# THREE-DIMENSIONAL WOODY VEGETATION STRUCTURE ACROSS LAND-USE INTENSITIES IN A SEMI-ARID SAVANNA

Jolene Fisher[a,b], Barend Erasmus[a], Ed Witkowski[a], Jan van Aardt[c],Greg Asner[d], Ty Kennedy-Bowdoin[d], Dave Knapp[d], Ruth Emerson[d], James Jacobson[d], Renaud Mathieu [b] and Konrad Wessels [b]

[a] School of Animal, Plant and Environmental Science, University of the Witwatersrand
[b] Natural Resources in the Environment, Council for Scientific and Industrial Research
[c] Laboratory for Imaging Algorithms and Systems, Rochester Institute of Technology
[d] Carnegie Airborne Observatory, Department of Global Ecology, Carnegie Institution for Science
(jolenefisher@gmail.com, Barend.Erasmus@wits.ac.za, Ed.Witkowski@wits.ac.za, vanaardt@cis.rit.edu, gpa@stanford.edu, tbowdoin@stanford.edu, dknapp@standford.edu, remerson@stanford.edu, jjacobson@stanford.edu, RMathieu@csir.co.za, kwessels@csir.co.za)

Unsustainable resource use and the associated land degradation is a key problem in sub-Saharan Africa, especially in rural communities where the members are very reliant on ecosystem goods and services. Land degradation refers to a reduced capacity of the ecosystem to deliver ecosystem goods and services including habitat for wildlife, sufficient grazing and wood for fuel or construction. Land degradation is the result of a number of processes which may operate independently or in conjunction with one another. Some of the processes that result in the loss of function are a reduction in herbaceous cover and –production due to overgrazing, soil erosion, bush encroachment and fuelwood removal, which are all related to the vegetation structure in the landscape. A land-use intensity (heavily utilised and lightly utilized communal rangeland) and –type (national protected area, private game reserve and communal rangelands) gradient across different geological substrates (gabbro- and granite-based soils) for different landscape positions (crests and valleys) in the Lowveld of Mpumalanga, South Africa, provide a case study for the synergistic effects of different drivers of degradation.

The Carnegie Airborne Observatory (CAO) 'Alpha systems" (integrated imagery spectroscopy and LiDAR remote sensing) was flown in South Africa for the first time in April 2008 giving scientists the opportunity to study three-dimensional vegetation structure across the landscape at high resolutions (both horizontal and vertical). The imaging spectroscopy data was collected at resolutions of 0.56 m and 1.12 m, whilst the laser pulse repetition frequency of the LiDAR instrument was 50

kHz for the low resolution and 70 kHz for the high resolution imagery. Studies using the CAO data will be at the cutting edge as such high quality data has not been previously collected in savannas. The land-use intensity gradient further provides an interesting comparison to the usual factors studied affecting vegetation structure such as herbivory, fire and climate.

The low resolution LiDAR data were used to investigate the differences in three-dimensional (3-D) woody vegetation structure across land-use types (communal grazing land and conservation areas), land-use intensities, geologies and landscape positions (crest and lowland). Ground truthing of data was conducted in April 2008 when the remotely sensed data were collected. A canopy height model (CHP) was constructed by subtracting the digital elevation model (DEM) from the digital surface model (DSM). The proportion of laser pulse returns were calculated for 5mx5mx1m voxels, and the resulting frequency distributions across different height classes were used to assess the differences in 3-D vegetation structure across the landscape. Kolmogorov Smirnov tests were used to test the statistical differences between frequency distributions of the laser pulse returns from the vegetation at the predetermined height class intervals across the landscape. Initial results show land-use intensity to be a large contributing factor impacting vegetation structure at fine scales. Using the multifactorial experimental design, we investigate the scales at which the different drivers of vegetation structure, and potentially, degradation, operate. These results are discussed in the context of our knowledge of savanna structure and function, with particular reference to 3-D vegetation heterogeneity. Such an improved understanding of the factors affecting savanna vegetation structure has significant implications for sustainability studies on fuelwood harvesting in the region.