Such human caused gap-dynamic of forest can be expected to vary among regions with different landscape properties and land use history, both along the north-south and east-west gradients. We estimated the gap-area dynamics in Northeastern Europe through three decades in the areas of Finland, the three Baltic states, Belarus and Russia, using Landsat and Sentinel-2 satellite images. Images from February and March were used, when the ground was covered with snow. Bright snow amplifies the contrast of background with dark tree crowns and their shadows, favoring to follow dynamics of tree crown coverage with more success than it is conceivable in summer seasons. We developed special analytical methods for images taken in the first half of February in low sun conditions to fit them into time series of images taken predominantly in March. We hypothesized that both the latitudinal and longitudinal gradients will be reflected in gap size distributions, grouping of gaps in forested landscapes and temporal trends in emergence of new gaps.
We found, indeed, that forest gaps in western more intensively managed regions are smaller than in the east, where forest areas have been less intensively used for centuries. However, there are also region-specific dynamics of gap size, which can have multiple reasons, unrelated to the landscape nature.

Keywords: forest-cover change, gap dynamics, Northeastern Europe, winter imagery

T_0791

Investigating the patterns of recurrent fires in highly urbanized Mediterranean landscapes

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Fire recurrence plays a key role in shaping landscapes in Mediterranean ecosystems. Short-term recurrent fires are increasingly affecting the landscapes, especially the highly urbanized landscape. Few published studies have addressed fire recurrence by analyzing environmental, climatic and human factors. Current models use fire recurrence polygons as the dependent variable; yet no published study has focused its analysis on fire recurrence considering recurrent ignition points as the dependent variable. To fill this gap, remote sensing and local available data were combined to examine the role of human and biophysical variables in predicting both the likelihood and frequency of recurrent fire ignition points over a nine-year period (2004-2012) in Southern Italy. We used a Negative Binomial Hurdle (NBH) model, owing to the stochastic nature of the phenomenon (fire recurrence), and the available fire dataset characterized by a high number of non-occurrences. Our results suggest that the likelihood and frequency of recurrent fire ignition points (dependent variables) had a negative relationship with population and road density and positive relationship with land-cover variables. Road density was the strongest predictor of recurrent fire ignitions, followed by the presence of shrublands and grasslands. Vegetation indices (NDVI and NDWI) were also good predictors of fire recurrence. More broadly, this study is intended to be a further experimental step in fire-management analysis where constant alterations of the human and natural systems associated with population growth, natural fuels, and global change can create conditions for short-time interval recurrent fires.

Keywords: Fire recurrence, Remote sensing , Mediterranean ecosystems

T0916

Modeling landscape patterns presented by the coastal ridge landforms in the lake basins of arid regions

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The global desertification and irrigation leads to the lake surface shrinking in arid regions. A complex set of endogenous processes impacts on freshly drained areas. Often it leads to the generation of coastal ridge landforms such as ripples, dunes or dune chains. The land cover change may destroy natural coastal ecosystems and harm local community's economy. We present the results of studying landscape patterns formed by coastal ridge landforms. The objects are located in different arid and semi-arid regions. We considered coastal landscapes of Caspian Lowland, Chad Lake and Qinghai Lake, analyzed their patterns and compared them with each other. The methods for studying patterns included the use of remote sensing data and statistical analysis. We used high-resolution «Bing» images to outline patches that presents ridge landforms and count their point and linear metrics. Statistical analysis was carried out in «Statistica» program. Ten sample areas revealed that the linear metrics of the ridges fit the lognormal distribution. Spatial point metrics fit Poisson's distribution in most cases. Comparison of patterns located in different regions showed similar results. It allowed us to create a model of coastal dune dynamics. We proposed two basic scenarios of land cover change in case of increasing lake evaporation.

The study results may help us to predict coastal dynamics in case of further lake surface shrinking. The conclusions of our research may be considered as an additional method for spatial monitoring of lake basins. Land cover change influences on local biodiversity and land use so it is important to research the phenomena of coastal ridge relief and apply quantitative models describing those landscapes.

Keywords: landscape patterns, ridge landforms, remote sensing, mathematical methods in geography

Session Soil, Vegetation and Biodiversity

T0238

Impacts of forest restoration on soil organic carbon and nitrogen dynamics

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Consequences of afforestation on soil organic carbon (C) and nitrogen (N) dynamics due to spatial heterogeneity are not fully understood. We investigated soil organic C and N dynamics following uncultivated area converted to P. massoniana forest of 10, 18, 25, and 30 years old of reforestation by soil fractionation and stable C and N isotopes in South China, and the temporal variations in CO2, CH4 and N2O fluxes in afforested soils (implementing woodland and shrubland) and the adjacent uncultivated area in Central China. Moreover, we examined the effects of soil factors [e.g. soil temperature, soil moisture, soil pH, soil organic C, soil organic N], litter exclusion and vegetation types on greenhouse gas (GHG) fluxes. We found that reforestation of P. massoniana after 18–30 years significantly increased soil C and N levels, whereas reforestation after 10 years did not significantly enhance soil C and N levels. The C accumulation following the reforestation appeared to be determined by a combination of large biomass input and low C decomposition. The change in the δ13C values indicated that the decay rates for old C in the 10 years old soil was faster than that at the 18–30 years old stand. The δ15N values of organic soil were more depleted with plantation age, indicating a decreased N loss with stand age. Afforestation lead to a higher average CO2 flux from soils by 63.96% and a higher N2O flux by 54.53% in the observed year. The peak CO2 and CH4 fluxes from afforested soils occurred in summer, while the peak N2O flux occurred in winter. The CO2, CH4 and N2O fluxes from soils were strongly influenced by soil temperature, moisture and SOC content across seasons. The N2O flux was also strongly affected by SON content in our experimental field. Our results suggested that afforestation indeed significantly increased SOC stock, but it could enhance the GHG emissions from soils.

Keywords: Reforestation, Stable C and N isotopes, Soil organic C and N, Greenhouse gas, Soil C turnover

T0264

Mediterranean riparian forests as carbon bankers

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Riparian ecosystems have a great potential for long-term carbon storage and sequestration. However, there is a growing demand on accurate estimations for the Mediterranean region and particularly using remote sensing approaches. In this study, we estimated the Above Ground Biomass (AGB) of a Mediterranean riparian forest using high-resolution multispectral Unmanned Aerial Vehicle (UAV) imagery supported by field data collected in 2018. An object-based approach was used to identify clusters of riparian trees at species-level – Riparian Objects (RO), in the 3 km-long reach of a Tagus River tributary, Portugal, SW Europe. We used the in situ Above Ground Biomass as training and validation data. Allometric biomass models were developed for an Iberian endemic willow (Salix salviifolia) while available equations were applied for black alder (Alnus glutinosa) using Diameter at Breast Height (DBH) and Total Height (H), recorded in 13 circular sampling plots. Predictor variables included spectral, geometric and textural RO variables. We found that riparian woods dominated by Salix salviifolia stored 69tC/ha in the aboveground components, while riparian areas dominated by Alnus glutinosa stored 127tC/ha, values considered high when compared with other Mediterranean terrestrial ecosystems. We observed a high variability in soil carbon stocks (up to 20 cm depth) ranging between 6.2 and 70.7 tC/ha, which is related with species-specific litterfall turnover and also with local soil texture characteristics. Parametric and nonparametric regression models showed that RO spectral variables derived using Red-Edge and Near-Infrared bands generates the most accurate remote AGB retrievals while RO geometric variables were also considered important variables in the models. This study provided the foundations for the assessment of the riparian carbon sequestration in similar Mediterranean riparian forests, a highly relevant Ecosystem Service for the regulation of climate change effects.

