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Institutional settings, herder livelihoods and rangeland condition in the Gobi Desert

Jane Addison

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Abstract

Policies governing access to the forage resource of livestock in arid rangelands have been a topic of intense debate globally. Institutional design is highly political in Mongolia where about 35% of people are employed in the agricultural sector, primarily as herders. A number of stakeholders assert that the weakening of institutions governing access to the forage resource has contributed to declines in rangeland condition and herder livelihoods. Institutions are being redesigned in light of this assertion. Yet empirical relationships between institutions, rangeland condition and herder livelihoods have been poorly examined.

In recent years, international understandings of the biophysical and socio-economic causes of rangeland change have shifted. Hence, assumptions of land degradation require careful examination, particularly in rangelands that are arid and highly variable across space and time. This research examines these assumptions in the Gobi Desert by exploring the relationships between rangeland condition, herder livelihoods and institutional settings. The Gobi Desert was selected because it is the most arid area in Mongolia and borders Chinese Inner Mongolia, a similar landscape with different institutional settings governing access to the forage resource.

In this research, Gobi Desert rangelands were approached as a system with interacting social and ecological components. Study sites represented three forms of bureaucratic institutions: the Mongolian national Law on Land; Pasture User Groups (PUGs), which were established as common property institutions to improve rangeland condition and herder livelihoods; and the Household Responsibility System of Inner Mongolia. Data were sourced from rangeland condition surveys, herder and local official interviews, and secondary sources. Socially embedded institutions were identified. A range of socio-economic and biophysical metrics at a variety of scales and levels were analysed and modelled to explore the types of change that may have contributed to perceived declines in rangeland condition. The risks of livestock feed gaps produced by climatic and forage variability were assessed. Interactions between socially embedded institutions, bureaucratic institutions and feed gaps were explored. Alternative tools for managing the risk of feed gaps were assessed, including their availability and affordability through time and space. This analysis identified the periods when feed gaps were most likely. Indicators of rangeland condition and herder livelihoods were then assessed to identify the impact of feed gaps in different institutional settings.

Land degradation levels in all Mongolian Gobi Desert study sites were found to be relatively low. Many indicators of rangeland condition were not significantly different between Law on Land and PUG institutional settings. Those indicators that were different suggested that rangeland condition was slightly better in the PUG areas that herders recognised as being ‘steppe-like.’ However analysis did not reveal any institutional mechanism that accounted for this difference.

There are three possible explanations for these findings. Firstly, PUGs may have been effective at improving condition, but were established in areas that were originally in poorer condition. Secondly, neither Law on Land nor PUG institutions had an impact on rangeland condition compared to socially embedded institutions that are common to both. Thirdly, neither bureaucratic nor socially embedded institutions substantially affected rangeland condition. Rather, exogenous shocks and stresses that affected livestock grazing pressures, such as atypical winter conditions and volatile commodity prices, challenged the ability of current institutions to influence rangeland condition. The second and third explanations are the most likely. Consequently, improving rangeland condition and herder livelihoods requires that policy extends beyond institutions governing access to the forage resource.

Policy needs to consider the dynamic relationships between biophysical, social, political and economic spheres in ways that are appropriately scaled and recognise non-linearity. In the case of the Mongolian Gobi Desert, theories of both the tragedy of the commons and common property have been inappropriately applied to institutional design. Any intervention needs to be tailored to the local social and ecological context. Where forage resource boundaries are fuzzy through space and time, institutions must be equally fuzzy through space and time.

Policy makers are in the difficult position of balancing domestic and international interests that sometimes conflict. Nevertheless, new institutions to address rangeland degradation are not warranted if rangelands are not degraded. In arid rangelands where forage availability is highly variable in space and time, livelihood outcomes are also likely to vary in space and time. Interventions need to extend beyond managing access to forage in order to improve herder livelihoods for the long-term.

Declaration by author

This thesis is composed of my original work, and contains no material previously published or written by another person except where due reference has been made in the text. I have clearly stated the contribution by others to jointly-authored works that I have included in my thesis.

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Publications during candidature

Peer-reviewed papers:

Addison, J., Friedel, M., Brown, C., Davies, J., Waldron, S. 2012 A critical review of degradation assumptions applied to Mongolia's Gobi Desert. *Rangeland Journal*. 34, 2, 125-137.

Addison, J., Friedel, M., Davies, J., Brown, C., Waldron, S. 2012 Do herder groups lead to improved rangeland condition in the Mongolian Gobi Desert? *Journal of Arid Environments.* (*Submitted and currently under revision).*

Conference papers:

Addison, J. Friedel, M. Davies, J. Brown, C. Tiver, F. Urgamal, M, Zhao, M. 2011 Understanding tenure systems in the Gobi Desert. In: *Proceedings 9th International Rangeland Congress,* eds. S. R. Fledman, G.E. Oliva and M.B. Sacido, p781. (Instituto Nacional de Tecnologia Agropecuaria and Asociacion Argentina para el Majejo de Pastizales Naturales, Argentina). ISBN 978-987-23175-1-5. Spoken paper.

Davies, J., **Addison, J.,** Maru, Y. 2011 Experiences from Australia for China's remote western regions. In: *The Workshop of Sustainable Grassland Management in China and Australia Proceedings*, eds Y. Zhang, Kemp, D, p17. Urumqi, China. August 2011.

Maru, Y. **Addison, J.** 2011 What are the dynamics of pastoral mobility in the Gobi Desert and Central Australia*?* In: *Proceedings 9th International Rangeland Congress*, eds. S. R. Fledman, G.E. Oliva and M.B. Sacido, p781. (Instituto Nacional de Tecnologia Agropecuaria and Asociacion Argentina para el Majejo de Pastizales Naturales, Argentina). ISBN 978-987-23175-1-5.

Addison, J. Friedel, M. Davies, J. Tiver, F. Bastin, G. 2010 The risky business of designing land tenure policy in the Gobi Desert. *Proceedings of the 16th Australian Rangelands Society Biennial Conference*, Bourke. (Eds D.J. Eldridge and C. Waters) (Australian Rangeland Society: Perth).

Publications included in this thesis

None.

Contributions by others to the thesis

Secondary datasets are used in this thesis. Chapter 3 describes how these datasets were sourced and the relative contribution by others in their production. Data collection was a shared endeavour for the forage verification dataset – see Chapter 3 for the relative contribution of others to this dataset. The PHYGROW model was designed by the CNRIT team at Texas A and M University, as referenced throughout.

Statement of parts of the thesis submitted to qualify for the award of another degree

None

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Keywords

Gobi Desert, rangeland, institutions, pastoral, degradation, livelihood, risk, variability, Mongolia, Inner Mongolia

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Glossary

Glossary of terms

Terms of on the left of the table are defined as per the right side of the table. Italicised terms are non-English. Alternative spellings of these words are provided underneath these terms.

Aimag (cf. *aimak*)	The first and largest level Mongolian administrative subdivision in rural areas.
Argali	Wild sheep (*Ovis ammon*) native to the Gobi Gurvan Saikhan Strictly Protected Area
Bag (cf. *bagh, bug*)	The third and smallest level Mongolian administrative subdivision in rural areas. Most closely related to a council/shire/Chinese *gaacha*.
Banner	The third level Inner Mongolian administrative division.
Borth	Dried meat produced in Mongolia, particularly for consumption over winter.
Dzud *(*cf. *zud)*	A multifaceted term implying atypical winter conditions. Generally refers to winter conditions in which livestock cannot forage, conditions that are sometimes as exacerbated by previous seasonal conditions such as a dry summer (Reading *et al*. 2006). The vulnerability of herders to dzud is also affected by social, political and cultural factors (Murphy 2011)
Forage availability	The quantity and quality of the vegetative food resource available to livestock at any one point at time.
Gaacha	Chinese administrative area at the level of a village.
Ger	A Mongolian term used to describe a herder's circular dwelling of one room. *Gers* are easily moveable, and usually made of felt. The term is synonymous with the Russian term, '*yurt*.'
Guanz	A small eatery that is ubiquitous in Mongolia.
Hadag (cf *hadak*)	A scarf, often blue, commonly used for ceremonial purposes.
Jin	A Chinese unit of measurement that is equal to 500 g.
Khot ail (cf. *hot ail*)	A number of adjacent *gers.* These *gers* usually belonging to relatives and facilitate benefits such as shared labour and the socialisation of children.
League	The second level Inner Mongolian administrative division.
Mongolian	A citizen of the Republic of Mongolia. The ethnicity of herders in China who identify as being Mongolian people is referred to as 'ethnic Mongolian' in this thesis.
Mu	A Chinese unit of measurement that is equal to about $666.66m^2$
Negdel	Agricultural collectives of Mongolia. *Negdels* were introduced in the socialist era but were dissolved during democratisation of Mongolia in the early 1990s.

Otor	Long distance migration of herders and their livestock to areas of forage availability. *Otor* commonly occurs in summer months in response to forage shortages in the local area.
Rangeland	Land producing native forage for consumption by livestock, and lands that are vegetated naturally or artificially to provide a forage cover that is managed like native vegetation. Generally considered as land that is not cultivated.
Rangeland condition	The status of vegetative and soil processes occurring in a rangeland as it relates to the long-term ability to sustain livestock production. This is assessed in comparison with other sites of the same land type, or in relation to a theoretical potential to be used in the long-term by the pastoral land-use.
Sheep Forage Unit	A standardized measure for assessing the total grazing pressure that livestock of different types are having in an area. Sheep = 1 SFU, camel = 5 SFU, horse = SFU, cow/yak = 6 SFU, goat = 0.9 SFU
Soum (cf. *sum, somon*)	The second and moderately sized level Mongolian administrative subdivision in rural areas
Soum centre (cf. *sum* centre)	The administrative township (seat) of a *soum*. There is generally only one settlement in each *soum*.
Strictly Protected Area	The highest order conservation area in Mongolia, affording the highest level of protection.
Sumu	A village in Inner Mongolia.
Tsagaan Sar (cf. *Tsagaan Tsar*)	Mongolian Lunar New Year. The date varies each year, but is generally in late January or February.
Tsenter	A metric unit of mass equivalent to 100 kg. Commonly used for assessing forage yield in Russia and ex-USSR countries.
Tugrik (T) (cf. *Togrog, Tugrok, Togrok*)	Mongolian currency. As of June 2012, 1 USD was equal to about 1,330 Tugrik.
Yuan	Chinese currency. As of September 2011, 1 USD was equal to about 6.4 Yuan.

Alternative spellings for place names used in this thesis

Place names on the left of the table are those used throughout the thesis.

Baotou Prefecture	包头, *Bāotóu*, Buγutu.
Bayannuur Prefecture	Bayannur, 巴彦淖尔市, Bayanuur, Bāyànnào'ěr Shì, Bayannuur, Bayannagur.
Darhan Muminggan United Banner	达尔罕茂明安联合旗, Dá'ěrhǎn Màomíng'ān Liánhé Qí.
Dundgobi	Dundgov, Dundgovi, Dundgob, Dundgov', Middle Gobi.
Gobi Gurvan Saikhan Strictly Protected Area	Three Beauties Strictly Protected Area, Three Beauties National Park, Gobi Gurvan Saikhan National Park.
Hohhot	Hohhot, Hoh hot, Huhehaote.
Household Responsibility System	Household Responsibility Scheme, Livestock Contract Program, Pasture Contract Responsibility Scheme.
Inner Mongolia	Inner Mongolia Autonomous Region, Öbür Monggol, Өвөр Монгол, Övör Mongol; 内蒙古, *Nèi Měnggǔ*, Nei Mongol.
Mandalgobi	Mandalgovi, Mandalgov, Mandalgob.
Mandal-ovoo	Mandal-oboo.
Omnogobi	Omnogob, Omnogovi, Omnogov, Omnogov', South Gobi.
Tsogt-ovoo	Tsogt-oboo, Tsogtoboo, Tsogtovoo.
Tsogtseggi	Tsogtsegi, Tsogsegi.
Ulaanbaatar	Ulan Bator, Ulaan Bator, Ulaan Baatar.
Urat Rear Banner	Urad Rear Banner, 乌拉特后旗, 烏拉特後旗, Wūlātè Hòu Qí, Urdyn Xoit xoshuu.

Acronyms used in the thesis.

ADB	Asian Development Bank
CV	Co-efficient of variation
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GPS	Global Positioning System
GTZ	German Technical Cooperation (translated from German)
LFA	Landscape Function Analysis (as per Tongway 2008)
MSRM	Mongolian Society for Rangeland Management
NDVI	Normalized Difference Vegetation Index
NGO	Non-government organisation
NZNI	New Zealand Nature Institute
PUG	Pasture user group
S.D.	Standard Deviation
SDC	Swiss Development Corporation
SFU	Sheep Forage Unit
SPA	Strictly Protected Area
T	Mongolian Tugrik
UN	United Nations
USAID	United States Agency for International Development
USD	United States Dollar
USSR	Union of Soviet Socialist Republics
Y	Chinese Yuan

1. Introduction

1.1 Background

Drylands are areas with low levels of precipitation that can effectively contribute to vegetation growth (Food and Agriculture Organization of the United Nations 2010). Drylands cover about 40% of the Earth's land surface, including large areas of Africa, Asia and South America. These landscapes are also home to close to 40% of the global population, many of whom are considered to be economically poor by global standards (see Reynolds *et al.* 2007). Consequently, the management of drylands has an impact on both environmental condition and human livelihoods at an international scale.

Drylands under a pastoral land-use are commonly known as rangelands. It is increasingly acknowledged that rangelands maintain many ecosystem services, and have high, possibly underrated, aesthetic and intrinsic value (Beard 2005; Havstad *et al.*2008). There is evidence that the pastoral land-use evolved to maximize long-term resource use in highly variable conditions (Fernandez-Gimenez 2006; Mworia and Kinyamario 2008), and that the persistence of pastoralism through time may also conflict with assumptions of irreversible declines in rangeland condition (see Ellis and Swift 1988).

A growing appreciation of the status and historical management of rangelands has paralleled an increasing body of literature critiquing more recent, externally-derived management systems of these same lands. Land tenure policies have been variously linked to declining herder livelihoods and land degradation in much of the world's arid rangelands (e.g. Hogg 1992; Fafchamps 1998). The landscapes of colonial and postcolonial Africa informed much of this literature during the mid to late 20th century (e.g. Blaikie and Brookfield 1987; Ellis and Swift 1988; Abel and Blaikie 1989). More recently, the dissolution of the U.S.S.R. and other socialist states has prompted another wave of interest in the design of policy for drylands under a pastoral land-use.

Policies that seek to govern access to the forage resource upon which livestock subsist are an ongoing topic of debate in Inner Asia. Discussion around the formulation of such policies, often referred to as 'the pasture issue,' is highly political in Mongolia. There, about 35% of the country's population is employed in the agricultural sector, primarily as herders (National Statistical Office of Mongolia 2010). The voices of these herders, academics and commentators based in the nation's capital of Ulaanbaatar, local and international development organisations and consultants all compete to be heard.

The draft Pastureland Law is one proposed solution to 'the pasture issue'. This draft Law has been debated by the Mongolian Parliament for several years. Individuals at the Ministry of Food and Agriculture and the Mongolian Society for Rangeland Management have autonomously drafted and promoted their own policy proposals (see, for example, Mearns 2005 and Dorligsuren 2010). Rangeland related conferences such as the 2010 'Towards developing favorable legal environment for sustainable pastureland management in Mongolia' often allude to, or directly address, institutional settings for rangeland management (Dorligsuren 2010). Newspapers publish opinion pieces on policies for governing forage access, such as Enkh-Amgalan's (2008) pro-privatisation article in the *UB Post*. International development agencies invest significant resources into programmes seeking to manage access to the forage resource (e.g. Millennium Challenge Corporation 2007). Meanwhile, across the border in China's Inner Mongolia, significant policy changes in rangeland areas have been linked with land degradation and declines in herder livelihoods (e.g. Li and Huntsinger 2011).

Numerous research, policy and development agencies (Asian Development Bank 1995; Enkh-Amgalan 2008; Millennium Challenge Account Mongolia 2008; Schulze 2009; Dorligsuren 2010; The World Bank 2011) have assumed that a weakened adherence to institutions governing access to the forage resource has created conflict between herders over pasture and declines in rangeland degradation. These assumptions have provided the rationale for a reassessment of policies that govern access to the forage resource. However there has been very little empirical analysis of the relationship between institutional settings, rangeland condition and herder livelihoods in the Mongolian Gobi Desert to support assumptions of conflict and degradation; the assumption that current grazing practises lead to significant, widespread degradation has been specifically challenged (Wesche and Retzer 2005).

The interrelationships between institutions, rangeland condition and herder livelihoods have been well studied internationally (e.g. Blaikie and Brookfield 1987) but remain poorly examined in the Mongolian Gobi Desert. Some ecological studies from the Mongolian Gobi Desert consider the pastoral system (e.g. Fernandez-Gimenez and Allen-Diaz 2001; Ronnenberg *et al.* 2008; Sasaki *et al.* 2009a; Wesche *et al.* 2010;

Cheng *et al.* 2011; Okayasu *et al.* 2011; Sasaki *et al.* 2011), and some social-political research considers the pastoral environment (e.g. Fernandez-Gimenez and Batbuyan 2004; Upton 2008; Upton 2009). Other research considers both herder or institutional perspectives, and ecology (e.g. Fernandez-Gimenez 2002; Marin 2010; Sternberg *et al.* 2009; Sternberg *et al.* 2011). Agrawal (2001) noted that studies of common pool resources tend to neglect how aspects of the resource system interact with the external social, physical and institutional environment to affect institutional sustainability; this is certainly the case, with Fernandez-Gimenez *et al.* (2012) being a rare exception. The comparison with institutional settings in biographically similar parts of Inner Mongolia is rare.

Given the body of literature from the international rangelands linking newly introduced institutions with declines in livelihoods and rangeland condition, these knowledge gaps should be of concern to those interested in improving herder livelihoods or rangeland condition in Mongolia. This research aims to fill some of these knowledge gaps by empirically examining some of the interrelationships between institutions, rangeland condition and herder livelihoods in the Gobi Desert. Particular attention is given to how different forms of variability and scale affect these relationships, with the spatial and temporal variability of both the forage resource and risk management options being a primary focus.

1.2 Approach

A review of the literature (Chapter 2) highlights two key areas affecting both how research questions in arid rangeland systems should be framed, and the methodological approach needed to explore these research questions. Firstly, little onground change has been achieved by new understandings of dryland ecology and common property resource management, but this difficulty may be resolved through work that is grounded in specific social and ecological contexts (Turner 2011). Secondly, a multi- or interdisciplinary approach to research is needed to understand rangelands as a social-ecological system. Drivers, pressures and the relationships between them must be considered at different levels within this system (Ness *et al*. 2010). For the analysis of common property management within such a system, it is also important to understand cross-level interactions with the external social, physical and institutional environment (Agrawal 2001).

These conclusions have implications for the research of institutional settings in the Gobi Desert. For example, livestock feed gaps occur when grazing demand is greater than the available, palatable forage at any one temporal or spatial scale. A household's large herd can be considered as the lowest level cause of feed gaps and over-utilisation. However herding practices at the household level are nested within multiple, higher level biophysical, cultural, socioeconomic and political levels (Murphy 2011). These levels are also nested within higher order levels, each of which has unique spatial and temporal dimensions. Higher order levels, such as national institutions, may facilitate or constrain the options available to herders for managing potential feed gaps.

Figure 1-1 illustrates various multi-scaled factors than can contribute to feed gaps in the Gobi Desert. As Figure 1-1 illustrates, institutions that govern access to the forage resource are only one of the factors that can exacerbate or reduce feed gaps. However they are still important, and remain little explored in the Mongolian Gobi Desert.

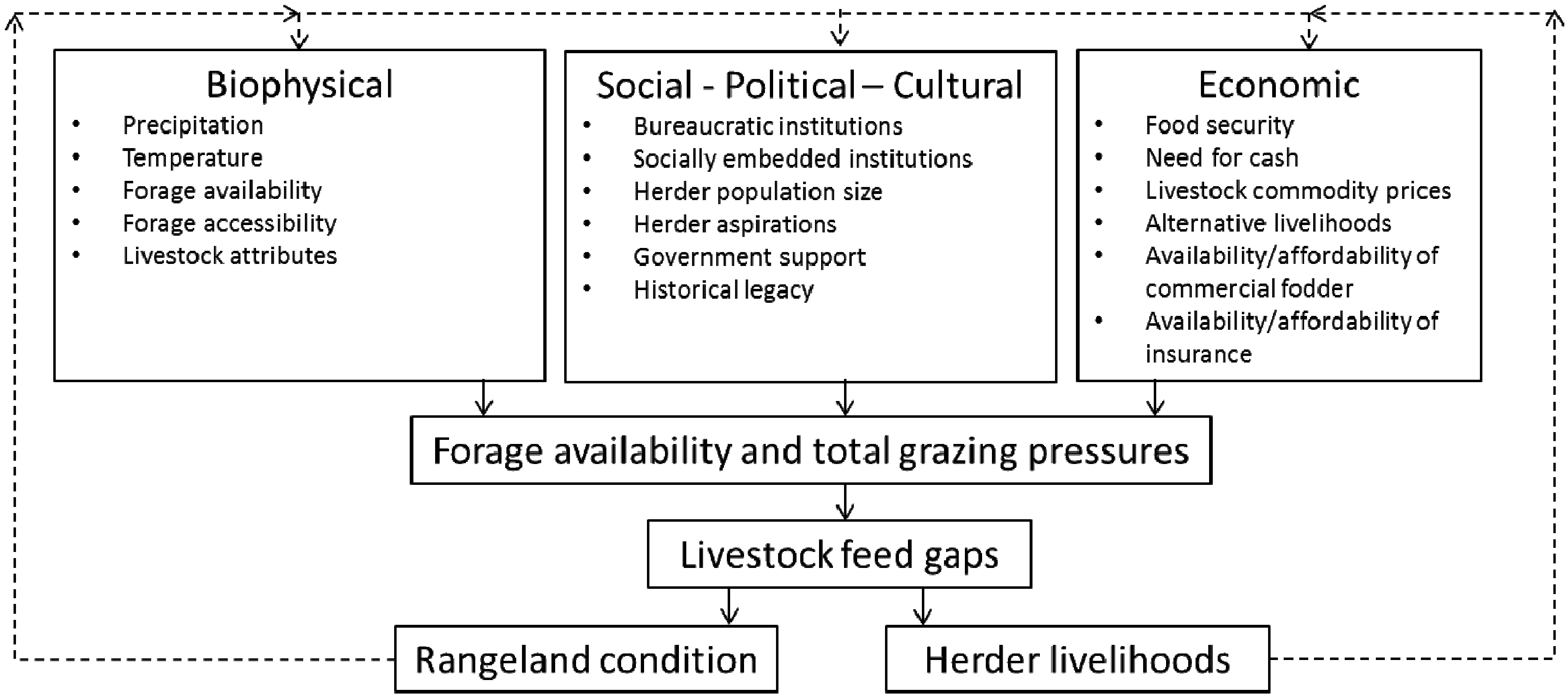

Figure 1-1 A simplified representation of the biophysical, social/political/cultural and economic factors that may affect feed gaps, rangeland condition and herder livelihoods in the Gobi Desert. Biophysical factors ultimately limit forage through space and time, but social-political-cultural and economic factors further constrain the ability of livestock to access the forage. Forage availability and demand interact to create feed surpluses or gaps, which then feedback to affect the biophysical, social-political-cultural and economic factors regulating the forage resource.

This research adds empirical data to the current discussion around policy options for governing the access of livestock to the forage resource. Three broad research questions that acknowledge the Gobi Desert as a social-ecological system are addressed. These questions are:

i) What is the state of rangeland condition in the Gobi Desert, given different institutional settings?

ii) What biophysical or socioeconomic factors may be contributing to the state of rangeland condition described in the first research question?

iii) How do institutional settings interact with the broader biophysical and socioeconomic context to affect rangeland condition and herder livelihoods at present and in the future?

Kates *et al*. (2001) noted that it is necessary to address questions about the relationship between the biophysical and the social/economic/political in ways that differ in structure, methods and content from science as it was previously known. Kates *et al*. (2001) suggested that such research needs to i) span spatial scales, ii) account for temporal inertia and urgency, iii) deal with functional complexity associated with multiple stresses, and iv) recognise a wide range of outlooks regarding what makes knowledge useable within both science and society. These four principles underpin the approach taken in this research.

Research questions are explored in a manner that is both multidisciplinary and interdisciplinary. The term multidisciplinary implies additive knowledge, whereas interdisciplinary implies a synthesis of knowledge that establishes a new discourse or integration of knowledge (Choi and Pak 2006). This research utilizes both biophysical data (e.g. indicators of rangeland condition, climatic, livestock and biomass data, and forage modelling) and socioeconomic data (e.g. policy and institutional analysis, interviews with herders and local officials, commodity data). At times in the analysis, these different types of data are used in a multidisciplinary way following standard disciplinary methodologies and analysis. For example, on-ground biophysical surveys are used to understand rangeland condition. At other times in the research, data is integrated with less commonly integrated forms of data to inform understanding, and the analysis becomes interdisciplinary. For example, rangeland condition surveys are combined with herder perspectives to help understand the causes of rangeland change.

One limitation of multidisciplinary or interdisciplinary research is that each preceding disciplinary area may be presented over-simplistically. That is, breadth may replace depth. To minimise this risk, Chapter 2 begins by carefully defining some key terms used in the thesis. Both biophysical and socioeconomic datasets are frequently used for horizontal cross-verification, or explain each other where possible. Triangulation is used to minimise the biases inherent in any one methodology or research approach. Data at different levels, such as herder accounts of commodity prices at the local level and official prices at the state level, are used for vertical cross-verification. Each of the main chapters in the thesis draws upon a variety of datasets to generate new outputs and inform discussion. It is intended that this approach generates new insights from the numerous multidisciplinary and interdisciplinary spaces in the thesis.

1.3 Thesis structure and chapter descriptions

This chapter provides an introduction to the research. Chapter 2 reviews the literature relevant to research questions and methodologies. It concludes that understanding the effects of institutional settings on rangeland condition in arid regions is difficult due to biophysical characteristics such as non-linearity and scaling issues, and for social, political and cultural reasons. There is evidence that these difficulties have been under-recognised in the Gobi Desert, and therefore assumed linkages between institutional settings, rangeland condition and herder livelihoods require re-examination. Chapter 3 then summarises key social-ecological features of the Gobi Desert, such as low precipitation and a long grazing history, before describing the research methods employed in the study.

Chapters 4 to 9 are data-driven, ‘results’ chapters. However as highlighted in Figure 1-2, there are strong linkages and inter-relationships between the results in each of these chapters. Whilst results are discussed or explained in the final section of each of these chapters, the discussion of the relationships between results in the different chapters is left until Chapter 10.

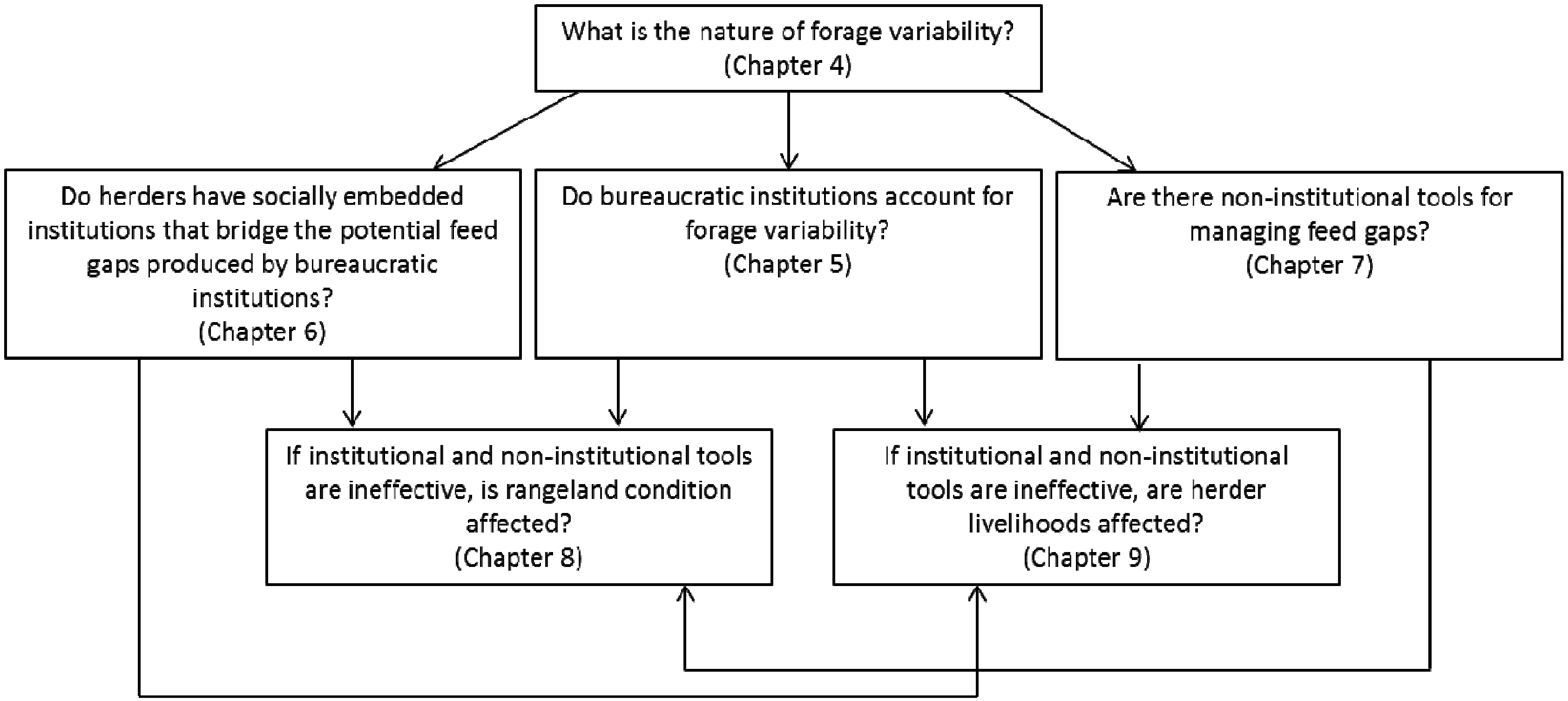

Figure 1-2 Broad linkages between results chapters, and the more specific research questions of each. The arrows between the chapters show the preceding chapter(s) by which each chapter is informed. Forage availability and variability constrain the socio-ecological, pastoral system (Chapter 4). Bureaucratic institutions are designed to govern access to the forage resource (Chapter 5). Socially embedded institutions can supplement or supersede bureaucratic institutions (Chapter 6). Whilst institutions governing access to the forage resource are important, herders can also manage the risks produced by feed gaps using other tools (Chapter 7). The ability of herders to adequately manage the risk results in feed gaps or surplus. Feed gaps/surplus, in turn, affect rangeland condition (Chapter 8) and herder livelihoods (Chapter 9).

