Which role play grazing and drought duration for desertification? Insights from a tipping point experiment in southern Africa

Behn, K.12, Mokoka, V.3, Mudongo, E.4, Ruppert, J.5, Ayisi, K.3, Linstädter, A.2

1Institute of Crop Science and Resource Conservation, University of Bonn, Germany; 2Biodiversity/Systematic Botany, Institute of Biochemistry and Biology, University of Potsdam, Germany; 3Risk and Vulnerability Science Center, University of Limpopo, South Africa; 4Communities Living Among Wildlife Sustainably (CLAWS) Botswana, Botswana; 5Plant Ecology Group, University of Tübingen, Germany

Introduction & Motivation

- Climate change:
  - Less rainfall
  - More variability
  - Prolonged droughts

Savanna ecosystem

- Socio-economic changes:
  - Increased demand for ecosystem services (e.g. forage)

Research gaps:

- Potentially interactive effects of drought and grazing on savanna ecosystems
- Importance of drought duration

Research questions:

1. How resistant is herbaceous vegetation to a two- and a six-year extreme drought?
2. How does vegetation recover after a two- and a six-year extreme drought?
3. Which role does grazing play for drought resistance and resilience?

Study site & Methods

Location:
Limpopo province, South Africa
Established in 2013 and with 2014/2015 as first treatment season
Semi-arid savanna moderate grazing pressure (cattle)
400 – 600 mm/year rainfall

Treatment combinations:
Grazing (G+) vs. resting (G-)
2-year drought and post-drought (H+)
6-year drought (D+)

Experimental drought:
Passive rainout shelters reducing ambient rainfall by 66% Turning a normal year into a year of "exceptional drought".

Results

Experimentally plots after five treatment years. Pictures: Vincent Mokoka

Key results and conclusions

- Drought impact increases with duration resulting in decrease of primary production, vegetation cover, perennial grasses and rain-use efficiency
- Vegetation can recover fast after a short drought
- Severe impacts of long drought indicate long recovery time, however, we could not detect a distinct desertification tipping point
- Moderate grazing can be beneficial during short drought and can stimulate recovery but can accelerate degradation under prolonged drought
- Seed production important for post-drought recovery

Reduction of aboveground net primary production (ANPP) relative to control (D+/D-) shown as black arrow. Initially, the reduction is relatively low. It increases with ongoing drought and exceeds the rainfall reduction (grey line) indicating a lower rain-use efficiency than under control conditions. Grazed (above) and rested (below) plots slightly differ in their response to drought.

ANPP in absolute numbers in comparison between control (left) and drought and post-drought (after 3rd season, right) treatments under grazed (above) and rested conditions (below). Grazed plots recovered fast (no significant reduction of ANPP after short drought) rested plots with drought history remained slightly below control (significant only in the first post-drought year)