Keywords: Above Ground Biomass (AGB), Carbon stocks, Ecosystem services, Riparian allometric equations, Unmanned Aerial Vehicle (UAV)

Black beauty on the rocks – distribution, function and C-storage potential of Tangel humus in the Calcareous Alps

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Thick forest floors overlying poorly weathered rocks and gravel ("Tangel") are a decisive site factor in mountain forests. As ecosystem services such as carbon storage, water retention and protection against erosion and avalanches crucially depend on intact forest floors more information about their extent and distribution is required.
To improve knowledge on the distribution of Tangel humus, ca. 11,900 humus samples were investigated in stratified forest areas of the entire Bavarian Alps. Supplemented by additional soil profile data and geodata on climate, relief and bedrock substrate, we predicted the distribution and thickness of Tangel humus by regression models.
The proportion of Tangel humus was highest on solid or coarsely weathered limestone and dolomite with poor mineral soil development, which is the most frequent bedrock in the Bavarian Alps. As Tangel humus can occur from montane forested gravel fans up to the subalpine krummholz zone, temperature is inapplicable as a main predictor. Instead, two crucial factors for the generation of thick forest floors are the lack of mineral soil and the sustained input of forest necromass (litter and deadwood). Even where these conditions have prevailed for centuries, disturbances by windfall, clearcut and bark beetle outbreaks lead to rapid loss of Tangel humus.
The spatial modelling of forest floor and related C-stocks allows to quantify unique ecosystem services, to delimit sensitive zones and recommend silvicultual management practices for protecting and enhancing the "black beauty on the rocks".

Keywords: ecosystem services, digital soil mapping, mountain forest, spatial modelling, Tangel humus

T0691

Legumes contribution to nitrogen supply in other plants and microhabitats in a green roof substrate.

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Green roofs are planted vegetated roofs which are viewed as an instrument that can help re-introduce biodiversity whilst mitigating the impact of climate change and urbanisation throughout cities. Green roof systems currently rely on the addition of synthetic fertiliser to maintain sufficient nutrient levels for plants to survive and thrive. This research adopts an ecosystem approach to the supply of nitrogen throughout extensive green roof systems. Legumes were introduced as N-fixers to more accurately mimic natural ecosystem function, in comparison to synthetic fertiliser. A mesocosm design with multiple treatments was implemented to examine nitrogen distribution from legumes and how this distribution impacts on other plants and below-ground collembola species. In this research, non-leguminous plants in treatments containing legumes experienced greater levels of plant health when compared to treatments with no legumes ($p = < 0.05$). Legumes based treatments with no fertiliser experienced significantly more total nitrogen ($p = < 0.05$) in non-leguminous plants when compared to 'no-legumes and no fertiliser' treatments. A legume based green roof, in the absence of synthetic nitrogen fertiliser, is a step closer towards a self-regulating sustainable system, requiring less maintenance and increasing the resilience of urban ecosystems.

Keywords: Nitrogen, Legumes, Green Roofs, Ecosystem approach

T0709

Structure and dynamics of forest landscapes of the north-western Caucasus

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The studies have been done to reveal the structure and dynamics of forest landscapes including unique sub-Mediterranean ones within the North-Western Caucasus of Russia. Particular attention has been paid to the "Utrish" reserve, which was established in 2010 and can be a good model for studying the restoration of forests after long-term use and for developing recommendations of rational use of neighboring territories. The complex of methods such as field landscape-geobotanic profiling and mapping, including microcenotic mapping, analyses of remote sensing data of high resolution, phytomass and productivity determination, statistical analyses of intercomponent relations was used during the study. For the first time, large-scale geobotanic and landscape maps of the study area were compiled. The classification of geosystems and characteristics of the main landscapes of two altitudinal belts – the sub-boreal mesophytic broad-leaved forests and sub-Mediterranean meso-xerophytic forests and woodlands were provided. The basic regularities of the spatial organization of the landscapes were revealed. The main role in the differentiation of the landscapes and vegetation diversity was defined by tectonic and geological structure, exposure, steepness and shading of the slopes, distance from the sea and anthropogenic effect. The most complex structure is typical for the sub-Mediterranean landscapes of juniper (Juniperus excelsa, L. foetidissima, J. oxycedrus), pistachio (Pistacia mutica) and oak (Quercus pubescens) forests of the south slopes due to the ability of geosystems of seism gravitational landforms. The main features of the primary succession stages after logging, recreational use and fires in different types of forests were identified and some recommendations on monitoring and use of neighboring territories to the reserve were suggested.

Keywords: forest sub-Mediterranean landscapes, structure, dynamics, vegetation diversity

T0867

Assessing impact of human disturbance in shaping forest plant communities structure, productivity and diversity in highly fragmented high-Andean forests

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In this study we present an extensive sampling for human disturbance effect in a highly fragmented ecosystem of the Colombian Andes. We measured a wide array of disturbance-related variables, spanning from landscape fragmentation metrics, structural and compositional parameters as to different diversity indexes and productivity in high-Andean forests. We divided our explanatory variables into 3 categories: "geo-environmental", "causes of disturbance" and" facilitators of disturbance". Response variables were also divided between "indicators of disturbance", "level of disturbance" and "diversity and productivity measures". We then asked the following questions: (1) which variables explain the most species composition of trees communities and understory?(2) how are diversity (here : species diversity, phylogenetic diversity and functional diversity) and productivity (above-ground biomass) related to each of the different category of predictors? (3) how are diversity and productivity related to the indicators and to the level of disturbance? (4) how the different component of diversity and productivity relate to each other? (5) how do climate,disturbance, community structure, diversity and ecosystem function (productivity) interact? To address our questions we identified the variables that correlate with overall forest canopy layer and understory composition using NMDS and CCA (1). We induced GLM between selected explanatory and response variables (2), (3) and (4) and finally, we created Structural Equation Models (SEM) to explore interrelations among climate, human disturbance, community structure, diversity and productivity (5). Our preliminary results suggest that: (i) human disturbance is impacting plant diversity and vegetation structure of high-Andean forests and (ii) plant phylogenetic and functional diversity have the potential to elucidate the effect of human disturbance in shaping plant communities.

Keywords: human disturbance, high-andean forests, phylogenetic diversity, functional diversity , aboveground biomass

T0918

Secondary forests have functionally eroded pollinator communities and reduced plant genetic diversity

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Secondary forests may play an important role for mitigating the negative effects of forest loss on species diversity. However, whether secondary forests have the capacity to maintain pollination networks and genetic diversity remains unclear. We investigated this question using a hummingbird-pollinated plant model system, the understory herb Heliconia tortuosa, in a highly fragmented Costa Rica forest landscape. We combined historical forest landscape data, microsatellite genetic data from more than 850 plants from 33 populations, and hummingbird occurrences from 49 forest fragments, to show that Heliconia populations were more inbred in secondary forests where generalist hummingbirds dominated the pollinator community. Further, amount of primary forest surrounding a given Heliconia population and the proportion of specialized hummingbird pollinators per forest fragment were associated with lower inbreeding. Finally, using empirically parameterized simulations, we demonstrate that specialist pollinators are likely to increase mating among unrelated plants, hereby maintaining plant genetic diversity. Overall, our results therefore indicate that functionally disrupted pollination networks in secondary forests can erode plant genetic diversity, even for a common plant species. This emphasizes that tropical primary forests are not only important for the maintenance of species diversity, but also for safeguarding mutualistic networks and plant genetic diversity.

Keywords: Pollination , Secondary forest, animal movement, mutualistic networks, genetic diversity

Grazing animals are important for distribution of plant genes in alpine summer farming landscapes and rangelands

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Agricultural practice in alpine regions in Norway has changed during the last century. Milk production has decreased considerably and the collection of winter fodder and firewood for the summer farms has ceased. As a result, earlier open landscapes have undergone a large-scale encroachment of trees and shrubs leading to extensive landscape changes and altered biodiversity. Today, alpine rangelands are important for meat production and are grazed by sheep and suckler cows. The aim of this study was to get knowledge about grazing animals and their ability to maintain grazing resources and biodiversity.