Chapter 4 explores the Mongolian Gobi Desert’s climatic and forage variability through time and space to respond to the question ‘What is the nature of forage variability?’ It finds that forage availability in study sites shift in space and time in ways that change the potential benefits that herders receive from defending the forage resource. The implications of shifts in the forage resource are discussed in relation to the potential for feed gaps.

Chapter 5 describes the main bureaucratic institutional settings, the Law on Land, Pasture User Groups (PUGs) and the Household Responsibility System, that govern access to the forage resource in the Gobi Desert. All bureaucratic institutional settings examined aimed to achieve good rangeland management. Despite international criticisms of the carrying capacity concept in highly variable rangelands (see Chapter 2), the matching of livestock numbers to perceived carrying capacity was the primary mechanism through which policies sought to regulate grazing pressures, with government involvement in the monitoring of rangeland degradation in all institutional settings except the Pasture User Groups (PUGs). The relative ability of the bureaucratic institutional settings to influence herder decision-making around stocking rates and respect for administrative boundaries appeared to be low, particularly in Mongolia.

Chapter 6 explores the socially embedded institutions governing access to the forage resource. It finds that shifts in the relative defendability of the forage resource (Chapter 4) are mirrored by mobility patterns, irrespective of bureaucratic institutions. ‘Rule breaking’ under bureaucratic institutional settings is less common when bureaucratic institutions mirror socially embedded institutions, which in turn reflect the shifts in the relative defendability of the forage resource. In Mongolia, sanctions for non-compliance with norms or shared strategies governing access to the forage resource are only weak and sometimes apparently non-existent. Nevertheless they may be sufficient at minimising feed gaps.

Chapter 7 examines non-institutional tools herders use to manage feed gaps. The purchase of fodder was relatively more important in Inner Mongolia than Mongolia. Demand for fodder was greater than that which could be supplied affordably during periods of extreme feed gaps. Across all bureaucratic institutional settings, the reliance on lactating livestock for milk products for subsistence in spring/summer, low commodity prices and a reluctance to cull more livestock than was needed for subsistence purposes over winter, constrained the use of culling for managing feed gaps. Longer term strategies for managing the impact that climatic variability had on both income and subsistence aims included maintaining a mixed flock of a minimum size.

Chapter 8 presents results on rangeland condition. In contrast to assumptions of widespread degradation, Chapter 8 finds that there was little evidence of widespread land degradation in the Mongolian Gobi Desert that was irreversible and grazing mediated. There was some difference in rangeland condition between Law on Land and PUG areas, but few PUG institutions to explain the difference. Some assumptions of degradation, such as declining forage production, had basis in empirical datasets. Others, such as an increase in total grazing pressures, did not.

Herder livelihoods, and opinions on bureaucratic institutional settings, are explored in Chapter 9. The chapter finds that Law on Land herders were poorer than those in other institutional settings if total herd size and herd composition were used as indicators. The minimum viable herd sizes that herders reported were, on average, higher than all figures cited in the literature, and were similar or higher than actual herd sizes in the summer of 2010. In Mongolia, herders were generally positive about the security that registration of their winter/spring camps under the Law on Land gave them. PUG herders were generally ambiguous about the ability of collective action to improve their livelihoods, although some provided examples of financial benefits associated with PUG institutions. Most Mongolian herders had a negative opinion of hypothetical formal rights in summer or autumn pastures due to the inability of a spatially fixed tenure system to account for spatially variable precipitation patterns. In Inner Mongolia, herders were generally positive about the benefits that exclusive rights under the Household Responsibility System gave them, primarily because it enabled government compensation when grazing bans were introduced. However they also felt that their livelihoods have been worsened by the grazing ban.

Chapter 10 provides the thesis discussion, synthesises the preceding ‘results’ chapters to directly address research questions and discusses the implications of the research for policy-making. In the Mongolian Gobi Desert, bureaucratic institutions were only adhered to by herders when they had a basis in socially embedded institutions governing accessing to the forage resource. Socially embedded institutions may have either contributed to the present, reasonable state of rangeland condition, or had no effect in the face of stochastic shocks. Either way, there is little evidence to suggest that new institutions governing access to the forage resource are either needed, or would prove to be effective, in the Mongolian Gobi Desert. Governments and development agencies may find more benefit in designing interventions that focus on herder livelihoods rather than rangeland condition. The strengths and weaknesses of four interventional options; high off-take, high mobility, ‘do nothing’ and high exclusivity/intensification, are discussed. Recommendations for future research are also included.

2 Literature Review

2.1 Terminology

In recent years, an expanded definition of the term ‘rangeland’ means that pastoral-centric references to declines in rangeland condition have been replaced by terms incorporating a wider range of causal mechanisms and impacts. These terms, including land degradation and desertification, can also have a variety of meanings. Reynolds and Stafford Smith (2002) estimated that ‘desertification’ has been used in over 100 ways to describe a variety of biophysical changes that may have ecological, meteorological or anthropogenic dimensions. The term has also become increasingly politicized. This may have created incentives for its usage outside its earlier meaning, for example through the potential funding benefits provided by the United Nations Convention to Combat Desertification (Reynolds and Stafford Smith 2002).

Confusion over terminology, methodological issues and politicization make it important to carefully define terms, particularly those that differentiate between manageable and unmanageable change. This thesis largely deals with dryland rangelands; that is, arid areas with a pastoral land-use. Unless otherwise specified, the term ‘rangeland’ is used in this thesis to describe dryland rangelands that are not significantly influenced by cropping or forestry land-uses.

Many rangelands have had a long history of utilization by herders and their grazing ruminants. Thus they are agro-ecosystems rather than ‘pristine’ environments because the existing vegetation communities have co-evolved with the grazing pressure, and/or may ‘resist’ or be promoted by some level of grazing pressure (McNaughton 1979; McNaughton 1985; Michunas *et al.* 1988; Li *et al.* 2008). In rangelands that have not co-evolved with pastoralism, as is the case in Australia, ‘good’ rangeland condition is not necessarily correlated with indicators of high biodiversity value (Fisher and Kutt 2006). Good rangeland condition and high biodiversity value may be more closely linked in rangelands with a longer term grazing history. Many of the cultural values found in rangelands with a long term grazing history have also co-evolved with pastoralism. Defining rangeland condition using a pastoral lens may therefore be less likely to ignore biodiversity, ecological functioning or cultural values than in more recently stocked rangelands.

Condition in rangelands with a long grazing history can be assessed according to the biophysical environment's perceived ability to maximize pastoral returns in the long-term. This thesis defines 'degradation' or 'poor rangeland condition' along pastoral utilitarian lines using a definition modified from Abel (1997):

'*an effective permanent decline that is attributable to the management of livestock in the rate at which land produces forage for a given input of precipitation. 'Effectively permanent' means that natural processes will not rehabilitate the land within a time-scale relevant to humans, and that capital or labour invested in rehabilitation are not justified. This definition excludes reversible vegetation changes (defined as 'overutilization' or 'overgrazing' in this thesis) even if these lead to temporary declines in secondary productivity. It includes effectively irreversible changes in both soils and vegetation*.'

Dryland rangelands, as defined in this thesis, are characterized not just by low annual precipitation, but often by precipitation patterns that are highly variable when compared with more temperate landscapes (Retzer *et al.* 2006; Sasaki *et al.* 2009a; Von Wehrden *et al.* 2010; Okayasu *et al.* 2011). Precipitation is variable in space, and both within years and between years. Given that precipitation events are well correlated with vegetation production, forage resources are often both temporally and spatially unpredictable for pastoral land-users (e.g. McNaughton 1985; Stafford Smith and McAllister 2008).

Climatic variability produces risk. Risk is defined as per Janes (2010), as '*the probability of adverse outcome and is a function of the intensity of the hazard (the exogenous event or shock) and level of vulnerability*'. A significant risk faced by herders in rangelands with a variable climate is unexpected and sometimes rapid livestock feed gaps, where the forage resource declines such that demand for the utilisation of vegetation exceeds its supply. Feed gaps can lead to overutilization and, potentially, degradation.

Feed gaps can also affect herder livelihoods, both immediately as livestock production declines, and in the longer term as the ability of the rangeland to produce the forage resource declines (see Figure 1-1, Chapter 1). Definitions of livelihoods in the literature have been unclear, inconsistent and narrow (Carswell 1997; Krantz 2001). The historical focus on livelihoods was reductionist (Chambers and Conway 1992; McGillivray 2007), almost exclusively emphasising income despite the widespread desire by people for '*adequate, secure and decent livelihoods which* [provide] *for physical and social wellbeing*' (Chambers 1987). A more inclusive definition for livelihoods are the capabilities, assets and activities required such that stocks and flows of food and cash are adequate enough to meet basic needs (e.g. Advisory Panel on Food Security, Agriculture, Forestry and Environment 1987; Chambers and Conway 1992; Carswell 1997; Ellis 1999).

Different forms of capital (human, physical, social, financial and natural) contribute to these livelihoods (e.g. Scoones 1998; Ellis 1999), but the availability and accessibility of these forms of capital to the individual are important. Factors mediating the availability and accessibility of capital include institutional and social factors at the local level, or overriding policies, economic processes, and legislation at a higher level (Krantz 2001). This thesis uses the term 'livelihoods' in a multi-dimensional way that recognises livelihoods beyond the accumulation of financial assets.

Livelihoods are considered sustainable when they can cope with and recover from stresses (continuous, cumulative, predictable or distressing pressures) and shocks (sudden and unpredictable pressures) (Chambers and Conway 1992). In arid rangelands, livestock feed gaps caused by long or short-term climatic events are significant stresses and shocks that herders can pre-empt, or to which they respond. Herders employ different strategies for this. Herd management (e.g. herd diversification, livestock banks or agistment), economic diversification (e.g. off-farm income, inter-household transfers/loans, or migration), or the building of social capital (e.g. reciprocal altruism) are some examples (e.g. see Cashdan 1985; Wienpahl 1985; Corbett 1988; Ellis and Swift 1988; Mearns 2004; Mworia and Kinyamario 2008; Warg Naess and Bardsen 2010). The order in which these strategies are utilised, and how quickly they are exhausted, depends upon both biophysical and socio-economic factors. An example of a biophysical factor is expected drought longevity; an example of a socio-economic factor is initial household wealth. The susceptibility of herder livelihoods to stochastic socio-economic or climatic events is known as vulnerability (Janes 2010).

Institutions are oral or written laws, policies or an agreement that identify who has what rights and responsibilities over a defined resource at any one time (Alimaev and Behnke

2008). There is no commonly accepted definition for institutions; the term draws upon a variety of disciplines including economics, anthropology and political science (Ostrom 2005). In this thesis, 'institutions' are defined as the rules or norms developed by the shared perceptions of a group of people about proper and improper behaviour, as per Crawford and Ostrom (1995) and Ostrom (2005).

In the pastoral sector, institutions distribute both resources and risk (Murphy 2011). New institutional economics professes that institutions create assurances around access to resources, in turn reducing transaction costs through information asymmetries and creating an increasingly efficient system (see Murphy 2011). Herders may create institutions to help manage the risk of feed gaps, with external agents (such as governments) also creating institutions for the same purpose when risks are outside of local control.

Institutions can be exclusive or inclusive, apply to individuals or large groups, can be nested or overlapping, or can change spatially or temporally (Bromley 1991; Ostrom 1999; Banks 2001; Carlsson and Berkes 2005; Ostrom 2005). They can be contained within an inclusive hierarchy, with one set embedded within a higher order set of institutions (Gibson *et al.* 2000; Ostrom 2005). They can also exist within an exclusive hierarchy, with different sets of rights operating separately to each other (Gibson *et al.* 2000; Ostrom 2005). A constitutive hierarchy of institutions can occur when different sets of institutions combine to create a new set of institutions with new emergent properties (Gibson *et al.* 2000; Ostrom 2005). By appearing naturalised, they can also support hegemony (Murphy 2011).

Institutional settings are the sum of institutions operating in a particular location, at a particular point in time. This thesis separates institutional settings into those that are bureaucratic, and those that are socially embedded. The term 'bureaucratic' and 'socially embedded' as descriptors of institutions share similarities with the widely used terms 'formal' and 'informal,' respectively e.g. Carswell (1997); Rudd (2000); Krantz (2001); Cleaver (2005). In this thesis, these two groups are defined using a modified version of Cleaver's (2002) definition:

"*Bureaucratic institutions are those formalised arrangements based on explicit organisational structures, contracts and legal rights. They are introduced, mediated or* *initiated by governments or development agencies with the aim of achieving environmental or livelihood outcomes. Socially embedded institutions are those based on culture, social organisation and/or daily practice*"

Although these two types of institution settings are distinguished between, they interact to inform each other at a variety of levels and scales (Murphy 2011). Neither is static in time or space. Indeed, Cleaver's (2002) definition is modified here in recognition that development agencies in the Gobi Desert have sometimes employed participatory methods in the establishment of new institutions. Often, these groups formalise or consolidate pre-existing, socially embedded institutions that coincide with their overall aims rather than introduce new institutions. This blurs the line between the two institutional types. As Soyler (2012) notes, there is a '*complex, dynamic and contextual…relationship between formal and informal realms, which can be negative, positive or double-edged'*.

The term 'socially embedded' should also not be confused with 'traditional' or 'customary' institutions in a way that implies cultural statism. Significant socio-political shifts in the Gobi Desert (Section 2.5) indicate that these institutions have changed markedly in recent time. For example, some of the current socially embedded institutions of the Mongolian Gobi Desert may be based upon bureaucratic institutions of the *negdel* period. These may be in turn in turn based upon pre-revolutionary socially embedded institutions that were bounded by institutions formalised by the Buddhist monasteries. Types of institutional settings, and the ways in which these different types may affect rangeland condition and herder livelihoods, are further presented in Chapters 5 and 6.

2.2 Complexity in the rangelands

In recent years, high rates of change and new emerging shocks have increased the level of risk and vulnerability experienced by many herders in many rangelands. These shocks and changes include high population growth, increased interaction with global markets, cost price squeeze or changing interactions with the State (Hogg 1992a; Campbell *et al.* 2001; Janes 2010). The extent and severity of external shocks have changed. Pressures on the risk management strategies by which herders can match forage availability with demand by livestock through time and space have increased (Anderson and Hill 1975; Passmore and Brown 1992; Abel and Benke 1996; Sneath

1998; Agrawal and Gibson 1999; Robinson *et al.* 2003; Dickinson and Webber 2004; Stokes *et al.* 2006). At times, strategies for managing risk can fail altogether (Blaikie and Brookfield 1987).

Governments have responded to these changes by investing in rangeland science and management. Rangeland science, as a western discipline, has consistently sought to better manage livestock utilization of the forage resource so as to maximize livestock productivity in the short-term whilst not compromising the ability of the biophysical environment to produce forage resources in the long term. However the discipline has undergone significant change in recent years as theoretical models have been created, and then modified. These models have changed with a growing understanding of the biophysical context, but also as social, economic and cultural factors have been recognised as an intrinsic part of rangeland systems. Some of these changes are now outlined and discussed.

Rangeland science historically foregrounded livestock, and the livestock manager, as the main agents of biophysical change. Vogel and Smith (2001) observed that under this approach to rangeland science and development, the cause of problems like hunger and land degradation was well known. 'Production thinking' linked problems like hunger to livestock production constraints (Chambers and Conway 1992). The attributed cause of degradation under linear rangeland models and approaches (discussed below and hereafter referred to as the classic approach) was that stocking rates exceeded carrying capacity, particularly in rangelands that had experienced high human and livestock population growth (a perception well described by Hogg 1992; Abel 1997; Ho 2001; Agrawal and Saberwal 2004). The manipulation of factors outside the knowledge or control of local pastoralists (Hogg 1992), via rehabilitation or extension services, were viewed as the primary tools for addressing these problems. So too were carrot and stick policy controls (Vogel and Smith 2001).

The classic approach to rangeland science relied upon linear or static theoretical models for understanding change; a model that Scoones (1999) noted had roots as far back as Greek, medieval Christian and eighteenth century rationalism. Whilst Clements (1916) noted that '*the most stable association is never in complete equilibrium*', Clementsian succession was widely interpreted as a linear progression to a stable vegetation community in response to a disturbance such as grazing. The Clementsian conceptual framework was then transplanted from predictably wet landscapes to those of the arid rangelands. Grazing by livestock was understood to exert a ‘downward’ pressure on this natural progression, with an overgrazed state being one in which utilisation exceeded the carrying capacity of the forage resource. The removal of livestock was understood to enable the vegetation community to return towards climax. Rangeland monitoring programmes were subsequently designed to assess the level of departure of a vegetation community from a hypothetical climax state (Dyksterhuis 1949).

The applicability of linear models to arid rangelands was increasingly challenged through the second half of the 20th century. Field based data suggested that plant abundance and composition varied discontinuously and irreversibly in some landscapes, and grazing could lead to soil conditions or a vegetation community not amenable to the growth of palatable plant species, regardless of a subsequent removal of grazing pressure (Dyksterhuis 1949; Westoby *et al.* 1989; Holling 1973; Friedel 1991). The establishment of some plant species was dependent upon stochastic events like a run of good rainfall years (Westoby *et al* 1989).

New biophysical models were developed to account for these findings. Noy-Meir (1975) proposed that there may be more than one ‘steady state’ in the relationship between livestock and vegetation, with relatively stable vegetation complexes separated by a turning point that could be reached by the presence or absence of a certain level of grazing pressure. Westoby *et al.* (1989) proposed a new model characterised by a set of discrete states, and transitions between them. State and transition models were based upon relatively stable vegetation assemblages that could move towards a series of alternative assemblages based on the type of management, or climatic or stochastic event(s). The concept of permanent thresholds between vegetation assemblages provided an explanatory mechanism that distinguished between such assemblages (Friedel 1991).

Ellis and Swift (1988) used the growing understanding of herbivore-plant interactions in a Kenyan rangeland system to explain the persistence of livestock production in a landscape that was believed by colonial administrators to be unsustainably overstocked. In doing so they departed from the classic rangeland science concept of equilibrium systems where precipitation was predictable, and livestock-forage interactions were tightly coupled. Ellis and Swift (1988) suggested that in rangelands with highly variable precipitation patterns, and where livestock numbers were not artificially supported during stochastic shocks such as the unpredictable but frequent droughts, high levels of livestock mortality allowed the vegetation community to recover episodically. This was largely because the reproduction time of livestock (and therefore grazing pressures) occurred more slowly than the reproductive time of vegetation (and therefore vegetation production available for consumption). Since whether a rangeland is equilibrium or non-equilibrium has been linked to its relative ability to be overgrazed and subsequently permanently degraded, much effort by rangeland scientists has been put into field-based assessments to distinguish between these two types of rangelands e.g. Fernandez-Gimenez and Allen-Diaz (1999); Retzer *et al.* (2006); Zemmrich (2007); Okayasu *et al.* (2011), or to progress non-equilibrium theory (Briske *et al.* 2003; Vetter 2005, Briske *et al.* 2010; Von Wehdren *et al.* 2012).

Both spatial and temporal scales are increasingly recognised as important. This has challenged the simplistic classification of landscapes based upon Clementsian succession theory, or models of state and transition or equilibrium/non-equilibrium processes. Conclusions about the state of degradation of a landscape were found to be dependent upon the spatial scale at which rangeland condition was assessed (Friedel *et al.* 1993; Friedel 1994; Reynolds and Stafford Smith 2002; Warren 2002). Grazing pressures around waterpoints can be greater than areas further out, but the relationship between distance to water and effect on soil and vegetation parameters can vary between land types, land use history or what indicator is being measured (Bastin *et al.* 1993; Friedel *et al.* 1993; Sasaki *et al.* 2009b). Pringle *et al.* (2006) showed that different methods of assessment led to opposite conclusions about the degradation state of the same area of arid shrubland in Western Australia. Pringle *et al.* (2006) concluded that the under-recognised scaling differences in the two rangeland condition assessments were the underlying reason for the opposing interpretation of rangeland condition trend.

The importance of temporal scale in understanding change is also increasingly recognised. Rangeland condition assessments that relied upon ‘faster’ variables that can rapidly change did not adequately differentiate between anthropogenically caused change in the vegetation, and short-term climatic responses (Bastin *et al.* 1993; Abel 1997; Stafford Smith and McAllister 2008). High grazing pressures may contribute to utilization that is sub-optimal because they reduce the photosynthetic ability of the vegetation community in the short-term. Despite overutilization, permanent degradation may or may not occur depending upon whether vegetation productivity and composition can return to a similarly productive state if the grazing pressure is removed. Even irreversibility was found to have its own temporality. The mineralisation of rocky substrates into soil may restore vegetation productivity over long time periods. Abel (1997) found that soil life in a pastoral area in Botswana at recommended stocking rates, and at a zero stocking rate, was over 1,000 years, but that under current stocking rates it had an estimated life of only 800 years. The hypothesis that destocking would lead to higher productivity was supported, but the estimated delay was over 500 years (Abel 1997).

For a variety of reasons, policy makers tend towards relatively spatially and temporally static solutions for addressing rangeland issues. However mismatches of scale between rangeland condition assessments, management and policy responses can create perverse outcomes. Erosion can be detected by remote sensing but often by the time it is large enough to be detected, it can be too difficult to manage (Prince 2002). The 500 year delay described by Abel (1997) may have been inappropriate for both the planning horizon of policy makers, and the herders impacted by policies requiring destocking. Temporally fixed carrying capacities for livestock, a common policy response designed to protect against overgrazing, ignore natural fluctuations in the forage resource (Ho 2001). Adherence to these carrying capacities can create an opportunity cost for livestock production in good forage years when forage may be overabundant relative to utilisation rates. It can also condone overgrazing in poor forage years if carrying capacities justify grazing pressures at levels higher than what forage availability can service (Scoones 1989; Leeuw and Tothill 1990; Bartels *et al.* 1993; Ho 2001). The implication is that both spatial and temporal scales need to be explicitly stated so that methods, assumptions, conclusions and, ultimately, policy responses are not extrapolated inappropriately through time and space (Warren 2002).

Non-linear models for understanding rangeland change have also provided insights, but not panaceas, for the management of arid rangelands. Non-equilibrium theory has informed policy making by, for example, weakening the case for prescribed carrying capacities that may have significant livelihood implications for herders (Hogg 1992). Non-equilibrium theory has also given a level of scientific credibility to the perspectives of herders who deny that grazing mediated degradation occurs, or who seek to maximise livestock numbers. However, there is persistent evidence that non-equilibrium rangelands can, and do, degrade (Pickup *et al.* 1998).

Like earlier linear models, the division of rangelands into two states, equilibrium or non-equilibrium, may oversimplify both biophysical and socioeconomic factors affecting rangelands. An annual coefficient of variation for precipitation or forage production of 0.30 or 0.33 is frequently used to distinguish between equilibrium and non-equilibrium precipitation patterns in rangelands (Ellis and Galvin 1994; Ho 2001; Okayasu *et al.* 2011). However a simplistic use of the coefficient of variation of precipitation for classifying variable landscapes ignores spatial scaling issues (Zemmrich 2007). Rangelands that have non-equilibrium precipitation patterns may include vegetation communities that are relatively equilibrial due to other biophysical factors such as soil type that may smooth the effects of short-term precipitation patterns (Ho 2001).

Rangelands categorised as having non-equilibrium precipitation patterns have also sometimes been confused with non-equilibrium pastoral landscapes. Ellis and Swift (1988) described 'boom and bust' cycles of livestock numbers in response to precipitation patterns. 'Boom and bust' cycles occurred in the absence of significant, artificial support of the pastoral sector that dampened mortality rates during droughts. The work of Ho (2001) also suggested that in some arid rangelands, socio-political factors can also dampen 'boom' (periods of high livestock numbers) and 'bust' (periods of low livestock numbers) responses. A dampened livestock 'bust' response may not allow enough time for vegetation to regenerate during a period of breaking rains when soil moisture is adequate but before livestock numbers build again. Linking high levels of precipitation variability to the potential of a landscape to degrade is therefore overly simplistic; social, political and cultural factors can affect this potential.

The inclusion of social understandings of change and degradation has further complicated attempts to understand the sustainability of rangeland systems. Like Ellis and Swift (1988), Abel and Blaikie (1989) found similar non-equilibrium 'boom and bust' livestock trends that were remarkably persistent in Botswana. This was despite assumptions by colonial administrators that such cycles would facilitate degradation. Increasing volumes of literature have provided examples of disconnects between degradation rhetoric and reality, and have used either social or biophysical theoretical models to explain these disconnects (see, for example, Blaikie and Brookfield 1987; Behnke *et al.* 1993; Abel and Benke 1996; Fairhead and Leach 1996; Agrawal and Saberwal 2004; Reynolds and Stafford Smith 2002).

One explanation for these disconnects is that degradation is at least partially a cultural construct. As an example, shrub encroachment has held significant currency as an indicator of rangeland degradation, and has been exported internationally from its conceptual origin in the U.S. (Eldridge *et al.* 2011). Holling (1973) described shrub encroachment as a negative response to grazing that was effectively irreversible, unable to be pushed 'upwards' towards a climax community when the grazing pressure was removed. However the meta-analysis of Eldridge *et al.* (2011) found that shrub encroachment can have positive, negative or neutral effects on a wide range of ecological processes, depending on the biophysical context.

The costs and benefits of these biophysical effects of shrub encroachment are also culturally determined. Abel (1997) found that shrubs in a Botswanan rangeland may assist livestock survival, and therefore human food security, during drought. Shrub encroachment may also increase fuel options for herders, or provide a form of secondary income (Campbell *et al.* 1997; Dahlberg 2000). The emphasis on livestock productivity and economic efficiency are narrow economic values, whereas herders may place more value on broader issues, such as food security (Hogg 1992).

There is another explanation for disconnect between rhetoric and reality in rangeland condition. Environmental degradation holds its own political, economic and cultural currency. Arid rangelands are largely situated in 'developing' countries with a high diversity of both internal and external stakeholders. These include local and international development agencies, environmentalists, consultants, scientists, government bureaucrats and herders, some of whom have competing interests. Land degradation has become politicised internationally (Reynolds and Stafford-Smith 2002), and can act as leverage for acquiring financial aid. The rising power of non-government organisations operating in the environmental policy and management sector, and the ability of these organisations to influence policy in Australia's democratically elected governments, has been raised as a concern (Lane and Morrison 2006). This issue may be compounded in countries more reliant on external aid. The potential for the misrepresentation or distortion of the extent, severity and causal mechanisms behind rangeland change are therefore significant.

Shifting understandings of rangeland condition, and the processes by which it may decline, have led to the acknowledgement that rangeland condition must be considered in its specific spatial, temporal, environmental, socioeconomic and cultural context (Warren 2002; Turner 2011). The movement away from generalized, linear models under the classic approach to rangeland science and development has led to the purpose and validity of rangeland monitoring, management and policy-making being challenged (Hogg 1992). The exclusive role of rangeland scientists, extension officers and policy-makers in defining or promoting sustainability in the rangelands has been challenged. Indeed, some regulatory bodies are purported to be reluctant to take action on cases of degradation in part because of uncertainty in the science (Pickup *et al.* 1998).

A grass-root, people-centred, political lens has increasingly been used to address some of this uncertainty (Blaikie and Brookfield 1987; Vogel and Smith 2001). A new discipline of political ecology (and allied perspectives of social or new ecology) evolved in response to the neo-Malthusian assumptions of the earlier classic approach (see Carswell 1997; Scoones 1999). In rangeland contexts, Turner (2011) referred to this new discipline as the "new pastoral development paradigm". Other factors have also contributed to the growth of a more people-centred approach to rangeland science and management. These include the increasing interest in ecological ways of thinking by social scientists (see Scoones 1999; Gibson *et al.* 2000), and the general decline in disciplinary reductionism through the 1970s and 1980s (Chambers and Conway 1992).

