Utilizing perennial grass species' population patterns to detect looming desertification tipping points in semi-arid regions

Munyebvu-Chambara, F; Nesongano, W C*; Bilton, M C*; Linstädter, A†.*
* University of Namibia, Department of Environmental Science, Windhoek, Namibia;
†University of Potsdam, Institute of Biochemistry and Biology, Potsdam, Germany.

INTRODUCTION

Dryland ecosystems are facing a severe threat from climate change (Maestre et al. 2012), often combined with heavy grazing pressure. Transitions from "good" to "poor" rangeland condition may pose catastrophic and possibly permanent consequences for rangeland Productivity, when the system reaches a threshold beyond which it becomes impossible to recover (desertification tipping point). The ability to predict desertification tipping points with the aid of suitable ecological indicators is critical (Eslami Andergoli *et al.* 2015). However, the underlying mechanisms and the sensitivity of plant species to desertification are rarely tested.

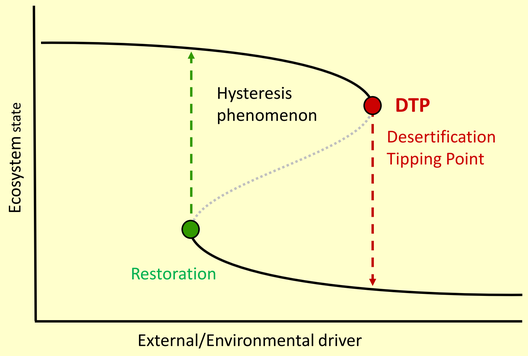

Figure 1: Schematic representation of desertification tipping point.

Aim

As changes in population dynamics are important precursors of ecosystem transition (O'Connor, 1995), the study aims to identify species- specific indicators which may show change from a "good" to "poor" rangeland condition.

METHODOLOGY

Study Area

The study was conducted in two land tenure systems: communal areas and commercial farms near and within the Greater Waterberg Landscape (GWL) area, central east of Namibia.

Research design

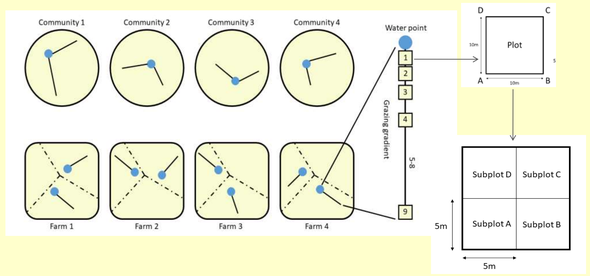

Figure 2: A schematic diagram of the research design.

- 4 communal areas
- 2 transects per site
- 9 (10m x 10m plots)
- 4 commercial farms
- 16 transects in total
- 144 plots in total

Species selection

4 perennial grasses	Ecological status
Aristida stipitata	- Poor forage value, often occur in degraded rangelands
Aristida congesta	
Stipagrostis uniplumis	- Better grazing value, often occur on healthier semi-arid rangelands.
Eragrostis rigidor	

(Muller, 2007)

Sampling

- Two basal diameters (semi-minor and semi-major axes) of a minimum of 25 individual tufts of each species were measured at 5 out of 9 plots.
- Individual adults and seedlings were counted in 9 plots to determine population densities and seedling abundance.

PRELIMINARY RESULTS

Species basal sizes and densities

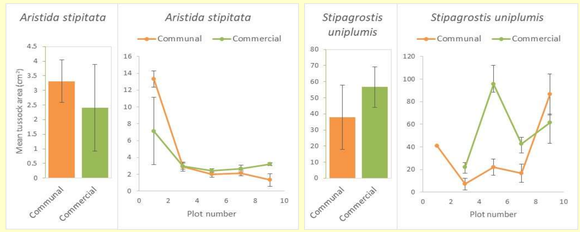

Figure 3: A comparison of basal sizes of two grass species between land tenure systems (*Aristida stipitata* and *Stipagrostis uniplumis*) and across grazing gradients. Plot 1 being closest to the water points and thus experiences higher grazing intensity.

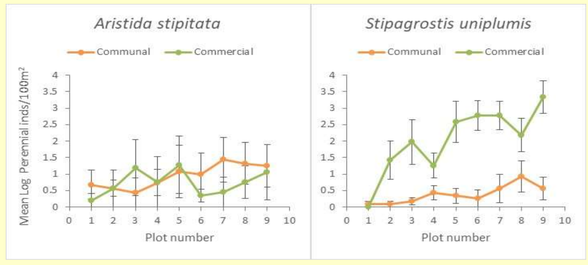

Figure 4: Density comparison of the two grass species between land tenure systems and across grazing gradients. There was no significant difference in the densities *of A. stipitata* both between tenure systems and across the gradient ($p > .05$) whilst densities of *S. uniplumis* differed significantly between the tenure systems ($p < .001$).

Overall densities and recruitment

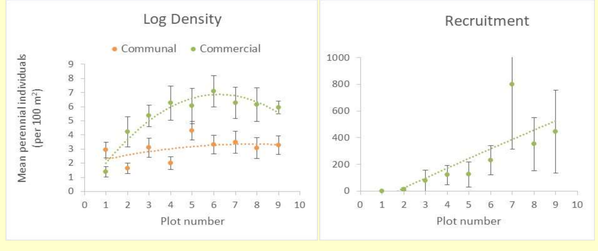

Figure 5: Combined densities and recruitment of the 4 grass species across the 8 transects of each land tenure system. Density is displayed on a log scale (i.e. 3 = 19; and 6 = 402 individuals).

NB: All error bars represent standard errors of the mean.

DISCUSSION

- Sub-climax species such as *A. stipitata* tend to be relatively larger in size on highly grazed plots.
- *S. uniplumis* had significantly larger tufts at intermediate grazing (Fig.3) and higher densities on commercial farms compared to communal areas (Fig.4).
- The absence of *E. rigidior* and rarity of *S. uniplumis* particularly on highly grazed plots in communal areas is a possible indicator of rangelands transitioning.
- Seedling recruitment was only recorded in commercial farms (Fig.5) which could possibly be due to controlled grazing practices.
- Total densities and seedling recruitment tend to gradually increase away from grazing pressure.

CONCLUSIONS

- Perennial grass species that are more responsive to grazing impact are probably useful early warning indicators of desertification tipping points.
- The basal sizes, density and recruitment all show such responses.
- Total and especially species-specific responses show potential early warning indications, however, further analyses is key to understand the patterns.

ACKNOWLEDGEMENTS

The study was conducted in the context of the "NamTip" project funded by the German Federal Ministry of Education and Research (FKZ: 01LC1821A-E). We thank the Namibian and Germany universities, local communities, farmers and stakeholders for supporting and encouraging our research.

Contact:
Faith Chambara (PhD candidate)
University of Namibia
Email: rutendomunyebvu@yahoo.com