The study area was Steinsetbygda (Etnedal and Nord Aurdal municipality, Oppland county), situated 700-1000 m a.s.l. in the northern boreal vegetation zone. The investigated area was 14 km2 and the vegetation were mapped in 2015. The grazing preferences and grazing patterns of four suckler cows and four sheep were studied by GPS tracking, modelling of GPS data, manual observations of the animals and botanical analyses of grazed vegetation during one season (June-September).

The most common vegetation type is bilberry woodland which cover approximately one third of the study area. Within the woodland there are small patches and remnants of semi-natural grassland. Semi-natural grassland cover approximately 12 % of the study area. The rest of the study area consists mainly of heathland (20 %) and fen (9 %).

Both sheep and cattle use 50 % of their grazing time in woodland, but they graze the patches of semi-natural grassland within the woodland. They also use 25 % grazing time in semi-natural grassland. Botanical analyses of grazed vegetation showed that a large portion of the plants had seeds adapted for animal dispersal. This study show that grazing animals are important for maintenance of grazing resources and genetic variation in meadow plants. The animals are helping the plants to spread their seeds from one suitable but isolated habitat to another.

Keywords: alpine rangelands, summer farming, grazing preferences, biodiversity, plant genetic diversity

Session Urban forestry

T0646

Influence of legislation regulations on the number of trees cut on private possessions in a city. Racibórz case study.

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Trees belong to the permanent vegetation in urban and peri-urban areas, shaping landscapes over the centuries. They give the characteristics of identity and unique character of places, they are dominant elements of the visual shape of territory and play a substantial functional role as air cleaners, stress reductants, social interaction stimulators, active lifestyle support and many more. Loss of these services caused by woody plants felling is often irreversible. Felling of the trees in Poland is regulated by specific enactment. Legal procedure of application for cutting down the trees in Poland has undergone specific development. The change of the Act on Nature Conservation (Dz.U. poz. 2249) of December 2016 abolishing the requirement of trees owners to apply for permission for cutting off trees on private possessions, constituted a significant change. Trees could be cut off freely for purposes unrelated to business activity. This situation lasted for a few months only, and the enactment was once again amended. The permissions were restored. This research aims to determine if change and liberalization of regulation concerning felling trees and shrubs in Poland, changed significantly the number of trees that were cut on private possessions. It will be done by analysis of regulations of tree felling (including documents provided by local government), which was at that time in Polish commune Raciborz. The evaluation would be conducted by comparision of administrative data (applications for felling) and changes in the area of trees covering in 3 available points of time. LiDAR data (Light Detection and Ranging) and digital photogrammetry enable the detection of changes between 2011 and 2017, giving long time perspective. Those data were completed with the precise analysis of Google Earth images from 1.09.2016 that enables the impact assessment of the change of legal regulations.

Keywords: urban greenery, administrative decisions, private properties, LiDAR, Google Earth

T0017

The cooling and ventilation effects of trees configuration in residential area in central China

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Due to a lot of people pouring into the city, it is necessary to build an amenity urban environment. Residential area is the main space for people living and social activities. Comfort microclimate in residential area is conducive to outdoor social activity. While some cities such as Wuhan are facing high temperature in summers and gust in winter, which seriously hinder people out. Vegetation is testified to have a great cooling effects on heat stress and resistance to ventilation. This study dictated the relationship between tree distributions and microclimate in residential area both in hot and cold season by using ENVI-met model. The simulation was based on high-rise buildings representing current development of residential area in Wuhan. Base on different height-to-distance ratio of trees (as "Aspect ratio of trees", ART), "spares"(ART <1), "covering"(1≦ART <2) and "density"(ART=2) vegetation spaces were shaped. Cinnamomum camphora and Koelreuteria paniculata were simulated representing evergreen and deciduous species, respectively. Finally, 21 scenarios of various tree distribution were simulated. Results showed that trees with different ART had various impact on high temperature and ventilation. Trees with ART ≤ 1 had better cooling effects on heat stress and resistance to air flow. Different tree distributes with same ART had little influent of microclimate in the whole residential area. Evergreen trees had obviously effects on decreasing wind speed in winter. Distances between buildings and trees also had an influence on wind environment. All of these give practice guides for residential planting design to improve residential microclimate both in summer and winter.

Keywords: tree configuration, residential area, microclimate, ENVI-met

T0076

Application of 3D ultrasonic tomography for tree risk assessment and wood evaluation

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At present many holm oak (Quercus ilex L.) trees in the private and public urban green are afflicted by decay for tail disease and bark cancer caused all over by pathogenic fungi. Moreover, standing trees are adapting themselves to the modified growth conditions caused by the climate change. A field methodology using ultrasonic tomography supported by a digital photogrammetry survey has been developed and evaluated as a tool to detect the presence and patterns of internal decay in a living adult holm oak tree. The ultrasonic parameters, especially longitudinal velocities, allow to recover information on materials related with their mechanical properties although the interpretation of the data is very complex because elastic wave propagation strictly depends on the heterogeneity, the porosity and other physical properties of the materials. In this study, considering the nature and size of the investigated tree and the target of the study, an ultrasonic investigation by the 3D ultrasonic tomography technique was carried out at 24kHz . By combining the digital photogrammetry and 3D ultrasonic tomography, a consistent diagnostic process of the conservation state of the investigated tree can be achieved to detect the presence of defects, fractures, weathering process inside the stem.

Keywords: 3D ultrasonic tomography, holm oak, decay detection, monitoring

T0134

Interannual Variation of Phenological Seasons in Beijing Demonstrates the Effect of Climate Change on Urban Vegetation

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Seasonality is the typical characteristic of local vegetation in Beijing,which can reflect in the seasonal dynamics of plant phenology.We explored the division of natural seasons according to the temporal distribution pattern of typical plant phenophases in Beijing,based on one-year-round phenology data of 120 deciduous tree species in Beijing Botanical Garden.The main results are as follows: 6th–19th pentad as Spring,with 54.03% of total phenophases featured with sprouting,leaf unfolding and flowering; 20th–45th pentad as Summer,with 12.95% of phenophases including the completion of leaf unfolding,intensive fruiting,fewer blooming and appearance of autumn-leaf in late summer;46th–59th pentad as Autumn,with 27.19% of phenophases characterized with leaf discoloration and defoliation,some fruiting and very few flowering; and 60th pentad till the beginning of next spring as Winter,with only 0.6% of phenophases that are all constituted with defoliation. Compared with the results of a counterpart research in the 1980s, spring in 2017 came earlier by 1 pentad than 30 years ago,while autumn came later by 3 pentads. Additionally, autumn duration was shortened by 2 pentads while summer duration was prolonged by 4 pentads,resulting in larger differences between the duration of the four seasons, which can demonstrate the integrated effect of climate change on urban vegetation.

Keywords: Seasonal division, Plant phenology, Interannual variation, Climate change

Strategy of Conserving Beijing's Imperial Garden Group as Urban National Park

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One of the world's largest group of Imperial gardens lies in north west of Beijing. They are composed mainly of three mountains and five gardens. The construction of gardens began as early as 1000 years ago, and reached their peak in 18-19th century. The Summer Palace has been designated as a world cultural heritage site, while Yuan Ming Yuan was totally burned down in 1840s and has been used as a memorial park. Other gardens are used as suburban forest parks or high official allocations. The spaces among them are filled with high density urban developments, in the form of urban villages, research institutions, universities, or commercial housings.

The important value of this former garden group is not limited to tourism and heritage conservation. They locate at the mountain foot, benefiting from abundant water flows and natural springs in the past. Different gardens are linked by natural waterways and bear important ecological functions. Fruit forests and rice lands disperse among them, and Beijing Swallows can be seen regularly. The river system further connects with Da Yun He (The Grand Canal) that flows all the way to southern China.

However, the recent land isolation and fragmentation makes the link among the gardens fragile. The paper examines the possibility of setting up an Urban National Park of Imperial Gardens. The new trend of Urban National Park will be illustrated, and ecological, visual and aesthetical linkages are to be strengthened. The infrastructures, buildings, urban facilities will be discussed as important tools and medium to correspond with this need. Design guidelines are proposed to ensure reasonable development and better conservation. Upon all these considerations, the Imperial Garden Group is hopeful of becoming an ecological conservation site, in addition to a more open public space.