The unification of previously disparate disciplines has resulted in new models for understanding the relationship between the rangeland resource and the ways in which herders interact with it. These models have tended to link rangeland ecology and common property resource management (Turner 2011). For example, Dyson-Hudson and Smith (1978) modelled the relationship between biophysical attributes of the forage resource, and the spatiality of herders. Under the Dyson-Hudson and Smith (1978) model, forage resources that have a distribution predictable in space and time have a greater economic defendability than resources that are relatively less predictable. That is, it is more efficient (requires less time/energy per unit return) for resource users to disperse to mutually exclusive grazing areas when forage has a uniform distribution and is predictable as territoriality is less viable below a certain threshold (Dyson-Hudson and Smith 1978; Mearns 1993). When resources are unpredictable, resource users will clump around resource pockets. At times, these resource patches can exceed the level that can be utilised (as predicted in arid rangelands by Ellis and Swift 1998), and is thus best shared rather than defended (Dyson-Hudson and Smith 1978).

Political ecology provides an increased emphasis on the effects that political economy can have on natural resource management, including in areas like the arid rangelands (Blaikie and Brookfield 1987; Chambers and Conway 1992; Hogg 1992; Vayda and Walters 1999; Agrawal and Saberwal 2004). Instead of being seen as irrational, whimsical, politically passive or backwards (Li and Li 2012), the agency of herders is increasingly acknowledged. There is increased recognition that herders actively pursue a variety of sophisticated strategies for maintaining their livelihoods (Hogg 1992; Agrawal and Saberwal 2004) but that this agency can be facilitated or constrained by higher level, structural features of the biophysical or socio-political landscape.

The discipline of political ecology also emphasises the importance of understanding how the scale of social, political and economic factors influences the assumed causes and effects of land degradation (Scoones 1999; Gibson *et al.* 2000). Scaling issues also have implications for the attribution of management responsibility (e.g. land-user, government or socio-economic system) for degradation (Blaikie and Brookfield 1987). Rather than degradation being caused by the localised affects of herders grazing too many animals, soil erosion could be caused by powerful elites, privileged by higher-level political systems and market power, for example. Consequently, the discipline has emphasised that an analysis of issues like land degradation requires sensitivity to the interrelationships between structural features of, for example, political and biophysical systems, and human agency, at different scales (Scoones 1999).

This approach has not been without critics. Political ecology pre-defines the political/economic variable believed to contribute to degradation, rather than robustly testing it (Vayda and Walters 1999). Emphasising the political and social dimensions of biophysical resource use without recognising the dynamics of the resource also risks misunderstanding the causes behind rangeland change. For example, Hogg (1992) suggested that it was ethnographic accounts stressing the cultural values of large herd sizes that masked the ecological and economic arguments in support of an individual herder increasing their herd size. Despite these limitations, political ecology has foregrounded the socio-cultural issues that can affect both the costs and benefits of resource utilisation. It has provided a more sophisticated understanding of degradation than that of the classic approach to rangeland science.

The literature review so far has summarised responses to shocks affecting the arid rangelands, with a focus on the general shifts in the way arid rangelands are understood by rangeland science. These shifts in understanding, as well as those in policy making and management practises, have been asymmetric through space and time. Despite the growing recognition of scaling issues in rangeland science, the use of livestock carrying capacities that ignore the high temporal variability of the forage resource. Indicators of rangeland condition that are temporally sensitive, like vegetation biomass, are still commonly used in many areas of arid rangelands. Indicators are sometimes used without first asking, what are we managing for? In some areas, these issues have combined with other social, economic and political drivers in complex ways. This has created confusion over the state and nature of rangeland condition, the causes for that condition, and potential policy mechanisms to address these causes. The arid rangelands of Inner Asia, the area including Mongolia and non-coastal, northern and western China, illustrate some of these issues.

2.3 Perceptions of land degradation in Inner Asia's rangelands

Cultural preconceptions have influenced the proposed causes of degradation in Inner Asia for a long time. As early as 1938, Lattimore (1938) criticised the extension of assumptions around the anthropogenic causes of the American dustbowl to Inner Asia. These conflicted understandings of Inner Asia's rangelands continue today.

The Chinese rangelands, relatively more reported in the English, peer-reviewed literature than other Inner Asian countries, provide a good example of government reports and articles presenting a more simplistic picture of rangeland degradation than the reality (Ho 2001). Poorly defined terminology and a lack of appreciation for temporal and spatial scaling issues found in other parts of China (Ho 2001) were also highlighted in Yang *et al.* (2005)'s comparison of three different Chinese desertification assessments (Chinese Committee for Implementing UN Convention to Combat Desertification 1997; Middleton and Thomas 1998; Zhu 1998). Zhu's (1998) estimate of the spatial extent of 'physical, chemical and other processes' erosion was about one eighth that of the Chinese Committee for Implementing UN Convention to Combat Desertification (1997) and UNEP (Middleton and Thomas 1998) estimates. Zha and Gao (1997) cited three different figures for the area affected by desertification in China; 1.1 million km^2 (Zhu and Cui 1981), 1.3 million km^2 (Guo *et al.* 1989) and 2.2 million km^2 (Zhou and Pu 1996). The lack of definitions and assumptions stipulated in the three papers make it difficult to compare these figures, or to estimate their precision or accuracy. For example, the Guo *et al.* (1989) figure included the substantial area already covered by deserts, and did not differentiate between the state of climatic 'deserts' and the process of 'areas undergoing desertification' (Zha and Gao 1997).

Not distinguishing between natural and anthropogenic change has also been problematic. The Chinese Committee for Implementing UN Convention to Combat Desertification (1997) used vegetation coverage, a temporally variable indicator, to assess the presence of wind erosion. The claim that the 1994 total biomass of the grasslands was 30 – 50 per cent of that of the 1950s led to the conclusion that Inner Mongolia's grasslands were severely desertified (Longworth and Williamson 1993; Ho 2000; Ho 2001; Sheehy *et al.* 2006; Williams 2006). However the choice of indicator did not differentiate between short-term vegetation responses and long-term degradation. During the 1990s, hundreds of questionnaires were used to define desertification as light, medium, severe or extremely severe (Wang *et al* 1998; Yang *et al.* 2005). Apart from the weaknesses of solely assessing degradation through surveys based on perceptions, the indicators of bare sand ratio, vegetation cover and total biomass also relied upon 'faster' variables driven by short-term precipitation patterns that may, or may not, mask permanent degradation.

Ho (2001) used a case study in Ningxia Hui Autonomous Region, China, to illustrate the problems of ignoring temporal scaling, and the weaknesses of relying upon linear rangeland models to understand condition. Over 90% of Yanchi County was classed as desertified in the early 1980s, with overgrazing cited as a primary mechanism for the degradation. In 1995, a government report stated that desertification affected only about three quarters of the county but it was unlikely that the extent of 'permanent' degradation could have so significantly declined during that time period. Regardless, the stocking rates in Yanchi County were below estimated carrying capacity. Government reports did not acknowledge the discrepancy between understocking and the large area of degradation. Other factors not cited by Ho (2001), such as poorly collected or reported statistics, may also have led to inappropriate conclusions.

The origins of desert expansion in northwest China has been linked to the Ming dynasty (1368 to 1644), when human influence was believed to be minimal (Ho 2001). High levels of desertification were probably an accurate description of Yanchi County if the assessed level of degradation used the historical baseline of the Ming dynasty. This means that the ‘pristine’ baseline under a linear rangelands model should have been a desert rather than a pre-desert state. Regardless, the usefulness of such an old baseline in terms of guiding expectations about the ability of present day rangeland management to produce good rangeland condition outcomes is tenuous.

Other socio-cultural factors may have contributed to inadequate understanding of rangeland condition and change in Inner Asia. Zhou and Pu (1996) in Zha and Gao (1997) noted translation errors of international meanings of ‘desertification’ into Chinese that overemphasised the material (sand) rather than the degrading process. Robinson *et al.* (2003) compared Soviet and western methods of ‘reading’ the Kazakh rangelands. They highlighted the vagaries of understanding rangeland condition when past and present assessments were underpinned by false assumptions imported from elsewhere, were methodologically inconsistent or did not include field-based assessment. In Mongolia during the early post-socialist 1990s, degradation was blamed on Soviet-influenced attempts to make herders more sedentary. This belief was later considered by some in the development sector to be a western bias against socialism rather than one based upon rangeland science (anonymous international consultant in Mongolia during the early 1990s, interviewed in 2011, personal communication).

The factors believed to contribute to rangeland degradation in Inner Asia have also varied depending upon whether the classic or political ecology approach to understanding degradation has been taken. Research following the classic approach has attributed the cause of degradation to overgrazing caused by too many livestock (Han *et al.* 2008) managed by ‘irrational’ or ‘backward’ herders (Zhaoli *et al.* 2005). Other research with an approach more closely aligned to political ecology has foregrounded significant social and demographic change, such as population increases associated with colonialism and expansionism (Neupert 1999; Williams 2000; Chen and Tang 2005; Janes 2010), or acknowledged that assessments of pastoral system efficiencies can be too narrow, missing key components that provide social or economic benefits other than immediate revenue in the form of cash (Banks 2003).

The growing acknowledgement that degradation has both a social and biophysical context has made it increasingly difficult for policy makers to interpret and respond to biophysical change. The design of policy must be both prescriptive enough to achieve natural resource management aims, and flexible enough to allow for social and biophysical variation across space and time. The institutional settings of arid rangelands illustrate some of the challenges associated with designing policy in a way that balances prescriptiveness and flexibility in such a difficult social and biophysical context. The thesis now turns to this discussion.

2.4 Institutional settings of the arid rangelands

Institutional settings can exert significant influence over the way in which herders manage the risk associated with a highly variable forage resource (Alimaev and Behnke 2008). In arid rangelands, institutional settings have evolved, or been designed and applied, for a multitude of reasons. Social, economic and political purposes (MacLeod 1990; Passmore and Brown 1992) are important, but so too are cultural legacies, such as the colonisation by people with institutions designed in more temperate landscapes. Consequently, institutional settings are diverse, complex, overlapping in time and space, and consist of a dynamic mix of bureaucratic and socially embedded institutions. This section firstly discusses attributes of the forage resource that are most relevant to the evolution of institutions in arid rangelands. It then describes the main institutional settings operating internationally.

Common pool resources act like public goods in that it is difficult to prevent their utilisation by others. However they are subtractable like private goods in that utilisation by an individual will lessen the potential for utilisation by another individual (Ostrom 1990). The common pool, forage resource is not exclusive to a defined group or individual at any point in time in open access situations. Access is neither controlled by local, socially embedded institutions that are policed by herders, nor by the State. Externalities can be created by this absence of institutions governing access to the forage resource.

The 'tragedy of the commons' concept (Hardin 1968) evolved from open access situations, or where such a situation was assumed to be present by external agents. The 'tragedy' was believed to arise when an individual's use of the resource provided them with benefit, but subtracted from the benefit of the resource to others when there was a lack of institutions governing resource use. For example, an individual herder gains for each additional animal that they bring to an open access resource, but other herders suffer through having less resource to use themselves. In such a scenario, there is no incentive for any one individual to cap their livestock number, so the total livestock number increases, ultimately degrading the forage resource such that the collective cost of resource utilisation is greater than the collective benefit. Overgrazing and declining rangeland condition across the world have been attributed to less exclusive settings and the 'tragedy of the commons' mechanism (e.g. Al-Rowaily 1999).

Exclusivity over the forage resource is one instrument by which the 'tragedy of the commons' mechanism can be resolved. Institutional settings that are exclusive are believed to evolve when it becomes economic for the costs of externalities to be internalised (Anderson and Hill 1975). Dyson-Hudson and Smith (1978) hypothesised that forage availability and variability were important biophysical attributes affecting the viability of institutions of exclusivity (Figure 2-1):

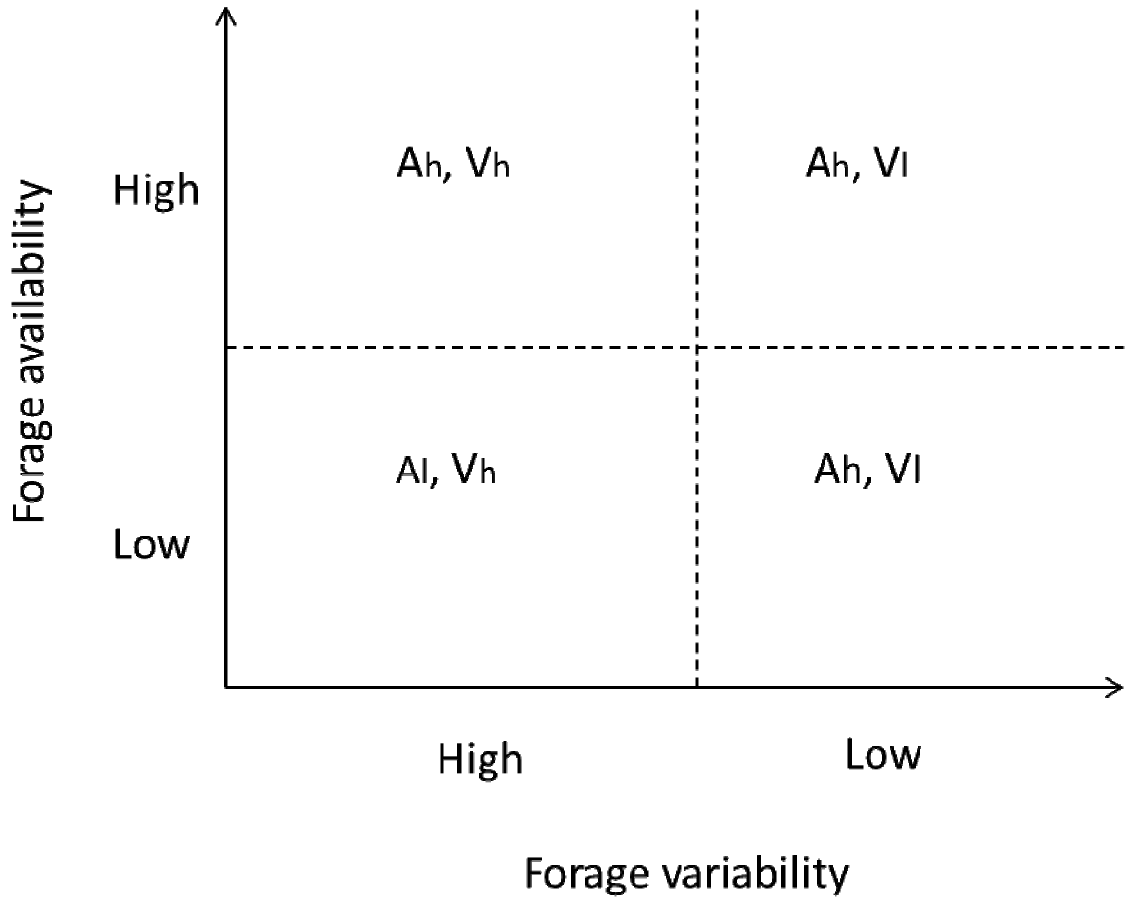

Figure 2-1 Territoriality as a product of forage resource attributes. A = availability, V = variability, l = low, h = high. Forage availability = forage production per head of livestock per unit area. Forage variability = the likelihood that a unit of forage will be present at any one point in time or space. Figure modified from Dyson-Hudson and Smith (1978).

In Figure 2-1, A_hV_h and A_lV_h represent low economic defendability. That is, herders gain little return from investing in the capture and defense of the forage resource. Access to the resource is less exclusive. In conditions of A_hV_h, Dyson and Hudson (1978) propose that resources will be secured through increased mobility over a large area, and that resource user boundaries will be weak and dynamic. Reciprocal altruism may arise for insurance purposes. There is high economic defendability in A_hV_l situations. Resources are abundant but their availability is limited. Territories will be defined for groups and will be stable through time. Access to the resource is more exclusive. Resource users will invest energy in defending their resource. The economic defendability of A_lV_l is fairly low, and there will be large home ranges with some overlap between resource users.

The evolution of institutions governing access to the forage resource is believed to reduce the risk of an individual herder being exposed to livestock feed gaps. They do this by effectively sharing the risk inherent in climatically variable landscapes amongst a group of herders at key times (Mearns 1993; Khodarkovsky 2002; Alimaev and Behnke 2008). Prior to Soviet influence, the clans and member encampments of the Kazakhs, and most people of the Inner and Central Asian steppe, had recognised territory between which they migrated in summer and winter (Alimaev and Behnke 2008). Bedouin herders allowed access to forage by other groups when it was locally sufficient but poorer in other areas (Perevolotsky 1987; Ostrom *et al.* 1999; McAllister *et al.* 2006).

The regulations of access to the forage resource by herders provided here demonstrate socially embedded institutions. However States and development organisations have made a considerable effort to develop pastoralism in recent years. That is, improve economic returns to herders whilst maintaining or improving the natural capital of the forage resource. Proposed policy interventions have often been to alter institutional settings in cases where there is an assumed lack of institutions that effectively govern access to the forage resource. This has included changing an institutional setting from that which is non-exclusive or exclusive to a group, to that which is exclusive to an individual household or business entity. The rationale has been that the value of exclusive rights, and the ability to transfer those rights, captures investments in good land management. In these rangelands, governments or other external agents have formalised grazing use rights at the level of the individual herder household. Rights are transferrable, recognised by the State and are effectively secure, regardless of whether they are leasehold or freehold.

Amongst other aims, such a policy change has attempted to encourage reductions in stocking rates (Ellis and Swift 1988; Abel and Blaikie 1989). Under the linear rangeland model of changes in vegetation assemblages over time, this reduction in stocking rates would theoretically remove the ‘downward’ pressure on the vegetation community, subsequently allowing it to progress back to an equilibrium state (Ellis and Swift 1988). Herders would leave the forage resource ‘in reserve’ without fear that others would utilise it. Restricting the number of herders with access to an area of forage was therefore believed to improve rangeland condition, with the higher value of rangeland in good condition adequately compensating the herder who had destocked.

The efficacy of this policy position appears to have varied according to, amongst other factors, the variability patterns of the forage resource. Semi-humid Zimbabwe and the Kenyan highlands, where rainfall is reliable, have reportedly been privatised successfully from a rangeland condition perspective (Fafchamps 1998). The privatisation of other parts of arid and semi-arid Africa has not been so successful (Fafchamps 1998). Hogg (1992) considers that the application of the exclusivity concept in general has failed in its ability to improve either rangeland condition or herder livelihoods. State-mediated attempts to develop pastoralism using the exclusive institutional settings as a policy instrument have been criticised as ignoring herder livelihood strategies; mobility has been removed as a risk management strategy without replacing it with a compensatory mechanism (Agrawal and Saberwal 2004).

There is growing recognition that the ‘tragedy of the commons’ is often misdiagnosed, and that the ability of the State to manage natural resources at the local level is extremely limited e.g. (Swallow and Bromley 1995; Agrawal and Gibson; 1999). Combined with the growth of political ecology (see earlier), the role of more socially embedded institutions and collective action in natural resource management has been re-examined (e.g. Ostrom 1990). Community based management, joint management, co-management and collaborative management are just a few of the different manifestations of a return to common property resource management (Campbell *et al.* 2001).

International development agencies, in particular, have sought to recreate or strengthen socially embedded institutions for natural resource management (Hogg 1992a; Brosius *et al.* 1998). Governments have also been supportive to varying degrees. At times, the support for these institutions has involved a co-management agreement between the State and resource users that recognises the ability of local resource users, like herders, to manage the local resource effectively. At other times, local land-users have attempted to re-establish weakened socially embedded institutions with the facilitation and support of an external agent such as a non-government organisation. In some countries, these institutional settings are formally recognised by the State, with Swallow and Bromley (1995) noting that they governing the rangelands of African countries including Ethiopia (Helland 1982), Tanzania (Lane 1991; Carswell 1997) and Morocco (Gilles *et al.* 1992).

Despite the renewed emphasis on socially embedded institutions and collective action, their purported benefits are being scrutinised on a variety of fronts. Theoretical assumptions may be flawed. Local ecological knowledge can be misunderstood or mistranslated by those from the dominant knowledge culture (e.g. western science), particularly when local resource users deliberately wield the power of the dominant culture's environmental rhetoric for their own purposes (Davis and Ruddle 2010). Defining a local 'group' or 'community' can be difficult, with definitions of the term often missing entirely in the documentation of those using this concepts to progress natural resource management aims (Clifford 1983; Hogg 1992a; Cleaver 2000). The belief that natural resources were historically managed sustainably and by a homogenous group of local actors may be similarly naive (Li 1996). This is particularly the case if new institutions are crafted from pre-existing ones that are no longer relevant to the new socio-economic context, and consequently may no longer be the best institutions for the task of natural resource management (Cleaver 2000).

Field complexities often strongly contrast with the expectations arising from theory. Some suggest that common property theory is overly optimistic, an artefact of a particular ideology or an overstatement of success (Hogg 1992a; Campbell *et al.* 2001). Assumptions that community control automatically translates into environmental benefits has been labelled as '*green romanticism*,' or naive (Vayda and Walters 1999; Davis and Ruddle 2010). Local groups may seek to maximise income, becoming involved in natural resource projects only for economic gain (Vayda and Walters 1999).

Local groups may deliberately attempt to become a co-operative community for the purposes of accessing donor resources (Cleaver 2000), and may prioritise monetary income over sustainability (Conklin and Graham 1995).

The resilience of common property or locally based institutions to shocks and stresses may also have been overstated. Collective action, despite being purported to increase wealth (see, for example, Rudd 2000), can fail to prevent degradation in the face of other social, political and economic pressures (Hogg 1992a; Agrawal and Gibson 1999; Campbell 2001; Sneath 2003). It can contribute to inequality or marginalisation of the most poor (Cleaver 2005; Upton 2009). Boesen (2007) found that top-down approaches for reducing corruption were more effective than bottom-up, collective action. Small, property sizes can contribute to unsustainably high stocking rates and grazing-facilitated degradation, regardless of the type of institutional exclusivity governing access to the forage resource e.g. Young (1985); MacLeod (1990); Passmore and Brown (1992); Williams (2006).

The involvement of an external agent in the manufacture of community-based interventions in the pastoral sector has also been criticised. Hogg (1992a) suggested that agencies operating in pastoral Africa that emphasised community-based development had '*ridden on a crest of a public and academic reaction against older, top-down, development approaches*', but that '*the record of NGO projects is rarely examined*'. Campbell *et al.* (2001) suggested that '*false optimism*' around the use of common property institutions to achieve natural resource management goals may be due to the dominance of developed countries in the development discourse, with the subject matter being predominantly about developing countries.

2.5 Institutional settings in the Gobi Desert

Sections 2.2 and 2.4 highlight that theoretical panacea can be risky to both rangeland condition and herder livelihoods. Newly introduced or evolved institutional settings will have different effects on rangeland condition and pastoral livelihoods in different biophysical, political, economic and cultural contexts (Cleaver 2000; Ostrom 2007). Accurately predicting the efficacy of new policy and programme interventions requires an understanding of the specific context in which new institutions are being introduced (Hogg 1992a). The following section documents the historical context of pastoral institutions in the Gobi Desert.

The Great Yassa legal code of the 13th century linked groups of herders to certain pastures in the Gobi Desert (Ykhanbai 2004). From the 16th to 20th century, an aristocratic elite controlled significant areas of both livestock and people under a monastic feudal system that became increasingly religious (Rosenberg 1981; Soucek 2000; Sneath 2003; Gaubatz and Stevens 2006). Pastoral households moved between different pastures within a banner, a large territorial unit managed by noble or religious officials (Sneath 2003). Whilst herders were not allowed to leave these areas, areas were relatively large and often straddled different ecological zones (e.g. the desert steppe zone of the Gobi Desert, and the mountain steppe zone of the Khangai mountains) (Mearns 1993). Mearns (1993) cites Shirendyb (1976) as stating that whilst some feudal lords had attempted to '*set up their own accord marks establishing the pastures not only of* [administrative subdivisions] *but also of individual households… these conditions… were never found in the gobi regions*'.

Large numbers of livestock owned by the elite were herded by subjects who received subsistence compensation for their labour in the form of animal produce (Sneath 2003). Many members of the elite were in debt to Chinese merchants, and large numbers of livestock were exported out of the country each year to service the debts (Sneath 2003). Officials also organized other activities that benefitted the pastoral economy, such as cultivation of wheat (Sneath 2003).

It is believed that the monasteries/noble lords buffered climatic risk to some extent by providing relief to poorer herders, including those affected by drought or *dzud* (a multifaceted term implying a winter/spring period, sometimes preceded by a drier than usual summer, that has an impact on pastoral production that is more negative than usual). Poor herders, perhaps impoverished by livestock mortalities, worked for wealthier herders (Humphrey 1978). Market forces allowed for the transfer of resources during this time, with the evolution of a market for winter/spring camps (Fernandez-Gimenez 1999). Such mechanisms may have helped herders manage the effects that stochastic events, such as *dzud*s, had on the pastoral system.

At a more local scale, recognized groups of herders had recognized grazing rights in time and space. Herding and migration patterns were governed by unwritten laws and customs (Fernandez-Gimenez 2002). Family groups would attempt to match grazing pressure with forage availability through moving themselves and their livestock frequently, with seasons and altitude. In addition, socioeconomic factors like household labour availability and wealth/debt dictated location (Gaubatz and Stevens 2006). Herders in the Gobi Desert moved greater distances than elsewhere in Inner Asia to compensate for the greater spatio-temporal variation in forage (Reading *et al.* 2006).

What is now the Inner Mongolia Autonomous Region of China (Inner Mongolia) was annexed from today's country of Mongolia in 1644 by the Manchu dynasty that ruled China. Mongolia became a dependency in 1691 (Soucek 2000). Large herds of livestock were traded from northwest Mongolia, across southern and central Mongolian Gobi Desert areas and into Hohhot, the capital of present day Inner Mongolia (Gaubatz and Stevens 2006). Regulations required that local herders keep their livestock a significant distance from the trade route to allow for forage for stock route animals, but the on-ground reality may have been that these regulations were not strictly enforced (Gaubatz and Stevens 2006). Trading companies controlled large areas of pasture. Significant areas of grasslands in Inner Mongolia were increasingly converted to agriculture as a result of Han Chinese agricultural colonization, with some sedentary Mongols also privately owning small pockets of land (Lattimore 1938; Gaubatz and Stevens 2006).

When the Manchu dynasty collapsed in 1911, Mongolia sought to be free of Chinese influence and debt to merchants (Sneath 2003). Military protection from Russia was sought to assist with this (Soucek 2000). From 1924, Mongolia became a protectorate of the Soviets and began to model itself institutionally on the Soviet system (Soucek 2000). Inner Mongolia stayed under Chinese control. This essentially cleaved the Gobi Desert politically, initiating increasingly divergent institutional settings between the two otherwise geographically and culturally similar areas.

Rosenberg (1981) described an institutional vacuum in 1920s Mongolia as the old feudal system broke down with the socialist revolution: '*there was a need for alternative community institutions to replace those that had disappeared or were in decline*' p25. '*Negdel*' co-operative herding groups, encouraged by the State between 1930 and 1933, filled this vacuum. Whilst some of the early attempts at collectivization were futile, from the 1950s until the start of the 1990s, individual herders largely managed livestock on behalf of a collective that was recognized by the State (Sneath 2003; Johnson *et al.* 2006). Pastoral households were paid a regular income, provided with veterinarian assistance, free healthcare and education (Potanski 1993). In addition, herder families were able to personally own a certain number of livestock. In Gobi Desert *aimag*s, this number stood at seventy five head of livestock (Soucek 2000).

The new territorial-administrative structure of the Socialist period produced significant differences in forage and its availability to herders and their livestock (Mearns 1993). Mobility became more regulated and bureaucratic (and hence less flexible) during this period, and the distance of territorial moves by herders and their livestock reduced (Potkanski 1993). The new structure meant that there was approximately one *negdel* per *soum* - an area smaller than the pre-revolutionary banners (Sneath 2003). Mearns (1993) estimated that the 330 districts since the 1930s compared to the 100 or so pre-revolutionary banners reduced the territorial area available to herders to one third of the previous area. Whilst herders informally crossed official boundaries to a greater extent than was officially acknowledged, the ability of herders to manage subsequent feed gaps through mobility was still reduced (Mearns 1993).

The State buffered some of the risk produced by these changes. Strategies that the State supported to improve and temporally 'smooth' livestock feed gaps and production included specialization of livestock within *negdel*s, the building of shelters that were provided with fodder each winter, the sinking of wells and the provision of freely available trucks for moving stock (Potkanski 1993; Johnson *et al.* 2006). The practice of *otor* (long distance movements) was maintained, facilitated by the trucks of the *negdel* (Sneath 2003). These factors meant that that the State, through the *negdel*s, carried much of the production risk (Mearns 1993). It also meant that livestock numbers in areas like the Gobi Desert may have stabilized at levels that at times were close to, or exceeded, the carrying capacity (Mearns 1993).

In the 1930s there was an estimated rangeland carrying capacity of 60 million Sheep Forage Units (SFU) in Mongolia (but see Section 2.2 for a critique of the carrying capacity concept). Whilst estimates of livestock numbers can only ever be approximate, Sneath (2003) cites the total number of livestock in the country in 1918 as 10 million, increasing to over 25 million livestock by 1940. Sheehy (1995) gives a figure of 56 million SFU by 1940. Despite the increased inputs of collectivization, livestock numbers did not continue to increase. In 1965 there were only 24 million animals in Mongolia (Soucek 2000; Reading *et al.* 2006). The decline since 1940 may have been due to a number of reasons. The coordinated export of pastoral products may have been important at removing surplus livestock from the national herd (Sneath 2003). The removal of incentives for herders to increase numbers, such as by the State provision of pensions and insurance or low commodity prices, may also have meant that herders may have had little incentive to increase their herd size as a way of buffering the risk associated with climatic variability (Mearns *et al.* 1992).

