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The Impact of Management Systems on Bush Encroachment and Soil Properties in Savannahs of South Africa

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Abstract

Extensive bush encroachment by *Acacia mellifera* and associated woody species are the most notable form of rangeland degradation in savannahs of South Africa. Grazing and different rangeland management systems (communal and freehold) are considered to be of major importance for degradation. A vegetation change is mostly accompanied by changes in soil properties, where soils in savannah systems can profit from woody species due to litter fall, root distribution, shadow and animal resting time. We hypothesised that spatial patterns of soil properties in South Africa's rangelands are controlled by vegetation and modulated by tenure systems with higher rangeland degradation in communal areas. To test this, we sampled soils at communal and commercial land in the Kuruman area of South Africa with the following design: three farms per tenure system, 6 randomly chosen plots (100×100 m) per farm, and 25 soil samples (0–10 cm) per plot, each in a 5×5 m sampling area. At every sampling point, information of overlying vegetation was recorded. For each plot, high resolution UAV aerial photos were taken to evaluate the extent of bush encroachment. Analyses involved main physical and chemical soil parameters and isotopic analyses. The results of aerial image classification (grass, woody species, bare ground) revealed significant with higher coverage of bare ground and shrubs at communal farms, and higher grass cover at commercial farms. The tenure systems had no differences in main texture classes of the soils, but significant differences in the composition of the sand fraction, with higher levels of fine sand and lower levels of coarse sand in communal farms. The chemical soil properties showed a high variability both within and between the farms, with much higher variability within communal than commercial farms. Additionally, concentrations of nitrogen, carbon, calcium and pH were significant higher in communal farms.. Different photosynthetic pathways are responsible for differences found in ^{13}C values, with higher levels (-13‰) in C4-grassland and lower values (-22–26‰) in soils under *Acacia* (C3). We found relationships between soil properties and species or bare ground, where differences in texture likely interact with both, vegetation cover and soil properties.

Keywords: Bush encroachment, rangeland management, soil carbon, soil texture

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