Keywords: Imperial garden group, Urban national park, Beijing, Ecological conservation

Growth of two street tree species in Kyoto City, Japan

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Street trees play an important role in urban ecosystems. Thus, recently some local governments have conducted ecosystem service evaluation of street trees. For modeling urban forest functions and values, including those of street trees, information on urban tree growth is indispensable. Especially growth equations underpin the calculations produced by many models used in urban forestry. In Japan, a study evaluating street trees as ecosystem services was conducted in Kawasaki City, with further development of the evaluation model being anticipated. Although the growth of urban trees has been studied in some countries and areas, the growth of street trees has not been studied well in Japan. The purpose of this study was to propose equations of diameter at breast height (DBH) growth and total height growth for street trees of Zelkova serrata (Thunb.) Makino. and Ginkgo biloba L. in Kyoto City, Japan.

The study was conducted in Kyoto city (35.0 ° N, 135.8 ° E), located in the middle of Honshu Island, Japan. DBH and total height of 66 Z. serrata (7.1% of total population of all street tree in Kyoto City) and 68 G. biloba (39.6%) as street tree were measured in Kyoto City, using a diameter tape and a TruPulse 360 laser rangefinder/clinometer. Planting years of sample trees were estimated using aerial photos and municipal maps of street trees.
Three polynomial models (linear, quadratic, and cubic) were tested to develop diameter growth equations. Fitted models were compared with existing urban tree database in USA.

Keywords: diameter growth, growth equation, street tree

Session Urban planning

How landscape heterogeneity influences the ecosystem services provision of urban green spaces?

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Ecosystem services are highly correlated with the ecosystem structure and process. Landscape pattern and process affect the flow of materials and energies, which accordingly influence the providing and flow of ecosystem services. While a large number of studies about assessing ecosystem services of urban green space and their value have been published, most of them are based on the assumption of the linear relationship between ecosystem services and the amount of green area. This research attempts to integrate landscape heterogeneity, including the area of green space, the characteristics of green patches and landscape connectivity, into the evaluation of ecosystem services of urban greening. Three types of ecosystem services, including cooling effect, bird diversity and cultural ecosystem service are examined. Results suggest that: 1) When a forest patch is smaller than 0.5 ha, the cooling effect significantly rises with the increase of patch area. However, when a forest patch is larger than 0.5 ha, cooling effect would not remarkably increase by enlarging its patch area. 2) Cooling effect first increases and then decreases with the growth of the value of LAI (Leaf Area Index), and the landscape connectivity is not strongly associated with the cooling effect. 3) Bird diversity service is sensitive to loss and fragmentation of natural habitats. RDA analyses indicate that mean patch area of forest land and connectivity of grass land are closely related to bird diversity. 4) The amount of green space, biodiversity, recreational infrastructure and accessibility are significant factors influencing the use of cultural ecosystem services of green space. In all, this study provides a way to consider landscape heterogeneity in the assessment of ecosystem services of urban greening, which could provide significant information for landscape and urban planning.

Keywords: Landscape heterogeneity, Ecosystem services, LAI, Cooling effect, Bird diversity

T0066

Strong contribution of rapid urbanization and urban agglomeration development to regional thermal environment dynamics and evolution

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Urbanization has significantly transformed natural surfaces into impervious surfaces, which has subsequently disturbed the balance of the global surface thermal energy. However, key dynamic processes that can affect land surface temperature (LST) and regional thermal environment (RTE) remain poorly understood, especially in the context of urban agglomerations. Hence, as the case area, we selected one of the world's most rapidly urbanized regions – the Pearl River Delta Metropolitan Region (PRDR) in southern China. With the help of Google Cloud Computing, land use transfer matrices, and spatial analyses, we quantified the strong contributions of urbanization and urban agglomeration development to RTE dynamics and evolution. Specifically, we found (1) from 1995 to 2015 in the PRDR, built-up land increased significantly, while the ecological land was significantly reduced, and the isolated urban heat islands were gradually connected and interacted with each other, forming the regional heat island. (2) We found that the RTE is not only dominated by specific land cover patterns but also significantly influenced by the specific land conversion processes. (3) We notably revealed that the cooling effects of ec0 logical land loss and gain are significantly different, which provides evidence that the existing natural ecosystems (especially forests) are valuable for climatic adaptation because newly constructed ecological land does not provide the same cooling effect. (4) We also proposed that the relationship between urbanization rate and temperature (RLST) may conform to the Environmental Kuznets Curve. This study enhances the understanding of RTE dynamics and evolution in urban agglomeration and provides important insights into existing natural ecosystem protection and climate adaptation planning.

Keywords: Rapid urbanization, Regional thermal environment, Dynamic and evolution, Climate adaption and mitigation, Environmental Kuznets curve

Exploring Planning Strategy of Urban Agriculture Based on Informal Sector in China

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As an integrated part of contribution to sustainable and equitable urban development, urban agriculture directly influences the space morphology and low-end employment opportunities in cities. However, most of researches on space of urban agriculture focus on different types of agriculture and ignore the spatial morphology and connection of each space in the food system. Moreover, informal sectors with large population struggle to survive under the exclusion of urban space and policies, while the contribution of vendors to the development of local biodiversity and sustainable development of the city is always neglected.
By establishing the space assessment system of food system, this research evaluates and compares food system at different levels and analyzes the positive and negative impacts of informal sector, so that to gain connections between urban space and food chains. Through the urban morphology analysis of urban space occupied by different parts in the food chain and its evolution rules, the research summarizes how to make spatial planning strategy for the food system of the informal sector. Moreover, based on the comparison of Nanjing(China), Rotterdam(Netherlands) and Cologne(Germany), the case study puts emphasis on the vulnerability of the food system and the characteristics of the informal sectors in Nanjing, and then evaluates the local production capacity of this city. Relying on the strength of the large informal employment population in Nanjing, the self-sufficiency of the city will be enhanced, and the food sources and access channels will be enriched.

Keywords: Urban agriculture, Informal sector, Food system, Urban morphology, Planning strategy

Efficiency and impacts of land use (governance) in the urban-rural nexus

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Globally, land consumption for traffic and settlement areas considerably increases. The need for ecological compensation of surface sealing due to settlement development can hardly be met in urban agglomerations. This reinforces a spatial separation between urban settlements and ecological compensation areas. An additional side-effect, which is less in focus, is the associated decline of agricultural land (e.g., in Germany and other parts of Europe). This trend is countered by an increasing demand for regional agricultural products in urban agglomerations. These impacts of these settlement driven land-use changes on equal living conditions and ecosystem services are hardly assessed in a spatially explicit manner and in the urban-rural nexus.

Using the metropolitan region of Nuremberg as an example, we analyze (i) how land-use changes and its drivers in the urban-rural nexus can be identified, (ii) how impacts on (agricultural) value creation, ecosystem services, and societal development can be measured, and (iii) which governance instruments could make land use more efficient.

First results for the period 1990 until 2012 show a decline in agricultural land predominately in rather remote rural areas. The decline is to a larger share attributable to near-nature areas. Additionally, spatial hotspots of compensation arise. Existing governance instruments such as regional planning show a rather weak impact on agricultural land-use change.