In Inner Mongolia between 1947 and 1953, land reform began in earnest (Ho 2000). Rangelands were collectivized. Disparities between different laws and local variations in their interpretation meant that collectivization was not evenly implemented through space and time (Ho 2000). Regardless, and in contrast to Mongolia, these reforms paralleled a long period of increasing livestock numbers. Sneath (2003) cited an increase in Inner Mongolian livestock numbers from 17 million head in 1957 to 32 million in 1980. Ho (2000; 2001) cited an increase in livestock numbers in Chinese pastoral areas from about 29 million in 1949 to 90 million by the 1990s. Whilst the more recent livestock figures are far greater than the older figures, Sneath (2003) noted that high livestock numbers may not have been historically atypical. Historical data from the 1930s placed the total SFU of Inner Mongolia at 67 million SFU – only marginally lower than the 72 million SFU of the early 1990s (Sneath 2003). An estimated 6.5 million hectares of the most productive rangelands areas were simultaneously claimed for farming, however, reducing their total area and increasing grazing pressures per unit area (Ho 2000).

In the early 1980s, and as part of the introduction of the Household Responsibility System to pastoral areas, the Inner Mongolian communes were dismantled. Collective livestock were allocated to individual herder households and the Rangeland Law's Household Responsibility System was introduced (Ho 2000; 2001). The System was copied from farmland areas with the aim of preventing '*everyone eating from the same pot*', considered to cause low production efficiency (Li and Huntsinger 2011). This System was designed for use across all China's rangelands, but different rangeland areas were contracted out at different times from the 1980s onwards. The System attempted to address the perceived 'tragedy of the commons' of collectivized pastoralism (Hardin 1968; Li and Duo 1995). In some rangelands, the rights and responsibilities of good rangeland management devolved to herders through the provision of pastoral use rights (Ho 2000). The government or collectives still retained ownership of this land (Ho 2000).

With the collapse of Mongolian socialism in the early 1990s, Mongolia also privatised livestock. Full privatization occurred in stages. In 1991, *negdel* animals were leased to families with the leasing company charging for the provision of fodder, veterinary drugs and transport (Potkanski 1993). In exchange, families were required to fulfil livestock production targets (Potkanski 1993). New forms of cooperatives also evolved, although these dissolved fairly quickly.

Unlike the Gobi Desert in Inner Mongolia, Mongolia did not introduce grazing use rights. The Mongolian Law on Land 1994 (revised 2002) defined the rangelands as common-use public property, with its privatisation banned (Fernandez-Gimenez and Batbuyan 2004; Tumur-Ochir 2002; Johnson *et al.* 2006). Although some of the Law's terminology was ambiguous in parts, leasing of winter and spring campsites and their immediate pasturelands was permitted, with the responsibility of allocation and regulation largely devolved to the governors of the smaller administrative *bags* and *soum*s.

In Mongolia, Gross Domestic Product (GDP) dropped significantly from 1989 levels during the early 1990s due to economic reforms and the removal of Soviet era subsidies. Mearns (2004) puts this decline at about 33% of GDP, with Luvsanjamts (2005) putting it at 20%. National savings declined and there were high levels of inflation (Asian Development Bank 1995; Mearns 2004). Poverty, believed to be almost non-exist prior to economic reforms, expanded to include about 36% of the population by 1995, and wealth inequality (as measured by herd sizes), also increased (Mearns 2004).

Mongolia began receiving aid from a number of western countries, firstly as an emergency measure and then for infrastructure development. Luvsanjamts (2005) estimated that 17 – 32% of Mongolia's GDP has come from foreign aid since the early 1990s. This has reportedly made Mongolia the fifth most aid dependent country in the world (Luvsanjamts 2005) despite it being only ranked 61st in the world in terms of lowest GDP per capita (International Monetary Fund 2011). With this relatively high level of aid dependency since the 1990s, non-Soviet international development organizations have become an increasingly important stakeholder in Mongolia's domestic affairs. Murphy (2011) suggested that whilst the influence of development 'experts' should not be exaggerated, they have influenced the shape of rural reforms.

The economic uncertainty of the early 1990s in Mongolia contributed to a mass exodus of people from urban areas (Mearns 2004). These people were absorbed into extended family groups in rural areas, doubling the number of herder families between 1992 and 2000 (Johnson *et al.* 2006). Even though the country's total herd size increased during the 1990s, there was a decline in herd size per family as livestock resources were split.

Combined with other economic changes during this time, the pastoral focus shifted from yield and export towards subsistence and food security as a household survival strategy (Sneath 2003; Mearns 2004). Sneath (2003) estimated that 5% of the national herd was exported to China each year during the feudal and *negdel* periods. By 1992, the total exported had declined to one-fifth of the 1985 figure as livestock were retained for personal consumption. The Asian Development Bank (1995) also cited high inflation and depressed meat consumption by the domestic market as reasons for reduced off-take of livestock, and the response of herders to high cashmere prices as being the primary reason for increased livestock numbers. The need to support more households with urban-rural migration also probably contributed. More rural households, a shift to subsistence and the retreat of the State from the pastoral sector led to smaller household herd sizes than those of the *negdel* collectives and pre-revolutionary elites. There was a decline in the economies of scale provided by *negdel*s, such as herds of one livestock type.

Socioeconomic changes made herds, and herders, more susceptible to extreme climatic events (Johnson *et al.* 2006), and contributed to a decline in agricultural and labour productivity (Mearns 2004). The State Emergency Fodder Fund supplied 200,000T of fodder to herders during 1990/91, a figure that dropped to 18,000T by 1994/95 (Asian Development Bank 1995). Declines in the transport of livestock and waterpoint maintenance occurred simultaneously. Droughts and *dzud*s of the late 20th and early 21st century killed a significant number of livestock in the Mongolian Gobi Desert, particularly in Dundgobi *aimag*. This exacerbated rural poverty and contributed to rural-urban migration as herders became destitute, or moved to urban areas to reduce market transaction costs and to access better terms of trade (Mearns 2004). The ways in which the *dzud* of 2009/2010 has affected pastoral patterns of movement in the Mongolian

Gobi Desert is not yet clear, although it is likely that herder destitution will contribute to increased rural-urban migration over the next few years as it did during the last *dzud* (Murphy 2011).

In Inner Mongolia, many herders also lost their livestock and began working as hired hands after *dzud*s in the early 1980s (Sneath 2003; Li and Huntsinger 2011). In parts of Inner Mongolia, these livestock deaths occurred despite local government attempts to dig wells, facilitate bank loans, provide veterinary care and improve livestock breeding programmes. Li and Huntsinger (2011) attributed these livestock deaths to higher levels of exclusivity under the Household Responsibility System. This was because higher exclusivity reduced cooperative relationships that facilitated labour sharing, and increased transaction costs of rent-paying and transport when herders wished to move livestock to others' properties whilst avoiding fences during poor forage periods. As no comparison was made with mortality rates in Inner Mongolian rangelands prior to higher levels of exclusivity, it is difficult to know whether government support programmes in Inner Mongolia off-set the risks associated with reduced levels of livestock mobility.

Back in Mongolia, socioeconomic changes associated with the transition to a market economy were associated with reduced customary norms over access to forage (Mearns 1993; Mearns 2004; Mearns 2005). Rapid change reduced the opportunity cost of maximizing individual gain by grazing available pasture to which a herder may or may not have rights, and made it difficult for experience to inform decision making and the evolution of norms (Mearns 1993). The resulting system, believed to increasingly resemble an open access institutional setting, became particularly evident around water points, roads, settlements and seasonal camps, contributing to overgrazing (Fernandez-Gimenez 2002; Mearns 2004; Johnson *et al.* 2006). Disruption to previous patterns of movement, as well as the increase in herders needing pastoral resources, is also believed to have caused an increase in disputes over access to water and grazing lands in some areas (Fernandez-Gimenez and Batbuyan 2004; Mearns 2004).

Whilst such changes were attributed to the economic and political changes of the early 1990s, Mearns (1993) suggested that some of the changes in the pastoral system preceding this time may also have also contributed to problems like overgrazing. Mearns (1993) suggested that camps in the late 1980s were closer to roads and tracks than they had been in the mid to late 1970s. Construction of the winter/spring shelters of the 1930s and 1940s significantly reduced livestock mortality, but also encouraged more sedentary herding practices. The increase in specialized herds increased grazing pressures on the plants most preferred by the particular livestock type. These changes, and the bearing of production risk by the State, increased overutilization of pastures and reduced herders' technical knowledge of pasture management (Mearns 1993). Mearns (1993) stated that conflict over water, pastures and other natural resources increased under collectivization. It is unclear whether the declines in customary institutions or land/livestock ratios were the primary reasons for the asserted increase in herder-to-herder conflict and overgrazing during the *negdel* period (Mearns 1993). However the decline in institutions governing access to the forage resource increasingly resembled the 'institutional vacuum' of the 1920s (Rosenberg 1981). Like the 1920s period, this vacuum was similarly perceived by government to be a problem that needed resolution.

During the early 1990s, Mongolia reassessed its institutional settings in light of overall market-driven reforms. Key donors were openly supportive of complete land privatisation e.g. GISL Ltd and Biotechnology Consultants Limited (1997). The Asian Development Bank (1995) stated that '*in market-driven agriculture, the ownership of land or land use rights are* [sic] *essential to provide farmers with the incentives to make investments and optimal use of productive assets*'. Such sentiments were extremely unpopular amongst the Mongolian public. The development of the 1995 Law on Land (Tumur-Ochir 2002), that granted use rights to winter/spring shelters, was still causing controversy in 1999 (Sneath 2003). Donor organisations have significant influence in the Mongolian rangeland and environment sector (Upton 2010). According to Sneath (2003), Prime Minister J. Narantsatsralt felt compelled to defend his government against accusations of being unduly influenced by donor loan requirements, stating to the Daily Newspaper that '*The ADB loan and the development, approval and implementation of the law* [on Land] *are two separate things*.'

To resolve the perceived 'tragedy of the commons' associated with institutional decline, policies and programmes have taken one of two different approaches. The first of these is supporting institutional exclusivity at the level of the individual household. In 2007, the Government of Mongolia and the Millennium Challenge Corporation signed an agreement to administer property rights to peri-urban rangeland herders to "[improve] *range and livestock management*" (Millennium Challenge Corporation 2007). The

Millennium Challenge Account provided a large sum of money to the programme with the aim of assisting peri-urban herders to intensify their herding enterprise. The signatories believed that this would increase the quality and quantity of milk and meat sold to Ulaanbaatar, the capital of Mongolia, and would improve rangeland condition. Plans or aspirations to privatize or intensify pastoral land-use in peri-urban areas of the Gobi Desert have also been floated for the same aims. Rangelands around Omnogobi *aimag*'s Dalanzadgad and the mining *soum* centres of Khanbogd and Tsogtseggi are proposed as being suitable locations for more exclusive institutional settings (Omnogobi *aimag* official, personal communication, 2010; GTZ staff member, personal communication, 2011).

Whilst the initial intention of the Millennium Challenge Corporation was to establish exclusive grazing use rights to individual households, the current project design has been modified to link use rights to herder groups. This change has been due to the practical difficulties of implementing a more exclusive institutional setting. However the purposes and assumptions behind project design remain the same; more exclusive institutions governing access to the forage resource will improve rangeland condition and livelihoods.

The second approach that policies and programmes have taken to improve rangeland condition and herder livelihoods is the support of institutional exclusivity at the group level. Pasture User Groups (PUGs) have become a major tool by which the internal regulation of forage use by self-organising herders has been encouraged (The International Development Research Centre 2007; Sarantuya and Nyamdorj 2003; Schmidt 2006; Hess *et al.* 2010; Usukh *et al.* 2010). PUGs are increasingly the institutional model of choice for the economically significant and arguably influential development sector (Upton 2010). There have been over 2000 PUGs and herder groups established by more than 12 different non-government organisation programmes (Mau and Chantsalkham (2006) in Fernandez-Gimenez *et al.* (2008)), and they vary widely in terms of the participatory process involved in their establishment and their functionality (see Section 5.2.2 for a more detailed discussion of PUGs). The PUGs model has also expanded into the policy arena. The draft Pastureland Law, debated by Parliament for some years as noted above, currently proposes to create a series of spatially bounded, PUG-like institutions across the entire country (United Nations Development

Programme, 2008). Continuing dialogue around institutional settings is also apparent in Inner Mongolia.

2.6 Institutions, rangeland condition and livelihoods

Over 20 years ago, Mearns *et al.* (1992) noted that '*the relationship between research and policy-making in Mongolia is an extremely weak one'*. Incongruity between the findings of empirically based research and policy direction may be, or may have been, true. However there are other ways of creating knowledge-based policy. Evidence from this research suggests that Mongolian Gobi Desert herders have a very good understanding of the relationships between institutions, rangeland condition and livelihoods. Herders have significant political power in Mongolia (Murphy 2011). They may therefore be an effective channel for the creation of knowledge-based policy, acting as a buffer between a lack of empirical evidence and policy making. Despite this potentially important function, the lack of empirical analysis of the ability of a change in institutional settings to affect rangeland condition and herder livelihoods in Mongolia is striking. This is of concern given the significant discussion, and lobbying, around bureaucratic institutional settings within the political and development sectors (Section 2.5).

2.6.1 Degradation in the Mongolian Gobi Desert rangelands under the current Law on Land

It is widely assumed by a range of stakeholders – policy-makers, development agencies, academics and the media – that the rangelands of Mongolia are degraded (see, for example, Batjargal 1997; Johnson *et al.* 2006; Mau and Dash 2007; United Nations Development Programme 2007; Enkh-Amgalan 2008; The World Bank 2009; Hess *et al.* 2010; Mongolian Society for Rangeland Management 2010; Usukh *et al.* 2010; Sneath 2003). An increase in the number of livestock, particularly goats, is commonly cited as a major contributor to landscape degradation (United Nations Development Programme 2007; Bayanmonkh 2007; Index Based Livestock Insurance Project Implementation Unit 2009; Sheehy and Damiran 2009; Whitten 2009; Hess *et al.* 2010; Sternberg 2010). A change in precipitation patterns, particularly the decline of rainfall and subsequent decline in forage productivity, is another commonly cited cause

(Bayanmonkh 2009; Index Based Livestock Insurance Project Implementation Unit 2009; Nakamura 2009).

Despite these widely held perceptions, the status of Mongolia's rangelands is neither as well documented nor agreed upon as is often assumed. Mongolia does not have a nationally recognised rangeland monitoring system, although one is currently in development (Mongolian Society for Rangeland Management, personal communication, 2010). Various rangeland condition assessments have used different scales, indicators and sampling regimes. Survey techniques and methodologies are rarely described when statements are made about degradation. This makes it impossible to assess their reliability – a problem noted in rangelands elsewhere (Hellden 1991). Mechanistic causes of assumed degradation have also been poorly explored.

These factors may have contributed to conflicting perceptions of Mongolia's rangeland condition. Batsuuri (2009) stated that 90% of the country was affected by desertification and land degradation, 70% of which was medium or severe, but Awaadorj and Badrakh (2007) quoted Chognii (2001) as stating that only 30% of Mongolia's rangeland area was degraded. Mau and Dash (2007) put this figure at 80%, whilst Bayankhishig (2009) stated that 77.2% was degraded to some extent. Sneath (1998) quoted Sheehy (1995) as stating that only 9% of the country was degraded. The 70% figure that is the most commonly cited (e.g. Sukhtulga 2009, Dorligsuren 2010), has also been contested (The World Bank 2003).

Assumptions of degradation have been uniformly applied across all Mongolian rangelands. However the peer-reviewed, English language literature counteracts some of the degradation assumptions when applied to the Mongolian Gobi Desert. The Mongolian desert and desert steppe vegetation zones occupying about 40% of the country's landmass (Sodnomdarjaa and Johnson 2003) and may respond differently to grazing than areas further north. Precipitation is increasingly foregrounded as the overriding factor affecting vegetation dynamics in the Mongolian desert steppe (Lavrenko and Karamysheva 1993; Wesche and Retzer 2005; Ronnenberg *et al.* 2008; Wesche *et al.* 2010; Sasaki *et al.* 2009a). Echoing international trends (see Section 2.2), research in the Gobi Desert assessing the effect of grazing pressures on vegetation dynamics over a number of seasons recognises that current grazing pressures have less effect on rangeland condition than was previously assumed (Wesche and Retzer 2005;

Wesche *et al.* 2010; Cheng *et al.* 2011). There is evidence from other similar landscapes that areas grazed for a long time have far greater levels of resilience to grazing (Cingolani *et al.* 2005), that Mongolian steppe areas are resilient to high grazing pressures and that grazing is needed to maintain functionality in the desired vegetation community (Lavrenko and Karamysheva 1993).

Conclusions about effectively irreversible degradation cannot be easily made from short-term vegetation assessments (Abel 1997). Field assessments in the Gobi Desert have often been of short duration, usually only a maximum of three years in length. This is a common and potentially significant weakness of environmental research in dryland rangelands (Allen *et al.* 2008). Studies on vegetation changes at varying distances around waterpoints in the Gobi Desert have attempted to mitigate this weakness (Fernandez-Gimenez and Allen-Diaz 2001; Sasaki *et al.* 2005; Sasaki *et al.* 2009b). Vegetation-based studies in the Mongolian Gobi Desert provide useful insights into grazing effects. However the use of soil-based indicators that may be better able to differentiate between biophysical change that is caused by human activities and that which is natural variability and what is reversible within planning horizons and what it is not. The use of such indicators has been lacking to date.

The uncertainty in the international literature about what constitutes degradation in arid rangelands (Section 2.2) suggests that the assumptions of degradation in the Mongolian Gobi Desert need careful examination. This is particularly true given the push for interventions that share similarities with institutional interventions that have been known to contribute to declines in rangeland condition and herder livelihoods elsewhere.

2.6.2 Degradation in the Mongolian Gobi Desert rangelands under PUGs

The common response to assumptions of weakened institutions has been an attempt to either directly rebuild them, or facilitate a context where they will rebuild ‘naturally’ (Murphy 2011). The explicit assumption has been that strengthened institutions will result in environmental and livelihood benefits (e.g. Mongolian National Livestock Program 2010), although see Murphy (2011) for an alternative argument that links the push for collective action with a neo-liberal agenda. Regardless of the underlying reasons, supporting collective action by a defined group of herders, often operating within a defined area, has become been an important part of policy and programme design. However there has been little assessment of how PUG creation may affect indicators of rangeland condition in the Gobi Desert. This is despite international evidence that formal collectives, such as those of pre-1980s Inner Mongolia (Sneath 2003), or collective informal institutions such as those in the forests of Zimbabwe (Campbell *et al.* 2001), have been unable to prevent degradation in the face of other social, political and economic pressures.

There has been some assessment of the effect of PUG creation on pastoral livelihoods in the Mongolian Gobi Desert. Hess *et al.* (2010) described member-perceived benefits from PUGs that included empowerment of women and better communication between herders. Upton (2009) supported the claims of development organisations that PUG membership brought benefits to herders. However her work also suggested that PUG creation may have contributed to feelings of exclusion amongst non-members who could not participate in the group due to their relative poverty and lack of labour for activities. Upton (2009) concluded that the devolution of power to the PUG may have exacerbated inequity, threatening the overall livelihood goals of development organisations.

Bias towards collection of social data not directly related to natural resource management, despite the natural resource aims of development projects, has been noted elsewhere (Hogg 1992a). The social benefits attributable to PUG institutions are not necessarily correlated with rangeland condition. Baseline biophysical data are rarely collected, a weakness noted in rangeland development projects internationally (Hogg 1992a). Herder accounts of perceived environmental benefits are more commonly used to understand the biophysical effects of PUGs than biophysical assessments. Leisher *et al*. (2012) are a rare exception. They found that remotely sensed NDVI, an indicator of vegetation production, was higher in PUG areas than non-PUG areas in Omnogobi *aimag*. Leisher *et al*. (2012) linked this difference to the presence of the PUG. However they did not stipulate which institutions attributable to the PUG could have contributed to this difference, such as declining grazing pressures within the PUG due to group members exerting pressure on each other to destock. An assessment of PUGs' ability to contribute to sustainable rangeland use in a way that quantifies an ecological mechanism by which this may occur would have strengthened their assertion that PUGs improve rangeland condition.

For PUG institutions to be successful at improving rangeland condition in the long-term, they must maintain functionality during periods when the pastoral system is exposed to external shocks. The post-*dzud* time period is an opportune period in which to assess the efficacy of PUG institutions. There has been little assessment of the ability PUG of institutions to be maintained through these periods.

As described earlier in this literature review, non-equilibrium theory suggests that highly variable landscapes like that of the Gobi Desert may be more resilient to ‘boom and bust’ changes in grazing pressures than landscapes with more predictable precipitation patterns. However the present rangeland condition of the Mongolian Gobi Desert rangelands is uncertain. Mechanisms assumed to contribute to degradation, such as increased grazing pressures, have not been tested at a scale relevant to management. Neither the ability of PUG institutions to be maintained through variable climatic conditions, nor the ability of institutions to improve rangeland condition, has been robustly assessed. Local and international development organisations have put considerable effort into developing PUGs, and the nation-wide draft Pastureland Law may ultimately borrow from PUG design. Given these factors, a more critical examination of the ability of PUGs to improve rangeland condition and herder livelihoods is required.

2.6.3 Biophysical and socioeconomic factors influencing adherence to institutional settings

Pastoralism is affected by a variety of social, political, economic and environmental variables and shocks and stresses that occur at different spatial and temporal scales (see Section 2.2). Institutions are only one of a large number of attributes affecting behaviour in a particular situation (Boesen 2007). Herders constantly engage with this larger pastoral context. The likelihood that externally-derived interventions will fail increases if these interventions are scaled in ways that do not consider shocks and stresses (Hogg 1992a). The lowest level of institution, operational institutions over day to day activities (Ostrom 2005), may amplify the risk of feed gaps in situations with a highly dynamic resource by being too prescriptive, for example.

For pastoral institutions to be sustainable, they must provide tangible benefit to herders (Hogg 1992a). Shocks, stresses and exogenous factors can permanently or temporarily supersede or modify institutional settings by changing the relative strength of the 'reward' or 'punishment' that herders are exposed to when breaking a institutional rule or norm (Boesen 2007). Understanding interactions between these factors and the institutions governing herding can help provide explanatory mechanisms for why some institutions are more appropriate than others.

Livestock mobility is an adaptation to risk (Hogg 1992). A significant form of risk faced by Gobi Desert herders is climatic variability. As described earlier, Mongolia's Gobi Desert has a variable pattern of precipitation that has been described as non-equilibrium (Fernandez-Gimenez and Allen-Diaz 1999; Begzsuren 2004; Zemmrich 2007; Okayasu *et al.* 2011). Given that *dzud*s add a layer of unpredictability to the forage resource, the risk management options available to herders are likely to be most constrained during *dzud* situations. Climatic variability may interact with other factors to amplify risk. For example, the Mongolian Gobi Desert, like many other arid rangelands (Stafford Smith 2008), is poorly connected via transport links to large urban centres. Access to markets is more difficult during *dzud*s. This may constrain timely responses by herders for dealing with climatic variability, such as mobility.

Institutional settings can directly modify the risk management tools available to herders by placing spatial and temporal constraints upon access to forage (Agrawal and Saberwal 2004; Fernandez-Gimenez and Le Febre 2006; Stokes *et al.* 2006). However, non-institutional options may adequately compensate for the feed gaps produced by altered institutional settings. The discussion of institutional settings in Mongolia rarely examines non-institutional options for resolving feed gaps, such as the use availability and affordability of commercial fodder. To understand the costs and benefits to herders of bureaucratic institutional settings that are produced in highly variable landscapes, interactions between the following therefore need to be appreciated, i) the spatial and temporal nature of climatic variability, ii) the options available to herders for managing this variability, and iii) how institutions may interact with these options.

Forage modelling can assist with exploring the spatial and temporal nature of climatic variability. However the quantity of palatable forage production does not directly equate to the total resource pool that herders have available to them because it ignores the broader social context in which herders operate (Fernandez-Gimenez and Le Febre 2006; Vogel and O'Brien 2006). There may also be gaps between the scale at which modelling occurs and the most appropriate scale for herder risk management strategies, for example.

Herder accounts can reveal access issues that facilitate or constrain utilisation of the resource, an important factor affecting livelihoods (Chambers and Conway 1992).The accounts of herders can also help verify whether the outputs of forage modelling translate into on-ground biophysical conditions, decision-making or risk. Herder accounts can distinguish where along a continuum from 'good' to 'bad' any one year or season may be placed from a livelihoods perspective, rather than making simplistic assumptions based on modelled forage quantity alone. Dyson-Hudson and Smith's (1978) model asserts that forage availability and variability has important implications for institutions. Understanding the forage resource, and the factors affecting herder access to it, can therefore help predict periods in which herders may 'rule-break' institutions.

An analysis of institutional settings must also consider herder livelihoods (Fernandez-Gimenez 2006). Reducing the vulnerability of herder livelihoods to shocks and stresses is needed for the secure and adequate livelihood in Gobi Desert herders (Chambers 1987). Pastoral economic viability is difficult to measure, in part because of the difficulties in accounting for the vulnerability of herder livelihoods to numerous shocks and stresses. Viability is also a product of wealth aspirations, other non-pastoral income opportunities, the relative number of dependents in a household (Mearns *et al.* 1992) and labour requirements etc (Chambers 1987). It should account for the non-economic or indirect economic value of the pastoral enterprise, such as the role of pastoralism in cultural identity, the use of livestock for transport, manure for fire etc (Bennison *et al.* 1997; Ayalew *et al.* 2002).

Mongolian pastoralism is primarily subsistent (National Statistical Office of Mongolia 2009). Consequently, herd size is the key indicator of vulnerability to climatic variability in Mongolia (Janes 2010). However the transition to a market economy means that Mongolian herder households must now engage with a cash economy. Sales of commodities, such as cashmere, are necessary to pay for livestock transport, imported fodder and school fees. Volatility in commodity prices through space and time creates price risk (Barrett and Luseno 2004). This risk can counteract, or amplify, the risks caused by a variable climate.

Access to markets by herders can be constrained by external factors such as road access, money for fuel or whether herders believe prices are high enough to make accessing the market viable (Banks 2003; Barrett and Luseno 2004; Vogel and O'Brien 2006). Market participation can also be constrained by factors internal to the household economy, such as the trade-offs between domestic subsistence needs versus off-take for cash. Edstrom (1993) found that both internal and external factors had a significant effect on the risk management options available to Mongolian herders. The timely off-take of livestock is an important risk management strategy in rangelands with both high levels of climatic variability and exclusive tenure systems. In Mongolia, this strategy was found to be particularly constrained by low prices and the need for herders to minimise levels of off-take to enlarge their herds, minimise production risks and enhance food security (Edstrom 1993). Understanding herder decision making given the constraints placed upon them by a broader social and economic context can therefore assist with an analysis of institutional efficacy.

2.7 Summary

Degradation is increasingly recognised as being dependent upon biophysical, social and cultural context. The use of a reduced suite of biophysical indicators for understanding rangeland change is therefore risky. As an example, vegetation in arid rangelands is increasingly understood to have non-linear and scale-dependent responses to grazing pressures. Such responses have challenged the ability of pre-existing rangeland models to differentiate between manageable and unmanageable change. In turn, these complexities make it difficult for stakeholders to understand the causes of rangeland change, and to design broad-scale policy responses in order to address it where it is considered to be socially undesirable.

There are conflicting perceptions of land condition in the arid rangelands of Inner Asia. Mongolia's Gobi Desert is often assumed to be degraded. In response, international development organisations and local policy makers often propose institutional responses to perceived degradation that include exclusivity over the forage resource. The high levels of climatic variability inherent in arid rangelands create risk for herders, and the feasibility of accessing alternative options for managing climatic risk other than mobility is largely unrecognised by policy and programme makers. The condition of the Mongolian Gobi Desert rangelands is uncertain, and there are international precedents suggesting that more exclusive institutional settings in arid rangelands can exacerbate degradation. Assumptions of degradation in the Mongolian Gobi Desert, and of the ability of institutions to respond to degradation, therefore need careful examination.

3 Methods

3.1 Introduction

A number of conclusions can be drawn from the issues raised in the introduction (Chapter 1) and literature review (Chapter 2). One of these is that a multitude of social, political, cultural and biophysical factors can affect rangeland condition, some of which are shown in Figure 1-1. This conclusion has important implications for research methodologies. Aspects of livelihood resources and strategies cannot be meaningfully analysed as separate elements; the institutional processes and organizational structures that link these various elements together must also be examined (Scoones 1998). Similarly, institutions cannot be analysed without understanding the resources to which they govern access. The strategies that resource users employ to access these resources must also be understood.

In line with the observations made by Scoones (1998), this research examines i) attributes of the forage resource, ii) the institutions governing access to this resource, iii) non-institutional strategies for accessing resources within the pastoral sector, iv) the biophysical condition of the rangeland resource under different institutional settings, and v) livelihood interactions with institutional settings, options and challenges. In doing so, the following key research questions are explored:

i) What is the state of rangeland condition in the Gobi Desert, given different institutional settings?

ii) What biophysical and socioeconomic factors may contribute to the state of rangeland condition described in the first research question? and

iii) How might institutional settings interact with the broader biophysical and socioeconomic context to affect rangeland condition and herder livelihoods, at present and in the future?

This chapter outlines the inter/multidisciplinary methodological framework by which these research questions are investigated. It begins by providing a broad overview of the biophysical and socio-economic context of study sites. It then describes why and how study sites were selected for research. Next, an overview of the sampling regime and specific methods employed in this research is provided. This section also includes the rationale for the generation of primary social and biophysical datasets, and for the selection of secondary datasets.

