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Classification Model Development: Using Remote Sensing to Monitor the Spread of Invasive Plant Species *Acacia Longifolia*

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Introduction

The invasive tree *Acacia longifolia* (A.) Willd. (Mimosaceae) strongly affects biogeochemical cycles of the native system and can have a negative impact on native and endemic species performance and on biodiversity, but most of the existing studies are limited to plot or stand level (e.g. Rascher et al. 2011a, b, 2012). A promising approach for analysing the impact and for upscaling the results from leaf to ecosystem scale is to use hyperspectral remote sensing. As baseline information, a robust classification model based on field spectral data and biochemical leaf properties is essential. In order to distinguish *A. longifolia* from other invasive and native species, leaf reflectance spectra (350-2500 nm) and tannin concentration were used to develop a robust classification model.

Aim of the Study

This study focuses on the following questions:

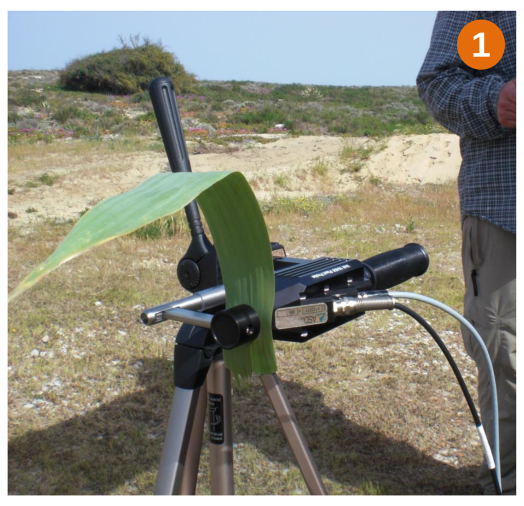
1. Can the measured tannin concentrations of *A. longifolia* be linked to the measured leaf reflectance spectra?

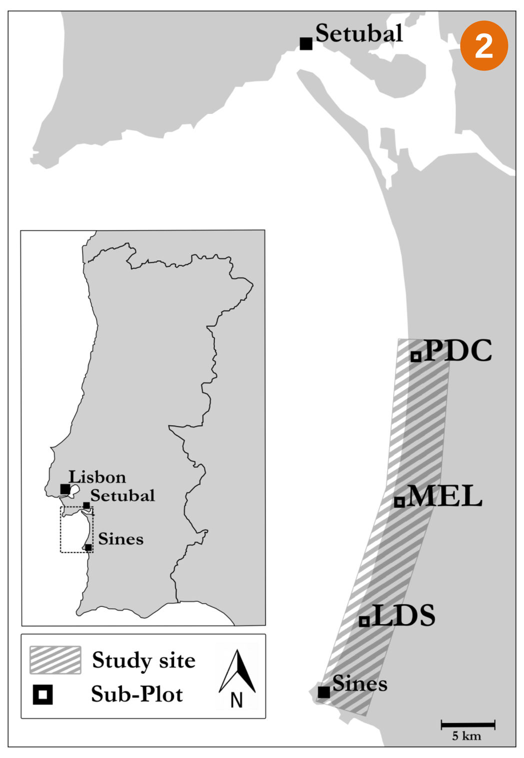
2. Can the identified tannin related wavelengths improve the accuracy of the classification model for *A. longifolia* on leaf scale?

Materials & Methods

In the field, an ASD FieldSpec FR Spectroradiometer attached to an ASD single leaf clip assembly (1) allowed to collect 750 in-situ leaf reflectance spectra of *A. longifolia* and six further characteristic dune species (*Acacia cyanophylla* (L.), *Corema album* (L.) D. Don, *Halimium halimifolium* (L.) Willk, *Juniperus phoenicea* subsp. *turbinata* (Guss.), *Pistacia lentiscus* (L.) and *Pinus pinaster* (L.)) at three sites (Pinheiro da Cruz (PDC), Melides (MEL) and Lagoa da Sancha (LDS)) in a study area of 15 km² in SW Portugal (2)(3).

Partial least square (PLS) regression was used to link the obtained leaf reflectance spectra of *A. longifolia* to their corresponding tannin concentration (4). Then, a spectral-based classification model of the different plant species was performed using linear discriminant analysis (LDA) combined with principal component analysis (PCA) including linear, quadratic and Mahalanobis distance.





