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Livelihood security in face of drought – Assessing the vulnerability of pastoral households☆

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ABSTRACT

Livestock grazing in drylands supports pastoral livelihoods but is facing multiple changes including shocks such as severe droughts. Herdsmen specifically cite drought events as a reason for the abandonment of their transhumance practices. The purpose of this study is to assess the relevance of drought as a driving force for losses of livelihood security leading to a specific systemic change – households abandoning transhumant pastoralism.

We present and apply a framework for systematic analyses of the social–ecological functioning of pastoral resource use that consists of the following components: (1) A spatially-explicit social–ecological model for analyzing the system dynamics, especially in face of severe drought in connection with other driving forces of variability, (2) an operationalized measure for assessing livelihood security, and (3) a strategy for systematic vulnerability assessments of pastoral households by scenario comparison. This approach is applied to the land use system of the transhumant pastoralists in the High Atlas Mountains of Morocco.

The results indicate that drought is the main threat to livelihood security in only a few cases, eventually forcing households to abandon their transhumant lifestyle. Instead, other (endogenous and exogenous) sources of variability were found to be the main driving force for vulnerability, depending on the household characteristics such as income needs and the level of pastoral mobility. We discuss implications on the role of severe drought in connection with other processes of global change such as social change and land use change for livelihood security in pastoral systems.

Moreover, on the basis of these findings, we discuss how the relevance of shocks as a driving force of systemic changes in coupled human-nature-systems may be adequately explored. These conclusions concern the interplay of exogenous and endogenous factors, and unintended side-effects of intended changes.

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1. Introduction

Drylands cover 40% of the earth's land surface and are home to about 30% of the human world population (IUCN, 2013). They are characterized by low but highly variable rainfall that strongly influences the entire dynamics (Fernandez-Gimenez and Allen-Diaz, 1999; von Wehrden et al., 2012, Ruppert et al. in press). These harsh and unpredictable environmental conditions require a flexible and adaptive utilization of natural resources (McAllister et al., 2006). In many regions, livestock mobility, which in practice ranges from nomadic, transhumant to rotational grazing, is a key strategy for delivering sustainable land use through flexible resource usage (Brottem et al., 2014). Transhumance is the regular movement of livestock and the whole household to areas with better forage availability (Reid et al., 2008). For pastoral nomads or transhumant households, livestock-related activities are typically the main source of income (Dahl and Hjort, 1976; Breuer, 2007) and their livelihood security thus closely depends on access to forage resources.

Drylands are subject to various transformations as they are exposed to climate change, but also social, land use or institutional change (Reynolds et al., 2007). These processes can alter the

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conditions for pastoralism and also threaten transhumant livelihoods (Breuer, 2007). If pastoral livelihoods are no longer secure, households are eventually forced to abandon the transhumant lifestyle. It may be assumed that a systemic change affecting type of land use and livelihoods may be triggered if a critical proportion of households has abandoned transhumant pastoralism.

Drought is frequently identified as a major threat to livelihood security (see for example Scoones, 1992; Fafchamps et al., 1998; Angassa and Oba, 2008; UNISDR, 2009; UNCCD, 2010). However, drought is an ambiguous term, subject to human objectives and to the weight of emphasis on meteorological, hydrological, agricultural, or socio-economic dimensions (Thurow and Taylor, 1999; Meze-Hausken, 2004). We use the concept of a meteorological drought, defined as persistent negative precipitation anomalies, lasting several years (Méndez and Magaña, 2010; Brown et al., 2011). Defined in this way, drought is an external shock with the potential to drive a systemic change. Many studies have shown that negative effects of a meteorological drought on livelihood security can be mitigated by an adaptive risk range management, as practiced by pastoralists in drylands (Müller et al., 2007b; Linstädter et al., 2013; Mogotsi et al., 2013). Thus, a drought is a risk inherent in the system to which pastoralist economies have adapted to a certain extent (Morton and Barton, 2002). Despite pastoral societies' adaptive capacity in dealing with drought, *severe* droughts have also been shown to have – together with top-down forces of resource endowment and entitlement (Leach et al., 1999) – triggered the abandonment of transhumant practices (Thébaud and Batterbury, 2001; Turner, 2011). This underlines that even the best risk management strategy will necessarily fail if drought events are too severe. Thus, it is still an open question how relevant droughts are as a potential threat to transhumant pastoralism.

In our study, we concentrate on severe drought events which are supposed to have a high potential to threaten pastoral livelihoods by reducing available forage (Ruppert et al. in press). Severe droughts are a typical example for an "extreme climatic event" (ECE). For ecosystems, ECEs have been recently defined to include 'extremeness' in both the driver and the response (Smith, 2011). We transfer this concept to social–ecological systems, and consider the abandonment of transhumant practices as an 'extreme' response to severe drought when the households' adaptive capacity is overcharged. Our focus on singular, severe droughts is also in line with field observations from other pastoral systems, describing three typical stages of systemic change in Australia (Stafford Smith et al., 2007), the Sahel (Batterbury and Warren, 2001) and in southern Africa (Sander et al., 1998): A stage of good climatic and economic conditions is followed by a major drought and an inability to respond in an economically appropriate way, and then by permanent or temporary declines in grazing productivity due to detrimental feedback mechanisms between the ecological and the social subsystems of a social–ecological system.

The description of typical stages of systemic change underlines that, besides drought, other sources of variability might also affect forage availability and thereby cause a fluctuating income from livestock. As mentioned in stage three (see above), livestock dynamics are subject to variability caused by resource–consumer interactions (Illius and O'Connor, 1999; Tews et al., 2006) through plant–herbivore feedbacks. On top of these (deterministic) dynamics, natural rainfall variability is another (stochastic) source of environmental variation. It is inherent to dryland systems, and livestock and people are thus adapted to it to a certain extent (McAllister et al., 2009). However, it remains to be analyzed to what extent livestock dynamics can be attributed to these different sources of variability. This is important to identify effective response options for pastoralists.

In the present paper, we take up these debates and assess the economic vulnerability of pastoral households towards drought-induced crashes in livestock herds, but in interplay with other drivers of income variability. With this approach, we aim to provide an improved mechanistic understanding of vulnerability of pastoralists. Considering that climate change projections suggest an increased risk of more severe drought events in drought-prone dryland regions (Dai, 2013; IPCC, 2007), such an understanding is urgently needed as it is also explored via models of diverse farming systems (Bergez et al., 2013). While previous studies either investigated the dynamics of the social–ecological system of pastoralism (Janssen et al., 2000; Milner-Gulland et al., 2006) or studied economic risk in the broader context of environmental variability (McPeak, 2004; Gross et al., 2006; Quaas et al., 2007), only a few studies related the ecological threat that is posed by droughts to an economic vulnerability assessment (Smith and Foran, 1992; Hatfield and Davies, 2006).

Our exploratory modeling study thus addresses the following questions: (i) What is the role of severe drought and other sources of variability in the loss of livelihood in drylands? In other words, is severe drought really a major threat to livelihood security and key driving force for eventually abandoning transhumant practices? (ii) To what extent does the threat to pastoral livelihoods depend on the characteristics of the household? (iii) What role do income needs and the management strategy of the household play in this context? We address these questions with the case study of a pastoral system from the High Atlas Mountains in Morocco. In this case study, severe drought is perceived by the pastoralists as a major threat for livelihood security, and is frequently blamed by former pastoral households as the main reason for an abandonment of transhumant practices (Breuer, 2007). Future climate is projected to be characterized by more severe drought events (see for climate outlooks for North African drylands Paeth et al., 2009; Linstädter et al., 2010).

At the core of this paper is a novel analytical framework for systematically addressing our research questions. It is based on a process-based model which explicitly considers interactions and feedbacks between the ecological and the social subsystem (for recent social–ecological modeling reviews see Schlüter et al., 2012; Filatova et al., 2013). Apart from model building, the framework presents a strategy for systematic model analysis and the operationalization of central concepts with respect to our study (e.g. livelihood security, vulnerability to drought, abandonment of transhumant practices). By exemplary application of this framework, we provide new insights into the vulnerability of pastoral households and the role of severe drought in its interplay with other factors characteristic for drylands. We do this by step-wise testing the livelihood security as a response to the different sources of variability. Finally, we draw some general conclusions on the framework's potential to assess how shocks drive systemic change. In this way, we also aim to contribute to the discourse of principal driving forces for systemic change (with this at the core of this special issue).

2. Methods

2.1. Case study: pastoralism as social–ecological system

The pastoral social–ecological system from Southern Morocco is situated at the southern slope of the High Atlas Mountains. This area is characterized by a steep altitudinal gradient from the Mgoun massive (4070 m asl) to the Pre-Saharan plains (1000–1500 m asl). This constitutes a climatic gradient from semi-arid to arid environments with low mean annual rainfall (150–360 mm) and high coefficients of variation (20–30%; Schulz et al. (2010)). Along the altitudinal gradient, four vegetation belts can be distinguished (Finckh and Poete, 2008; Linstädter and Baumann, 2013): semidesert, sagebrush steppe, woodsteppe and oromediterranean shrubland. Apart from arable farming in the valleys, the main source of income of the local population is traditionally generated by extensive livestock

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