3.2 Site description

The Gobi Desert occupies the basin of Central Asia. Its southern regions include the northern central parts of the People's Republic of China (China) and southern aimags (States) in the Republic of Mongolia (Mongolia). The location of study sites referred to in this research is shown in Figure 3-1.

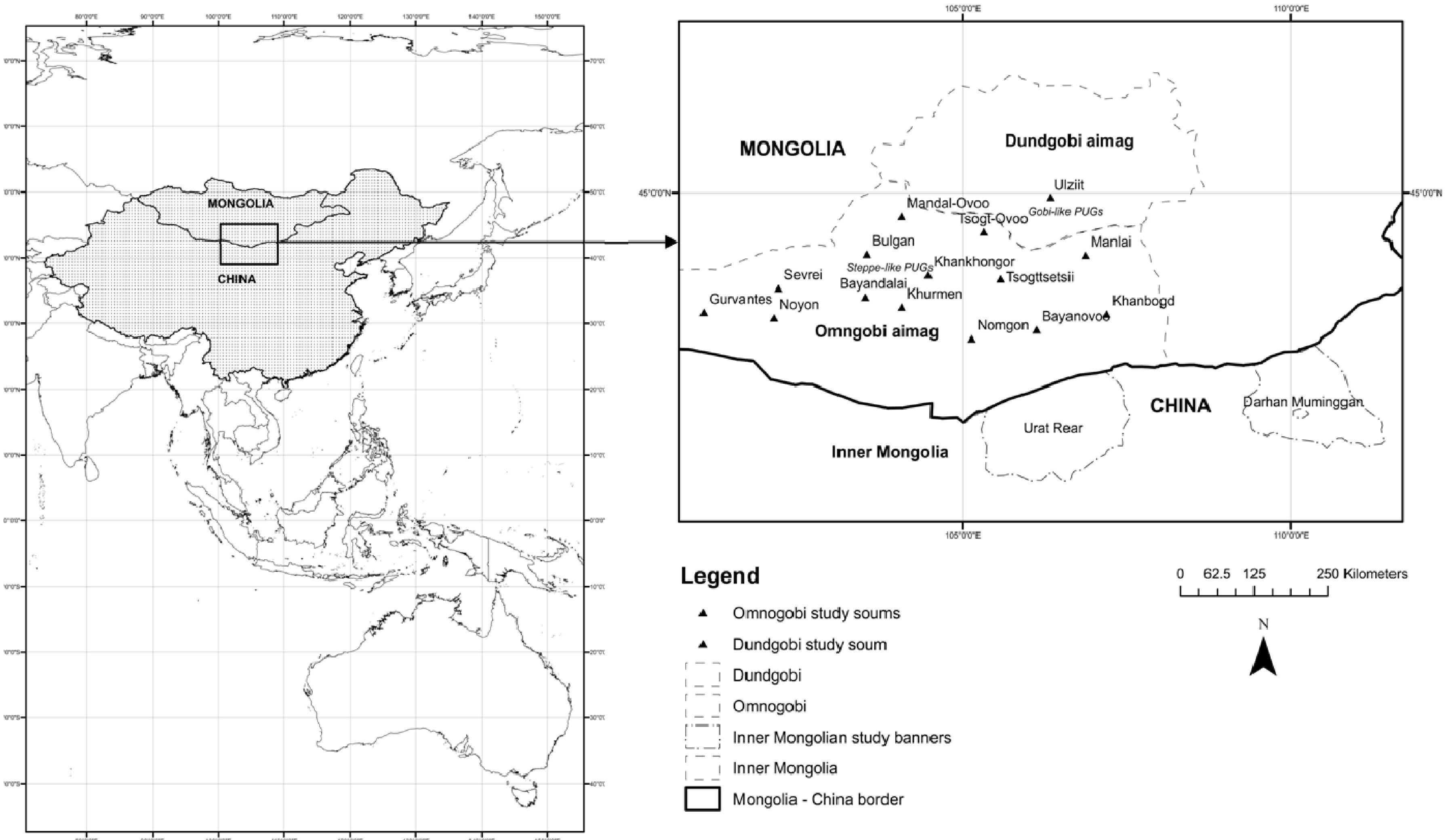

Figure 3-1 General map of the study area. The Gobi Desert straddles both northern China and southern Mongolia. Ulziit *soum*, about 300 km south of the Mongolian capital of Ulaanbaatar, is located on its north-eastern edge. Urat Rear Banner is about 800 km west-north-west of Beijing. Gobi and steppe-like PUG areas are italicized.

The Gobi Desert sits atop a relatively high plateau that is broadly undulating and has occasional rocky rises. The mountain range of the Gobi Gurvan Saikhan Strictly Protected Area in Omnogobi *aimag*, Mongolia, reaches a height of about 2800 m above sea level. Drainage is primarily internal. There are few areas of permanent surface water, apart from occasional springs provided by melting snow from mountain ranges. Where present, springs are occasionally used for small-scale irrigated agriculture. Figure 3-2 shows a typical desert steppe landscape in the Mongolian part of the Gobi Desert.

Figure 3-2 A typical desert steppe landscape in Khanbogd *soum*, Omnogobi *aimag*, Mongolian Gobi Desert. June 2010. *Allium polyrrhizum* Turcz. et Rgl and *Allium mongolicum* Regel are the main plant species seen in this figure. The figure shows the transect line used in rangeland condition surveys.

The northern part of the Mongolian Gobi Desert is desert steppe, with more southern areas referred to as true desert or hyper-desert (Lavrenko and Karamysheva 1993). Soils in desert steppe areas of the Gobi Desert are largely kastanozems and calcisols. They tend to have an accumulated calcium carbonate layer to some depth that often manifests as calcrete lag. Kastanozem calcic skeletic soils make up about 80% of Omnogobi *aimag's* land area (soil data sourced from FAO shapefiles provided by the Institute of Geoecology, Ulaanbaatar, 2007). In order of dominance, calcisols skeletic, kastanozem haplic skeletic, kastanozem calcic skeletic, fluvisols haplic and calcisols haplic make up the remaining 20%.

Annual precipitation in the Gobi Desert is low and variable. Precipitation varies over space and time, and is often described as non-equilibrium (Fernandez-Gimenez and Allen-Diaz 2001; Wesche and Retzer 2005; Wesche *et al.* 2010; Marin 2010). Precipitation mostly falls between May and September as rain. Around 80% of the total annual precipitation between 1990 and 2010 in Bulgan *soum*, Omnogobi *aimag*, Mongolia, fell within this time period (Institute of Meteorology and Hydrology, Ulaanbaatar, 2010). For the remainder of this year, precipitation normally falls as snow. Temperatures show significant, predictable intra-annual variability

Two meteorological stations in the Mongolian Gobi Desert study area in Omnogobi *aimag* recorded an average annual precipitation over the last 20 years of 72 mm and 132 mm, with annual co-efficient of variations of 0.41 and 0.26, respectively (Institute of Meteorology and Hydrology, Ulaanbaatar, 2010). Reliable long-term precipitation data was not able to be sourced for the southern part of the Gobi Desert within Inner Mongolia (see Section 3.4.5), but Linhe District, Urat Rear Banner's nearest main city, is cited by Wikipedia (2011) as having had an average annual precipitation of 145.7 mm between 1971 and 2000. The Haliut meteorological station in Inner Mongolia (latitude 41.57, longitude 108.52), had a mean annual precipitation of 207.3 mm between 1951 and 1980 according to Web-GIS China (2011). The average maximum temperature at the Haliut station during this same period was cited as 14.93°C, and the average minimum temperature during this period was 2.03°C (Wikipedia 2011). Baotou Prefecture, to the east of Urat Rear Banner, had an average annual precipitation of 297.6 mm between 1971 and 2000, with an average annual maximum temperature of 14.12°C and an average annual minimum temperature of 0.84°C (Wikipedia 2011).

Dzuds occasionally occur in both Mongolia (Sternberg 2010) and Inner Mongolia (Brown *et al.* 2008; Li and Huntsinger 2011), and add a further level of unpredictability to the pastoral environment. *Dzuds* are a multifaceted term implying winter conditions that have an unusually negative impact on pastoral production (e.g. higher than average levels of livestock mortality, and are sometimes preceded by a dry summer that limits pastoral production). Livestock management can affect the impact of *dzuds* on livestock production (Li and Huntsinger 2011). The Gobi Desert experienced a significant *dzud* during 2009/2010 that resulted in substantial livestock losses for many herders in both Mongolia (Sternberg 2010) and Inner Mongolia (Li and Huntsinger 2011). The majority of Mongolian herders interviewed for this thesis classified the 2010 summer as fair to good due to good pasture growth, with the preceding winter season assessed as poor due to extremely cold temperatures.

The term ‘gobi’ comes from a Mongolian term referring to a particular type of rocky desert. Mongolian herders interviewed for this thesis identified two types of landscape bounded by the Mongolian desert steppe area, namely ‘gobi-like’ and ‘steppe-like’ (Table 3-1).

Table 3-1 Examples of features distinguishing the two types of desert steppe landscapes identified by herders and local officials in Mongolian desert steppe areas.

	Gobi-like	Steppe-like
Annual mean precipitation (1990-2009)	72 mm[A]	94 mm[B]
Annual precipitation coefficient of variation (1990-2009)	0.53[C]	0.30 [C]
Altitude	~ 1200 m	~ 1800 m
Major soil differences	Greater proportion of calcisols	Greater proportion of kastenozems
Vegetation	Greater proportion of shrubs such as *Reaumaria soongoorica* Pall., *Salsola passerina* Bge. and *Anabasis brevifolia* C.A. Mey	Greater proportion of perennial forbs and grasses such as *Allium polyrrhizum* Turcz. et Rgl., *Artemisia frigida* Willd. and *Stipa* spp

[A] A gobi-like meteorological station recorded an average annual precipitation of 72 mm between 1990 and 2009 (Institute of Meteorology and Hydrology, Ulaanbaatar, 2010), [B] A steppe-like meteorological stations recorded an average annual precipitation between 1990 and 2009 of 94 mm (Institute of Meteorology and Hydrology, Ulaanbaatar, 2010), [C] An average annual precipitation coefficient of variation during the forage growing period between 1990 and 2010 (Institute of Meteorology and Hydrology, Ulaanbaatar, 2010).

In Inner Mongolia, the Darhan Muminggan United Banner (Damao) grassland, north east of Baotao, is akin to the steppe-like landscape identified by herders in Mongolia (Table 3-1). Urat Rear Banner, north west of Baotou, grades from desert steppe into true desert. The true desert of Urat Rear Banner is similar to the gobi-like landscape identified by Mongolian herders.

In 2009, the official population densities of Omnogobi and Dundgobi *aimags* in Mongolia were 0.3 and 0.6 people km^2, respectively (National Statistical Office of Mongolia 2010) but it is unclear how the population density fluctuated with space and time as herders moved in and out of *aimags* to exploit the forage resource. Omnogobi and Dundgobi *aimags* had populations that were approximately 66 and 78% rural, respectively (National Statistical Office of Mongolia 2010). Of the total number of households in 2009, 41% and 54% described themselves as herding households, respectively (National Statistical Office of Mongolia 2010). These figures may be explained by the relatively higher levels of vegetation productivity in Dundgobi *aimag* that can support relatively higher numbers of herders per unit area than in Omnogobi *aimag*.

In summer (June – August) and autumn (September – November), most Mongolian Gobi Desert herders move their livestock to more productive valley areas and mountain pediments (Figure 3-3).

Figure 3-3 A mobile summer *ger* in Manlai *soum*, Omnogobi *aimag*, Mongolia. October 2010. *Ger* normally take less than an hour or two to pack up for transportation. Russian jeeps and a small trailer are commonly used for transportation. Some herders had multiple *ger*, with a smaller one with less furniture being used in warmer months to make relocation easier. Photo: Margaret Friedel.

In winter, Mongolian Gobi Desert herders seek shelter from the wind in rocky gorges and midslopes. Winter/spring shelters, or camps, generally consist of a pen with walls made of rocks or livestock dung, with some wooden supports. These livestock shelters often have a low ceiling in one section of the shelter, and a floor of compacted dung that both insulates livestock during winter, and provides brickettes of fuel to herders (Figure 3-4). Herders live in a separate, transportable *ger*.

Figure 3-4 A permanent winter/spring camp in Omnogobi *aimag*, Mongolia that is only accessed seasonally. Camps are relatively open, and function to contain livestock and provide some protection from the wind. August 2010. The herder household was absent at the time of the photo.

In winter/spring, a *ger* is usually situated nearby to a livestock shelter as living quarters for herders. A small, permanent, lockable shed is also sometimes located nearby, and a well for livestock and domestic use located within a few kilometres of the permanent winter/spring camp. A low range of hills, like that shown in Figure 3-4, gives some protection from the wind.

The first of the two Inner Mongolian areas used in the study is Urat Rear Banner, which is in Bayannuur Prefecture. The banner's area is about 24,925km^2. In 2004, Urat Rear Banner had a population of about 60,000 people, making a population density of about 2 people km^2. About 94% of people in Bayannuur Prefecture were ethnic Han Chinese, with about 5% being ethnic Mongolian. As this figure includes densely settled irrigated agricultural areas and cities that are often dominated by Han Chinese, the ethnic Mongolian population in the more pastoral Urat Rear Banner is probably a much higher proportion than this. The majority of herders lived in bricked livestock compounds that were fully enclosed and attached to permanent brick living quarters (Figure 3-5). Only small enclosures for key forage resources, like *Achnatherum splendens* (Trin.) Nevski., were fenced.

Figure 3-5 Permanent house and pen in Urat Rear Banner, Inner Mongolia, that is used all year. July 2009. The herder's property was unfenced with livestock, primarily goats like the newborn in this photo, able to access pasture on demand during the day. *Salsola passerina* Bge. dominated the pasture when this photo was taken. Goats were sighted foraging on *Achnatherum splendens* (Trin.) Nevski.

The second Inner Mongolian study site is Damao, which is in Baotou Prefecture. The population of the prefecture in 2004 was about 110,000 people (Wikipedia 2011). The area of the banner is 17,410km^2 giving a population density of about 6 people km^2. About 94% of the population is Han Chinese, with about 3% being ethnic Mongolian. Eighty seven percent of the herders interviewed in 2010 were ethnic Mongolian (Table 3-5) but it is likely that the relatively small proportion of ethnic Mongolians in the Prefecture as a whole is a product of the large numbers of Han Chinese in Baotou City, mining and irrigated agricultural areas, rather than a biased sampled of herders.

In the Damao study area, most herders had been resettled into compounds surrounding major towns by 2010 (Figure 3-5). Resettlement was a result of regional grazing bans put in place three years earlier to reduce the frequency and severity of dust-storms affecting urban centres such as Beijing. Herders said in interviews that they still had grazing use rights, and were compensated on a per area basis for not being able to graze livestock (see Chapter 5). They also had rights over small areas of irrigated land that they use to feed penned livestock. Those herders who had not been resettled had exclusive rights over an area of land, and a fixed homestead that usually included a brick penned area (Figure 3-6).

A local official interviewed as part of this research stated that the population around Damao was founded in 1950, but the meaning of this term is unclear given that the area had long been utilised by primarily ethnic Mongolian herders. Regardless, the population was high at that time. It then decreased before increasing again. About 20 years ago, there were about 1,200,000 livestock in the Damao area. Before the grazing ban (see Chapter 5), this had increased to 1,600,000. As of July 2010, the same local official estimated that there were an estimated 500,000 livestock in the region. It is unclear whether this figure included penned dairy cows, which are common in the resettlement villages.

Figure 3-6 Resettlement village on the edge of Damao city, Inner Mongolia. July 2010. Each occupancy included a small living quarters and a partially covered pen for dairy cows, within a brick compound. Electricity was provided, with a shared ablution block.

Figure 3-7 Homestead, Chagaan Hada grazing area north of Damao, Inner Mongolia, July 2010. The goats were penned at the time the photo was taken, but were generally allowed to graze freely during the day. The surrounding area was unfenced.

3.3 Site selection

This section outlines why the study areas were selected for research. Rationales for study site selection are presented and discussed at different spatial scales, with a focus first on Mongolia, then Inner Mongolia. The rationale for selection of sites at the more local scale can be found in Section 3.4 of this chapter.

3.3.1 Gobi Desert

The Gobi Desert was selected as a research area for the following reasons:

- There were contiguous Gobi Desert areas in both Mongolia and Inner Mongolia with different institutional settings, allowing a comparative study to be attempted;
- Precipitation is highly variable. Consequently, any effect that institutional settings placing spatial and temporal constraints on pasture access have on the social-ecological systems (such as ‘rule-breaking’ associated with disrespecting administrative boundaries) may be more apparent than in landscapes with more predictable precipitation patterns (see below for a counter-argument to this assumption); and
- I had a greater level of professional experience with arid landscapes than steppe, mountain or forest landscapes, was somewhat familiar with the landscape and people of the Mongolian Gobi Desert, and had previously met some of the local officials.

Because this thesis aimed to assess rangeland condition, one limitation with using the Gobi Desert as a study area was that land degradation facilitated by overgrazing may be less likely there than in rangelands where precipitation was more predictable and grazing/precipitation relationships were more tightly coupled (see Chapter 2). The affects of institutional or management interventions on rangeland condition may therefore take longer to become apparent, if at all. However the demonstration of these effects would also provide useful information by challenging the efficacy of institutions or management interventions.

3.3.2 Mongolia

Omnogobi and Dundgobi *aimags* were selected for the following reasons:

- Pasture user groups (PUGs) were present in those *aimags*;

- There was English language, peer reviewed literature from within these *aimags* that could supplement my understanding. From Omnogobi *aimag*, this included Bedunah and Schmidt (2004), Sasaki *et al.* (2005), Wesche and Retzer (2005), Schmidt (2006), Ronnenberg *et al.* (2008), Sternberg *et al.* (2009), Wesche *et al.* (2010), Sternberg (2010). From Dundgobi *aimag*, these included Sasaki *et al.* (2009a and b), Okayasu *et al.* (2010) and Sasaki *et al.* (2011).
- Cost and accessibility. Omnogobi and Dundgobi were the Gobi Desert *aimags* closest to the Mongolian capital, Ulaanbaatar, and were serviced by a reasonable unsealed road.

There were two potential limitations to the choice of *aimags*, particularly Omnogobi *aimag*. Firstly, Omnogobi *aimag* had higher levels of tourism and mining than other Gobi Desert *aimags*. The impact of these on local economies may have affected the pastoral system by making some areas unsuitable or inaccessible for grazing. In addition, herders may have moved themselves and their livestock to areas in which they could supplement their income (see Chapter 7). This means that the Omnogobi *aimag* dataset presented in this thesis may not be relevant to other *aimags*.

Secondly, the pastoral system of Omnogobi *aimag* had also been disproportionately researched and 'developed' when compared to other Gobi Desert *aimags*. This was largely due to the presence of the Gobi Gurvan Saikhan Strictly Protected Area within the *aimag*. Multiple development agencies and researchers with environmental agendas have worked within the Strictly Protected Area and its buffer zone to conserve rare/iconic flora and fauna (e.g. Bedunah and Schmidt 2004; Wesche and Retzer 2005; Schmidt 2006; Ronnenberg *et al.* 2008; Wesche *et al.* 2010). Relative proximity to Ulaanbaatar, the presence of an airport and the same drawcards of natural beauty that attracted tourists may also have encouraged research and the presence of development agencies in Omnogobi *aimag*. The research 'snowball' effect associated with one researcher passing on local contacts to new researchers may have similarly focused research in this *aimag*.

The low population density in the Mongolian Gobi Desert combined with this focus on the area meant that some herders had been interviewed multiple times. A number of herders interviewed during this research stated they had been interviewed previously, sometimes on a similar topic. At least two interviews with near destitute herders in close proximity to international mining camps were probably influenced by the interviewees' assumption that I could facilitate financial aid from either the mine or a development agency, even though it was explained that this was not the case. Herder responses may have been influenced by development agency or interviewer attitudes, or as they sought to leverage access to funding (either actual or expected). However as the research focussed on institutional settings, including PUG institutions that by their very nature had been established with the involvement of external agents, these factors were not considered important.

Mongolian *soums* were selected to have:

- An annual average precipitation between 70 and 130 mm;
- A dominance of kastanozems and calcisols; and
- Accessibility. *Soums* along a loop across northern Omnogobi *aimag* were selected to minimise travel times and costs.

Some Mongolian study sites were located under Law on Land institutional settings, with other areas having the additional institutions of PUGs. I included sites with both institutional settings for comparative reasons, and because of conversations held with a well-informed Ulaanbaatar-based researcher (anonymous, personal communication, 2007) who suggested that PUG institutions were not maintained after withdrawal of funding by external development agencies, which suggested to me that PUG institutions may be not be appropriate for the Gobi Desert. The intellectual input of this person is acknowledged.

Additional criteria for choosing PUG sites were:

i) Essential:
   - Environmental purpose related to pasture management; and
   - Desert steppe location.

ii) Desirable criteria:
   - At least one effective vegetation growing season had passed since PUG establishment;
   - At least some level of institutional functionality remained;
   - A biophysically comparable Law on Land area was located nearby for comparison; and
   - An exclusive boundary.

Discussions were held with a number of Ulaanbaatar and Gobi Desert based non-government organizations to find PUGs that met the criteria. A number of PUGs, including those facilitated by MercyCorps Mongolia, were discounted because their aims did not include pasture management. The Swiss Agency for Development and Cooperation (SDC) and the New Zealand Nature Institute (NZNI) were both known to have PUG areas in Dundgobi and Omnogobi *aimags*, respectively. Ulaanbaatar-based meetings with these organisations, project documentation and meetings with local group leaders during a reconnaissance trip in June 2009 established the suitability of their PUGs.

The southern area of SDC's PUGs in Ulziit *soum*, Dundgobi *aimag*, met the criterion of having a desert steppe landscape. The PUGs had only recently been established, in 2007. There had not been an exceptionally above average precipitation year between 2007 and the 2009/2010 surveys, with the 2007 – 2009 annual precipitation average of 49 mm being much lower than the 20 year annual precipitation average of 72 mm (Institute of Meteorology, Ulaanbaatar, 2010). Thus, the first of the desirable criteria for a PUG earlier (see earlier) was not met although all others were.

Two PUGs (9-Erdene, Bulgan *soum*, and Ireedui, Bayandalai *soum*) in Omnogobi *aimag* were selected due to the relative accessibility of background information, age of the groups and greater level of functionality than other available groups. However, Law on Land sites that were biophysically matched were not available for direct comparison with PUG areas in Omnogobi *aimag*. PUG sites were primarily clustered along the Gobi Gurvan Saikhan Strictly Protected Area. Altitude effects meant that this area had more of a steppe vegetation community rather than a desert-steppe community. There were also a multitude of other government and non-government projects along the Gobi Gurvan Saikhan Strictly Protected Area. Given the large number of external agencies involved in the area, and the high mobility of herders, it was difficult to ascertain where and when groups were established, and whether they overlapped. A map of some PUGs in the area provided to me by NZNI suggested that all nearby areas with similar landscape characteristics all had a PUG established there at some point.

3.3.3 Inner Mongolia

The primary focus of this thesis is the relationships between institutional settings, rangeland condition and herder livelihoods in the Mongolian Gobi Desert. However, the pastoral system across the border in Inner Mongolia has a common cultural and biogeographical heritage (see Chapter 2). A notable exception to this heritage is the introduction of more exclusive institutional settings in pastoral regions. For this reason, Inner Mongolia can provide a surrogate institutional setting that may be applicable to the Mongolian Gobi Desert. For this reason, datasets from Inner Mongolia are used in this thesis to supplement understandings of the pastoral system in the Mongolian Gobi Desert.

Inner Mongolia was selected over other provinces/autonomous regions for the following reasons:

- Inner Mongolia was contiguous with Mongolian *aimag*s;
- An area of Inner Mongolia was able to be biophysically matched with Mongolian *aimags*, having similar soils and average annual precipitation; and
- A relationship had been established with researchers at the Inner Mongolia Agricultural University prior to commencing research.

Urat Rear Banner was selected for the following reasons:

- It was the most closely matched area to Omnogobi and Dundgobi *aimags* in terms of total annual rainfall and soil type; and
- Researchers at the Inner Mongolia Agricultural University had contacts with local officials in the area. This was essential in China, whereas accessing herders and rangelands directly was more difficult than in Mongolia.

Urat Rear Banner was visited in 2009 for rangeland condition and interview pilots, and forage model verification. In 2010, attempts to revisit the 2009 Urat Rear Banner sites for rangeland condition surveys and interviews failed. These areas were considered by police and military authorities at the time to be too close to the Mongolian border for foreigners to access, and were also difficult to access due to recent roadworks. An alternative location was therefore needed in 2010.

Damao in Inner Mongolia was selected in 2010 for the following reasons:

- The area was desert steppe;

- It was considered to be accessible; and
- Researchers at the Inner Mongolia Agricultural University had contacts with local officials in the area.

However this area had a higher annual precipitation than Mongolian Gobi Desert sites (about 270 mm cf. ~70 – 130 mm). Further problems were encountered for data collection in this area in 2010. A lack of support from local officials for rangeland condition surveys and forage model verification meant that biophysical data could not be collected. A grazing ban meant herders were unavailable to be interviewed on their Darhan Muminggan United Banner grazing lands. As a result, data collection was limited to interviews with resettled herders in two resettlement compounds, Nayan and Dwa Ama, which were facilitated by a local official.

The following sections describe methods for assessing rangeland condition, forage model verification and conducting interviews within study sites, and how data were assessed and analysed.

3.4 Methodology

3.4.1 Overview

This research compared three different bureaucratic institutional settings, two in Mongolia and one in Inner Mongolia. The first of these three institutional settings was governed by the Law on Land, Mongolia. The second was that covered by the institutions of PUGs in Ulziit *soum*, Dundgobi, and Bulgan and Bayandalai *soums*, Omnogobi *aimag*, Mongolia. These institutions existed in addition to the Law on Land, an overlap more fully described in Section 5.2.2. The third was that covered by Household Responsibility Systems in Inner Mongolia.

These three institutional settings are simplistically labelled as Law on Land, PUGs and Household Responsibility System for the sake of brevity throughout the thesis. Whilst all three settings aimed to facilitate or constrain the access of herders and their livestock to the forage resource, they are distinguished here by the way their institutions evolved or functioned, as well as the more specific ways in which they regulated access to the forage resource. An historical account of these three institutional settings was provided in Chapter 2, with a more detailed account of their characteristic institutions provided in Chapters 5 and 6.

Forage modelling sites were located across the areas in which the first and second institutional setting applied, but not the third (see Section 3.4.2 for further explanation). Twenty-five rangeland condition surveys were conducted in each of the areas of the first and second institutional settings, but only pilot surveys were taken in the third (see Section 3.4.3 for further explanation). Herders were interviewed in each of these three institutional settings, approximately 25 in each (see Section 3.4.4 for exceptions). Table 3-2 summarises the sampling regime for all data sets used in this thesis.

Table 3-2 Summary of the location, type and sample size of data used in this thesis. Data sources are as follows: forage verification (primary data, MercyCorps Mongolia), rangeland condition (primary data), interviews for herders and officials (primary data), fodder and livestock prices (Media for Business 2010), biomass and climate data (Institute of Meteorology and Hydrology, local officials), livestock data (local officials). Ppt = precipitation. Temp = temperature.

		Forage verification[A]	Rangeland condition[B]	Interviews		Secondary data				
				Herders [C]	Officials [D]	Fodder prices[E]	Livestock prices[F]	Biomass[G]	Ppt/ Temp[H]	Livestock[I]
Mongolia										
Ulziit	*Soum*	15	15	15	1	0	0	1990 -2010	1990 - 2010	2009 and 2010
Tsogt-ovoo	*Soum*	2	2	6	1	0	0	0	0	0
Manlai	*Soum*	6	5	7	1	0	0	0	0	1960 - 2010
Bulgan	*Soum*	8	8	6	1	0	0	1990 -2010	1990 – 2010	0
Bayandalai	*Soum*	5	5	4	1	0	0	1990 -2010	1990 - 2010	1960 - 2009
Tsogtseggi	*Soum*	3	3	5	1	0	0	1990 -2010	1990 - 2010	1960 - 2010
Khanbogd	*Soum*	0	0	1	0	0	0	1990 -2010	1990 - 2010	1960 – 2009
Sevrei	*Soum*	3	3	4	0	0	0	1990 -2010	1990 - 2010	1960 – 2009
Noyon	*Soum*	1	1	0	0	0	0	0	0	1960 – 2009
Nomgon	*Soum*	1	1	0	0	0	0	0	0	1960 – 2009
Bayan-ovoo	*Soum*	1	1	0	0	0	0	0	0	1960 – 2009
Khankhongor	*Soum*	3	3	0	0	0	0	0	0	1960 – 2009
Mandal-ovoo	*Soum*	1	1	2	0	0	0	0	0	1960 – 2009
Gurvantes	*Soum*	0	0	0	0	0	0	0	0	1960 – 2009
Khurmen	*Soum*	1	1	0	0	0	0	0	0	1960 - 2009
Mandalgobi	*Aimag*	-	0	0	1	2007 - 2010	2007 - 2010	0	0	0
Omnogobi	*Aimag*	-	0	0	1	2007 - 2010	2007 - 2010	0	0	1960 - 2009
Inner Mongolia										
Urat Rear	Banner	0 [J]	0	0	1	0	0	0	0	1990, 2007, 2010
Damao	Banner	0	0	23	1	0	0	0	2001 - 2009	No fixed years
TOTAL		50	50	73	11	2	2	6	6	14

[A] Assessment frequency varies – once for Inner Mongolian sites, multiple times for Mongolian sites. Figures in table refer to the number of forage modelling sites that were assessed. [B] Number of rangeland condition sites, each assessed once. [C] Number of interviewed herders, each interviewed once. [D] Number of officials, each interviewed once. [E] Time period over which fodder prices were sourced, with prices being collected twice weekly throughout the cited time period. [F] Time period over which livestock prices were sourced, with prices being collected twice weekly throughout the cited time period. [G] Time period over which annual biomass data was collected. [H] Time period over which monthly precipitation and temperature data was collected. [I] Time period over which annual livestock numbers were collected. [J] Data collected but not used. “0” = not available, “-” = not applicable at that scale.

