European green urban areas: A landscape characterization and their regional differences

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Background: Plan des Berliner Tiergartens aus dem Jahre 1833
Introduction

• Increase of global population living un urban areas. In Europe 83% by 2050. (EC 2010)
• This concentration of population increases the demand for resources and changes the land use patterns.
• Drives the implementation of sustainability policies. Varying highly in between countries. (Gairarola and Noresah 2010 and Forman 2008)
• The Implementation/ improvement/ preservation of GUA: a major issue with different rates of success depending on the country or city. (Baycan-Levent et al. 2009)
• Every city can be considered an “individual” with its own history, population, location, culture, climate and economical structure. (Wittig et al. 2008)
At a regional level: similarities can be observed, due to cultural and geographical proximities. (Jordan 2005)
- Western, Eastern, Central, Southern, Northern, Mediterranean, Continental, Atlantic, Scandinavian, Baltic...

Therefore, **Can the European cities be differentiated or grouped according to the Green Urban Areas?**

- Create a methodology that allows the comparison between cities.
- Determine if there are differences in between the regions of Europe according to the GUA.
- Create an indicator that evaluates the cities according to the GUA.
Green infrastructure

Values / Services:
- Educational
- Enhance the movement and quality of air
- Illustrate the local succession processes
- Serve as limit to urbanization
- Protect special habitats
- Provide grounds for social integration
- Facilitate dispersal of species
- Provide food for humans and wildlife
- Provide quiet spaces for rare species
- Provide recreational spaces
- Provide resting place for migrating birds
- Serve as spaces with inspirational / spiritual value
- Provide therapeutic spaces
- Serve as visual barriers
- Reduce flood hazard
- Regulate temperature
- Retain storm water and intercept rainfall
- Support Biodiversity

THREATS:
- Reduction in situ.
- Reduction in number.
- Artificial design.
- Exclusion from planning process.
- the “green city” and the omission of ecologic efficiency elements in planning (amount, type, size, distribution and ability to provide ecosystem services)

<table>
<thead>
<tr>
<th>Types of green infrastructure (after Forman 2008)</th>
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<tbody>
<tr>
<td>Botanical Gardens</td>
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<tr>
<td>Brownfields</td>
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<tr>
<td>Cemeteries</td>
</tr>
<tr>
<td>Coastlines</td>
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<tr>
<td>Community gardens</td>
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<tr>
<td>Cultural sites</td>
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<tr>
<td>Empty lots</td>
</tr>
<tr>
<td>Golf Courses</td>
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<tr>
<td>Grasslands / Meadows</td>
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<tr>
<td>Green roofs</td>
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<tr>
<td>Green wedges</td>
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<tr>
<td>Greenbelts</td>
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<tr>
<td>Greenways</td>
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<tr>
<td>Hedgerows</td>
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<tr>
<td>Household gardens</td>
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</tbody>
</table>
Green urban areas

- Patches of green cover *integrated into the built-matrix* of the urban region.

- Geographically *limited by any official boundary of the city* and are directly or indirectly *available to the citizen* (Forman 2008; Rowntree 2008; Baycan-Levent et al. 2009)

- Part of the city identity.
  - *Tiergarten, Central Park, Hyde Park...*

- Enhance attractiveness for living, working, investment and tourism.

- Provide basic ecosystem services (Bolund and Hunhammar 1999; Baycan-Levent et al. 2009; Forman 2008; Rowntree 2008; Sandström et al. 2006)

- Origins: the gardens developed by Egyptian, Babylonian and Persian civilizations.

- Greeks and Romans: into European context

- Middle ages: “enclosed and Peasant gardens”, with horticultural and leisure purposes (Aben 1999).

- Early modern times: shift into scientific purposes -Botanical gardens-. 

- Industrial revolution: places for recreation available to the increasing population (Hough 2004).
  - Origin of the “city parks” in UK.
  - Further dispersal of the idea across Europe and the American continent.

