SPECTRAL VARIABILITY WITHIN SPECIES AND ITS EFFECTS ON SAVANNA TREE SPECIES DISCRIMINATION

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Abstract

The ability to map vegetation to the species level is of wide interest in Ecology. Species-level maps of vegetation have important applications in resource inventories, biodiversity assessment, and fire hazard assessment. Species mapping with remote sensing is based on the assumption that each species has a unique spectral signature. Spectral signatures of vegetation vary according to biochemical content, physical structure of plant tissue and canopy architecture. However, vertical (along the canopy from top to bottom) and horizontal (from leaf burst to death) phenological profiles present important challenges to species differentiation. Other challenges include structural differences driven by factors such as bush fire, herbivory, disease infection etc.

In this study we examine the effect of within species spectral variability on species differentiation of seven savanna tree species in the Kruger National Park in South Africa. The research question is whether high within species spectral variability is a nuisance to species discrimination. Between seven to ten leaf spectra were measured for each species using the leaf probe of the ASD spectrometer (FieldSpec3 Pro FR, Analytical spectral Device, Inc, USA) in the 350-2500 nm range. The measurements were made on sunlit leaves collected from the middle of the tree canopy. The mean and standard deviation for each band were subsequently calculated. The degree of spectral similarity was measured using spectral angle mapper (SAM), which determines the degree of similarity between two spectra by treating the spectra as vectors in a space with dimensionality equal to the number of bands. SAM was calculated between species pairs using the mean spectra for the full spectrum (350-2500 nm), visible (350-700 nm), NIR (700-1300 nm) and SWIR (1300-2500 nm).

Smaller values represent a higher degree of similarity between two spectra of interest. The following mean standard deviations of the reflectance for all species were observed for the various spectral regions; full spectrum= 0.047, visible region = 0.023, NIR = 0.060 and SWIR = 0.048. The highest and lowest within species variability were observed for the NIR and visible region, respectively. The mean SAM values for twenty-one (21) pairs of species were; full spectrum= 0.129, visible region = 0.115, NIR = 0.024 and SWIR = 0.133, thus producing a negative correlation coefficient of 0.54 with the standard deviations. That is, the higher the within species standard deviation, the lower the inter-species SAMs. In other words, the higher the within species spectral variance, the lower the ability to discriminate between species. The NIR showed the lowest potential to discriminate between species.