3.4.2 Forage modelling

In arid rangelands, forage variability is closely aligned with climatic variability. High levels of climatic variability can increase the risk of feed gaps, and hence, declines in rangeland condition. Forage modelling was used in this thesis to explore the spatial and temporal nature of forage variability in Gobi Desert study areas, and to assess sites against the Dyson-Hudson and Smith (1978) model shown in Figure 2-1. The following section describes the methods employed for this purpose.

PHYGROW model

Forage modelling can be used to understand the temporal and spatial dynamics of the forage resource. PHYGROW is a simulation model used to predict forage availability (in kg/ha) in the short-term (Rowan 1995; Lemberg *et al.* 2002; Stuth *et al.* 2003). It uses soil, weather, grazing and plant community parameters to characterise rangeland sites, with factors like biomass production, herbivory (with grazing preferences considered) and water balance incorporated as feedback loops (Lemberg *et al.* 2002).

PHYGROW has been used internationally. It was found to be a good predictor (r^2 = 0.69) of forage availability in Uganda (Byenka 2004), and Kenya (r^2=0.99) when two outliers were excluded (Ryan 2004). In Mongolia, a collaborative project involving USAID, Texas A and M University, MercyCorps Mongolia and the World Bank uses the PHYGROW model as part of a livestock early warning system. Field-based verification of the PHYGROW model has been led by MercyCorps Mongolia in the Mongolian Gobi Desert since 2005. PHYGROW's strengths lie in its temporal scale, with the daily input of climatic data via CMORPH, a satellite based estimate of daily climatic parameters like rainfall and temperature. As it has been used as part of an ongoing livestock early warning system in the Mongolian Gobi Desert, each verification site has been sampled multiple times. This has allowed the manipulation of parameters to increase the accuracy of model outputs. The model assesses plant species as a livestock resource. Its productivity outputs reflect palatability to different livestock types at different times of the year. This contrasts with the 'greenness' index of NDVI which includes unpalatable species such as *Peganum nigellastrum* Bunge. In this thesis, 'total standing crop' model outputs only refer to standing crop that is palatable to livestock.

The model has several weaknesses. The spatial scale of the model is constrained by the size of CMORPH rainfall grid cells (64 km^2). This means that the model treats each grid cell as a single, uniform point, despite potentially high levels of on-ground variability within these grids. The model assumes that run-on and run-off between grids does not occur through water or wind vectors. Plant physiological parameters are highly detailed and particularly sensitive, so that their modification may have a significant effect on production values. Their accuracy is important in determining model outputs. However many are derived from standard one-off assessments of crop species (sourced from the U.S. Natural Resources Conservation Service) that have been assumed to be applicable to Gobi Desert pasture species. The model also ignores forage off-take by non-livestock grazers, like the *pika* (a small mammal), that are known to consume large volumes of biomass in some areas and at certain times (Retzer *et al.* 2006). These limitations mean that PHYGROW outputs are best used for comparative and exploratory purposes, rather than taken as accurately reflecting an on-ground reality. In the context of this thesis, PHYGROW is a useful tool for understanding and illustrating forage dynamics.

Field verification

Data collected in Mongolia by MercyCorps Mongolia form the base verification dataset for modelling in Mongolia. No attempt was made by me to confirm the accuracy of the dataset's plant identification. Additional model verification of previously established sites was conducted with MercyCorps Mongolia in May/June 2009. Twenty-five of these sites that were biophysically matched with PUG and Inner Mongolian sites were then chosen within the *soums* described in Table 3-2 on the basis of practical considerations such as accessibility.

Sites in 9-Erdene and Ireedui PUG areas (5 sites in each PUG) were established and verified in May/June 2009. Some Ulziit *soum* PUG sites were established and verified with MercyCorps in September 2009, with the rest of these sites established and verified independently by myself in November 2009 to make a total of 15 sites. Litter was additionally collected from all sites, including from Ireedui and 9-Erdene PUG sites, in November 2009.

Urat Rear Banner was selected as the best biophysical match in Inner Mongolia for Mongolian Gobi Desert areas. In July 2009, a reconnaissance and forage verification trip confirmed that Urat Rear Banner landscapes matched many areas of Mongolia under Law on Land and PUG institutions. Practical constraints influenced selection of forage sites within Urat Rear Banner. During the 2009 field trip, the lack of availability of a vehicle suitable for going off-road meant that only sites accessible on foot from a main road were available. There were only three main roads in the area, and one of these was inaccessible due to its proximity with the Chinese-Mongolian border. Given that each site needed to be at least 8 km from the other to match CMORPH satellite data used in forage modelling (see below), this created a less representative and more linear selection of sites than ideal. Nevertheless, 25 verification sites in Household Responsibility System areas of Urat Rear Banner were established with field assistance from the Inner Mongolian Agricultural University, and after verbal permission had been granted by herders.

Whilst verification occurred over different periods, one potential weakness of the PHYGROW verification dataset (both MercyCorps' pre-existing dataset and that created for this research) was the lack of verification during winter and spring months when forage availability is likely to be at its lowest. Sites verified in November 2009, at the beginning of a *dzud* period, may have partially rectified this weakness. Other issues that may have affected the ability to accurately ground-truth parameters, such as the difficulty of collecting leaf litter through the snow when standing vegetation is also frozen and liable to snap, arose during this sampling period (Figure 3-8). Snow cover and temperatures around -30°C during field verification made it difficult to follow methods designed for warmer months. Attempts were made to dig through the snow to determine the type of ground cover at sampling points. Rings were brushed free of snow to collect litter or forage, but litter may have combined with frozen standing dead vegetation at times as this vegetation detached easily at sub-zero temperatures.

Figure 3-8 PHYGROW verification, PUG site DGHL10. Ulziit *soum*, Dundgobi *aimag*, Mongolia. The tool used for site establishment is shown in the centre foreground. The photo was taken in November 2009 and there had been an unseasonably early blizzard in the days preceding. The 2009/2010 *dzud* followed.

Precipitation data generated from CMORPH is an input to PHYGROW. As it is generated via satellite, there is a need for sites to be placed at least 8km apart to avoid repeating samples within one satellite pixel. All sites were therefore selected to represent the ‘typical’ pasture type within CMORPH precipitation grid cells. Atypical geographical features were avoided, as were areas within a few kilometres of permanent water points or settlements.

9-Erdene and Ireedui PUG sites were selected to reflect as much forage variability as herders in the PUG had access to whilst staying within the PUG boundary. This resulted in sites being placed along an altitudinal gradient. Some sites were invariably situated within the same remote sensing rainfall grid cell, as sites needed to be about 5 km apart (rather than 8km as planned) in order to fit enough replicates into the one PUG area. In the larger Ulziit *soum* PUGs areas, sites were randomly situated at distances greater than 8 km.

The establishment of new sites involved a different process to the verification of earlier sites. Landscape photos were taken at each site. New sites were assessed for latitude/longitude, elevation, soil type, aspect and slope, and two photographs (one horizontal, one vertical) were taken. Five sampling areas were defined by two nails welded flat, and one sharpened nail welded at an angle onto a 1m long star-picket (Figure 3-9). The sharpened nails were 25 cm apart. The presence of litter, bare ground, surface rock and grass cover were recorded where the sharpened nail 'hit' one of these functional groups. Measurements were repeated at each new site 25 times at an interval of 10 m along a linear transect.

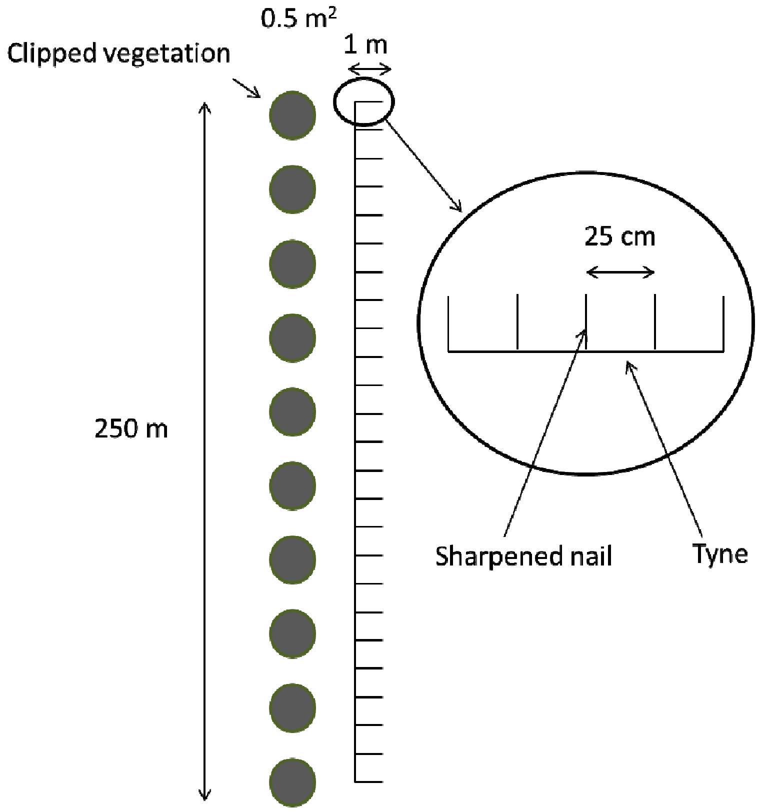

Figure 3-9 Layout of sampling plots used for forage model verification.

Plant species were identified with the help of MercyCorps Mongolia staff member and botanist M. Urgamal. Plants were identified in the field or photos and pressed samples taken for later identification. The online plant identification database, FloraGREIF - Virtual Flora of Mongolia, described by Rilke and Najmi (2011), was used as reference material, as was Grubov (2001) and Sodnomdarjaa and Johnson (2003).

After site establishment, and during each round of verification after that, a $0.5m^2$ wire ring (Figure 3-9) was used to define an area of vegetation to be clipped. All non-woody vegetation within each quadrat was clipped with heavy duty scissors and placed in paper bags. For previously established sites, the cover estimates were replaced by presence/absence records by species (both annuals and perennials) for each wire quadrat, followed by clipping and bagging. This was repeated 10 times at 25 step intervals (with one step equating to approximately one metre) along a linear transect. Bagged samples were oven-dried in the laboratory at 60ºC for 48 hours, and weighed and averaged to determine forage availability in kg/ha.

Over a two week period in January/February 2010, I received training from the Centre for Natural Resource Information Technology at Texas A and M University as to the use and parameterisation of the PHYGROW model through its online interface, PHYWEB 2.0. A separate, virtual project was created for the purpose of modelling with a combination of the MercyCorps Mongolia dataset from the existing project, and the new data that I had collected. The parameters of pre-existing MercyCorps Mongolia forage verification sites were copied into the new project. The field data I collected in 2009 was then entered into the model.

As a result of this PHYGROW training, I decided to gather additional field based information that could be used to increase the robustness of model parameterization. In June 2010, 20 Law on Land sites and five PUG sites in Omnogobi *aimag* were revisited and verified according to the methods described earlier. During August and October, an additional 20 PUG and five Law on Land sites were also revisited. Most of these sites had been clipped previously by MercyCorps Mongolia, but other easily measurable parameters such as litter cover (%) and dry weight, bare ground (%), rock cover (%) and soil texture had not been verified at these sites.

All collectable litter material was taken from within ten, $0.5m^2$ quadrats located 25 m apart. Litter was then oven-dried at 60ºC for 48 hours in the laboratory, and then weighed and averaged to determine litter dry weight per site. These litter weights were then used to assist verification of the model, as PHYGROW produces litter weight outputs in addition to forage availability. In the same five quadrats, % bare ground, % litter cover and % rock cover (> 20 mm) was also visually estimated. These parameters were averaged with the intention that they would be later used in model parameterisation. Field textures of soils were estimated concurrently with rangeland condition surveys (see Section 3.4.3) based on five quadrats placed at equal distances along a transect line of a length that was determined by the relative length of patch (obstructions such as rocks or perennial vegetation that could obstructive erosive vectors) and interpatches (areas between patches).

<u>Parameterisation</u>

The parameters used to model standing crop and total standing crop are shown in Table 3-3.

Table 3-3 PHYGROW parameters used to model biomass,

Scenario data	Weather	Plants	Soils	Grazing regimes
Latitude[A]	Min. temp[B]	*(All the below for each species present)*	Surface rock[A]	Decision day
Longitude[A]	Max. temp.[B]	Dry matter to radiation[C]	Bareground[A]	Minimum stocking rates[C]
Aspect[A]	Solar rad.[B]	Suppression temperature[C]	Soil group[A]	Maximum stocking rates[C]
Surface slope[A]	NDVI[B]	Optimum temperature[C]	Soil depth[A]	Stocking rate increment[C]
Elevation[A]	Precipitation[B]	Leaf turnover rate[C]	Surface water storage[C]	Minimum pdu[C]
		Green to dead ratio[C]	Bottom type[C]	Maximum pdu[C]
		Max. leaf litter decomposition rate[C]	Max SCS curve	
		Leaf/above ground biomass ratio[C]	Min SCS curve[C]	
		Stem turnover[C]	*(All the below for each soil layer)*	
		Cover type[C]	Thickness[C]	
		Fuel[C]	Rock factor[C]	
		Cover class[C]	Saturated hydraulic conductivity[C]	
		Functional group[A,C]	Bulk density[C]	
		Leaf area index[C]	Volumetric water contact at 0, -1/3 and -15 bar[C]	
		Decomposition rate[C]	Dry bulk density[C]	
		Rooting depth[C]		
		Percentage maximum expression[C]		

[A] Parameter data was collected *in situ* (by myself or others).
[B] Parameter data was linked to CMORPH.
[C] Parameter data was estimated from the literature or expert option.

The type of data was sourced to populate the parameters shown in Table 3-3 is as follows. Field parameters, including forage dry weights, slope, altitude, litter dry weights, species composition and frequency, field texture, % bare ground, % litter and % rock were loaded into the PHYGROW model via the PHYWEB 2.0 interface. Parameters were estimated for new plant species and soil types using various sources, such as FAO soil classes (IUSS Working Group WRB 2007), Sodnomdarjaa and Johnson (2003), Damiran (2005), site photos and the author's own experience with Gobi Desert plant species and soil types. It was assumed that pre-existing parameters were as accurate as was possible given that they had been constructed by the Gobi Forage team using a combination of peer-reviewed literature, substitution of parameters from functionally similar plant species known from elsewhere, and/or the knowledge of Mongolian soil scientists, botanists and livestock nutritionists. Grazing parameters for all sites were set to zero to model the innate productivity of the sites. It is acknowledged that many of the plant species in the Gobi Desert may have positive responses to the presence or absence of grazing not considered in PHYGROW feedback loops, but this was ignored for the purposes of this exercise.

<u>Running the model</u>

In June 2010, Texas A and M University discovered that the CMORPH precipitation data that fed into PHYGROW had had previously undetected problems since August 1, 2009 (Jay Angerer, personal communication, 2011). Other, ongoing technical issues with the PHYWEB 2.0 interface occurred over a more extended period of time. These could not be resolved by the author as they were controlled by model programmers in Texas. It was therefore decided that the use of PHYWEB 2.0 for modelling new sites should be abandoned.

Pre-existing PHYGROW output files for total standing crop and NDVI were downloaded from the Gobi Project website because these data had been checked and corrected by Texas A and M University. By choosing to abandon PHYWEB 2.0, an ability to assess variations in forage production in Inner Mongolia was lost, as was the capacity to analyse new verification sites for the Ulziit *soum* PUGs. Model runs for 9-Erdene and Ireedui PUGs were available, but could not be verified against primary data. For this reason, no attempt is made to statistically analyse the outputs, even though these runs are included in this thesis as data for illustrative purposes.

Parameter files for NDVI and modelled standing crop (by species) and total standing crop for all Gobi Forage sites in Ulziit *soum*, Dundgobi *aimag*, and Omnogobi *aimag* were downloaded from http://glews.tamu.edu/ on the 11th of January, 2011. These sites were largely within Law on Land areas. An additional dataset that went back as far as 1970 was downloaded for selected sites in January 2012 to help crosscheck both conclusions made from the verified time period, and herder accounts of forage availability during the *negdel* period. Whilst references are made to this dataset in the thesis, it was never verified in the field and its accuracy cannot be assessed. Consequently, raw forage modelling prior to the verification period is not presented in this thesis.

Analysis

Scatterplots of both NDVI and total standing crop outputs were produced in SPSS (SPSS Inc 2003) to check for outliers, with both then graphed. Pearson correlation coefficients comparing NDVI and total standing crop for several sites were assessed to check that modelled outputs were reasonably correlated with 'real world' data.

The modelled total standing crop and standing crop of individual plant species at i) all sites, ii) five sites within 9-Erdene PUG, and iii) five sites within Ireedui PUG, were graphed. These were visually assessed for temporal and spatial trends. Monthly co-efficients of variation for modelled total standing crop were additionally graphed for Ulziit *soum*, Dundgobi *aimag* sites, and for all Omnogobi *aimag* sites, to explore the temporality of forage variability. Herder accounts of good and bad years were visually cross-checked with forage outputs from sites within their *soum*.

Forage that is biophysically available does not necessarily reflect the forage that herders have access to in practice (see Chapter 2). Multiple factors other than forage availability contribute to herder decision making around mobility (see, for example, Chapter 6), including limited economic resources and the desire to stay near friends/relatives. In general, these factors suggest that herders will choose to move to the area closest to their 'base' (e.g. registered winter/spring camp) that has available forage. The modelled total standing forage available to a mobile herder at key mobility decision periods was estimated, as in Box 1, to explore differences in forage availability to herders at different spatial scales.

Box 1. An estimate of total standing forage available to a mobile herder (see Chapter 4 for results)

Two *soums* were selected that each had three previously verified Gobi Desert forage sites: Bulgan *soum* because it included 'steppe-like' landscapes and because modelled total standing crop was available for the 9-Erdene PUG; and Nomgon *soum* selected at random as a 'gobi-like' landscape. In a herder-defined good year (2008 – see Chapter 4), two hypothetical herders and their livestock start at Nomgon *soum* centre, and in April choose to move their livestock to a new pasture. They choose between the three nearest modelled total standing crop sites for which they have information on forage availability. They choose the site with the most total standing crop at the time, and move their livestock there. They may choose to not move if the forage is greater in their current location. They repeat the decision making process on July 1, September 1 and November 1. One herder respects *soum* boundaries, and does not cross into another *soum*. The second herder makes their decision based on modelled forage availability alone. The modelled total standing crop at each of the sites the two herders visit is summed. The two herders, beginning from the same starting point and under the same restrictions, repeat the process in a herder-defined bad year (2009 – see Chapter 4).

A similar exercise was simulated for Bulgan *soum* in both good and bad years in which additional hypothetical herder followed the same decision-making process, but was not allowed to enter winter pastures of the mountain range if it was not winter. The exercise was repeated for the PUG in Bulgan *soum*, 9-Erdene. In this case, one hypothetical herder must stay within the PUG boundary, choosing sites based on three forage verification sites established in 2009. Another stayed within the PUG boundary, but was forced to leave the winter pastures of the mountain if it was not winter. Total standing crop was summed, as described earlier.

3.4.3 Rangeland condition

Rangeland condition was assessed in order to explore whether Mongolian Gobi Desert rangelands were degraded under the Law on Land, and whether PUG areas were in different rangeland condition states than Law on Land areas. More specifically, rangeland condition surveys explored the following questions:

i) Do 'slower' rangeland condition indicators, such as the presence of erosive features, indicate land degradation in Gobi Desert areas?;

ii) Are there other indicators, such as the proportion of unpalatable, perennial forage species, which indicate an overgrazed and/or degraded system?; and

iii) Do rangeland condition indicators have different attributes under Law on Land and PUG institutional settings?

The results of rangeland condition surveys are presented and discussed in Chapter 8, where they are combined with the accounts of local officials and herders, as well as secondary data, to explore assumptions of degradation in the Mongolian Gobi Desert. The following section describes the methods employed.

<u>Pilot studies and rationale for the selection of indicators</u>

Tongway and Hindley (1995) argue that functional landscapes minimise nutrient and moisture flows out of the system as vegetation patches ‘capture’ nutrients and water, and recycle them. Indicators of perennial vegetation patch and litter cover can be important in assessing the landscape’s ability to ‘capture’ resources, as can soil surface condition indicators such as biological crusts, soil erosion, crust brokenness, amount of eroded material, surface nature, soil texture and microtopography (Tongway and Hindley 1995). Landscape Function Analysis (LFA) (Tongway and Hindley 1995) is a rangeland monitoring framework that includes many of these indicators. Like all rangeland monitoring techniques (see Chapter 2), what is functional versus dysfunctional, and what is resource ‘leaky’ versus not ‘leaky’ in landscapes, is inherently scaled. With careful recognition of the limitations of scale, many of the indicators commonly used in LFA can overcome the weaknesses of methods based on linear models of plant succession, as well as those methods that cannot differentiate between anthropogenic caused change and short-term variability in precipitation (see Chapter 2).

Rangeland condition surveys using a modified version of LFA (Table 3-4 and as follows) were piloted at 10 sites during October 2009 in Ulziit *soum*, Dundgobi *aimag*, Mongolia. Socioeconomic interviews were simultaneously piloted. This helped explore the ability of social and biophysical data to be integrated. Other desert-steppe study sites were visually inspected during May and July 2007, and between May and September 2009.

A suite of site information attributes were initially included for surveying. Distance to nearest water and *gers* were subsequently removed from these attributes as a result of the pilots as it was impractical to assess these in the field. *Gers* are mobile, and the relationship between long-term grazing pressures and summer surface waters may be tenuous as many summer waters are ephemeral. Site distances from these were visually assessed as having limited functional use. Instead, it was determined that would be at least 1 km from permanent settlements, wells or winter/spring camps, with the distance to these recorded if feasible.

As no site was located close to permanent water or winter/spring shelters, it was assumed that grazing pressures were comparatively low at all sites. A number of indicators of livestock utilization of the sites were assessed, as follows, to explore this assumption. It became evident that each had their weaknesses. Perhaps due to the lack of obstructions impeding mobility, livestock in the Mongolian Gobi Desert tended to ‘fan’ whilst foraging rather than following a distinct livestock pad/track. This makes the presence of livestock pads/tracks a relatively insensitive indicator of grazing pressures. The rate of breakdown of livestock manure was not known. Given the long winter and aridity of the area, the degradation rate may be very low, making it difficult to use the level of livestock manure as a surrogate for short-term grazing pressures. This difficulty was compounded by the collection of livestock manure as a fuel source by herders. The presence of defoliation by livestock was assessed as being the most useful indicator of recent grazing pressures, but this cannot indicate longer-term pressure. In an attempt to off-set the weakness of any one indicator, all indicators were ultimately retained.

The length and width of obstructive patches and interpatches along a transect were assessed, with obstructive patches including rocks and logs more than 1cm in length and perennial vegetation, and interpatches being the areas in between. The length of the transect depended upon the patch/interpatch length. Whilst this method generally worked well, at the site and landscape scale it is suggested that the ‘patchiness’ of the Gobi Desert is less than at the location where the LFA methodology was developed (arid Australian rangelands). This difference, combined with the rockier surface in the Gobi Desert, made it difficult to balance temporal representativeness and patch/interpatch assumptions. For example, at some sites, the dominance of gravel lag/fine rock armouring meant that each rock more than 1 cm was recorded as a patch. The patch/interpatch sample size grew extremely quickly, reaching the required replicate number (seventy) over an extremely short area (sometimes just a few metres). The alternative, defining ‘patches’ at the vegetation community level, would have meant transects tens of kilometres long. The method was therefore retained as initially designed.

Five $1m^2$ quadrats were also used to assess a range of indicators Table 3-4 along each transect. This quadrat size was the maximum commonly used in Mongolian desert steppe areas (Sheehy and Damiran 2009; Sasaki *et al.* 2009a; MercyCorps Mongolia and Texas A and M University, personal communication, 2009). Litter and most vegetation based indicators appeared to provide little useful information during the pilots as, for example, litter seemed to be a much more significant indicator of inherent productivity than condition. It therefore has limited use for spatial comparisons between institutional settings. The relative windiness of the Gobi Desert meant that very little litter accumulated on the soil surface. Vegetation was dominated by geophytes like *Allium* spp. or perennial grasses such as *Stipa* spp. that were highly responsive to short-term precipitation events. This confounding factor made interpreting the causes of differences in indicator states difficult.

These factors, and the acknowledgement that rangeland condition surveys need to manage the weaknesses inherent in a one-off assessment of rangeland condition, meant that additional soil-based indicators were included in surveys. Whilst vegetation/litter indicators were retained, these additional indicators aimed to assess the relative level of erosion and armouring of the soil surface. The additional inclusion of soil-based indicators (such as the relative cover of gravel and rocks of different size classes) sought to further investigate the potentially fine distinction between ‘natural’ and accelerated rates of soil erosion.

<u>Surveys</u>

Fifty sites were assessed for indicators of rangeland condition across thirteen Mongolian *soums* (Table 3-2) in central and northern Omnogobi *aimag*, and southern Dundgobi *aimag* between June and October, 2010. Table 3-4 summarises all the indicators of rangeland condition, and other descriptors, assessed.

Table 3-4 Indicators of rangeland condition and other descriptors. The table describes the data recorded at each of 50 sites. More detailed information on the indicators can be found in the main text.

Indicator	Spatiality/sample size	Methods
Latitude/longitude	Point	Global Positioning System
Date	Point	-
Photo	-	Landscape, full zoom out
Utilization	Transect and 5 x $1m^2$ points along transect	Presence/absence of livestock pads/tracks, dung and plant defoliation
Plant species list	In immediate area of transect	Dominant species (by frequency) noted
Phenological features	In immediate area of transect	Flowering or seeding plant species noted where present
Patch: interpatch ratio	Transect	As per Tongway (2008). Dependent on the length of landscape structural elements, but generally <50m
Basal cover	Transect	As per Tongway (2008). Basal cover by obstruction type, or functional plant group along transect
Plant frequency	Transect	Derived from basal cover indicator, with proportional species ‘hits’ along transect
Litter	5 x $1m^2$ quadrats along transect	% cover of quadrat
Litter origin	5 x $1m^2$ quadrats along transect	As per Tongway (2008) – local or foreign in origin (local was defined as within a few metres of the quadrat)
Incorporation of litter	5 x $1m^2$ quadrats along transect	As per Tongway (2008) – incorporated or not incorporated into the soil surface
Aerial cover	5 x $1m^2$ quadrats along transect	As per Fehmi (2010) - % cover of quadrat
Bare	5 x $1m^2$ quadrats along transect	% of quadrat with a surface of particle size < 2 mm
Fine gravel	5 x $1m^2$ quadrats along transect	% of quadrat with a surface of particle size 2 mm – 20 mm
Coarse gravel	5 x $1m^2$ quadrats along transect	% of quadrat with a surface of particle size > 20 mm
Erosion extent	5 x $1m^2$ quadrats along transect	Presence or absence of accelerated erosion
Erosion type	5 x $1m^2$ quadrats along transect	Rilling/Pedestals/Hummocking/Sheeting/Terracettes/Scalding/Gullying
Erosion severity	5 x $1m^2$ quadrats along transect	Score of 1 – 4 (1 = erosion is least severe, 4 = most severe)
Category of surface	5 x $1m^2$ quadrats along transect	Modified from Friedel *et al* (1993).
Biological crust	5 x $1m^2$ quadrats along transect	As per Tongway (2008) – presence/absence
Slake test	5 x $1m^2$ quadrats along transect	Modified from Tongway (2008). Score of 0 – 4 (0 = soil ped not achievable, 1= slakes within seconds, 4 = intact)
Crust brokenness	5 x $1m^2$ quadrats along transect	Modified from Tongway (2008). Score of 0 – 4 (0 = soil surface has no crust, 1 = crust extremely broken, 4 = intact)
Texture	5 x $1m^2$ quadrats along transect	Modified from Tongway (2008). Score of 1 – 4 (1 = soil surface is more clayey, 4 = more sandy).
Deposited materials	5 x $1m^2$ quadrats along transect	As per Tongway (2008). Score of 1 – 4 (1 = >50% of quadrat is covered in deposited soil/plant material, 4 = <5%)

Twenty-five sites were located in areas that had been established as PUG areas, and 25 were located in non-PUG areas. Although crossing a range of soil-types, these sites were all classed as desert steppe (Lavrenko and Karamysheva 1993) and had 20 year annual precipitation means between 67 and 132 mm. A broad, landscape-scale approach to sampling was taken with the aim of maximising spatial representativeness. Unrepresentative features of the landscape (such as mountain-tops, or areas relatively close to settlements and water) were avoided.