- After the 19th century: recognized as one of the most important elements of urban planning, molded by concepts of aesthetics and architecture (Hough 2004).
Methods

• Based on the analysis of land use maps from cities listed on the “GMES Urban Atlas” database (European Environmental Agency 2010).
  – Land use classes according to the CORINE LC

• Uses the regional differentiation of Europe to divide the cities into groups with similar traits: Northern, Eastern, Southeastern, Southern, Central, and Western (Jordan 2005).

<table>
<thead>
<tr>
<th>Studied cities per region</th>
<th>Northern</th>
<th>Southeastern</th>
<th>Southern</th>
<th>Central</th>
<th>Western</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copenhagen (DK)</td>
<td>Bucharest (RO)</td>
<td>Barcelona (ES)</td>
<td>Budapest (HU)</td>
<td>Amsterdam (NL)</td>
<td></td>
</tr>
<tr>
<td>Jonköping (SE)</td>
<td>Larisa (GR)</td>
<td>Lisboa (PT)</td>
<td>Prague (CZ)</td>
<td>Brussels (BE)</td>
<td></td>
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<tr>
<td>Malmö (SE)</td>
<td>Nicosia (CY)</td>
<td>Florence (IT)</td>
<td>Köln (DE)</td>
<td>Nantes (FR)</td>
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<tr>
<td>Tampere (FI)</td>
<td>Varna (BG)</td>
<td>Montpellier (FR)</td>
<td>Vienna (AT)</td>
<td>Liverpool (UK)</td>
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<tr>
<td>Aarhus (DK)</td>
<td>Thessaloniki (GR)</td>
<td>Sevilla (ES)</td>
<td>Vilnius (LT)</td>
<td>Leicester (UK)</td>
<td></td>
</tr>
<tr>
<td>Helsinki (FI)</td>
<td>Sofia (BG)</td>
<td>Valletta (MT)</td>
<td>Warsaw (PL)</td>
<td>Bordeaux (FR)</td>
<td></td>
</tr>
</tbody>
</table>
Methods - The metrics

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>%CTL</td>
<td>Percentage of the class in the total landscape</td>
<td>Percentage of Green Urban areas in the urban region</td>
</tr>
<tr>
<td>CA</td>
<td>Class Area</td>
<td>sum of areas of all patches belonging to a given class (ha)</td>
</tr>
<tr>
<td>ED</td>
<td>Edge density</td>
<td>Amount of edge relative to the landscape area= TE/TLA (m/ha)</td>
</tr>
<tr>
<td>GApC</td>
<td>Green urban area per capita</td>
<td>m2/resident</td>
</tr>
<tr>
<td>NumP</td>
<td>Number of patches</td>
<td>Number of Patches for each land use class</td>
</tr>
<tr>
<td>PD</td>
<td>Patch density</td>
<td>Patches / km2</td>
</tr>
<tr>
<td>TE</td>
<td>Total edge</td>
<td>Perimeter of patches (meters)</td>
</tr>
</tbody>
</table>

1. Standardization of the data into new land use classes:
   - Agricultural Semi-natural and Wetlands,
   - Industrial, Public and Commercial areas
   - Residential Areas
   - Forests
   - Green urban areas
   - Roads and Railways
   - Water bodies

2. Calculation of metrics (at the class level) with Patch analyst.
3. Values not expressing variation were discarded.
4. Results given per city and region
5. These are the base for the creation of the city profiles and the indicator.
Methods – City profiles

• Land use maps
• Radar charts: graphic expression of the metrics that facilitate the identification of similar traits.
• Urban-rural gradient of green urban areas
Methods - Indicator

• From the necessity for a methodology that values the green areas by its characteristics and solves the problem of the “greener city” (Hall 2006).

• Basis: the metrics, that give a reference to the quantity and quality of the GUA.

• Replicable procedure, includes the description of a trend, provides integrative information and opens the possibility to give diagnostics about the GUA.
Results

**AMOUNT AND NUMBER OF GUA**

- Southern region: contradictory with the statement of Baycan-Levent *et al.*, (2009). That recognizes the southern European cities as the leaders in the availability of green areas. *(Inclusion of forests?)*

- In accordance with Fuller and Gaston (2009), that predict an increase of the proportion of green areas with the latitude, as an increase from east to west.

