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

A. Sandhage-Hofmann\textsuperscript{1a}, E. Kotzé\textsuperscript{2}, C.C. du Preez\textsuperscript{2}, J. Löffler\textsuperscript{1b}, D. Wundram\textsuperscript{1b}, W. Amelung\textsuperscript{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 grazed 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, $\delta^{13}$C, $\delta^{15}$N

Results - Bush encroachment and soil organic carbon

<table>
<thead>
<tr>
<th>Land cover (%)</th>
<th>Soil organic carbon (topsoil)</th>
<th>$\delta^{13}$C in topsoils</th>
<th>C\textsubscript{3} derived carbon (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>rotational</td>
<td>Carbon stocks depend on aboveground vegetation. Carbon stocks in CG significant higher.</td>
<td>Significant higher $\delta^{13}$C values in RG indicating more grassy vegetation.</td>
<td>C\textsubscript{3} derived C in CG indicate a shift to bushy vegetation ('')</td>
</tr>
<tr>
<td>continuous</td>
<td>Carbon stocks depend on tree height.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Results - Texture and Evaporation

<table>
<thead>
<tr>
<th>Sand fractions (%)</th>
<th>Evaporation (mm)</th>
<th>Shrub vs. fine sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant (p&lt;0.05) differences in land cover between tenure systems.</td>
<td>Higher evaporation in continuously grazed system</td>
<td>No relationship between fine sand fraction and shrub cover</td>
</tr>
</tbody>
</table>

Significant (p<0.05) differences in fine and coarse sand fractions

The interaction between environmental factors like soil and management 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 C\textsubscript{3} 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.