In steppe-like 9-Erdene and Ireedui PUG areas, winter/spring camps tended to be in the mountains, with summer pastures on mountain pediments. Rangeland condition sites were therefore located along an altitudinal gradient on the slopes leading to and including the Gobi Gurvan Saikhan Strictly Protected Area. In the gobi-like Ulziit PUG areas, spatial variability appeared to be more random. In these and non-PUG areas of Omnogobi/Dundgobi *aimags*, surveys were therefore located more randomly in space, but were still representative of topographical features. Surveys were sited close to forage modelling sites (Section 3.4.2) for practical reasons (fieldwork time and funding constraints), and so that the information gained from either forage availability or rangeland condition surveys could complement the information gained from the other. Sites were chosen to be at least one kilometre from a waterpoint or permanent settlement so as to minimise any localised piosphere effect (Sasaki *et al.* 2009b).

A 50 m transect was laid perpendicular to the main erosive vector at each site. If slope was significant, it was assumed that water was a more significant vector of nutrient/water flow than wind but wind was the most significant vector at most sites. If obvious hummock-lags were visible, the wind direction was calculated based on sediment alignment in relation to an obstruction. Otherwise, the prevailing spring wind direction was used with the assumption that spring was the time of year when obstructive cover was lowest, hence the time when accelerated soil erosion was most likely. A site photo was taken, with land-type, distance from water and permanent winter/spring camps noted. The immediate presence/absence of grazing livestock was recorded, as were indicators of local grazing densities (described earlier).

The length and width of obstructive patches and interpatches along the transect were assessed using a modified version of Landscape Function Analysis (Tongway 2008). Perennial species were generally identified to species level if known, or genus level if not. Species were identified as per forage verification (described in Section 3.4.2). Livestock nutritionist Udval at MercyCorps Mongolia, and Sodnomdarjaa and Johnson (2003), were additionally consulted in regards to plant palatability. In the few instances where the genus was not known, the functional type e.g. 'perennial forb,' was recorded. Desert perennials, such as the perennial forb *Allium polyrrhizum* Turcz. et Rgl, contract to underground bulbs in dry times. If such bulbs were visible during recording, they were recorded separately although they did not functionally act as perennials under all LFA assumptions, or as a bad-precipitation season source of forage for grazing livestock.

Five 1m^2 quadrats were laid equi-distance along the LFA transect. In each quadrat, the percentage cover of fine gravel, coarse gravel and bare ground were assessed visually. The extent (presence/absence), severity (1 – 4, with 4 being most severe) and type of erosional features were noted. The percentage of each quadrat covered by litter, whether this litter was incorporated into the soil or not, and whether the litter was spatially local or foreign in origin was visually assessed. Percentage aerial cover was visually assessed, and the presence/absence of a biological crust was recorded. Field texture, slake-ability of a soil ped and crust-brokenness were categorised using LFA methods (Tongway 2008). Major erosive features encountered along the transect were also assessed for breadth and length.

As precipitation in the area was relatively high in winter/spring (see Chapter 2), soil moisture was such that many more species were present/identifiable during the 2010 survey period than in previous, lower rainfall years. Species presence/absence was therefore recorded opportunistically during rangeland condition surveys, with phenology noted.

<u>Analysis</u>

Indicators of rangeland condition were entered into an Excel spreadsheet, and then imported into SPSS Inc (2003) for statistical analysis. All analytical tests were selected following Pallant (2011). Indicators with a continuous dependent variable were assessed for normality using a variety of quantitative and qualitative tests. Trimmed means, kurtosis, skewedness, Kolmogorov-Smirnov statistics were assessed, with histograms and q-q plots visually checked. All indicators were reasonably normally distributed apart from coarse gravel cover and aerial vegetation cover. These indicators were subsequently transformed via *squr(coarsegravel)* and *log(aerialvegcover)* to meet assumptions of normality. Litter cover also did not meet assumptions of normality, but transformation via *squr(littercover)* did not significantly improve normality. For this reason, litter cover was subsequently treated as a non-parametric variable.

One-way ANOVA tested whether normal, continuous indicators were significantly different between institutional settings. If differences were found, Tukey's HSD test for an unequal sample size (the Spjotvoll-Stoline test) identified how the institutional settings were different for that particular indicator. Categorical indicators were tested using the Kruskal-Wallis test. If significant differences were found between institutional settings, the Mann-Whitney U test was used post-hoc to identify how the institutional settings were different for that particular indicator.

3.4.4 Interviews

Interviews with herders, local officials and staff of development agencies explored the following broad questions:

i) What types of climatic variability do herders recognize, and how do they manage this variability in Gobi Desert study areas?
ii) What kind of changes in the rangelands have herders noticed, if any, and what do they believe are the causes of these changes?
iii) Are there institutional mechanisms that can substantiate the claim that PUGs reduce and repair land degradation in the Gobi Desert?
iv) Is there any evidence that herder livelihoods in PUG areas are different than those on Law on Land areas?
v) How do herders think different institutional settings impact, or may impact, the pastoral system?
vi) How might institutional settings interact with feed variability to create, or mitigate, feed gaps?

This section outlines the methods used for interviewing herders, local officials and development agency staff in Mongolia and Inner Mongolia, and then describes the subsequent process of data analysis. The results of analysis of interview data are found in multiple chapters throughout the thesis. Chapter 4 describes good and bad years for the pastoral system from the perspective of herders. In Chapters 5 and 6, interview data is used in conjunction with the Figure 2-1model and Crawford and Ostrom (1995) typology to identify the likelihood of feed gaps under different institutional settings. In Chapter 7 interview data is used to explore the options herders have available for managing climatic risk. In Chapter 8 it used to explore assumptions of degradation and, in Chapter 9, to look at linkages between rangeland condition and herder livelihoods.

The interviewer-interviewee relationship

The primary purpose of interviews, and this research, was not to gain an in-depth insight into cultural values and practices of Mongolian pastoralism, such as was the aim of the anthropological work of Murphy (2011). Nevertheless, specific cultural values and practices are acknowledged here where known to be relevant to the thesis objectives. The more general anthropological assertion that research cannot adequately sample, interpret and present an '*unruly*' social experience as a meaningful, discrete dataset is also relevant, particularly in the cross-cultural situation created by this research (Geertz 1976, Clifford 1983). The reasons for this in the context of this research are varied but, as an example, a researcher can indirectly affect data collected during interviews through factors such as their social position in relation to the individuals being interviewed, and what each party seeks to achieve from the interview (Clifford 1983, Bertrand 1994).

It is unlikely that herder responses in their entirety were significantly affected by gender as the male/female ratio of respondents was about 50% (Table 3-5). Responses did not appear to be significantly different between male and female respondents, although female respondents in PUG areas appeared to be more knowledgeable about PUG operations than male respondents. The 2009/2010 *dzud* that preceded the interviews was more likely to have had an effect on interviews. Post-*dzud* interviews may have created more negative expectations about livelihoods than the pre-*dzud* period. Some herders impoverished by the *dzud* may also have sought to access financial resources from external agents such as myself, hence biasing results. One interview in Inner Mongolia was stopped prematurely when the herder asked if I was a journalist, despite having the purpose of the interview explained previously. Another interview in Mongolia was stopped prematurely when one of the interviewees stated that herders are always asked questions by researchers who had never given anything back.

Other attributes of the interviewer that may have affected responses are discussed where relevant in the sections that follow. Attempts to mitigate other observer-observed effects are also included. Factors that reduce the risk of misinterpreting social data in this research include the two years I spent living in Mongolia, one of which preceded the research discussed here, the literature review of anthropological papers relevant to Mongolia and Inner Mongolia (Chapter 2) and the triangulation of social and biophysical datasets (Davis and Ruddle 2010).

Pilot studies and rationale for the selection of questions

Ethics approval for interviews was obtained, and then extended, at the University of South Australia Ethics Committee (Ethics Protocol P008/09 "Rangeland condition, herder livelihoods and land tenure in the Gobi Desert") on the 22nd of February 2009.

Ten herder interviews were piloted during October 2009 in Ulziit *soum*, Dundgobi *aimag*, Mongolia. Interviews took a semi-structured approach, with occasional diversions from questions if herders wished to elaborate, or if additional questions would provide a more nuanced understanding of the topic. Only one herder in the pilot study declined to be interviewed, citing other commitments. Initially pilots were held early in the morning but this was subsequently changed to being later in the morning after morning milking activities were completed.

Piloted indicators of material wealth were initially quantified for each herder interviewed. This was later abandoned as assets were often not fixed in space (e.g. motorcycles were highly mobile) and consequently their presence or absence may have reflected on factors other than wealth. The mobility of herders in Mongolia, and the subsequent necessity for few consumer goods in summer *gers*, meant that wealth may also have been underestimated for more mobile herders. The author concurred with research suggesting that livestock numbers are the most suitable surrogate of wealth in the Mongolian pastoral context (Mearns *et al.* 1992; Mearns 2004; Janes 2010). This indicator of household wealth was therefore retained. Livestock wealth and other livelihood indicators were selected from those established by Mearns *et al.* (1992), Mearns (2004) and Janes (2010) as being important to Mongolian herders, and from indicators within the international literature (Chambers and Conway 1992; Scoones 1998).

Piloted questions relating to herder expectations about livestock mortality were later dropped from interviews. This was largely because some herders were found to believe that the expression of negative expectations about the future converted that expectation into an outcome, producing a *fait accompli*. Some herders were likely to have expressed over-optimism about their livestock's' ability to survive a bad winter for similar reasons. The detailed household costs and revenues needed to undertake a complete household economic modelling were found to be too difficult to ascertain within a reasonable timeframe. The informal economy and its constituent parts, such as the flow of resources (e.g. cash and livestock) within extended families, are significant in Mongolia (Mearns 2004; Sneath 2006). Food security is not necessarily related to the immediate generation of income. The reluctance of Mongolian herders to elucidate their often high level of debt (Fairclough 2009) and the author's own cultural values produced a reluctance to ask in-depth questions about finances. To replace questions around detailed household costs and revenues, herders were asked broader surrogate questions (such as 'Do you want your children to keep herding?). This allowed them to weigh the attributes of well-being that they felt were important. Livelihood elements assessed by herders as being valuable could then be considered, removing the *a priori* assumption that a household economic budget was an adequate indicator of livelihoods.

Questions found to be overly time consuming, or those that became redundant due to prior answers, were also removed. The list of questions thus refined was used in subsequent interviews.

<u>Interview questions</u>

Twenty-five herder households were interviewed in each of the Law on Land and PUG institutional settings in Mongolia between July and October, 2010. Data collection was structured around the following themes:

i) Herder household demographics e.g.
   - Sex of the primary respondent;
   - Years the primary respondent had been herding;
   - Number of household members;
   - Number of livestock, by type; and
   - *Soum* in which they were registered, *soum* in which they were currently located.

ii) The types, and nature of, select bureaucratic and socially embedded institutions governing access to the forage resource, and the level of adherence to bureaucratic institutions e.g.

- Number of registered winter/spring camps per household;
- Herder group membership and the activities of such a group, particularly in relation to institutions that regulated grazing pressures;
- Institutions managing access to winter/spring camps;
- Decision making around mobility; and
- Mobility patterns in herder-defined good and bad years, including frequency of movements, and distances moved, and how these interacted with other institutions.

iii) The relative availability and uptake of financial, technical or behavioural tools that allowed herders to manage climatic risk e.g.

- The nature and type of State and non-State support of pastoral livelihoods;
- Commodity prices received at key times;
- Livestock management in relation to climate; and
- Decision making in choosing risk management options,

iv) Perceptions around social and environmental change e.g.

- The nature, timing and causes of environmental change since the herder had begun herding;
- How bureaucratic institutional settings affected, or may affect, herding activities; and
- How positive herders were about the future of pastoralism.

A map drawing exercise was also used early in the interview to illicit mobility patterns in herder defined good and bad years. Herders were asked to draw their camps during the last good year, and the distances between them. *Soum*/*aimag* boundaries and key landscape features (such as wells or mountain ranges) were included. The exercise was repeated for the last bad year. Herders were asked to nominate which camps overlapped between the last good and bad year. This exercise served secondary functions of prompting a more general discussion of the pastoral system, and encouraging a better interviewer-interviewee relationship.

If further information was volunteered, or a response warranted follow-up, additional questions were asked. Not all questions were answered by all herders, and not all questions were asked of all herders if constraints, such as time, were present.
The map exercise was dropped from interviews if there were time limitations, as were questions that elicited similar answers between herders.

Inner Mongolian herders were generally asked questions with similar themes as Mongolian herders. However Inner Mongolian and Mongolian herders were sometimes asked differently worded questions, as interviews needed to be tailored according to institutional settings. For example, Inner Mongolian herders were asked about the dimensions of their lease areas rather than their number of registered winter/spring camps. There were also some differences in the way herders were recruited for interview. These are as follows.

Interviews in Mongolia

Herders were approached directly at their *ger*. The initial intention was to conduct interviews near rangeland condition and/or forage verification sites. Spatially patchy precipitation meant that herders had moved from some of these areas. Herders were therefore chosen opportunistically for interview if they were sighted between rangeland condition or forage verification sites, although inter-*aimag* roads were avoided as herders in these areas may have moved near the road to exploit the economic opportunities provided by through-traffic, and were thus likely to have atypical mobility patterns.

Some interviewed herders engaged in illegal mining activities (as indicated by the presence of gold detectors in *gers*, or as self-described).These herders all granted permission to be interviewed but interviews were still uncomfortable for interviewees. This was probably either because of the illegality of their activities, or because ‘unbalancing nature’ by ‘digging the topsoil’ was believed by some Mongolian herders to create negative consequences via a spiritual pathway (Humphrey 1978; Humphrey 1993). This made for poorer quality interviews. Herders engaged in illegal mining activities were therefore increasingly avoided for interview over time. This may have added a level of bias to the results, particularly in relation to mobility patterns.

Time was allowed to fulfil social etiquette requirements prior to the formal interview. This generally involved entering the *ger*, sitting down, accepting a cup of tea and occasionally some food. Some conversation about the weather, or where the author/translator and driver had been or were going next, generally followed. The translator then explained the nature of the research to the herder household, and herders were asked for permission to be interviewed. After accepting the invitation to be interviewed, herders were then asked if they consented to the interview being tape recorded. More than half of Mongolian herders agreed to being recorded. Field notes were taken for all interviews.

Ideally the same translator would have been used for all interviews, but three different translators were used due to unavoidable circumstances. The first translator assisted with all pilot interviews. She was in her late 20s and female, and fluent in English and Mongolian. The second translator assisted with a small number of interviews with local officials. He was in his 30s and male, and was fluent in English. The third assisted with the majority of herder interviews, and a number of interviews with officials. She was in her early 20s and female. Her English was good, although she was not as fluent as the previous two. Her understanding of Mongolian herding was superior to the former two translators. The two female translators appeared to quickly establish rapport with the herders interviewed, particularly if the primary respondent was female.

The translator followed social cues to determine who the most appropriate person was to be asked for interview, and generally the household self-identified who they felt was the most appropriate person. This was generally an older, although not always the oldest, herder who owned the *ger* in which the interview took place. It was not unusual for the partners of the primary respondent, whether male or female, or adult herding children, to additionally contribute to the interview. At times, visiting neighbours also contributed. For a demographic summary, see Table 3-5.

Interviews varied greatly in length - 30 minutes to five hours - depending on the responsiveness of the herder being interviewed. The average length was one hour. Longer interviews sometimes involved rest for food or ablution breaks. If the primary respondent was female, she generally continued working (e.g. preparing meals) whilst responding to questions. Male respondents were generally more at rest. Attempts were made to make the interview less burdensome for the herder, particularly if they continued to work. For example, my translator or I were able to provide assistance with child-care during the interview. The driver occasionally borrowed the interviewed herder’s motorbike to check on livestock.

A small gift was presented upon interview completion, which usually included a *hadag* (ceremonial scarf) and incense. This was generally given to the primary respondent, or eldest household member, at the suggestion of the translator. In a small number of interviews, photos were then taken. The translator was first asked whether she/he thought it appropriate to ask for permission. In cases where the *ger* was small or the family obviously poor, the translator sometimes suggested that asking to take a photo was not appropriate. If permission was asked it was usually granted. These photos primarily involved features within the *ger* (for example, supplementary feedstuff for livestock) or of livestock themselves. Where photos were taken of herders, colour copies were always printed and sent to them via their *soum* address. At other times, herders were given a lift into town at their request, or additional small items, e.g. medicine for headaches, or a set of batteries for a child's toy, were given. An Australian pastoralist joined in with interviews on one fieldtrip, and she shared anecdotes and photos of Australian pastoralism. This appeared to give legitimacy to the interview process, as interviewees felt that the sharing of information between herders was a valid reason for conducting interviews. Cash was never given, although on two occasions the translator purchased milk products from the herder at the end of the interview.

Interviews in Inner Mongolia

In July 2009, five herders in Inner Mongolia were interviewed. The translator was young (early 20s), male, ethnic Mongolian and from a pastoral background, and had been provided by the Inner Mongolia Agricultural University. These interviews were severely constrained by his limited English. Basic questions, such as the herder's grazing lease area and number of livestock, were all that could be asked.

In July 2010, 23 interviews were completed in Inner Mongolia. This was fewer than the planned 25 due to restrictions imposed by a local grassland official. The local grassland official arranged a local 'fixer'[1] at each of the two settlements. These fixers were both male, ethnic Mongolian herders who could speak both Mandarin and Mongolian. They had been elected by each settlement of (ex)-herders as their representative, and were remunerated for their time. The use of these fixers may have reduced the potential impact that having a young (early 20s), female and ethnic Han Chinese translator, arranged by Inner Mongolia Agricultural University, who was not familiar with pastoralism and did not speak Mongolian, had on interview responses.

[1] Cultural translator who is able to act as a bridge between two cultures (in this case, between my culture and as a researcher, and the culture of the herders interviewed)

Each of the fixers was interviewed. They then approached herders to organize the interviews at which they were mostly present. Most herders were ethnic Mongolian. This meant that although the interviewed herders may not have been representative of the local population that was largely Han Chinese, a better comparison could be made with Mongolian herders. At times, the fixer assisted with translation from Chinese to Mongolian or vice versa. The author's knowledge of Mongolian was adequate enough to confirm that fixers translated questions rather than suggesting answers, although the first three interviews were conducted with the local official present, and he answered on behalf of herders on several occasions. It was unclear how the local fixer chose appropriate herders for interview, but interviews had a representative spread of physical location within the settlement, sex, grazing location, household size, the year the herder household moved into the settlement, and livestock wealth. Interview etiquette generally followed that of Mongolia, with Inner Mongolian herders also rewarded in a similar manner. The first five Inner Mongolian herders were asked to be tape recorded but all declined. For this reason, later herders were not asked to be taped. Instead, field notes were taken for each interview.

Demographic attributes of the herders interviewed are in Table 3-5.

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Table 3-5 Demographics of interviewed herders, by institutional settings. Results are means, with standard deviations bracketed. Min = minimum, max=maximum.

	Law on Land	**PUG**	**Household Responsibility System[A]**
Location	Mongolia	Mongolia	Inner Mongolia
% female	53%	48%	43%
% ethnic Mongolian	100%	100%	87%
Mean household size	4.8 (1.7) (min=3, max=8)	4.8 (1.4) (min=2, max=8)	4.4 (1.4) (min=3. max=8)
Mean years herding	23 (8) (min=8, max=30)	21 (8) (min=8, max=30)	24 (7) (min=10, max=30)
Mean number livestock	181 (126) (min=70, max=440)	319 (207) (min=56, max=1001)	540 (471) (min=120, max=2040)

[A] Prior to the grazing ban (see Chapter 5).

Interviews with local officials and leaders

In Mongolia, local officials from Ulziit, Tsogt-ovoo, Manlai, Bulgan, Bayandalai and Tsogtseggi *soums*, and Dundgobi and Omnogobi *aimags*, were interviewed. A *bag* leader from Ulziit *soum* was also interviewed. A mixture of *soums* with and without PUGs was chosen, and a geographically representative selection was sampled. Officials generally had agricultural responsibilities or, if interviews with these officials could not be obtained, pasture land registration responsibilities.

Officials were directly approached in their *soum* or *aimag* office. In many cases, they were reported as sick or missing, and repeat visits were made. A phone/skype interview from Ulaanbaatar was conducted after the Dundgobi *aimag* official was twice missed. The *bag* leader from Ulziit *soum* was opportunistically interviewed at a mechanic's workshop in the Ulziit *soum* centre. Research aims were described to officials, and permission for interview was requested. Local officials in Mongolia who were interviewed were not remunerated.

Local officials in Mongolia were interviewed to determine their views on rangeland condition in their administrative region, bureaucratic institutions governing access to the forage resource and the relationship between the two. Officials of administrative districts which included PUGs within their administrative districts were asked about the nature of these groups, and their efficacy. Officials without such groups were asked about the appropriateness of PUGs for their area. The nature and extent of support that their administration provided to herders was also elucidated.

In Inner Mongolia, the Inner Mongolia Agriculture University brokered an informal meeting between two higher level officials and me in 2009. Approval was subsequently given to visit study areas. Additional approval from local officials was also required for the interviews to proceed. Two local grassland officials were contacted on my behalf by the Inner Mongolian Agricultural University, and a meeting was arranged to facilitate the process of interviewing herders. Interviews with these two Inner Mongolian officials were conducted both formally and informally (mostly over banquets). Officials were asked about the administration of the Household Responsibility System and grazing bans in their banner. Requests were made for temporal series of climate and livestock data. Banquets were generally paid for by the local officials, but gifts were given in appreciation. One official was male, one was female, and they were both Han Chinese.

<u>Interviews with other key informants</u>

In 2009, two representatives from the development agency administering Ulziit *soum*, Dundgobi *aimag*, PUGs were interviewed. This programme established the PUGs in Ulziit *soum*, Dundgobi *aimag*. One of these interviewees was an Ulaanbaatar-based administrator, and the other was the PUG representative in the *soum*. They were interviewed about the aims and operationalization of the PUGs, PUG institutions, as well as their perspectives on the efficacy of the groups. Some programme documentation on the PUGs was received from a staff member in 2009 and 2010. One herder interviewed from Ulziit *soum* (PUG, Ulziit *soum*, 5 years herding) was a PUG leader, and he provided additional detail on the functionality of the group.

A representative from NZNI, the agency that established the Omnogobi *aimag* PUGs with funding from the GTZ, was briefly interviewed in 2009. Follow-up informal verbal interviews and email correspondence occurred in 2010 and 2011. Discussions largely centred on the aims and operationalization of the PUGs, and their efficacy. Documentation about the functioning of PUGs was provided. The Omnogobi *aimag* representative of the group was interviewed to ascertain the overall nature of PUGs established by that development agency, and to gain the contact details of local PUG representatives. The 9-Erdene PUG representative was additionally interviewed to ascertain operational attributes of the group, particularly in relation to the spatial and temporal dimensions of the group. Other development agencies were interviewed as part of the selection process for choosing PUG areas but, as these interviews do not form part of the dataset, they are not described further.

<u>Analysis</u>

Ten taped interviews were translated then transcribed from Mongolian into English by an independent transcriber. Field-notes were cross-checked with interviews where transcriptions were available, and were found to be reasonably accurate. Direct interview quotations were therefore sourced directly from these transcriptions/translations, with field-notes informing quantitative data[2].

Data analysis was done manually rather than using coding based software due to translation issues. Quantitative data, such as demographic data, was assessed for means and standard deviations where appropriate. Interview responses that were opinion based were grouped thematically, with themes selected to either directly answer research questions (see Chapter 1), or to triangulate with, or provide explanations for, other data sources. Categorical responses to interrogative questions such as ‘did the herder have a

[2] Whilst the initial aim had been to translate, transcribe and code all taped interviews, after several months the translator had failed to deliver transcriptions, despite payment. Given that the translator had since left the country, her work was ‘written off’. An alternative translator was located but was both prohibitively expensive and could not guarantee delivery of transcriptions within a reasonable timeframe.

positive opinion of the future of herding?' were then calculated by percentage. Quotations from transcriptions that were representative of response types, or assisted in explaining response types, were then selected. All responses were managed so that herders were not identifiable, with only location, institutional setting and the number of years a herder had been herding included with responses. Other identifiers, such as sex, were not considered to significantly influence responses, and were therefore not included. Herder-cited institutions that were socially embedded were also tabulated and coded as per Crawford and Ostrom's (1995) DEONIC typology.

3.4.5 Additional secondary datasets used in this research

<u>Policies</u>

Policies were sought in order to investigate the bureaucratic institutions governing access to the forage resource in the Gobi Desert. The following questions were asked in respect to these policies:

i) Do herders conform to bureaucratic institutions governing forage access?
ii) For what reason do herders not conform to these bureaucratic institutions?
iii) How do bureaucratic institutions contribute to, or help to reduce, feed gaps?

The Law on Land (Tumur-Ochir 2002) and draft Law on Pastureland (United Nations Development Programme 2008) were sourced from Mandakh Nyamtseren at the Institute of Geoecology in 2007. The Mongolian Society for Range Management draft Law on Pastureland (Mongolian Society for Range Management, unknown year) was sourced from the Mongolian Society for Range Management via their consultant, Gavin Sheath, in 2009. An example of an individual Household Responsibility System contract could not be sourced. The Grassland Law of China (2002), Agriculture Law of China (2002), Measures of Right to Contract Rural Land (2003) and Ministry of Agriculture Livestock Fodder Balance Measures (2005) policies and laws were obtained in 2011. Information on PUGs was sourced from interviews with herders, local group leaders and representatives, development agencies and as referenced throughout the thesis, between 2009 and 2011.

Documentation was viewed and manually checked for the following:

i) Policy/institutional aim;
ii) Basic attributes, such as the time period over which a grazing use right could be granted, or the spatial dimensions of the grazing rights; and

iii) Any attribute that may influence grazing pressures, or other factors affecting the sustainability of the forage resource.

Institutions were assessed in relation to the forage dynamics established in Chapter 4, with the aim of identifying their ability to influence rangeland condition via:

i) Livestock numbers per herder household, or the number of herder households with livestock;
ii) Spatiality of the grazing pressure;
iii) Temporality of the grazing pressure; or
iv) The direct off-take of forage by humans or animals other than livestock.

<u>Climate</u>

Climate data (precipitation and temperature) were used to assess the nature of climatic variability in Gobi Desert study areas. Specifically, climate data were used to explore the following questions:

i) What is the temporal nature of climate variability?
ii) What is the spatiality of climate variability?
iii) Have climatic attributes changed over time in a way commonly asserted by herders and the formal rangeland sector?

The climate data are used in the analysis presented in Chapter 4, where they are used to describe climatic variability in study areas, and Chapter 8, where they are used to test assumptions related to declining rangeland condition. Monthly precipitation and temperature data were purchased from local officials for Bulgan *soum*, Omnogobi *aimag*, for the period January 1990 to May 2010. The same data were sourced for no payment for Bayandalai *soum*, Omnogobi *aimag*, from January 1990 to December 2009. Climatic data for additional *soums* (see Table 3-2) were sourced from the Institute of Meteorology and Hydrology in Ulaanbaatar. As these data required payment, only 20 years of data could be sourced for a select number of *soums*.

Official precipitation records could not be obtained for the Inner Mongolian sites; local meteorological officials in China considered that the study sites were too close to the Mongolian border for precipitation data to be released, and that these were classified. Limited records for this area were sourced from other officials. These data lacked metadata and were for a limited timespan. Sourced data included annual precipitation means from 1987 to 2002 for Urat Rear Banner, and monthly records for three sites within the banner between 2003 and 2008. Monthly precipitation figures for 2001 to 2008 were sourced for Damao. Approximate livestock estimates for three points in time were additionally sourced from the Damao Grassland Officer.

Data were graphed to check for outliers and unexpected data points. The data were generally assessed to be of reasonable quality, and only a small number of outliers presumably created from data entry errors, were removed. Descriptive statistics, including means and standard deviations, were calculated for all months, years and the complete dataset. Average monthly temperatures above and below 0°C were used to distinguish between vegetation growth and non-growth periods. It was assumed that temperatures above 0°C defined the growth period but it is acknowledged that different plant species will have different physiological responses to temperature, and that monthly means will mask intra-mean variability in temperatures to which plants may respond. Means and standard deviations for precipitation were calculated separately for growth and non-growth periods.

The co-efficient of variation, by month and by years, was calculated for each *soum* where precipitation data were sourced. The standard equation, $c_v = \sigma/\mu$ where σ is the standard deviation and μ the mean, was used. Coefficients of variation of precipitation were calculated for growth, non-growth, and combined periods. The significance of linear regressions of seasonal precipitation totals and average monthly temperatures (1990 - 2009) were calculated for six Mongolian *soums* in SPSS Inc (2003), following Pallant (2011).

<u>Livestock</u>

Assumptions about declining rangeland condition in the Gobi Desert are often attributed to an increase in livestock numbers. Data on the number of livestock in Mongolian Gobi Desert *soums* were used to test this assumption. The Omnogobi *aimag* Food and Agricultural Specialist freely provided data by type and *soum* for livestock in Omngobi *aimag* between 1960 and 2009. Bulgan *soum* provided detailed livestock data but requested payment, which was given. The Ulziit *soum* official stated that livestock information was classified. Limited data were able to be sourced freely from the Dundgobi *aimag* official instead. Livestock numbers were graphed through time by total number of goats, total livestock numbers and total sheep forage units, the last of which was calculated by converting the total number of all livestock by type following the conversion rates in Sheehy and Damiran (2008): 1 goat = 0.8 sheep, 1 cow = 5 sheep, 1 horse = 6 sheep, 1 camel = 6 sheep. Total sheep forage units were graphed to ascertain whether grazing pressures had increased over time. The significance of linear regressions of annual total number of goats, total sheep forage units and total livestock numbers (1990 - 2009) were calculated for eight Mongolian *soums* in SPSS Inc (2003), following Pallant (2011).

