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

A. Sandhage-Hofmann[1a], E. Kotzé[2], C.C. du Preez[2], J. Löffler[1b], D. Wundram[1b], W. Amelung[1a]

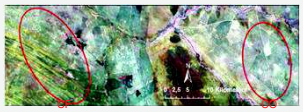
Background and Objectives

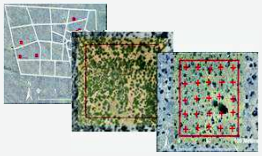
Subtropical rangelands are increasingly threatened by bush encroachment, which may be among others related to management The aim of the present study was to evaluate the impact of rotational and continuous grazing management on soil properties in the savanna system on farm level. We hypothesized

- that bush encroachment is more pronounced in continuously grazing systems than in rotational ones, that
- this process improves soil nutrient status and organic matter, but
- alters the spatial heterogeneity of soil chemical properties.

Materials and Methods

- 2 tenure systems
  - rotational (**RG**)
  - continuous (**CG**)
- 3 farms per system
- 6 random plots a 100x100m





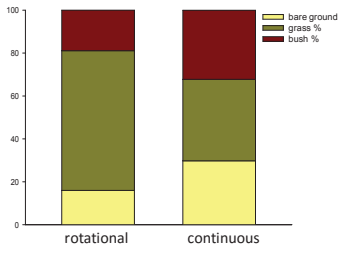
- Land cover classification based on octocopter flights
- 5x5 sampling sites
- Vegetation survey
- Soil sampling (0-10 cm) & analyses Texture, pH, CEC, C, N, δ^{13}C, δ^{15}N

Tab. 1: Main soil properties

	commercial		communal	
pH	5,9	0,3	6,3	0,4
clay	3,3	0,4	3,2	0,4
silt	2,9	0,8	3,3	0,8
sand	94,6	1,1	94,3	1,3

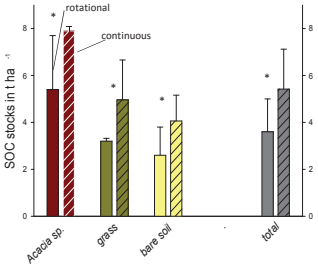
Results - Bush encroachment and soil organic carbon

Land cover (%)

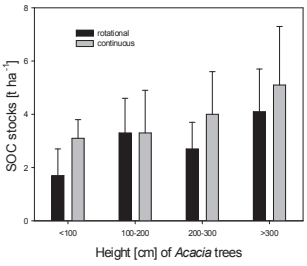


Significant ($p<0.05$) differences in land cover between tenure systems.

Soil organic carbon (topsoil)

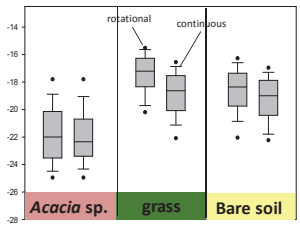


Carbon stocks depend on aboveground vegetation. Carbon stocks in CG significant higher.



Carbon stocks depend on tree height.

δ ^{13}C ‰ in topsoils



Significant higher δ ^{13}C values in RG indicating more grassy vegetation.

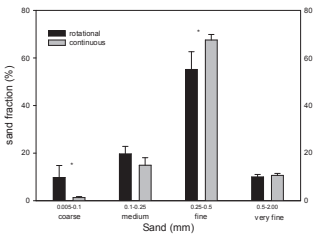
C_3 derived carbon (%)

rotational	con-tinuous
48,5 (± 13)	59,9 (± 13)
28,2 (± 9)	37,8 (± 11)
36,9 (± 12)	40,8 (± 9)

C3 derived C in CG indicate a shift to bushy vegetation ([1])

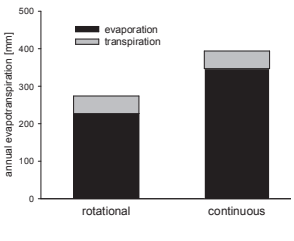
Results - Texture and Evaporation

Sand fractions (%)



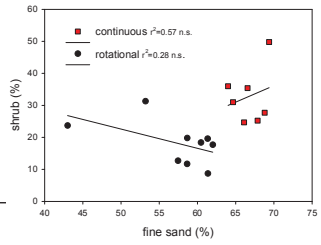
Significant ($p<0.01$) differences in fine and coarse sand fractions

Evaporation (mm)



Higher evaporation in continuously grazed system

Shrub vs. fine sand



No relationship between fine sand fraction and shrub cover

The interaction between <u>environmental</u> factors like soil and <u>management</u> factors like grazing might lead to self-sustaining spiral of bush encroachment in the continuous grazing systems.

Conclusions

Bush encroachment is a major threat in the savanna biome of South Africa. The results confirmed advanced bush encroachment in continuously grazed systems, which went along with an enrichment of organic matter and major nutrients by up to a factor of 1.5. Isotopic analyses identified woody C3 vegetation debris as main C input to soil patches. Among the management systems, differences in sand fractions were detected and hydrological modelling indicated an increasing vulnerability to dryness in continuously grazed systems. Particle-size distribution must be considered as an important co-variate affecting bush encroachment.

Sandhage-Hofmann, A., Kotzé, E., Van Delden, L., Dominiak, M., Fouché, H.J., Van der Westhuizen, H.C., Oomen, R.J., Du Preez, C.C., Amelung, W., 2015. Rangeland management effects on soil properties in the savanna biome, South Africa: A case study along grazing gradients in communal and commercial farms. Journal of Arid Environments 120, 14-25.

1a Institut für Nutzpflanzenwissenschaften und Ressourcenschutz (INRES) – Bodenwissenschaften und Bodenökologie, sandhage@uni-bonn.de, 1b Institut für Geographie, Universität Bonn 2.Institute of Soil Science, University of Bloemfontein

RESILIENCE, COLLAPSE and REORGANISATION in Social-Ecological Systems of African Savannas