Conclusion & Outlook

For up-scaling of our classification model on canopy or ecosystem level two models are suggested: either the range of 675-710 nm or the range of 1360-1450 nm in combination with linear distance algorithm. Since the range 675-710 nm is still within the UV/VIS region this model may be more robust for further up-scaling from sensors with a lower spectral range. Another advantage of this chosen wavelength region is the connection of its spectral features to the group of anthocyanins. In addition, the region is less sensitive to noise effects such as atmospheric differences and therefore may provide more reliable and robust data.

This classification model will be applied on canopy and ecosystem scale using airborne high-resolution hyperspectral remote sensing data. We will also implement more biochemical leaf properties such as carbon, nitrogen, and chlorophyll content for further classification and interpretation of our data.

Results & Discussion

1. PLS regression enables to link leaf reflectance spectra of *A. longifolia* successfully to their corresponding tannin concentration. Consequently, five wavelength regions (675-710 nm, 1060-1170 nm, 1360-1450 nm, 1630-1740 nm and 1840-1920 nm) being highly correlated with tannins, were identified. In particular, the wavelength region between 675 and 710 nm shows a high correlation to the tannin concentration of *A. longifolia*. As stated by Gitelson et al. (2001), the wavelength regions around 550 and 700 nm corresponded amongst others to group of anthocyanins, being a pre-stage of tannins, which confirmed the quality and performance of the PLS regression.

2. The tannin related wavelength regions improved the accuracy of classifying *A. longifolia*. The best prediction of LDA-PCA classification was achieved by using wavelength regions between 675 and 710 nm (92.9% *A. longifolia* correctly classified) and between 1350 and 1410 nm (100% *A. longifolia* correctly classified) with linear distance algorithm. In comparison, selecting the entire wavelength range (350-2500 nm), only 85% of *A. longifolia* were predicted correctly.

