Functional diversity as an indicator of rangeland degradation – insights from a Namibian grazing gradient study

Schwarz, L.-M.[1,4]; Bilton, M.[2]; Munyebvu-Chambara, F.[3]; Behn, K.[1]; Linstädter, A.[4]

[1] University of Bonn, Institute of Crop Science and Resource Conservation – Plant Nutrition, Germany
[2] Namibia University of Science and Technology, Department of Agriculture and Natural Resources Sciences, Namibia
[3] University of Namibia, Department of Environmental Sciences, Namibia
[4] University of Potsdam, Biodiversity Research / Systematic Botany, Germany

1. Introduction

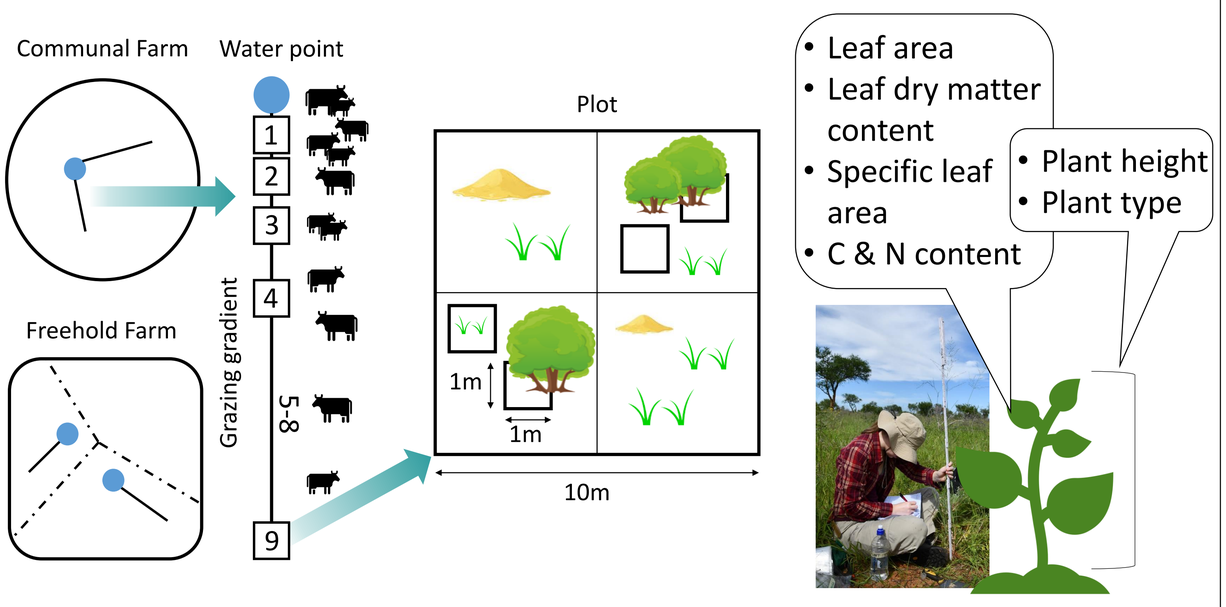
Droughts and **overgrazing** can result in rangeland **degradation**. This is particularly true for the **semi-arid rangelands** of Namibia. To mitigate rangeland degradation beyond a point of no return it is important to identify **early warning signs**. As vegetation responds to degradation processes, **taxonomic** and **functional diversity** could be valuable indicators for rangelands approaching a tipping point.

Degraded Namibian rangeland

Research questions:

1. How does grazing pressure affect functional trait space?
2. Does management affect taxonomic and functional diversity?
3. Is functional diversity a suitable early-warning indicator of rangeland degradation?

2. Study Design & Methods



Study setup

- 2 management types: communal rangelands with year-round grazing, and freehold farms with rotational grazing
- 8 farms, each with 2 grazing gradients
- 9 observational plots along a gradient from highest grazing pressure (close to water point)

Taxonomic data collection

- In each plot: 2 quadrats in open grassland, 2 in subcanopy areas
- In each quadrat: herbaceous plant inventory including species-specific cover estimation

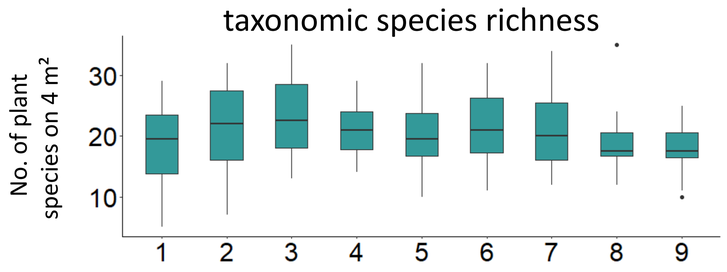
Functional trait collection

- Sampling of all dominant species
- Processing of leaf traits (e.g., leaf area and leaf dry matter content)
- Setting up a functional trait database that can be related to species inventories

