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The relative influences of gradients in rainfall and landscape position on woody vegetation composition and structure in communal rangelands in Bushbuckridge, Mpumalanga province

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ABSTRACT

Over one-third of South Africa's surface area is covered by savanna woodlands. The structure and dynamics of savannas within communal rangelands have not only been formed by environmental determinants (rainfall and soil) but have also been influenced and manipulated by anthropogenic disturbances (fire, herbivory by livestock, harvesting of resources and cultivation). The aim of this study was to determine the individual and interactive influences of rainfall and catenal position on woody vegetation composition and structure in human-impacted woodlands of Bushbuckridge, Mpumalanga Province, from 2011 to 2013. Three zones were selected that differed in mean annual rainfall: (a) wet west (>700mm), (b) mesic (600-700mm), and semi-dry east (<600m), with three villages per zone. For the rangeland of each village, plots were sampled in 2011, 2012 and 2013 to cover the upland and bottomland variations in catenal position. All trees >6m in height, and their individual stems, were counted and measured within a total of 56 circular plots (only 28 in 2011) each with a radius of 50m. Trees <6m, and their stems, were counted and measured in a circular plot with a radius of 6m, nested centrally within each 50m plot. All analyses were undertaken on (a) total trees and stems and (b) recently harvested (within the last 12 month) trees and stems.

The density of small trees (<6m in height) was significantly higher than that of large trees (>6m in height) from 2011 to 2013. Trees and stems were more abundant in the smaller height and diameter classes, respectively, indicating stable populations. The densities of stems for large trees did not show any change over time, whereas the densities of small trees decreased from 2011 to 2013. When comparing across time between rainfall zones, the densities were higher in the high rainfall zone than in the low and medium rainfall zones for each survey year. On the other hand, densities were similar between uplands and bottomlands for each survey year. The intensity of harvesting increased for large trees over time (between 0% in 2011, 2.3% in 2012 and 10.6% in 2013), whereas small trees did not show any change over time. The most harvested trees were between 0.6-4m in height and 1.1-10cm in stem diameter. There were however some signs that harvesting in the larger size classes (>6m in height and >20cm diameter) were increasing over time. The highest proportion of trees was harvested in the medium rainfall zone compared to the other two rainfall zones, but there was similar harvesting intensity between uplands and bottomlands.

Overall species richness, Shannon and Simpson's (Diversity), and Evenness at the plot level did not change for either large or small trees from 2011 to 2013. The species richness and Shannon's diversity was higher in the high rainfall zone than in the other two rainfall zones, whereas there was no difference in species richness, diversity or evenness between catenal positions for either large or small trees over time. Because there are similar patterns between the species accumulation and rarefaction curves for both the large and small trees, species are distributed at random across the plots, and this is consistent for the three survey years. The most abundance large tree species were *Sclerocarya birrea* > *Philenoptera violacea* > *Pterocarpus angolensis*, which were very different from the most abundant small tree species that were dominated by *Dichrostachys cinerea, Terminalia sericea, Acacia exuvialis, Strychnos madagascariensis* and *Combretum hereroense*. A greater species richness, diversity and evenness of harvested trees were observed in 2013 compared to 2011 and 2012. Species that were most harvested for large trees comprised *Combretum collinum*, *Acacia gerrardii*, *T. sericea*, *Acacia robusta, Combretum zeyheri* and *S. birrea,* whereas harvested small trees comprised *D. cinerea, T. sericea, A. exuvialis* and *C. hereroense*. Even though there were no differences in density, structure, species richness, diversity or harvesting intensity, the species composition did however differ between the uplands and bottomlands. The bottomlands had more abundant fine-leaved species (e.g. *Acacia* spp. and *Dichrostachys cinerea*) and the uplands had more abundant broad-leaved species (particularly *Combretum* spp.). There was a greater difference in species composition in the high rainfall zone relative to the low and medium rainfall zones. This difference in species composition was consistent with the findings that the high rainfall zone had higher density, and a taller, single stemmed tree structure, as well as species richness and diversity when compared to the low and medium rainfall zones. Harvesting intensity was higher in the bottomlands than in the uplands and also higher in the low and medium rainfall zones than in the high rainfall zone. Recent harvesting appeared to have had less influence on species composition than catenal position or rainfall zone.

The harvesting of these resources has an impact on both human livelihoods and the ecosystem and must therefore occur in a sustainable way. When the rate of wood production is less than or equal to the rate of wood harvesting, harvesting can be defined as sustainable. The rate of fuelwood harvesting is driven by the demand for the resource, which in most cases is driven by local human population size. With the increase in human population size over time, and the scarcity of fuelwood from the surrounding rangelands, the existence of

fuelwood markets is fast becoming a part of daily life as it ensures fuelwood for daily usage such as cooking. For this reason, long-term monitoring is needed. Long-term monitoring will not only allow for better future management of natural resources, but it also allows for the communities to get involved in protecting the resources which are so vital to a vast number of people for daily living. Future studies analysing the data from these plots over longer time periods will provide a better understanding of the role that environmental and anthropogenic determinants play in the changes observed over time in the woody vegetation.