FRACTIONAL COVER AND STRUCTURAL VARIATIONS ALONG A LAND USE DEGRADATION GRADIENT IN SAVANNAS IN AND AROUND THE KRUGER NATIONAL PARK, SOUTH AFRICA

R Mathieu[1], K Wessels[2], G Asner[3], D. Knapp[3], J. van Aardt[4], M Cho[1], B. Erasmus[5], I. Smit[6]

[1]CSIR Natural Resource and the Environment, Pretoria, South Africa
[2]CSIR Meraka Institute, Pretoria, South Africa
[3]Department of Global Ecology, Stanford University, Stanford, CA, USA
[4]Centre for Imaging Science, Rochester Institute of Technology, Rochester, NY, USA
[5]School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Johannesburg, South Africa
[6]Kruger National Park Scientific Services, Skukuza, South Africa

ABSTRACT

Land degradation is one of the most significant environmental problems in the semi-arid and arid savannas of Southern Africa. Degradation affects vegetation structure, cover and patchiness and this result in the loss of vegetation resources used by rural populations (grazing, fuel wood, and other non-timber forest products) and wildlife. Land degradation processes are influenced by rainfall, land management, soil properties and topographic effects (through slope redistribution of water and nutrients). These aspects control the type and distribution of vegetation cover types and biological materials on the land surface. Our primary goal was to quantify variations in the vegetation fractional cover and structure along a land use degradation gradient ranging from conservation in the Kruger National Park (South Africa) to communal rangelands, using detailed airborne hyperspectral and discrete return LiDAR data. High resolution (1 meter) airborne high-fidelity hyperspectral imagery (visible – NIR) and LiDAR data were collected using the state of the art Carnegie Airborne Observatory (CAO) instrument (Asner) in April-May 2008. The sampling design considered variations in land use management types, geological substrates (nutrient-poor granite and nutrient-rich gabbro), and topographical positions (hill crest and valley bottom). Management types ranged from moderate use by wildlife in the Kruger National Park to heavier use by wildlife in adjacent private reserves (Sabi Sands Game Reserve), and light, medium, and heavy use by people and livestock in the rural areas, Bushbuck Ridge. The latter areas are widely regarded to be degraded following their historical status as communal lands of the formerly segregated "homelands" which are characterized by densely settled, poor rural communities, mostly as a result of forced resettlement. Studies suggest that these communal rangelands also exhibit a consistent long-term reduction in vegetation production per unit rainfall.

Spectral unmixing of the hyperspectral imagery provided sub-pixel fractional cover (percent cover relative to pixel) for green or photosynthetic vegetation (PV), senescent or non-photosynthetic vegetation (NPV), and bare soil (BS) [1]. Concurrent discrete LiDAR data were used to quantify the fractional cover according to three structural classes: grass and bare ground (<0.5 m), shrub (0.5 - 4m), and trees (>4m). The analysis of fractional cover was carried out considering two scales: i) at plot level based on 36 50x50m plots sampled in the field and ii) at landscape level using the CAO imagery collected along the degradation transect. The former scale supported the calibration of the relationship between ground and imagery variables, in particular the fractional cover using field-based measurements of woody vegetation cover, grass cover and biomass, as well as bare ground cover. The latter scale was analyzed to quantify variations in fractional cover and spatial patterns of vegetation in relation to different land use management strategies and edaphic factors. The variation of cover fractions with distance from rural settlements (potential surrogate of land use intensity) was investigated in the context of changing topographic and geological settings. Preliminary results indicate a higher fractional cover of bare soil in the rangelands close to the settlements, but little difference in fractional covers between conservation areas and communal rangelands at increasing distances from the settlements.

REFERENCES

[1] A.T. Harris and G.P. Asner, "Grazing gradient detection with airborne imaging spectroscopy on a semi-arid rangeland", Journal of Arid Environment, vol. 55, pp. 391-404, 2003.