SPECIES DISCRIMINATION OF AFRICAN SAVANNAH TREES AT LEAF LEVEL USING HYPERSPECTRAL REMOTE SENSING

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Introduction

The management of the Kruger National Park, South Africa has expressed the need to find cost-effective and rapid means to assess tree species diversity in the park. To do this, remote sensing is viewed as a cost-effective alternative to intensive field sampling. Therefore, there is a need to spectrally discriminate various tree species to understand their composition and distribution.

The assessment of species diversity using remote sensing necessitates to build a spectral library of tree species occurring in savannah ecosystems. Along with the development of the spectral library, there is a need to investigate how similar or dissimilar are savannah tree species. Leaf optical properties are determined by the species-specific leaf structure, concentration of chlorophyll and other biochemical constituents e.g. water content (Asner, 1998, Jacquemoud and Baret, 1990). Several studies have shown the capability of using leaf optical properties to separate grasses, shrubs and trees in various ecosystems, including the Mediterranean environment (Shobhan et al., 2007, Schmidt, 2001, 2004). Limited tree species libraries exist in the savannah ecosystem, particularly in the Kruger National Park.

This study was carried out to (1) develop a spectral library of dominant tree species in the Kruger National Park and (2) assess the utility of hyperspectral remote sensing in discriminating the dominant species in central part of the Park.

Material and Method

The study was conducted in the Kruger National Park, South Africa (Figure 1a). The park is located in both eastern part of the country, in the savannah ecosystem characterised by rich biodiversity (both wild vegetation and animals).

The spectral reflectances of seven common tree species (Combretum apiculatum, Combretum hereroense, Combretum zeyheri, Gymnosporia buxifolia, Gymnosporia senegalensis, Lonchorchocarpus capillariss, Terminalia sericeae) were measured using the ASD spectrometer (Analytical Spectral Radiometer (ASD) (350-2500 nm)). Ten (10) leaf reflectances were collected and averaged for each tree species. In addition, a variance of a mean spectra for each species was computed. Four similarity measures, namely, spectral correlation measure (SCM) (van der Meer and Bakker, 1997), spectral angle mapper (SAM) (Yuhas et al.,1992, Kruse et al., 1993), spectral information divergence (SID) (Chang 2003 and van der Meer, 2006) and a combination of SAM and SID (with either sin (SSS) or tan (SST)) (Du et al., 2003, 2004) were used to measure the similarities amongst species. A statistical approach was used to determine the performance of the various similarity measures, namely, relative spectral discriminatory probability (RSDPB) (Chang 2003, van der Meer, 2006). The higher the RSDPB, the better the discrimination capability of a particular spectral similarity measure. These similarity and discriminatory measures were applied to the whole spectrum, visible range, near infrared (NIR) range and short wave infra red (SWIR) range.

Conclusion

SAM outperformed other similarity measures in discriminating several species. This results differ with what Shobhan et al., (2007) and Du et al (2004) found. Though they were using completely different species, they concluded that SST and SID outperformed SAM. The difference might be attributed to the different locations, species and methods used in this study.

Whole spectrum outperformed other wavelength regions in discriminating several tree species using SAM specifically. Second best wavelength region to discriminate considered tree species is SWIR.

In Combretum species, C. apiculatum is completely different from the reflectance of both C. hereroense and C. zeyheri using all, NIR and SWIR bands. This shows a high intra-species variability (at genus level). While Gymnosporia species are similar in visible and dissimilar in whole spectrum, NIR and SWIR bands. L. capassia and T. sericea were generally separated from C. apiculatum and G. senegalensis (Figure 2)

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