WOODY COVER AND HETEROGENEITY IN THE SAVANNAS OF THE KRUGER NATIONAL PARK, SOUTH AFRICA

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Abstract

The woody vegetation of the Kruger National Park varies greatly in species composition, biomass and cover at regional scales. This variability is associated primarily with broad-scale geological and climatic variations. At landscape scales woody density and cover are highly variable, associated with event-driven woody establishment and mortality processes, and spatially and temporally discontinuous disturbances related to fire, grazers, browsers (particularly elephants), and other disturbances. Tree and/or shrub cover is a defining characteristic of savannas, with direct and cascading affects across multiple taxa on biodiversity, productivity and biogeochemistry, and interactions with fire frequency and intensity, herbivore density and consumption, and carnivore dynamics.

The spatial and temporal variability of woody cover is significant for Park managers in support of priorities relating to maintenance of biodiversity, ecosystem resilience, heterogeneity and sustainable tourism. In particular, because of the links between structural and biotic heterogeneity and the maintenance of biodiversity and ecosystem resilience, 'heterogeneity' has been adopted by Kruger National Park authorities as one of the major goals and benchmarks for Park management practices.

In this paper, we present research combining field measurements, optical and radar remote sensing to map woody cover across the whole of the Kruger Park at medium resolution (90 m). We use field data on woody canopy cover from 73 field sites to develop multiple regression relationships between Landsat ETM+ and JERS-1 data and measured woody cover. We use the relationships developed at the field sites to estimate woody cover over the whole Park. The best predictive model was selected among models containing all the possible variable combinations using the Akaike information criterion (AIC). The JERS-1 radar backscatter (HH L-band) and the ETM+ green band reflectance resulted the two most important variables in the predictive model. The set of significant variables also included Landsat band 5 (Near Infrared), the Soil Adjusted Vegetation Index (SAVI) and the third principal component retrieved from the Landsat bands. We explore relationships between the mapped woody cover, species composition, climate, fire, herbivory and other potentially influential variables applying regression tree analysis. We found that the east-west division between basalt and granite parent materials explained the largest difference in woody density in the Park with granite rocks supporting in general higher woody cover than basalt rocks. Within each of these two zones, different sets of ecological and environmental variables appear to be correlated with the variability in woody cover. The basalt open savannas appear to be related to fire frequency and MAP. Higher fire frequencies and lower MAP are associated with lower woody cover. The woody vegetation on the granite appears to be controlled by MAP, elevation and herbivory. Higher woody cover tends to be associated with higher MAP, lower elevations and lower elephant densities. The northern topographic area with only ~400 mm MAP stands out as a separate granitic area for its relatively high woody cover Despite corrections applied to the radar imagery, we think that some residual effect from surface roughness and topography gives rise to an enhanced backscatter and to some level of overestimation in woody vegetation.

Our work also provides a product that quantifies the spatial heterogeneity in woody cover. A heterogeneity map is calculated using the standard deviation of woody cover percent within 1-km cells. This map is an exploratory tool for managers and ecologists involved in planning strategies that maintain structural and biotic heterogeneity in the Kruger Park. The underlying idea is that agents such as fire or herbivory not only act on and react to the average amount of woody plants present in a certain area but also to the variability in plant spatial distribution within that area. The combination of the woody cover percent map and the woody cover heterogeneity map provides a more comprehensive and quantitative description of woody vegetation patterns in the Park.