**Tropentag, September 14-16, 2010, Zurich**

"World Food System —
A Contribution from Europe"

# Adaptation of Livestock Farming to Spatiotemporal Variability in Semi-arid Rangelands: An Ecological-economic Modelling Approach

Oliver Jakoby[1], Martin F. Quaas[2], Stefan Baumgärtner[3], Karin Frank[1]

[1] *Helmholtz Centre for Environmental Research - Ufz, Ecological Modelling, Germany*
[2] *Christian Albrechts University, Department of Economics, Germany*
[3] *Leuphana University Lüneburg, Department of Sustainability Sciences, Germany*

**Abstract**

Arid and semi-arid rangelands are characterised by highly uncertain and variable climatic conditions. This pose the major challenge to extensive livestock farming that is the predominant form of utilisation in these areas and provides food and livelihood for millions of people. Hence, the need for well adapted grazing strategies is especially high to enable an effective risk management. However, there exist several contradictory management approaches that differ in their level of complexity and flexibility, *e.g.* in their consideration of spatial variability.

In this paper we analyse how to adapt semi-arid grazing systems to spatial and temporal variability in ecosystem conditions. In particular, we evaluate the viability of different management options, and their response to fluctuating climatic conditions. We study the importance of space in management decisions and figure out how it should be incorporated into the management approach.

To this end, we use a generic simulation model that consists of a physiologically well-founded vegetation model combined with a rule-based model for the livestock management. The vegetation is represented by a perennial grass species, described by storage biomass (the 'vigour' of the plant) and aboveground biomass, which provides forage for the livestock. Vegetation growth rates increase with precipitation, which underlies stochastic fluctuations due to temporal heterogeneity of the rainfall. Furthermore, the state of the vegetation is negatively affected by livestock grazing. Therefore, the way a farmer manages his livestock has a direct feedback to the ecosystem providing his livelihood. The characteristics of a management strategy include the rules of herd rotation, and the stocking rate.

This study shows that adaptive stocking rates are less sensitive to overstocking compared to a constant stocking strategy. Furthermore, the spatial element of the grazing strategy becomes important at optimal stocking numbers, where the highest income is generated. Altogether, an adaptive stocking rate combined with a rotation that adapts the spatial fodder availability and seasonality is the best tested strategy to maximise the mean income while maintaining a viable rangeland condition. We conclude that adaptivity is a powerful instrument for management improvement and risk mitigation, if all important system properties are considered in the management approach.

**Keywords:** Livestock production, modelling, semi-arid rangelands

**Contact Address:** Oliver Jakoby, Helmholtz Centre for Environmental Research - Ufz, Ecological Modelling, Permoserstr. 15, 04318 Leipzig, Germany, e-mail: oliver.jakoby@ufz.de