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Detecting and analyzing the spread of exotic *Acacia longifolia* in West-Mediterranean biodiverse costal dunes with hyperspectral images and LiDAR

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Introduction

Invasive plant species can have a high impact on ecosystems services, biodiversity and ecosystem functioning. Analysing impacts of invasive species requires distribution data on landscape scale. Combining high resolution hyperspectral and LiDAR (Light Detection and Ranging) remote sensing data is an innovative method to detect exotic plant species especially when they are invading the understory of forests. These data can deliver detailed information about the biochemistry of the canopy and about the vegetation structure for detection and impact assessment (e.g. Asner et al. 2008).

Aim of the Study

The Australian tree *Acacia longifolia* L. is an exotic invasive species in Mediterranean dune ecosystems. It alters ecosystem characteristics such as water and nutrient cycling, as well as vegetation structure in the open dunes and in the understorey of dune forests (Hellmann et al. 2011, Rascher et al. 2011a, b, Werner et al. 2010). Studies on stand level show that it is able to facilitate its invasion while having negative impacts on native ecosystems (Rascher et al. 2011a).

Our research objectives are:

I. Detection of exotic *A. longifolia* in the open dunes directly based on distinctive physiological and/or structural features via hyperspectral and LiDAR remote sensing

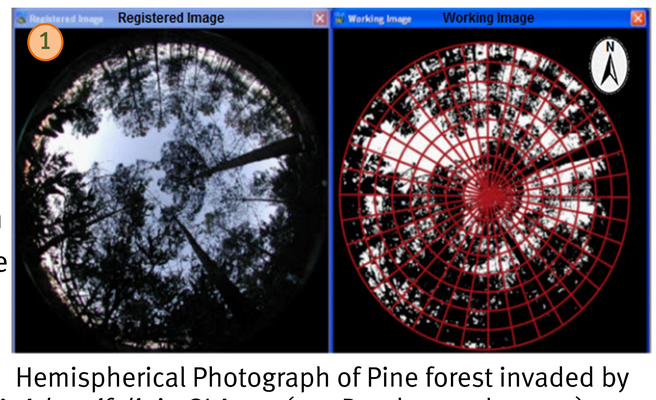
II. Detection of exotic *A. longifolia* in the understorey of dune forests indirectly based on its impact in nutrient cycling and vegetation structure via hyperspectral and LiDAR remote sensing

III. Upscaling the impact of *A. longifolia* from stand to landscape scale and determining the invasion potential on landscape scale.

Material & Methods

- **Study Area:** 5 x 35km coastal strip in SW-Portugal between Sínes and Pinheiro da Cruz
- **Habitat types:** Open dunes and dune forests
- **Flight campaign details:**
  - Operator: Natural Environment Research Council (NERC)
  - Hyperspectral AISA Eagle/Hawk sensor
    - Spectral resolution: 350-2400nm, 2.9 /8 nm
    - Spatial resolution: 0.75m / 1.7m
  - LiDAR Leica Geosystems ALS50-II
    - Average point density 4.5 points/m²
    - Average Point spacing 0.64m
    - Multiple Pulse in Air (MPiA), up to 4 returns
- **Ground truth field data:**
  1. Hemispherical Photographs analysed with Gap Light Analyzer 2.0 to estimate Transmitted Gap Light and Leaf Area Index (LAI)
  2. Mapping of vegetation structure and different *A. longifolia* stages of invasion with high accurate Trimble D-GPS
  3. Field spectral measurements with ASD Fieldspec 3 incl. „plant probe extension" of exotic and native species on leaf and plant level
  - Chemical analysis: Leaf Pigments, Tannin, C, N, δ13C, δ15N

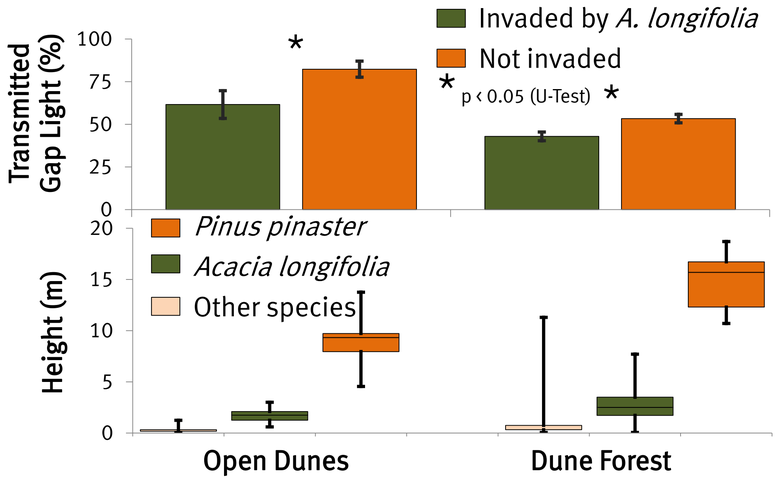
D-GPS mapping of *A.longifolia* in dune forest understorey



