Session 29 - Ecoholicology of Drylands - Recent insights, perspectives and challenges

Chairs: Katja Geißler, Anja Linstädter, Jan C. Ruppert

O1 - Impact of feedbacks between vegetation pattern and ecosystem functioning in the response of drylands to external stress

Angelina G. Mayor1,2, Susana Bautista3, Francisco Rodriguez4, Sonia Keffe5, Max Rietkerk1

1Utrecht University, Utrecht, NL, ag.mayor@uu.nl
2Wageningen University, Wageningen, NL, ag.mayor@uu.nl
3Institute for Evolutionary Sciences, CNRS, Montpellier, FR
4University of Alicante, Alicante, ES

Despite the increasing interest in the feedbacks between vegetation pattern and ecosystem functioning in drylands, modeling and field studies testing or quantifying the underlying key assumptions driving these relationships are very scarce. In this study, we used a modeling approach to represent feedbacks between vegetation pattern and ecosystem functioning driven by the connectivity of runoff-source areas (e.g., bare soils) and to investigate the impact of various feedback strengths on the response of the ecosystem to changing climate and human pressure. In general, the connectivity-mediated feedbacks decrease the amount of pressure required to cause a critical shift to a degraded state and increase the pressure release needed to achieve the ecosystem recovery. The impact of these feedbacks is markedly non-linear, which is linked to the also non-linear increase in bare-soil hydrological connectivity with decreasing vegetation cover. Modeling studies on dryland vegetation dynamics not accounting for the connectivity-mediated feedbacks studied here may underestimate the risk of critical shifts from vegetated to degraded states in response to external stress. Our results also suggest that the acceleration of bare-soil hydrological connectivity from spatially-explicit time-series data may provide an early warning of imminent shift.

O2 - Savanna or Grassland - Which biome is more resilient to anomalies in precipitation? A data-fusion study in arid and semi-arid Africa

Jan C. Ruppert1,2, Anja Linstädter1

1Universität zu Köln, Köln, DE, jan.ruppert@uni-koeln.de
2Universität Bonn, Bonn, DE, jan.ruppert@uni-koeln.de

Climate Change is assumed to alter temperature and precipitation patterns throughout (semi-) arid Africa and to even increase the already high climatic variability which is characteristic for drylands. Projections indicate an increase in temperature and in intra- and interannual variability of rainfall, leading to erratic switches between high and low rainfall years. Savanna and grassland biomes represent the majority of terrestrial ecosystems in Sub-Saharan Africa. The two biomes are assumed
to differ in their buffering capacity for rainfall variability including extreme events such as droughts. Besides biome type, grazing intensity also seems to play a crucial role for vegetation resilience to drought.

Our study aims to assess the resilience of savanna and grassland vegetation to droughts, comparing monitoring data from sites with different grazing intensities. We analyze 11 long-term plant productivity studies from Sub-Saharan Africa (7 savanna and 4 grassland studies). Aboveground net primary production (ANPP) and rain-use efficiency (RUE; ANPP/annual precipitation) are used as proxy for vegetation performance. We evaluate vegetation response to droughts in the past decades with respect to two aspects of resilience, i.e. drought resistance and recovery. We define resistance as the reciprocal difference in ANPP and RUE between drought years and the average of years with average rainfall. Similarly, recovery is tested as differences in ANPP and RUE between drought and post-drought years.

From preliminary and published studies, we know that the grassland and savanna biome show distinct responses to precipitation and precipitation anomalies. The coupling between productivity and precipitation is stronger in grasslands as compared to savanna systems (Ruppert et al. 2012). At the same time grassland sites are also more resilient to precipitation anomalies, while savanna sites are more prone to degradation via bush encroachment and/or erosion. By improving the understanding of the role of rainfall anomalies, and specifically its interference with grazing intensity, in savanna and grassland systems, this study might help adapting the right management strategies to climate change.

O3 - The role of a water dependent bottleneck in semi-arid savannas response to Climate Change

Dirk Lohmann\(^1\), Britta Tietjen\(^2\), Niels Blaum\(^1\), Dave F. Joubert\(^3\), Florian Jeltsch\(^1\)

\(^1\)University of Potsdam, Potsdam, DE, dirk.lohmann@uni-potsdam.de
\(^2\)Freie Universität Berlin, Berlin, DE
\(^3\)Polytechnic of Namibia, Windhoek, NA

Semi-arid and arid savannas exhibit non-linear responses to land use and climatic variations in form of losses in vegetation cover and/or changes in vegetation composition with negative consequences for biodiversity, water retention, soil protection and biomass provision. Recent studies come to different conclusions with regard to the future dynamics of dryland ecosystems under livestock grazing, altered climatic conditions and increased levels of atmospheric CO\(_2\). At this, several studies predict increased levels of shrub encroachment due to positive effects of CO\(_2\) fertilization, which is assumed to favour C\(_3\) shrubs over C\(_4\) grasses.

We enhanced and parameterized an eco-hydrological savanna model to assess the impacts of a range of climate change scenarios on the response of a semi-arid African savanna to grazing. We focused on the effects of temperature and CO\(_2\)-level increase in combination with changes in inter-