Keywords: land-use change, urban-rural nexus, regional planning, land-use governance

Assessment of the management effectiveness of Dinadiawan River protected landscape in Aurora province, Philippines

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The sustainability of Dinadiawan River Protected Landscape (DRPL) Aurora Province, Philippines was assessed using the Management Effectiveness Tracking Tool (METT). The METT criteria used include context, planning, input, process, output and outcome. Results revealed mixed and relatively modest to low scores. Protected Area Management Board (PAMB) members gave the DRPL overall management a total score of 30.11 out of 105 points. This is equivalent to a 28.68% average score which is a fair reflection of the mixed findings across the METT components. The context was rated highest (62.96%) which suggests that the presence of presidential affirmation presently matter significantly in DRPL's management. Absence of any grave and evident threat to the area reconciles with the modest outcome score (39.51%). This goes similarly with process (33.05%) and planning (28.21%) which also garnered modest ratings. Rating for these latter two components is consistent with KII findings of ongoing management activities in the PA, although largely driven by the PAMB members' personal commitment and initiatives, with much room for complementation on the part of institutional action/support in the long term in terms of logistics, planning, regulation, monitoring and policy enforcement. The low input (17.33%) and output (3.7%) ratings are consistent with findings of very few to practically no support for the operational/ logistical needs of the PAMB for its effective management of the DRPL. While the PA garnered a relatively low score, its relatively intact forest cover and undisturbed natural resources coupled with the absence of significant threats provide a great opportunity for its sustainable management.

Keywords: protected landscape, Management Effectiveness Tracking Tool (METT), sustainable development

Conformance and Performance Implementation Evaluation of Green Space Planning Based on Landscape Ecological Effects in Beijing Metropolitan Area

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Green space planning aims to provide a series of ecosystem service functions. As one of the earliest cities to carry out this planning in China, the planning implementation evaluation of Beijing is a weakness. Usually, the planning implementation only evaluates the conformance of the plan, and lack of the performance of the planning. Furthermore, there is a gap between theory and practice. Therefore, according to the planning and implementation documents of green space planning, Fractal Vegetation Coverage (FVC) and Net Primary Productivity (NPP) in 2000-2005, 2005-2010 and 2010-2015, this study has evaluated the conformance and performance implementation of green space planning based on landscape ecological effects in Beijing metropolitan area. The results showed that, from 2000 to 2005, the predominant proportion of significant change of FVC was the significant reduced area, which was about 8.7%. The predominant proportion of significant change of NPP was the significant growth area, which was about 15.0%. From 2005 to 2010, the significant growth of FVC was predominant. The proportion was about 6.7%. However, NPP was significant decreased. The proportion was 5.1%. From 2010 to 2015, the predominant proportion of significant change of both FVC and NPP was significant growth, which was 22.5% and 7.9%. The conformance of green space planning implementation was better. The performance was insufficient. The conformance and performance of the central city is better than Beijing metropolitan area. The development and effect of the green space pattern have gradually improved under ecological context. While the continuous stability in the future is weak. This study provides scientific basis for the capital ecological management, comprehensive decision-making of sustainable development and promoting the construction of ecological civilization.

Keywords: landscape ecological effects, urban green space, Implementation Evaluation, conformance, performance

Climate Justicescape: Integrating green infrastructure in Social-Ecological-Technological vulnerability assessment for identifying climate justice patterns in USA

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Climate change has exacerbated socioeconomic and environmental stresses in places where social and ecological vulnerability persist. Understanding the interlinked relationship between social and ecological vulnerability is critical to understand the resilience of social-ecological systems in communities. Green infrastructure has been identified as a critical climate change adaptation strategy and can enhance coping capacity of a community. Climate justicescape reveals spatial patterns of climate justice illustrating inequitable coping capacity to climate change impacts among socially vulnerable groups. Leveraging the role of green infrastructure in climate actions for enhancing resilience of vulnerable communities will redefine the role of green infrastructure in ecological planning to integrate social and institutional resilience. Climate justicescape integrates spatial patterns of exposure to climate change associated hazards (ecological vulnerability), sensitivity (social vulnerability) and adaptability (technological vulnerability)(Cheng 2016). In the case of a national scale in 50 states of the United States, Geographical Information Systems was employed to analyze and synthesize spatial distributions of climate change associated hazards events and impacts from 2005-2015, Social Vulnerability Index (Cutter 2003), and land cover data demonstrating a lack of green infrastructure. Results revealed climate justice hotspots in both rural towns and large cities in USA. The findings have implications in prioritizing resources in investing green infrastructure for increasing coping capacity to climate change in underserved communities. This paper explores the integration of social and ecological planning and provides a spatial tool to inform landscape and urban planning policies for strengthening social-ecological resilience of communities under considerations of climate change impacts and address local climate justice in Anthropocene.

Keywords: Climate Justice, Green Infrastructure, Vulnerability Assessment, USA

T0452

Evaluating environmental and ecological landscape characteristics relevant to urban resilience across gradients of land-sharing-sparing and urbanity

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The concept of green infrastructure has emerged as a promising framework to manage and enhance the multiple benefits delivered by nature in highly fragmented landscapes. A primary aim of a green infrastructure approach involves optimising multi-functionality in terms of social, ecological and economic benefits and seeking resilience through landscape diversity, connectivity and micro-climate regulation. With the unabated growth of urban areas and associated sprawl into the rural hinterland, debate persists on the optimum spatial configuration(s) for urban planning. At the heart of this debate exists a dichotomy of land-sparing (densification prioritising large public green spaces) versus land-sharing (implying lower-density development, and greater cover by smaller private green spaces). Using part of Greater Manchester (UK) as a case-study, we present an integrated approach to mapping urban green infrastructure. Coincident measures of land-use and land-cover in conjunction with open-source environmental datasets enable accurate estimates of the influence of land-sparing-sharing and land-use-land-cover combinations on critical social (green-space access), environmental (air quality and micro-climate regulation) and ecological (landscape connectivity, diversity and core area) conditions. In addition we report on the distribution and quality of green infrastructure and associations with human health outcomes, showing that these vary as a function of public-private green space provision and socio-demographic status. Results imply potential trade-offs related to land-sparing-sharing and land-use-land-cover configurations within social-ecological systems. These trade-offs may be particularly complex due to the parallel influence of attributes such as patch size, and the relevance of socio-demographic contexts. Integrated socio-economic-ecological approaches and datasets will be required if such trade-offs are to be successfully navigated.

Keywords: Green infrastructure, Land-sparing-sharing, Urban ecosystems, Social-ecological systems

The combination of a Green and Open Space Factor with a microclimate simulation model as a steering tool to support green and climate-sensitive urban planning

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Without doubt, it is well known that the use of green infrastructure in cities is essential for environmental and socioeconomic benefits, such as mitigation of urban heat island effect, improvement of air quality, increase of well-being etc. However, continued urban growth, densification and the continuously increasing number of days of great heat provide challenging conditions for urban green infrastructure (UGI) and requires new approaches. So far, existing Green and Open Space Factors are restricted by shortcomings such as their almost exclusive focus on ecological aspects as well as their lack of consideration of different building typologies and urban fabrics. This submission presents a Green and Open Space Factor (GFF), which was developed in cooperation with the City of Vienna, as an urban development index and control instrument on plot level, based on two case studies in Vienna. The GFF considers the ecological, climatic and socio-economic aspects of UGI in relation to ecosystem services. As part of a research project, it was embedded in a multiscale toolset which enables climate simulations at various planning levels for regulation, optimization and assessment for green and climate-sensitive planning.
The unprecedented amalgamation of the GFF on parcel level and the GREENPASS® as an optimization instrument on neighborhood level, allows the testing and optimization of different UGIs with a focus on their influence on the climatic performance of the proposed design of an urban development project. Subsequently, its practical use is clearly to identify optimization possibilities throughout the planning process, as well as to evaluate the current state of planning of urban structures. Furthermore, it serves as a scientific basis for urban planning decisions on a political level where it can be integrated into everyday planning to provide quantitative specifications, depending on the respective urban structure and building typology.