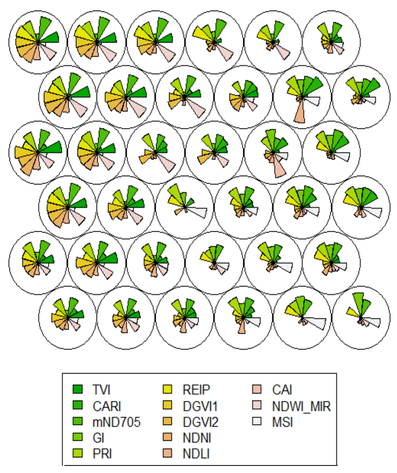
Hemispherical Photograph of Pine forest invaded by *A.longifolia* in GLA 2.0 (see Rascher et al. 2011a)

Ground Truthing of Remote Sensing Data

1 2 Impact of *Acacia longifolia* on Light Regime and Vegetation Structure in SW-Portugal (see Rascher et al. 2011a)



3 Identification of Plant Groups based on Biophysical Indices: Kohonen Self Organizing Map and Classification



	Acacia	Creeper	Dwarf shrub	Grass	Herbs	Mesotree	Conif.Tree
Acacia	**193**	0	15	6	1	0	4
Creeper	0	**21**	0	0	0	0	0
Dwarf shrub	2	0	**323**	0	0	2	10
Grass	1	0	1	**20**	1	0	0
Herbs	5	0	16	5	**14**	0	0
Mesotree	8	0	7	0	6	**8**	0
Conif.Tree	1	0	14	0	0	0	**101**

Test: 1200 Cohen's Kappa: 0.81
Training: 785 Percentage Correctly Classified: 87%

Outlook

(1) Spectral and Chemical Analysis: Spectral library of Mediterranean dune plant species (exotic and native) and their biochemical characteristics

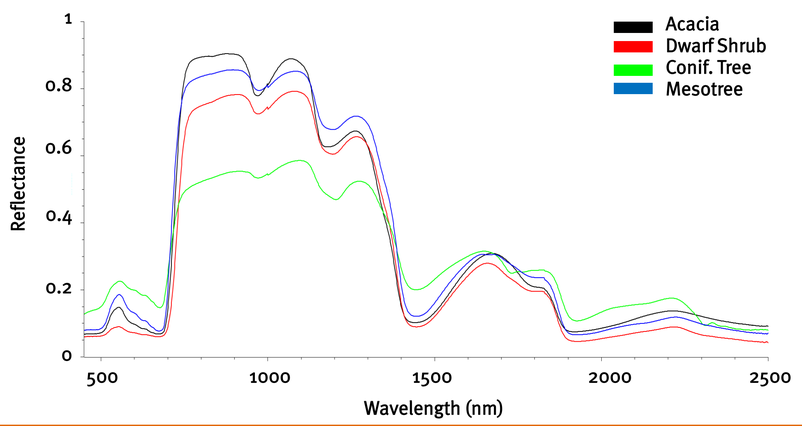
(2) LiDAR data and hemispherical Fotos: Digital Terrain Model (DTM), Digital Surface Model (DSM), Canopy Height Model (CHM), Canopy Gap Fraction, Leaf Area Index (LAI)

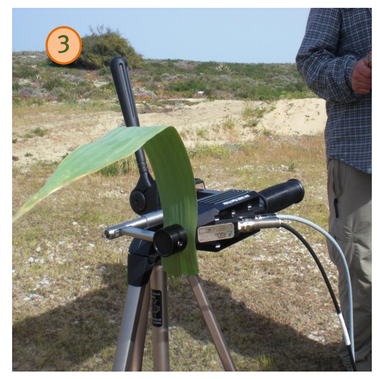
(3) Fusion of airborne and field data: Distinctive spectral, biochemical and structural features of native and exotic species

(4) Analysis of fused airborne and field data: Map of *Acacia longifolia* distribution

(5) Spatial Analysis of *Acacia longifolia* distribution: Characteristics of habitats invaded by *Acacia longifolia* and estimation of its invasion potential on landscape scale

3 Examples of field spectral measurements





ASD Fieldspec plant probe

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