3. Results

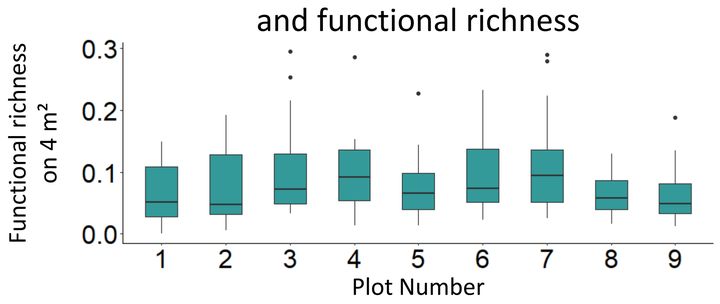
Taxonomic species richness does not differ significantly along the grazing gradient (p=0.278)

Relationship between grazing pressure and taxonomic species richness

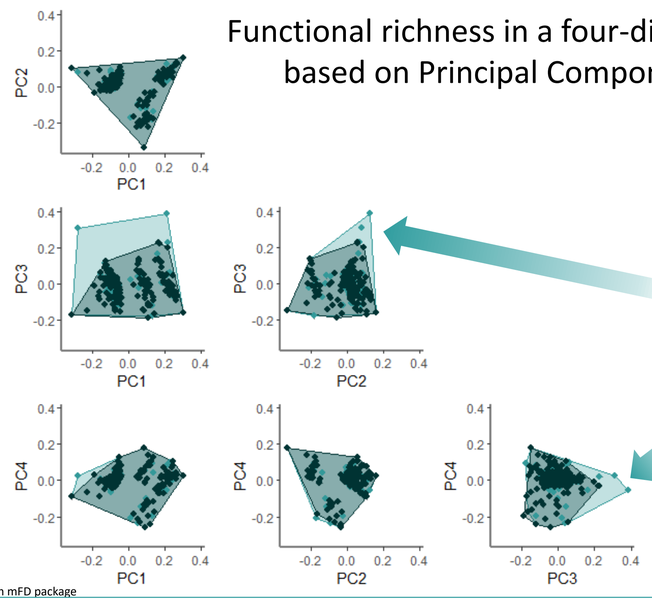


None of the 9 functional alpha diversity indices were affected by grazing pressure. See functional richness against grazing pressure as an example (p=0.139)

Relationship between grazing pressure and functional richness



Functional richness in a four-dimensional space based on Principal Component Analysis



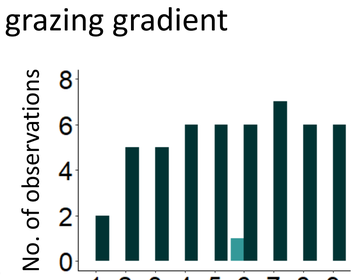
Made with mFD package

Communal farms: 0.989
Freehold farms: 0.646

The plant communities on communal rangeland filled more of the total trait space

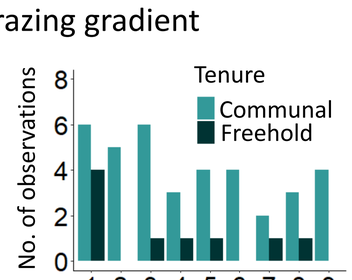
Presence of *Eragrostis rigidior* along the grazing gradient

Eragrostis rigidior: important palatable grass species



Presence of *Sida cordifolia* along the grazing gradient

Sida cordifolia: exotic; invader of overgrazed fields



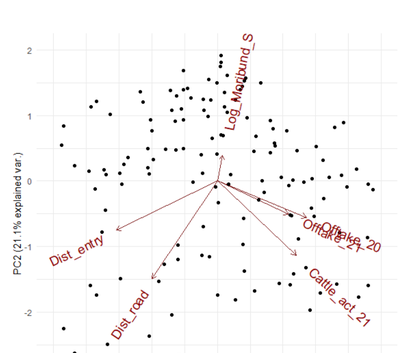
Eragrostis rigidior occurred mainly on freehold farms and at larger distances from water points, while the invader *Sida cordifolia* occurred mostly on communal lands and closer to water points → possible indicator species of rangeland degradation?

4. Conclusions

- Trait space — based on leaf traits, plant height, and plant type — was unrelated to the grazing pressure gradient
- Taxonomic and functional diversity were unrelated to the grazing pressure gradient, irrespective of the two management systems
- In contrast to our expectation, we found slightly higher functional diversity in the more degraded, communal farms
- Functional diversity is not a suitable early-warning indicator to detect early-stage rangeland degradation
- Certain species show potential as indicator species of rangeland degradation

5. Outlook

- Complement functional trait database with C/N data, and re-evaluate functional diversity analysis; include functional beta diversity indices
- Since distance from water point is merely a proxy of grazing pressure, develop a more accurate grazing index
- Conduct multivariate analyses on functional diversity indices to determine importance of environmental variables
- Further evaluation of potential indicator species



Initial Principal Component Analysis to develop a grazing index

Contact Author: Lisa-Maricia Schwarz
Mail: lisa.schwarz@uni-bonn.de
Address: University of Bonn, INRES – Plant nutrition, Karlrobert-Kreiten-Str. 13, 53115 Bonn, Germany

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