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"Development on the margin"

Is Degradation of South African Grasslands Related to Temporal Variability or Spatial Autocorrelation of Vegetation Parameters?

Anja Linstädter[1], Katharina Brüser[2], Jürgen Schellberg[2], Roelof Oomen[2], Jan Ruppert[1], Christiaan C. Du Preez[3], Frank Ewert[2]

[1] *University of Cologne, Range Ecology and Range Management, Germany*
[2] *University of Bonn, Inst. of Crop Science and Resource Conserv. (INRES), Germany*
[3] *University of the Free State, Dept. of Soil, Crop and Climate Sciences, South Africa*

Abstract

In drylands, ecosystem shifts to highly unfavourable states are a common reason for land degradation with large implications for local livelihoods. The resilience of grasslands to system shifts is the result of complex interactions between human management and environmental factors. In South African semiarid grassland systems, degradation processes are mostly due to feedback mechanisms between grazing, vegetation structure, and soil characteristics. Changes in vegetation structure as affected by the intensity of grazing are recordable as dominance shifts in species composition and plant functional types. However, these directional changes are overlain by fluctuations in species composition related to stochastic rainfall. This makes it particularly difficult to identify changes in system resilience. Recent modelling studies suggest that a loss of resilience is coupled to an increased amplitude in the temporal variability, and to an increased spatial autocorrelation of vegetation performance. To analyse a real-world example, high-resolution remote sensing data are a promising tool. In our study, we perform a combined analysis of data on the intra-seasonal variability and spatial heterogeneity of vegetation indices derived from broadband RapidEye^{TM} data, together with data on vegetation composition and topsoil characteristics.

Our case study regions are situated in South Africa's Free State province. We selected pastures in two tenure systems (communal and commercial) with different intensities and frequencies of grazing. On permanent plots located on grazed pastures and within livestock exclosures, we recorded vegetation composition and surface characteristics. Topsoil samples were taken on all plots and analysed for physical and chemical parameters. For plot pixels and neighbouring cells, vegetation proxies were derived using RapidEye^{TM} time series. We used multivariate statistics (Canonical Correspondence Analysis) and General Linear Models to assess if vegetation composition on intensively grazed pastures was connected to an increased intra-seasonal variability and spatial correlation of vegetation proxies. We will present first results from these analyses, and discuss how useful information about the temporal variability and spatial autocorrelation of vegetation parameters is to indicate relative changes of resilience in a real-world system.

Keywords: Rangeland ecology, remote sensing, resilience, threshold indicator

Contact Address: Anja Linstädter, University of Cologne, Range Ecology and Range Management, Zülpicher Str. 47b, 50674 Cologne, Germany, e-mail: anja.linstaedter@uni-koeln.de