Keywords: Green and Open Space Factor, steering instrument, climate-sensitive urban planning, urban heat island, microclimate simulation

P0143

Effects of unplanned occupation and Brazilian legislation on Atlantic Forest conservation in an urban matrix

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[2]*University of São Paulo – USP Department of Ecology*

Unplanned urban occupation has become a major concern in large Brazilian cities, especially in water source areas, due to possible effects of deforestation on public water supply. This study evaluated whether compliance of Atlantic forest protection legislation is sufficient to minimize the negative effects of unplanned urban occupation on forest conservation in the most critical metropolitan area of São Paulo (Diadema-SP). We created and compared a legal scenario of historical land use/cover maps, including a future trend scenario developed based on the Markov chain in association with cellular automata. Forest conservation was evaluated based on a set of landscape metrics - optimal resource availability (ORA), fragment isolation (NN), and forest fragmentation trends (ED and ESD), using as reference a residential development in protected areas of Serra do Japi (Jundiaí-SP). In the last five decades (1962-2011), urban areas have increased by 37% in association with 50% of deforestation. The main driving forces of historic landscape changes were roads (54%) and human-modified fields (41%). Compared to 1962, the current status of optimal resource availability (ORA reduced by 75%) and isolation (ENN increased by 361%) is critical, although it could be improved by legal compliance, which provides 4 times more ORA and less ENN. However, as seen in Japi, the legal scenario does not avoid the tendency of new fragmentation caused by the pressure of the urban matrix (boundaries forest-urban and forest-road: ED2011 = 12 and 4%, EDLegal = 17 and 16%). In addition, future trends indicate that, without changes in management, deforestation can occur continuously and rapidly until only 10% of the forest remains. We conclude that compliance with legal protection could play a fundamental role in the maintenance of forests and potentially contribute to their services on water availability and quality in this urban area.

Keywords: land use and cover change, landscape metrics, legal scenario, environmental law, urban sprawl

Session Open Symposium Poster

Modeling of Landscape Pattern-Process Interaction for Ankara City

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In most of the studies that claim to explain the dynamic structure of urban systems, it is mentioned that the understanding of the complex nature of the city, which is shaped by biophysical and human processes, and which at the same time is shaping and reproducing these processes, is difficult because of the wide variety and different scales of many parameters but is a necessary process due to the influence of the system on ecological, economic and social parameters. In this framework, models developed to understand the movements of urban systems are crucial for ensuring the sustainability of social, economic and natural resources, affected by urban land use change, and for predicting the future impacts of land use policies created by resource managers. However, the models used today can not sufficiently explain the interaction between the pattern change and the ecological processes, for concentrating either on formal growth of the city based on the simple mechanisms of spatial interaction and economic axioms, or on the effect of the spatial structure on the ecosystem processes. In this context, the urban systems should be understood in a comprehensive way and the models that will be used to develop sustainable land use strategies in these areas should integrate the landscape pattern and process and economic and cultural axioms. Moving from this necessity, the research aim to model the current trend of urban land use change in Ankara city (Turkey's second largest city) and and to determine the effect of this change on landscape processes, to establish the Sustainable Land Use Model by creating scenarios in line with different land use priorities. In the research, multi-time satellite imagery (1984-1992-2001-2010-2018) and biophysical, infrastructure and socio-economic variable sets that are effective in pattern change were modeled using multi-layer artificial neural network technique.

Keywords: Landscape pattern, Landscape Process, Urban growth models, Sustainable land use strategies, Landscape metrics

P0131

Effect of variation in habitat selection and gut passage time on seed dispersal in a fragmented landscape in Costa Rica

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Forest loss and fragmentation can affect plant populations indirectly if the behavioral response of seed dispersers affects seed dispersal rates. Variation in habitat selection and gut passage time within or between species might affect seed dispersal distance and, consequently, seed immigration and emigration rates. We assessed gut passage time and characterized the habitat selection and movement behavior of the main seed disperser of Heliconia tortuosa, Turdus grayii, by radio-tracking individuals in forest patches of different size and forest cover in a 1 km radius. Habitat selection analysis showed that there were T. grayi individuals which moved mainly in forested areas but others that moved in non-forested areas. Using this information, we modified the model parameters of habitat selection and gut passage time to simulate different behavioral responses of birds to habitat fragmentation and estimate seed dispersal in the landscape. We then estimated mean seed dispersal distance and immigration/emigration rates as a function of patch size and connectivity. We expect that mean seed dispersal distance will be higher in fragmented landscapes and with longer gut passage time, while immigration/emigration rates will increase when seed dispersers select for forested areas, have a longer gut passage time and/or when patch connectivity is high.

Keywords: forest loss and fragmentation, seed dispersal, habitat selection, gut passage time, movement analysis

P0141

Designing ecological networks using focal species: area-limited vs dispersal-limited species

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Focal species are generally used to design ecological networks in fragmented landscapes. Accordingly, area-limited species are usually used to define the minimum patch size, and dispersal-limited species are used to define the best patches' configuration within networks. As shortage of funds often forces to switch to a single-species approach, area-limited are frequently used as single focal species, but no study has been performed to test the best approach. We investigated if a network for an area-limited species (Capreolus capreolus) is actually more effective for the conservation of a dispersal-limited species (Muscardinus avellanarius), or if the opposite holds.

We designed ecological networks for both species in a fragmented agroecosystem by mapping suitable areas (species presence probability > 65%) in terms of habitat amount and connectivity. We overlapped the networks and calculated the proportion of the hazel dormouse network that overlaps the roe deer network and vice versa. We then calculated the proportion of patches of each network that was embedded into the network of the other species. We repeated all the analyses by considering a 1-km buffer (average of dispersal abilities of the two species) around the network of the focal species.

The roe deer network covered 45% of the hazel dormouse network and encompassed 17% of its patches, while the dormouse network covered 27% of the deer network and 17% of its patches. Conversely, the 1-km buffered deer network covered 69% of the dormouse network and 37% of its patches, while the 1-km buffered dormouse network covered 80% of the deer network and 69% of its patches.

Buffering ecological networks of focal species greatly increased their ability to cover suitable areas for other species. Through this approach, the dispersal-limited dormouse resulted a significantly better focal species compared to the area demanding deer, especially when the identification of the patches to be protected is the final goal.

Keywords: Habitat fragmentation, Landscape management, Indicator species

P0143

Effects of unplanned occupation and Brazilian legislation on Atlantic Forest conservation in an urban matrix

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Keywords: land use and cover change, landscape metrics, legal scenario, environmental law, urban sprawl

P0148

Characterizing patterns and drivers of seasonal elevational movement of birds using citizen science data

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Altitudinal migration is a common and important but understudied behavior in birds. Difficulty in characterizing avian altitudinal migration has prevented a comprehensive understanding of both patterns and drivers of this behavior. To address this, we investigated the altitudinal migration patterns and underlying mechanisms for a major proportion of an entire resident bird community on a subtropical island with an almost 4000 m elevational gradient. We characterized altitudinal migration patterns for 118 bird species based on the eBird dataset. We then built phylogeny-controlled regression models to investigate the associations between the birds' migration tendencies and eight of their traits to test four hypotheses on the mechanisms of altitudinal migration. Results showed a common but variable pattern among the birds. The species that have a narrower thermal tolerance range, can tolerate lower temperatures, have a smaller body size, have a more diverse or invertebrate-rich diet, or use an open nest had a higher post-breeding downhill migration tendency. In contrast, no traits examined showed consistent associations with the uphill migration tendency. This relatively comprehensive study generally supported all major previously proposed hypotheses, but also revealed patterns that are not apparent from conventional research approaches. The study also demonstrated the power of citizen science data to provide new insights into this behavior by characterizing the general patterns and mechanisms across a large number of species.

Keywords: altitudinal migration, citizen science, eBird, elevational gradient, functional traits

P0164

Improving water retention in urban setting by ecohydrological segmentation: case study from Czechia

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Recent challenges posed to highly urbanized environments by multiple effects of climate change (e.g., intensifying heat islands, droughts), flood impacts (both hydrodynamic and hydrostatic impacts of extreme floods) and overall ecosystem degradation call for integral spatial approach that would support urban planners in their decisions about land use and development, and that would reconcile planning agenda that is frequently fragmented among environmental, economic and social priorities. While such integrative approaches have been recently provided by concepts of water sensitive cities or ecosystem services, for instance, the implementation of these concepts may struggle due to lacking spatial base-sources in appropriate scales and with sufficient accuracy. In this poster, we present a novel procedure for delimitation of the ecohydrological microstructures in a medium-sized town in Norther Czechia. Multiple official data sources as well as data obtained from on-screen analyses of aerial images and field data were processed in GIS (geographical information systems) in order to define spatial microstructures assigned with values of infiltration, runoff, potential for water pollution and degree of anthropogenic modification to water streams (channels). In the next step, the microstructures suitable for specific types of measures supporting blue/green infrastructure are determined. Finally, we discuss eventual institutional barriers that may hamper implementation of the water retention measures in specific types of the urban setting.

Keywords: ecohydrology, urban planning, blue/green infrastructure

P0172

Does grizzly bear habitat quality reflect biodiversity and the provision of ecosystem services in western Canada?

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The wide-ranging grizzly bear has been viewed as a barometer for the health of the entire landscape and as a measure of sustainable land use practices in western Canada. We assessed associations between grizzly bear habitat quality, biodiversity, and the provision of ecosystem services (ES) across a range of spatial scales to determine if grizzly bear can be considered as an umbrella species for land use and conservation planning. Overall, we found a positive relationship between the grizzly bear habitat quality and total plant diversity and a negative relationship between the grizzly bear habitat quality and total bird diversity across different spatial scales. However, further assessment of the relative abundance of individual plant and bird species revealed different relationships (i.e., positive, negative or no relationship) with the grizzly bear habitat quality. These findings collectively demonstrate that grizzly bear habitat quality reflects plant and bird diversity to a certain extent depending on the nature of co-occurring species, and spatial scale considered. Also, we found a negative relationship between the grizzly bear habitat quality and the amount of N and P loaded into surface runoff water across different spatial scales. The grizzly bear habitat quality, therefore, reflects the provision of water purification ES at both small and large spatial scales. Nevertheless, the results of this study are sensitive to the set of ES and co-occurring plant and bird species studied. Given the habitat requirements and omnivorous nature of the grizzly bear, their habitat protection must benefit a broader range of ES and co-occurring species. Our approach can be used to quantify gains or losses of biodiversity and ES from management activities for grizzly bear and other locally identified umbrella species.

Keywords: Biodiversity gain and loss, Canadian Rocky Mountains , Conservation practices, Land use plannig, Umbrella species

Tourism Village as One Effort of Community-based Environmental Conservation Education

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This research was conducted in Bantaragung Village, Majalengka Regency, West Java Province, Indonesia, with the aim of preserving environmental-based local wisdom. The method used is Participatory Rural Appraisal (PRA). The village which is directly adjacent to the Ciremai Mountain National Park has local wisdom in protecting their environment. Local people manage rice fields using terracing systems to prevent erosion. The agroforestry system is also carried out by participating in the cultivation of several crops other than rice, namely durian, menteng, and banana. Areas that are included as national parks under the law are permitted to be managed by the community at 30%. The community with its awareness to manage the area becomes a natural tourist area that uses ecological or environmentally friendly principles. One of them uses natural material and comes from the local environment. The only problem that the community wants to solve is to restore the practice of organic rice cultivation which was forced to move because of the national green revolution program. The steps to solving the problems carried out include (1) conducting a history search, especially organic farming, (2) carrying out testing on organic farming, (3) socializing, and (4) developing organic agriculture agrotourism plans. The results obtained are that the community positively welcomes and has developed a plan for developing a tourism village based on environmental conservation education.

Keywords: Agroforestry, Agrotourism, Local wisdom, National Park, Organic farming

P0205

Cultural ecosystem services in an urban park: the case of Parco Nord (Milan) in integrating scientific research with management

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Urban green areas have great potential as a nature-based strategy to improve quality of life of people and cities resilience through the provision of ecosystem services. In this context, cultural ecosystem services (CES) are fundamental and engagement and support from civic groups in stewardship of green infrastructure are often based on perceptions of CES. A correct valuation of CES may help to meet both socially acceptable and ecologically functional sustainability goals. However, there are still many uncertainties associated with CES valuation and mapping because of their less tangible value in respect to other ES. In this study we integrated two different methods to assess and map CES in a urban park in Milan (Northern Italy). We used both PPGIS (Public Participatory GISS) involving citizens to describe their perception of CES provision in the park and data from social media. The results derived from the two methods of data collection were compared in order to evaluate differences and advantage/disadvantage of the methods discussed. Moreover, a combination of the two dataset is proposed in order to explore whether they can be combined in future data collections. Valuation of CES provision was made also by interviewing urban park managers, in order to map the park' management perception and compare it with citizen perception. Results show match and mismatches between CES provision perceptions among managers and citizens that can provide relevant insights for enhancing human well-being in urban areas.

Keywords: cultural ecosystem services, urban parks

P0223

Effect of landscape configuration on the community structure of waterbird in a conservation gradient of western south coast of Cuba

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In this study, we investigate the effect of landscape configuration on the structure of waterbird communities in coastal wetlands with a conservation gradient on southwest coast of Cuba and evaluate the contribution of landscape heterogeneity, pond spatial configuration, mangrove, rice field and anthropogenically modified habitat proportion to the waterbird diversity. We conducted waterbird surveys across 14 landscape units on southwest coast during fall migration (October-November) of 2016. Landscape structure was described with six indices at the scale of 6 km of buffers around the sample points. We used Generalized Linear Models-family negative binomial to test the effect of landscape indices in waterbird richness and abundance. Our results show that in a wide scale the size of mangrove fragments have an influenced in waterbird richness. Instead, a higher percentage of lagoons and salt marshes have a positive effect in waterbird abundance. The percentage of anthropogenically modified habitat in analyzed landscape varied from 0 to 40%, being mostly covered by cultivation areas. Under these levels of anthropization, at the evaluated scale, waterbird richness did not change, whereas there was a slight positive effect on waterbird abundance, which may be due to the use that some species make of crop fields for feeding.

Keywords: Generelized Lineal Model, Landscape structure, Spatial scale, Waterbird community, Wetlands coast

P0078

A comprehensive assessment of the aesthetic quality of urban riparian landscapes

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Ongoing urbanization has threatened green spaces and waterbodies, although there is increasing awareness that greenery and waterbody are critical for providing aesthetic benefits to city residents. To address landscape management issues, we developed a comprehensive framework to assess the aesthetic quality of urban greenery and waterbody, based on a four-level assessment system including general objective, components (vegetation and waterbody), landscape attributes (plant species diversity, landscape heterogeneity, landscape naturalness, river naturalness, water surface area, and water quality), and landscape biophysical features corresponding to each landscape attribute. Quantitative landscape metrics provided objective information on visual and spatial features and ecological implications, while qualitative surveys provided data on subjective aesthetic perceptions and preferences. The aesthetic quality of a landscape was measured by integrating objective and subjective aesthetics and coupling with implied ecological functions. In our case study for artificially restored riparian landscapes in Beijing, China, we observed that vegetation aesthetics measured by landscape metrics had a significantly positive relationship with perception-based aesthetic judgments. And, the estimated aesthetic vegetation and waterbody qualities were able to explain recreational activities within the vegetation buffer and at the riverside, respectively. These results thus validated the proposed landscape features and the reliability of the method. The results also showed that plan species diversity and landscape naturalness were better predictors than landscape heterogeneity, and holistic attributes were better than single features. The comprehensive framework is expected to supplement assessments of landscape aesthetic value and draw attention to the aesthetic services of urban greenery and waterbody. It can also be a tool for landscape planning and design to improve aesthetic value.