- Leontidou (1990) regarding the “planning culture” of the regions to the north and the spontaneity and individual reclamation of space for living to the south.
Results

**EDGE METRICS**

- Highest values in C, N and W.
- Indicates the presence of elongated shapes working as corridors, and improve the fluxes of energy and mater (Savard et al 2000).
- Higher “permeability” that implies a major contact with the surrounding urban elements. (Helzer and Jelinski 1999).
- Indication of the probability of encountering green space in the urban areas.
Results

GREEN AREA PER CAPITA
- Follows the predictions of Fuller and Gaston (2009), resembling a gradient that increases to the north or to the west. But not in accordance with the value of 1.94m$^2$ (Nilsson and Randrup (1997).
- Decrease in population density to the north (Kasanko 2006).
- World Health Organization: a minimum of 9m$^2$

PATCH DENSITY
- Measure of spatial heterogeneity and it gives an idea of the distance between patches and the accumulation of those belonging to the same class in a landscape (Forman and Godron 1981).
- Chances of encountering green urban areas increase in the Western region.
City profiles - Southeastern

GREEN URBAN AREAS AND OTHER LAND USES
Sofia - Bulgaria

Proportion of green urban areas in the gradient - Sofia

European green urban areas
City profiles - Southern

GREEN URBAN AREAS AND OTHER LAND USES
Barcelona - Spain

Proportion of green urban areas in the gradient - Barcelona

Land use classes:
- Agricultural, Seminatural areas and wetlands
- Industrial, Public and Commercial areas
- Urban areas
- Forests
- Green Urban Areas
- Roads and Railways
- Water Bodies

European green urban areas
City profiles - Central

GREEN URBAN AREAS AND OTHER LAND USES
Prague - Czech Republic

Proportion of green urban areas in the gradient - Prague

American green urban areas
City profiles - Northern

GREEN URBAN AREAS AND OTHER LAND USES
Copenhagen - Denmark

Proportion of green urban areas in the gradient - Copenhagen

European green urban areas
Indicator - Cities

• Related to areas in the radar charts. Increased area => higher value
• Cities with results different from the expectations for the region. Aarhus (-), Lisbon(+) and Barcelona(+).
• Liverpool(*), Copenhagen, Amsterdam, and Prague have the best ecological performance according to the amount, characteristics and distribution of green areas.
Indicator - Regions

- South and southeastern values still present the poorest performance.
- The regional differentiation is occurring but not in the expected pattern.
- Northern, Central and Western regions of Europe could be considered as single unit.
- The thesis of a Mediterranean region differing from the Eastern and Northern ones proposed by Leontidou (1990) is validated.

[Diagram showing regional indicators with values for SE, S, N, C, and W regions]
Conclusions

- A regional differentiation of the cities according to landscape characteristics of the GUA can be done.
- S and SE regions of Europe show the poorest performance. This contradicts the statements of Baycan-Levent et al. (2009).
- The use of the metrics is valid for the identification of individual characteristics. For a regional overview, the city profiles and the indicator are necessary to agglomerate and compare the information.
- The individual analysis of the metrics shows no predominance of any of the regions, but when grouped in the indicator, 3 different groups can be observed: S; SE; and N-C-W.
- The methodological problem: the comparison with other studies is obstructed by the variability in the approaches.
- The city selection must be done according to groups that represent similar attributes.
- The urban-rural gradients have proven to be a very interesting and alternative way of interpreting the differences between regions and cities.
- A better distribution of GUA can be explained by a constant values in the gradient.
- The N, W and C regions present either increased amounts of green areas and even values along the urban region.
- This analysis provided to be a practical way of evaluating the green infrastructure in urban areas.
Thank you for your attention!
References

- Aben, R., de Wit, S., 1999. The enclosed garden: history and development of the hortus conclusus and its reintroduction into the present-day urban landscape. 010 Publishers. Rotterdam

Online resources: