



# A multi-scaled analysis of the effect of climate, commodity prices and risk on the livelihoods of Mongolian pastoralists



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## ABSTRACT

Studies of common pool resources tend to neglect how aspects of the resource system interact with the external social, physical and institutional environment. We test the hypothesis that select market and non-market based options available to Mongolian Gobi Desert pastoralists in the current institutional setting are not sufficient to ameliorate the risks of resource gaps caused by climatic and commodity price variability. An empirical decision tree was used to model interactions between climatic variability, commodity price volatility and economic returns. Results from the model were then discussed in light of a critical, qualitative analysis of risk management strategies and capabilities of pastoralists. Returns to pastoralists were dependent upon climate and commodity prices, as expected, but pastoralist decision-making could influence these returns. Pastoralist decision-making was further influenced by multi-scaled social, economic and climatic factors. Existing market-based options available to Mongolian Gobi Desert pastoralists reduced price, but not production, risks in this largely subsistent system. A focus on improving market-based options for reducing risk is likely to provide more benefits to livelihoods and landscape condition than modifying institutional settings governing access to the forage resource.

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## 1. Introduction

Studies of natural resources, including the common pool resources of much of the world's drylands, often neglect how aspects of the resource interact with the external social, physical and institutional environment (Addison et al., 2013; Agrawal, 2001; Turner, 2011). Drylands under an extensive pastoral land-use are characterized by precipitation patterns that are both low and highly variable when compared to higher precipitation landscapes (Retzer et al., 2006; Sasaki et al. 2009; Wehrden et al., 2010). Given that precipitation events are well correlated with vegetation production, forage resources are similarly temporally and spatially unpredictable. Social, institutional and economic factors within the dryland context, such as large distances from markets and decision making centres, and poor road conditions, increase transaction costs and price unpredictability (Kusan and Saizen, 2013; Stafford Smith, 2008). These factors contribute to drylands being considered amongst the most vulnerable areas to global environmental

change (Twyman et al., 2011), with pastoral livelihoods often perceived as more marginal or threatened than other resource-based livelihoods (see Fernandez-Gimenez and Le Febre, 2006).

Volatile biophysical and socioeconomic factors occur at a variety of spatial and temporal scales, create feedback loops, interact in different ways and can create or modify both production (unpredictable variations in the production of commodities) and price (unpredictable variations in prices paid for these commodities) risk. Whilst some types of volatility are predictable, high volatility can create forms of risk to which pastoralists must respond *ex ante* or *ex post* (Baas et al., 2012; Ouma et al., 2011), and can amplify exposure or reduce resilience to other stresses. Pressures on the strategies by which pastoralists historically managed shocks and stresses through time and space have increased (Agrawal and Gibson, 1999; Dickinson and Webber, 2004; Ouma et al., 2011; Robinson et al., 2003; Sneath, 1998; Stokes et al., 2006) resulting in more variable and unpredictable livelihoods (Fernandez-Gimenez et al., 2012 and compromised landscape condition (Blaikie and Brookfield, 1987). Understanding and, where possible, predicting the relationship between climatic state and resource user response, within any particular socio-economic context, may assist in the design of

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strategies to improve livelihoods and deal with environmental effects.

Internationally, there has been substantial research on decision making in dryland social–ecological systems (e.g. Bao Li et al., 2008; Janssen et al., 2000; Kong et al., 2014; Stroebel et al., 2011), and the factors affecting pastoral risk management strategies (e.g. Agrawal and Gibson, 1999; Dickinson and Webber, 2004; Fernandez-Gimenez et al., 2012; Robinson et al., 2003; Sneath, 1998; Stokes et al., 2006). However, with few exceptions (e.g. Milber-Gulland et al., 2006; Turner and Williams, 2002), this research has rarely recognised the significant role that fast variables such as weather patterns or commodity prices, and the interactions between them, can have on dryland systems. Ecological and economic vulnerabilities are linked through markets (Barrett and Luseno, 2004; Turner and Williams, 2002) as markets can reduce ecological vulnerabilities by providing options to reduce grazing pressures at key times, or by facilitating the substitution of a declining natural livestock feed source. Exploring the relationship between climate, commodity prices, production and price risk, at different points through time and space may, therefore, highlight where interventions are best placed to improve livelihoods and landscape condition.

Non-mobility options for managing climatic variability, particularly those which are market-based, have been under-examined in the Mongolian Gobi Desert. In this paper, we attempt to address some of these knowledge gaps by exploring the interactions between climate, commodity prices and production and price risk at different scales within that agro-ecological system, and by testing the hypothesis that stochastic shocks in commodity prices and climate overwhelm many of the risk management strategies available to pastoralists. The paper begins by introducing the case study area. Then, it outlines the way in which commodity data and pastoralist accounts of economic and social conditions are drawn upon to create a model that predicts relative pay-offs associated with the use of select risk management strategies during different climatic periods. The results of the model are presented but the risk management strategies implicit in the results are then discussed and interpreted in the context of real world constraints and the nuances of the pastoralists' decisions as identified in a critical qualitative analysis of semi-structured interviews with pastoralists. Through this process, the paper illustrates that pastoralist decision making and livestock productivity is currently constrained by differentially scaled social, economic and climatic realities, the need for food security and the potential opportunity costs associated with forward planning in a landscape significantly impacted by largely unpredictable shocks.

## 2. Methodology

### 2.1. Introduction to the case study area

Like other international drylands, the Mongolian Gobi Desert (Fig. 1) is dry and experiences high levels of spatial and temporal variability in precipitation (Begzsuren et al., 2004; Wehrden et al., 2010). Mean annual precipitation varies from about 67.5 mm to 132 mm with annual coefficients of variation estimated to be between 26 and 49%, depending on location (Addison et al., 2012). High variability in precipitation is mirrored by high levels of variability in the production of palatable grasses such as *Stipa* spp. and *Cleistogenes songorica*, forbs/herbs such as *Allium mongolicum* and *Allium polyrrhizum*, and to a lesser extent shrubs such as *Anabasis brevifolia* and *Reaumuria soongorica* (see Addison et al., 2012). Temperature is also highly variable within years. For example, Khanbogd had an average daily maximum of  $-12^{\circ}\text{C}$  in January, and  $27^{\circ}\text{C}$  in July between 2005 and 2010 (data provided by local official).

Mongolia's economic performance is primarily a factor of the weather and international commodity markets (Nixon and Walters, 2006). In recent years, the Mongolian pastoral sector has become more exposed to both. *Dzud*, a multifaceted term encompassing winter conditions having an unusually adverse impact on pastoral production, result in higher than average levels of livestock mortality (Baas et al., 2012). This type of shock adds a further level of unpredictability to the pastoral environment, and can have long lasting effects on the livelihoods and security of pastoralists (Baas et al., 2012). The Gobi Desert experienced a significant *dzud* during 2009/2010 that resulted in substantial livestock losses for many pastoralists in both Mongolia (Baas et al., 2012; Sternberg et al., 2011) and Chinese Inner Mongolia (Li and Huntsinger, 2011). The southern/central Mongolian *aimags* (states) of Omnogobi and Dundgobi were particularly affected, losing 34 and 37% of their total herd, respectively, in comparison with a national average of 22% (Baas et al., 2012).

The 2009/2010 *dzud* losses were exacerbated by a decline in pastoral support services. From the 1950s to the 1990s, the State carried much of the production risk produced by climatic variability (Mearns, 1993; Sneath, 2012). However during the early 1990s, Soviet era subsidies to Mongolia ceased and gross domestic product (GDP) fell to 20–33% of pre-shock therapy levels (Luvsanjamts and Soderberg, 2005; Mearns, 2004; Nixon and Walters, 2006). One consequence of the decline was a retreat by the State from the pastoral sector, and increased livelihood insecurity (Nixon and Walters, 2006). The State Emergency Fodder Fund supplied 200,000 tonnes of fodder to pastoralists during 1990/91, but this figure dropped to 18,000 tonnes by 1994/95 (Asian Development Bank, 1995). Whilst many pastoralists are still highly mobile (Addison et al., 2013), declines in the transport of livestock, maintenance of water points and livestock breeding services (Nixon and Walters, 2006) have further reduced the ability of pastoralists to manage climatic variability.

With the decline of socialist institutions and services from the early 1990s, the market-dependent proportion of pastoralists' incomes increased (Nixon and Walters, 2006). Significant fluctuations in the global cashmere market have subsequently led to significant fluctuations in rural livelihoods, creating a spiral of debt for many households (Sneath, 2012). Poverty, believed to be almost non-existent prior to economic reforms due to strong social services (Nixon and Walters, 2006), expanded to about 36% of the population by 1995 and wealth inequality increased (Mearns, 2004; Nixon and Walters, 2006). As of 2009 (National Statistical Yearbook, 2010), the mean monthly per capita income earned in the agricultural sector was 175,200T (about \$125USD at the time), only 58% of the national average.

More spatially restrictive institutional settings over a very mobile land-use are sometimes proposed in an attempt to address some of the recent changes in the Mongolian pastoral sector (Addison et al., 2013). However more restrictive institutional settings require reduced mobility and a subsequent loss of accessible livestock forage. This loss needs to be offset by, for example, imported fodder to prevent overgrazing and declining livelihoods. Whilst there is little evidence that the Mongolian Gobi Desert is currently degraded at the regional scale (Addison et al., 2012), the relationship between formal commodity and fodder markets, livestock management decisions and resource variability is poorly understood.

### 2.2. Approach

A state contingent conceptual approach (Rasmussen, 2011) is used to investigate production and price risks faced by Mongolian Gobi Desert pastoralists. The choice of approach is because, in contrast to more equilibrial landscapes, it is not possible to *a priori*

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