Dryland vulnerability
Typical patterns and dynamics in support of vulnerability reduction efforts

Diana Sietz, Cumulative dissertation

Abstract

The pronounced constraints on ecosystem functioning and human livelihoods in drylands are frequently exacerbated by natural and socio-economic stresses, including weather extremes and inequitable trade conditions. Therefore, a better understanding of the relation between these stresses and the socio-ecological systems is important for advancing dryland development. The concept of vulnerability as applied in this dissertation describes this relation as encompassing the exposure to climate, market and other stresses as well as the sensitivity of the systems to these stresses and their capacity to adapt. With regard to the interest in improving environmental and living conditions in drylands, this dissertation aims at a meaningful generalisation of heterogeneous vulnerability situations.

A pattern recognition approach based on clustering revealed typical vulnerability-creating mechanisms at global and local scales. One study presents the first analysis of dryland vulnerability with global coverage at a sub-national resolution. The cluster analysis resulted in seven typical patterns of vulnerability according to quantitative indication of poverty, water stress, soil degradation, natural agro-constraints and isolation. Independent case studies served to validate the identified patterns and to prove the transferability of vulnerability-reducing approaches. Due to their worldwide coverage, the global results allow the evaluation of a specific system's vulnerability in its wider context, even in poorly-documented areas. Moreover, climate vulnerability of smallholders was investigated with regard to their food security in the Peruvian Altiplano. Four typical groups of households were identified in this local dryland context using indicators for harvest failure risk, agricultural resources, education and non-agricultural income. An elaborate validation relying on independently acquired information demonstrated the clear correlation between weather-related damages and the identified clusters. It also showed that household-specific causes of vulnerability were consistent with the mechanisms implied by the corresponding patterns. The synthesis of the local study provides valuable insights towards the tailoring of interventions that reflect the heterogeneity within the social group of smallholders.

The conditions necessary to identify typical vulnerability patterns were summarised in five methodological steps. They aim to motivate and to facilitate the application of the selected pattern recognition approach in future vulnerability analyses. The five steps outline the elicitation of relevant cause-effect hypotheses and the quantitative indication of mechanisms as well as an evaluation of robustness, a validation and a ranking of the identified patterns. The precise definition of the hypotheses is essential to appropriately quantify the basic processes as well as to consistently interpret, validate and rank the clusters. In particular, the five steps reflect scale-dependent opportunities, such as the outcome-oriented aspect of validation in the local study.

Furthermore, the clusters identified in Northeast Brazil were assessed in the light of important endogenous processes in the smallholder systems which dominate this region. In order to capture these processes, a qualitative dynamic model was developed using generalised rules of labour allocation, yield extraction, budget constitution and the dynamics of natural and technological resources. The model resulted in a cyclic trajectory encompassing four states with differing degree of criticality. The joint assessment revealed aggravating conditions in major parts of the study region due to the overuse of natural resources and the potential for impoverishment. The changes in vulnerability-creating mechanisms identified in Northeast Brazil are well-suited to informing local adjustments to large-scale intervention programmes, such as "Avança Brasil".

Overall, the categorisation of a limited number of typical patterns and dynamics presents an efficient approach to improving our understanding of dryland vulnerability. Appropriate decision-making for sustainable dryland development through vulnerability reduction can be significantly enhanced by pattern-specific entry points combined with insights into changing hotspots of vulnerability and the transferability of successful adaptation strategies.