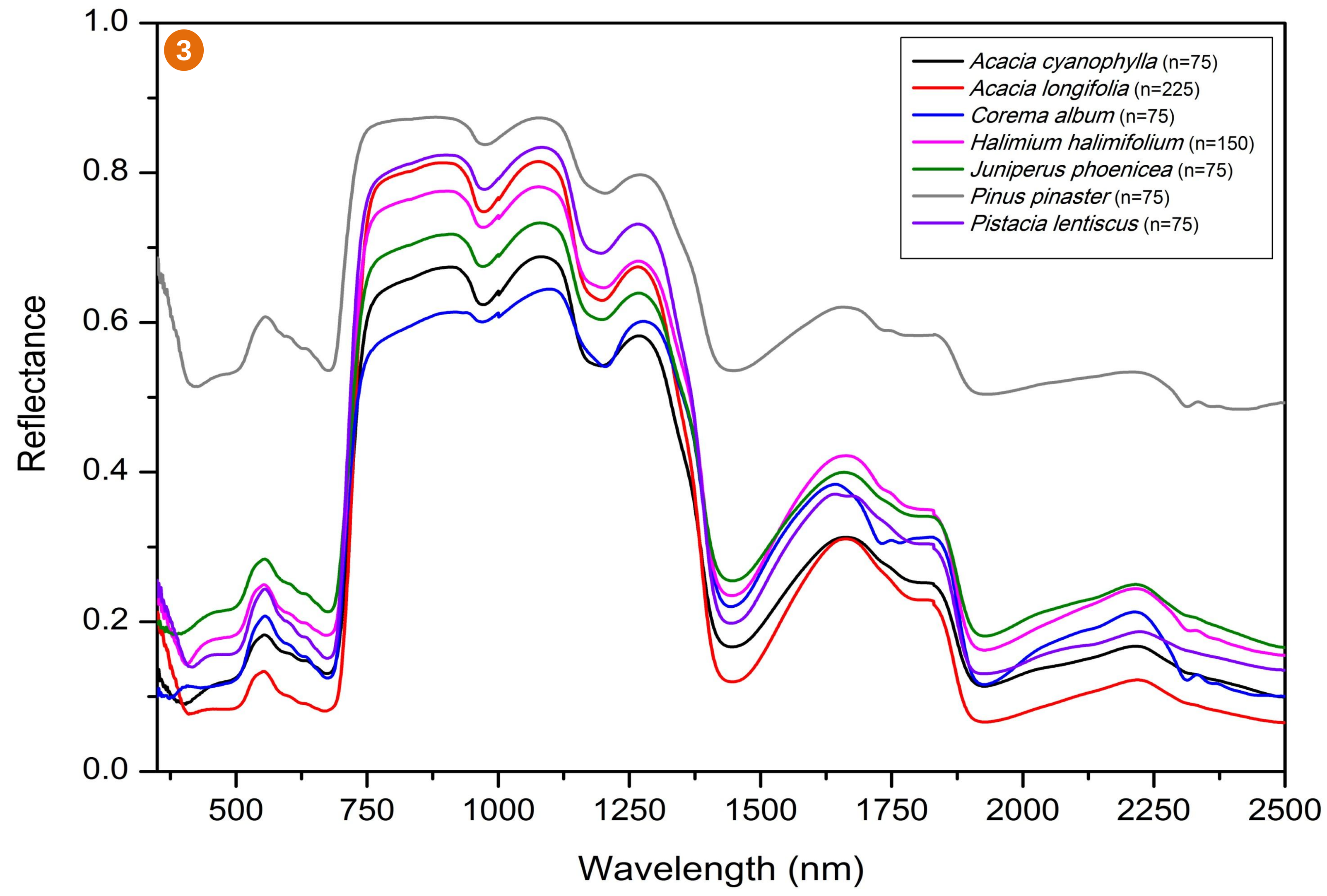


Figure 3: Mean leaf spectra of sampled plant species with an ASD FieldSpec FR Spectroradiometer attached to an ASD single leaf clip assembly.

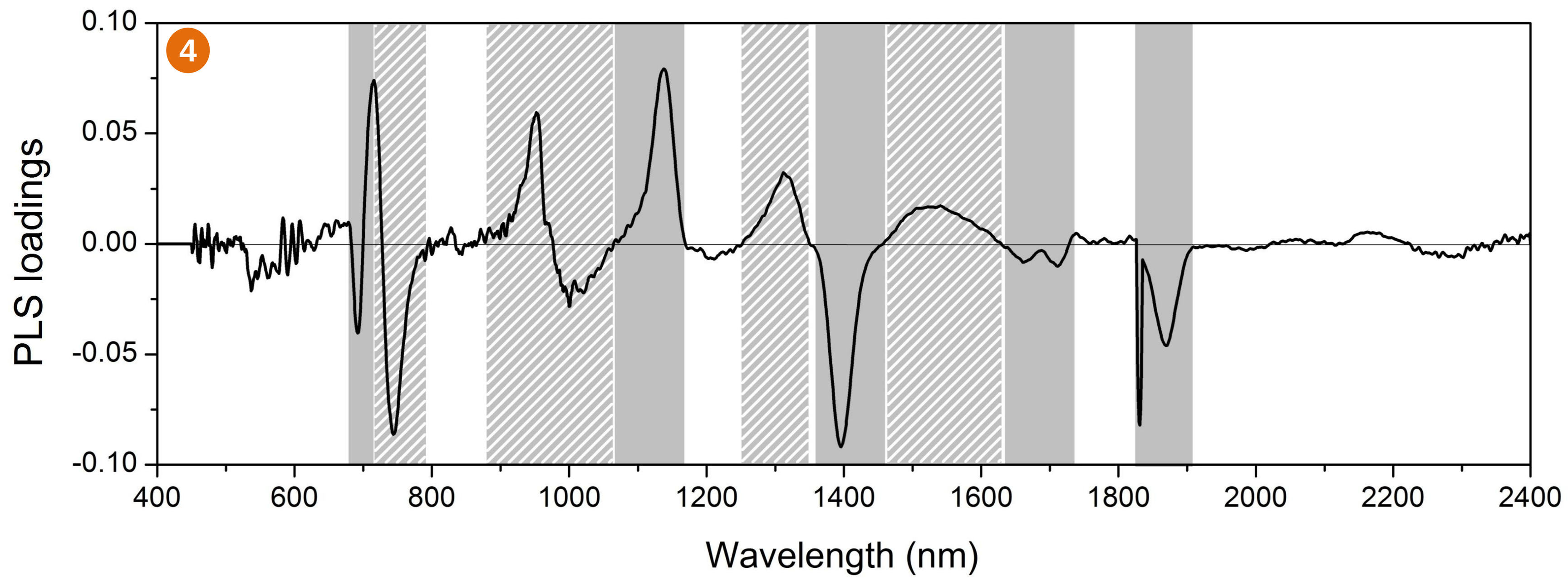


Figure 4: The wavelengths of great impact on the regression model are the ones strongly differing from zero (PLS loadings) and therefore are likely to be highly correlated. The importance of each identified region was tested by leaving out one region at a time. Regions of low impact on the calibration model were discarded for the classification model.

Selected wavelength regions for PCA-LDA

Wavelength regions showing low impact on the calibration model

References

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