Keywords: Landscape attributes, Landscape biophysical features, Aesthetic preference and perception, Riparian vegetation aesthetics, River waterbody aesthetics

P0021

The expressing efficiency of landscape indices on mangrove heath status monitoring in Coastal mangrove wetlands

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Mangrove communities patterns were analyzed to identify their ecological significance through a quantitative analysis of mangrove community health and landscape pattern indices of several mangrove communities based on images from 1964 KH and 2010 SPOT5, with the help of remote-sensing classification, landscape pattern analysis and relevant statistical analyses, several mangrove wetlands were included in the study. Results show 1) the mangrove communities occur in zones ranging from the A.marina community along the coast in sequence inland with the A. corniculatum and K. candel communities and the R. stylosa community occurring in turn; 2) Leaf Area Index (LAI) of mangrove communities varied by the community type and increased along a gradient from ocean to land; 3) Patch Size Coefficient of Variance (PSCoV) and Number of Patches (NP) also increased along a gradient from ocean to land while Mean Shape Index (MSI) and Mean Patch Edge (MPE) exhibited an opposite trend with lower values found in the A. marina community and higher values in more inland regions with greater species richness; 4) Landscape pattern indices were correlated significantly with LAI, and the correlation coefficient ranged from negative to positive as follows: MPE > PSCoV > NP and MSI. The relationship between both of these was mainly affected by spatial differential features of each mangrove community. The author concluded that both time sequence and space sequence should be considered when evaluating mangrove landscapes, and certain landscape pattern indices of each species should be evaluated, rather than evaluating the entire mangrove community.

Keywords: Correlation,, Leaf Area Index (LAI), ,mangrove community health,, landscape pattern indices

P0176

The rural landscape of "Val di Non" (Trentino - Northern Italy): storytelling, images and design of places

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This research project was developed within the master's thesis in Architecture and Building Engineering at the University of Trento. The aim was to study in deep some critical issues that concern living in the rural region of "Val di Non" and to find intervention strategies through the design.
Since the end of Nineteen Century the valley has been interested by a lot of quick and radical changes that concerned the agricultural sector and the building fabric of villages. The entrance in the market economy can be seen in a double way: on the one hand it has brought well-being for the local population, overcoming the great poverty that affected the countryside; on the other it has caused an impoverishment of the territory, erasing pre-existing signs through a homogeneous and undifferentiated blanket made of apple trees. Agriculture has followed the industry model, introducing standardized methods and producing "machine plants", more and more forced to productivity. In this context pesticides appeared in the 50s, causing a clear separation between actions of inhabiting and cultivating. At the same time the growth of villages produced new edges that divide private residences from orchards.
Achieved a good economic stability in the present condition, is it possible to find a balance between agriculture and living? Can this relationship return to be dominated by local people? Follow up on these questions is necessary to keep alive the small villages of the valley and protect the health of residents.
The research presents a reflection about what rural landscape means and which role can the designer have in it. Starting from visible marks on the territory, integrated with historical knowledge, statistic data and conversations with residents, an intervention strategy is proposed, based on the model of agricultural park. It wants to trigger autonomous processes that have residents as protagonists. This model was applied to one of the villages analysed through a specific design.

Keywords: Agricultural landscape, Alpine landscape, Landscape design, Landscape and utopia, Future of small villages

P_0233

Evaluation the Role of Urban Green Spaces and Urban Open Spaces on decrease of Noise pollution: A landscape ecology approach

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It is accepted that noise pollution has a major impact on health, such as physical, physiological, psychological and performance related effects, all over the world. This study aims to evaluate the role of urban green spaces and urban open spaces on decrease of Noise pollution. For this purpose have been selected 86 point to measure noise pollution; the distance between two stations was 2 km.The sound pressure level in this points were measured and then the noise pollution map of the Mashhad city was drown. At the same time Landsat 8 images in 2019 were used to produce the land coverage maps. Composition and configuration of green space and open space patches were determined using FRAGSTATS software. Results showed there is a significant correlation between composition and configuration of urban green space and urban open space and noise pollution.

Keywords: Noise pollution, Landscape Ecology, Remote Sensing, Green space, Open space

P0056

Noise level and water availability drive resident and migratory bird species richness within a Brazilian megacity

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A growing number of studies across the globe are showing that urbanization presents novel challenges as well as opportunities to survival and reproduction for multiple organisms; nevertheless, the majority of such research has been conducted at north-temperate latitudes, such that little is currently known about such dynamics within tropical regions. We examined responses of migratory and resident birds to human disturbance and landscape attributes in São Paulo, a tropical megacity in South America. We established 31 survey points across the urban gradient and we quantified tree, lawn, and impervious surface cover, level of human disturbance, size of green areas, and proximity to water. We counted 142 bird species, of which 126 are resident and 16 are migratory species. The landscape attribute with the highest relative importance was noise level, which made up >99% of the model weight explaining resident species richness and >95% explaining migratory species richness. Distance to water was the second-best predictor of resident (>72%) and migratory species richness (>36%), and resident and migratory bird species richness declined in relation to both noise level and distance to water. In contrast, tree cover, lawn area, and human population size explained <16% of variation in species richness. Our results support previous research showing how urban avian community composition is related to specific environmental characteristics (e.g., to noise), as well as new insights into their relationship with other components of the urban landscape (e.g., water availability), offering novel avenues for future tropical urban ecology research.

Keywords: Neotropical, Urbanization, Atlantic Forest, South America, Urban Parks

P0067

Conceptual patterns of movement by birds between habitat patches in forest landscape

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Human activity altered forest landscape and produced mosaic forest. The distribution ranges of wildlife species are often fragmented into mosaics of habitat patches. Whether or not wildlife species are able to cross the boundaries of patches is crucial information for conservation of species diversity and performance their ecosystem function, such as seed dispersal. To advance understanding of bird behavioral abilities in fragmented landscapes, we constructed a conceptual framework for bird movement between patches based on previous studies. We also observed bird movement behavior between different forest types and evaluated this framework based on the observed behavior. Bird behavior around a patch boundary is divided into two steps: 1) detection of the boundary, and 2) decision to cross the boundary or stay in the current patch. Detection of boundary by birds is triggered by contrast, i.e., differences in vegetation structure between patches. Birds more readily detect boundaries when there is a high contrast between patches. Then birds decide to move into the adjacent patch or to remain within boundary depending on cost-benefit relationships of both behaviors, i.e., birds move into the adjacent patch when they can obtain higher benefit by moving. Observation results also showed similar behavior pattern to this framework. At a broad-leaved forest adjacent to a clearcutting site, some forest birds remained in the broad-leaved forest, but other birds often moved into the adjacent clearcutting site to eat tree fruits.

Keywords: patch boundary, bird movement, mosaic landscape

P_8185

Within-community beta-diversity of breeding birds driven by environmental factors

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Spatial environmental conditions have long been recognized as a key landscape characteristic for determining biodiversity distribution. Changes in the environmental factors may have profound impacts on the variation in species compositions among communities across space, i.e. beta-diversity. However, because the effects of environmental factors are usually scale-dependent, whether environmental factors can contribute to beta-diversity at fine scales, e.g., within a community, is still unclear. To fill this knowledge gap, we measured the compositional dissimilarity across sampling sites within each of ~120 breeding bird communities along environmental gradients across Taiwan. We calculated the multiple-site Sorensen index as a measure of overall beta-diversity for each community based on Taiwan Breeding Bird Survey data collected from 2009-2015. We then split the overall beta-diversity into two components, turnover and nestedness, to account for the contributions of species replacement and species loss/gain. The associations between the three measures of biodiversity and the environmental factors of climates, land-cover, and resources were investigated by regression models. Results showed that the overall within-community beta-diversity had a mean value of 0.5, but was not driven by any environmental factors. However, the contributions of turnover and nestedness to the overall beta-diversity were mainly driven by physical environments and resources, respectively, and showed an antagonistic relationship. These results imply that even with their good mobility, breeding birds are still driven by fine-scale environmental factors and associated biotic interactions that result in species replacement or species loss/gain. This study improves our understanding of patterns and important drivers of beta-diversity of breeding birds at a fine spatial scale.

Keywords: community assembly, nestedness, turnover, Taiwan Breeding Bird Survey

P_0185

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