Livestock available biomass

Assumptions about declining rangeland condition in the Gobi Desert are often attributed to a decline in forage production. Data on livestock available biomass in Mongolian Gobi Desert *soums* were used to test this assumption in a way that forage modelling could only predict. Livestock available biomass data were obtained from the Institute of Meteorology and Hydrology in Ulaanbaatar for six *soums* over the last 20 years. These data were collected by local Institute of Meteorology and Hydrology staff by clipping, weighing and drying vegetation in non-grazed areas within *soum* meteorological stations. The methods by which these data were obtained were described by Munkhtsetseg *et al.* (2007), as follows:

'*The pasture yield (dry biomass) was measured at local plant observation sites near the meteorological stations.... Fences protected the vegetation in each* [plot] *site from grazing. The measurements were performed at 10-day intervals, beginning when the grass height exceeded 3 cm and continuing until the grass reached the senescence stage. The grass biomass was measured in four plots with areas of* $1m^2$*, while leaving a biomass under a height of 1cm to assess animal-available biomass*.'

The significance of linear regressions of livestock available biomass against time (1990 - 2009) were calculated for six Mongolian *soums* in SPSS Inc (2003), following Pallant (2011).

Commodity prices

Commodity prices are a key component of herder incomes. They can be used to assess the spatial and temporal price risks faced by herders and to help identify options herders have for managing potential feed gaps. However, aggregate, official or statistical commodity prices may not reflect the prices that herders actually receive (Barrett and Luseno 2004). Herder interviews can assist, as can exploring commodity prices at the *aimag* and *soum* levels. Price information on key pastoral commodities was purchased for markets in Mandalgobi, the capital of Dundgobi *aimag*, and Dalanzadgad, the capital of Omnogobi *aimag*. Purchased data was sourced from Media for Business, an Ulaanbaatar-based organisation created with seed money from MercyCorps Mongolia to provide a service on agricultural commodity prices to government and non-government organisations. Purchased data included prices in Mongolian Tugrik (T) for each week between 2007 and 2010 for light cashmere (T/kg), white cashmere (T/kg), brown cashmere (T/kg), sheep wool, hay grass (25kg packets) and fodder (25kg packets). Descriptive statistics (means and standard deviations) for price data at each market were produced, with data then graphed by mean monthly price.

Virtual and georeferenced datasets

A geographical information system (GIS) was used to produce the maps used in this research, and to assist with site stratification and selection (this chapter). Shapefiles for use in the GIS software, ArcMap (ESRI 9.3), were sourced from the Mongolian Institute of Geology and MercyCorps Mongolia. These included shapefiles for Mongolian soils, bioregions, rivers, *soum* and *aimag* centres and boundaries, the location of Ulaanbaatar, Strictly Protected Areas, and the Mongolian and Chinese national boundaries. Provinces and banners of China were also contained within the dataset of Mongolian administrative boundaries. The Mongolian soil layer data relied upon the Food and Agriculture Organisation classification system (described by IUSS Working Group WRB 2007). As metadata was unobtainable for these shapefiles, and reliability/accuracy could not be verified, these datasets were not used for spatial analysis. The Food and Agriculture Organisation's spatial Harmonized World Soil Database (Food and Agriculture Organisation 2008) was useful for the stratification of sites based on soil type in Inner Mongolia.

Other

Additional opportunistic information was collected between 2007 and 2010. Eighteen months of this time was spent with local rangeland-based research or non-government organizations, and about one month (in total) was spent in Inner Mongolia. Information collected during this time included informal interviews with non-government, government and research organizations, informal interviews with herders and the public in general, attendance at various local conferences and monitoring of both the local and international media. Whilst this information does not contribute to the formal dataset, it does inform an understanding of both the Gobi Desert context, and an interpretation of results. Personal communications are indicated where appropriate.

4 Variability

4.1 Introduction

The literature review in Chapter 2 highlighted that understanding spatial and temporal patterns of climate and forage metrics in arid rangelands is important for a number of reasons. Climate and forage metrics can be used to predict the likelihood of feed gaps and the risk of degradation (Von Wehrden *et al*. 2012). They can also be used to predict the preferred movements of herders and therefore the stresses and strains on pre-existing institutions that govern access to the forage resource (Dyson-Hudson and Smith 1978).

Arid rangelands are characterised by high inter-annual variation in precipitation. However patterns of climatic and forage variability are more spatially and temporally nuanced than can be detected by comparing precipitation totals between years. Other biophysical characteristics may also produce a forage resource more predictable through time than areas with vegetation more responsive to short-term precipitation patterns. This means that the relative benefit of any one set of institutions for managing access to the forage resource may change through time and space. Institutions must therefore be examined in a way that accounts for both intra- and inter-annual forage variability (Mearns 1993), and forage variability through different landscape types.

Chapter 2 included a model that used the biophysical dynamics of the forage resource to predict the territoriality of herding. Figure 2-1 predicted that, all else being equal, socially-embedded institutions are a function of forage availability (e.g. forage production per head of livestock per unit area) and forage variability (e.g. the likelihood that a unit of forage will be present at any one point in time or space). This model can help to explain the evolution of socially embedded institutions governing access to the forage resource. It can also be used to predict which bureaucratic institutional settings facilitate or reduce feed gaps, and which are most likely to fail or succeed. The model can ultimately be used to predict the likelihood of resource overutilization, with implications for both rangeland condition and herder livelihoods.

This chapter assesses climate and forage variability within and between years. Two biophysical contexts that herders feel have the most positive and negative impact on their pastoral livelihood, good and bad years, respectively, are examined but are not assumed to be discrete states separated by critical thresholds that affect herder decision making. This chapter also cross-checks the accounts of herders with biophysical data from good and bad years. This is important for the later validation of claims of degradation that may impact herder livelihoods but are based upon a limited number of biophysical indicators. Two landscapes with different vegetation and soil characteristics are also used to explore more locally nuanced variability. The interaction between these patterns of variability and existing bureaucratic institutions governing access to the forage resource (described in more detail in Chapter 5) is also investigated using a series of case studies. The results of this chapter are then used to inform and explain the institutional responses described in Chapters 5 and 6, explore the availability and uptake of the alternative tools for managing feed gaps that are described in Chapter 7, and examine the likelihood of forage being overutilised through time and space (Chapter 8).

4.2 How do herders see variability?

Herders in both Mongolia and Inner Mongolia were asked to describe the last year that they felt had a significantly positive affect on their pastoral livelihood (the last good year), and the last that had a significantly negative affect on their livelihood (the last bad year). Although 'good' and 'bad' are subjective, herders did not require clarification as to what was meant by the terms as they understood them readily. Herders were also relatively consistent in their responses, particularly in their assessment of the timing and nature of the last bad year. A 'year' as defined by herders generally spanned a 12 month period beginning at *Tsagaan Sar* (Mongolian New Year, late January or February depending on the year). In this thesis, references to good and bad years follow the description given by herders. This description is summarised in Table 4-1 and then described in more detail in the rest of the section.

Table 4-1 Summarized herder descriptions of the last good and bad year.

	Good year	**Bad year**
Last experienced	2008/2009	2009/2010
Frequency	Varied (rare – every one in three years)	Every three to four years
Summer precipitation	Early on-set, low intensity, well-spread, large quantity	Late on-set, high intensity, infrequent, small quantity
Winter precipitation	Moderate	Low or high
Summer temperatures	Warm but not hot	-
Winter temperatures	Warm	Cold
Other	Forage tall and dense	Forage inaccessible due to deep snow, windy, forage short and sparse

4.2.1 Good year

Herders incorporated a number of variables into their descriptions of a good year. A good year was consistently described as one in which climatic variables interacted to produce '*food for livestock, when livestock were able to get enough body fat'* (PUG, Ulziit *soum*, Omnogobi *aimag*, 25 years herding). A year that maximized livestock production included sufficient, early summer rains followed by additional low intensity showers such that palatable vegetation became abundant. One herder summarized such a good year:

'*There was more rain, more grass. All the grass had grown. The winter* [following] *was warm and because of that the livestock had enough fat for the winter. Because of that my soul was good*.' (Law on Land, Sevrei *soum*, Omnogobi *aimag*, 30 years herding)

Weather patterns that reduced vulnerability to exogenous shocks were seen favourably. A climatic variable that was seen as being particularly important for creating a good year was '*lots of rain that could help to grow the grass, so livestock could get along with severe winter weather*' (PUG, Ulziit *soum*, Omnogobi *aimag*, 30 years herding). Winter/spring was the period of highest livestock mortalities in the Gobi Desert, but herders recognized the importance of the preceding season(s) for decreasing the risk that these high mortalities were realized. Precipitation in early to mid-summer, that fell '*for about 10 weeks'* (Household Responsibility System, Chargaan choluu tuu, 30 years herding), was commonly described as the rainfall pattern most likely to contribute to the fattening of livestock. Additional rains later in summer were also considered important. A Mongolian herder stated that:

'*May/June rains are good. Also two to three days of rain as a follow-up in August is good*.' (PUG, Ulziit *soum*, Omnogobi *aimag*, 15 years herding)

Three rain episodes per month during the growing season were considered to be beneficial by one Household Responsibility System herder (Bayanbulag, unknown number of years herding). One Law on Land herder (Tsogtovoo *soum*, Omngobi *aimag*, 25 years herding) said that rain must begin on the 22nd of June, and it should be '*soft* [of low intensity]'. Another herder interviewed in August stated that:

'*Basically we wish to receive more rain in May and June. It would be nice if it rains in the next two or three days, it can refresh what we have now*.' (PUG, Ulziit *soum*, Omnogobi *aimag*, 30 years herding)

Snow during winter, '*about 15 cm of snow'* (Household Responsibility System, Chargaan choluu tuu, 30 years herding) was considered important, as were warm temperatures in winter.

Inner Mongolian herders also described the relative height or cover of forage being indicative of a good year. '*No bare ground'* (Household Responsibility System, Chargaan choluu tuu, 30 years herding) was a common characteristic of a good year described by Inner Mongolian herders. Grass heights of 15, 20, 30 or 50 cm were features attributed to good years. Some herders also described the attributes of specific plants, such as '*there is lots of Stipa* sp.' (Household Responsibility System, Char Gar Handa, 30 years herding) or that '*the* [Achnatherum splendens (Trin.) Nevski] *is up to 2 m* [high]' (Household Responsibility System, Chargaan choluu tuu, 30 years herding).

There was some variation in the year in which herders (n = 39) gave as being their last good year. Forty one percent of Mongolian herders cited 2008 as being their last good year. Eight percent of herders cited 2006 as their last good year. One herder described 2010 (the year of interview) as the last good year due to sufficient forage availability. Although there was general agreement amongst herders that the 2010 summer/autumn period was good, 2010 was not generally described as being a good year. This may have been because the year was not yet complete, or that it had included the end of the 2009/2010 *dzud*.

Twenty-nine percent of Inner Mongolian herders (n = 17) stated that 2000 had been the last good year. Eighteen percent stated that 2008 was the last good year, with 18% also stating that 1997 was the last good year. The remainder said that 1991, 1998, 2001 or 2007 were the last good years. These figures from Inner Mongolia may be influenced by the year that the responding herder had resettled from their grazing area. That is, herders may have given the date of the last good year based upon either their own experience, or the experience of other herders still herding in their registered area.

4.2.2 Bad year

Bad years were generally seen as those that had climatic conditions that surpassed the ability of herders to manage feed gaps, either in the short term or during a subsequent season. Descriptions of bad years were generally the opposite of those given for good years, but temperatures were considered to be relatively more important in determining bad years than they were in good years.

In contrast to the high level of forage available in good years, bad years were described as having shorter grass or no grass cover at all:

'*If there is no rain and the grass is bad, it is a bad year'* (Household Responsibility System, Bayanbulag, 30 years herding)

Dry, windy conditions were considered to be common. Whilst some winter snow was considered to be a characteristic of good years, too much snow characterized a bad year:

'*The last bad year was really cold. There were snowstorms and less grass. In December and January the snow depth was 30 – 40 cm, deeper to 1m in holes. The snow was too deep for the livestock to eat through. The tops of all shrubs were eaten*.' (PUG, Ulziit *soum*, Omnogobi *aimag*, 25 years herding)

Infrequent, heavy rainfall events, as opposed to 'soft' rainfall, were also considered to produce a bad year. Such events were believed to '*destroy the roots'* of plants by one herder (Law on Land, Tsogtovoo *soum*, Omnogobi *aimag,* 25 years herding). Late rains contributed to a bad year:

'*When the rain is late* [August/September], taan (Allium polyrrhizum *Turcz. et Rgl*) *and* humul (Allium mongolicum *Rgl*) *grow but others like* mongol uvs *(*Stipa *sp.) and* khazaar (Cleistogenes songorica *Roshev*) *do not*.' (Law on Land, Tsogtovoo *soum*, Omnogobi *aimag,* 30 years herding)

Cold temperatures were seen as being particularly significant during bad years, having a direct impact on livestock irrespective of feed gaps:

'*Last summer* [summer 2009] *there was no rain, no grass, the winter was really cold. The animals froze on the way to their pasture. No one has seen such a cold year. Even in my life I have never experienced such cold. We had more than 1,000 animals, now only 700. In cold weather even the fat and strong animals could not go to their pasture* [due to physical weakness], [I'm] *not* [just] *talking about newborns and two year olds. We used all of our resources of fodder and protein*.' (PUG, Bulgan *soum*, Omnogobi *aimag*, 30 years herding)

One hundred percent of Mongolian herders (n = 39) described 2009 (and early 2010) as being the last bad year. Seven Inner Mongolian herders (n = 12) also stated that 2009 (and early 2010) was the last bad year, with two noting 2003 as a bad year. The majority of resettled Inner Mongolian herders were less reliant on natural forage availability during 2010 than in the past when their major source of income was from herding rather than compensation payments (Chapter 3). As was the case with estimates of good years, it is unknown how this affected Inner Mongolian responses.

4.2.3 Frequency of good and bad years

Herders varied in their perspectives about the frequency of good and bad years. A few Mongolian herders stated that it had been so long since they had had a good year that they could not remember the year, or that it had been some time in the 1990s. An Inner Mongolian herder believed that good years only occurred once every 10 years (Household Responsibility System, Char Gar Handa, 30 years herding). One Household Responsibility System herder (Household Responsibility System, Chargaan choluu tuu, 30 years herding) stated that good years were more common, occurring about three times in any 10 year period. A Mongolian herder agreed, initially stating that good years were rare, but then stating that they occurred in about one of every three years (PUG, Bulgan *soum*, Omngobi *aimag*, 25 years herding). The highest frequency of good years was given by an Inner Mongolian herder who stated that:

'*In the last 10 years, most of the years have been good. In my area the rain is good.*' (Household Responsibility System, Bi Li Tov, 20 years herding)

The lowest frequency of good years cited in Inner Mongolia was:

'*There are no good years in ten. I don't remember the last good year*.' (Household Responsibility System, Hoerhot, 25 years herding)

One Ulziit *soum* herder stated:

'*It looks like* [bad years] *circulate every three or four years*.' (PUG, Ulziit *soum*, Omnogobi *aimag*, 30 years herding)

Another stated that bad years were becoming more frequent (PUG, Bulgan *soum*, Omnogobi *aimag*, 15 years herding). This view was indirectly confirmed by the responses of many herders describing rangeland change in the context of changed weather patterns (see Chapter 8) or increasingly risky livelihoods (Chapter 9).

4.3 Spatial and temporal variability

At a broad scale, variability in the Gobi Desert's forage resource is closely linked to climatic variability (Von Wehdren and Wesche 2007). This section begins by describing key climatic variables in the Gobi Desert, and then their effect on the forage resource. Interactions between forage variability, scale and institutions are then explored.

4.3.1 Precipitation and temperature

A weak, negative relationship existed between the average annual precipitation and the annual precipitation variability in the study *soums* between 1990 and 2010 (Figure 4-1).

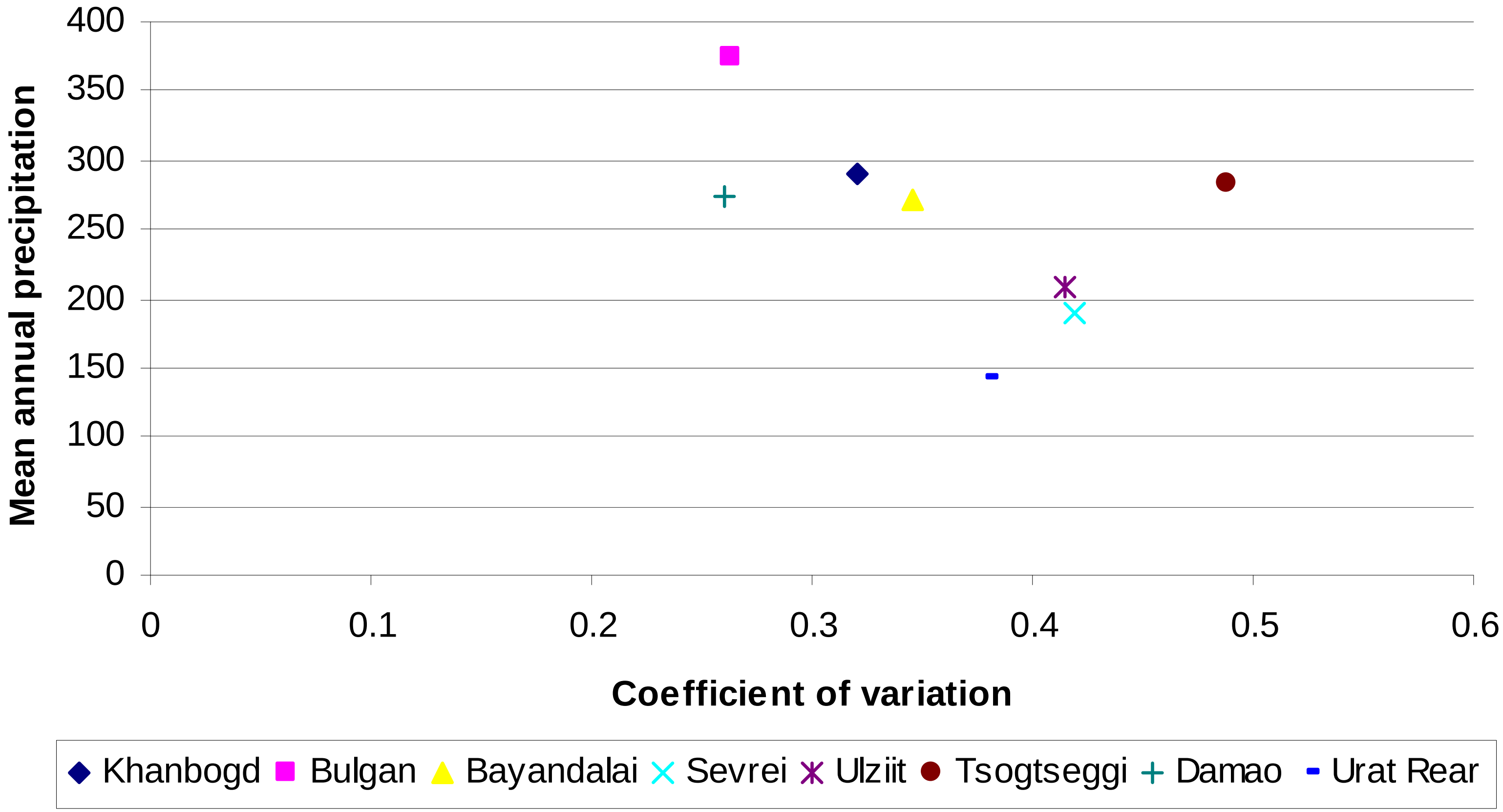


Figure 4-1 Coefficient of variation of total mean annual precipitation (%), and the mean annual precipitation (mm) for select Gobi Desert meteorological stations. Mongolian precipitation records were from 1990 – 2009 (Institute of Meteorology and Hydrology, Ulaanbaatar, 2010). Inner Mongolian precipitation records were from 2001 – 2009 (Damao) and 2003 – 2008 (Urat Rear), and were provided by local officials.

Two sites, Damao in Inner Mongolia's Urat Rear Banner and Bulgan *soum* in Omnogobi *aimag*, Mongolia, had annual precipitation coefficients of variation less than 0.33, a figure often used to distinguish between equilibrium and non-equilibrium precipitation patterns (see Begzsuren 2004). Damao's low coefficient of variation may be explained by the small sample size but a lower CV is predicted by the negative relationship between CV and mean annual precipitation in regional studies (Von Wehdren *et al.* 2010).

Intra-annual precipitation patterns were relatively predictable, with summer rainfall dominating across all *soums*. Autumn (September, October and November) had the most variable inter-annual precipitation of all seasons (Figure 4-2). Coefficient of variations of precipitation for summer months (June, July and August) were much lower than those for autumn.

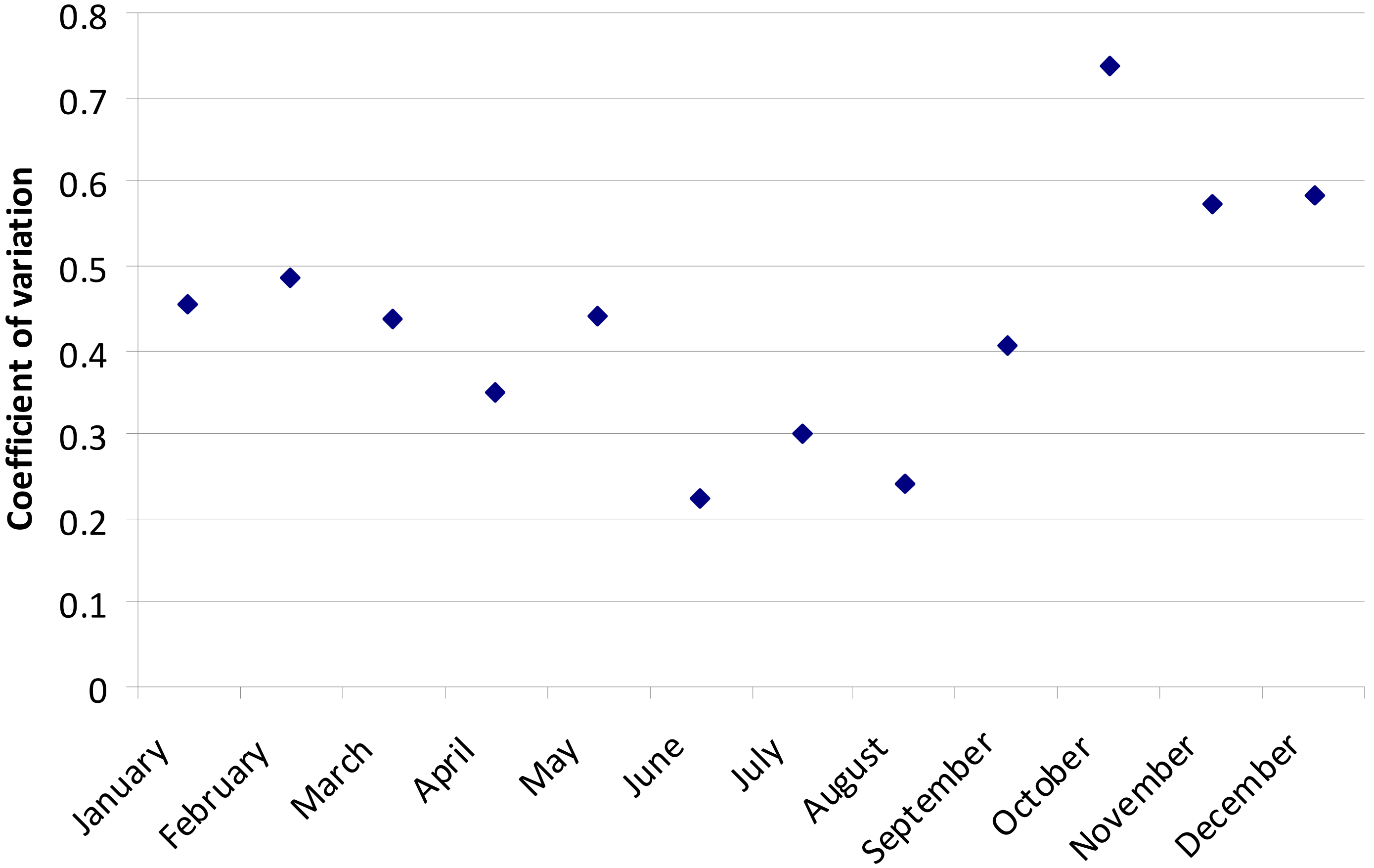


Figure 4-2 Monthly coefficient of variation of precipitation for six *soums* (Khanbogd, Bulgan, Bayandalai, Sevrei, Ulziit, Tsogtseggi). Coefficients of variation represent the spatial variability between these six *soums* during any one month period.

Mean monthly temperatures showed a predictable pattern through time, with little variation through space (Figure 4-3). The greatest difference in mean temperatures between *soums* occurred in winter months (December – February) although this matters little from a forage growth perspective as all temperatures are below freezing during this period.

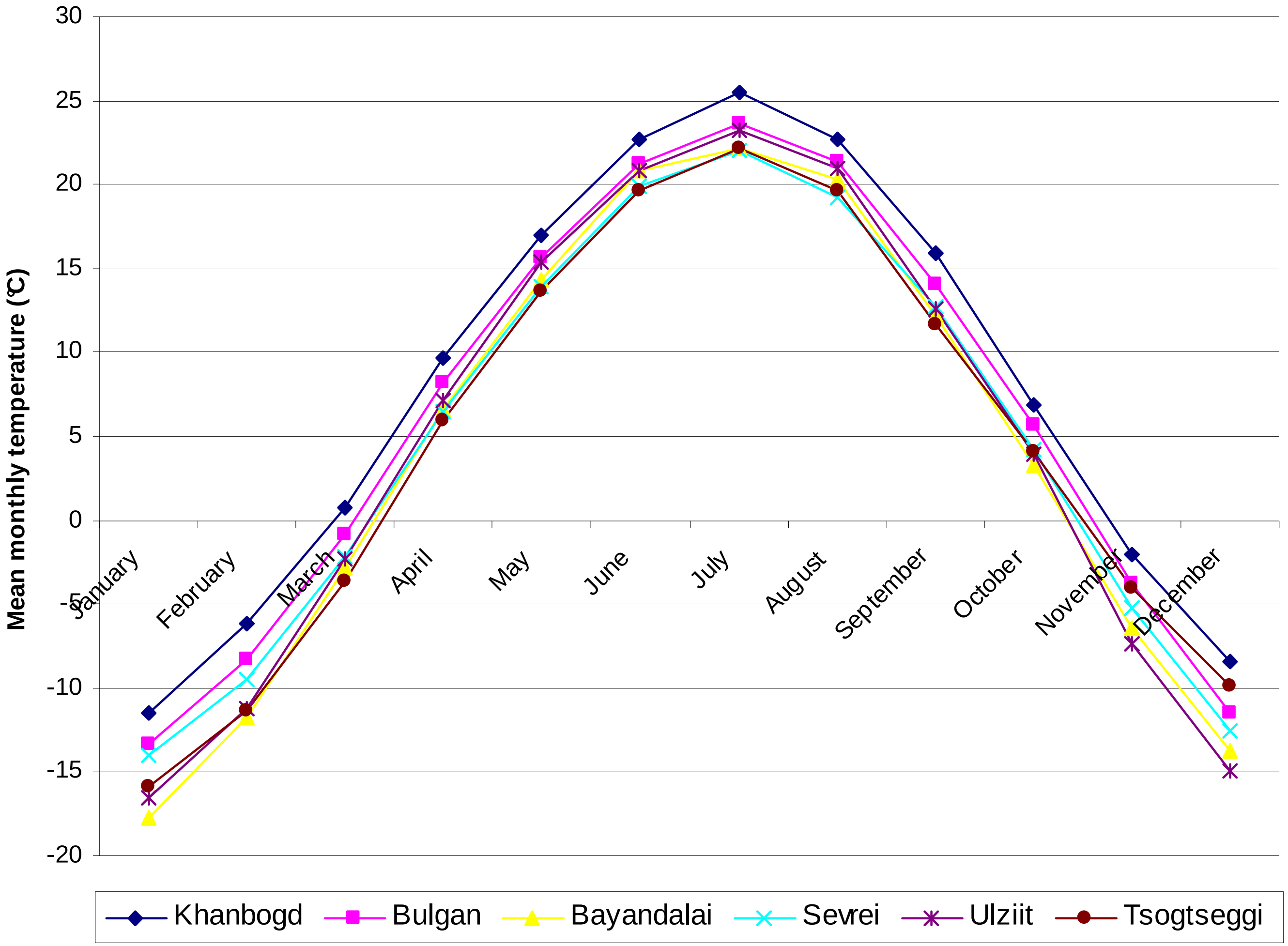


Figure 4-3 Monthly average temperatures between 1990 and 2010 for six *soums*.

Total cumulative precipitation over cold months is of interest as sub-zero temperatures (Figure 4-3) prevent vegetation from utilizing precipitation until temperatures rise above zero once more. Precipitation variability when temperatures are sub-zero therefore affects vegetation dynamics less than when temperatures are above freezing. Total cumulative precipitation between October and March varied between years, with 2009/2010 having the highest cumulative precipitation between 1990 and 2010 (Figure 4-4):

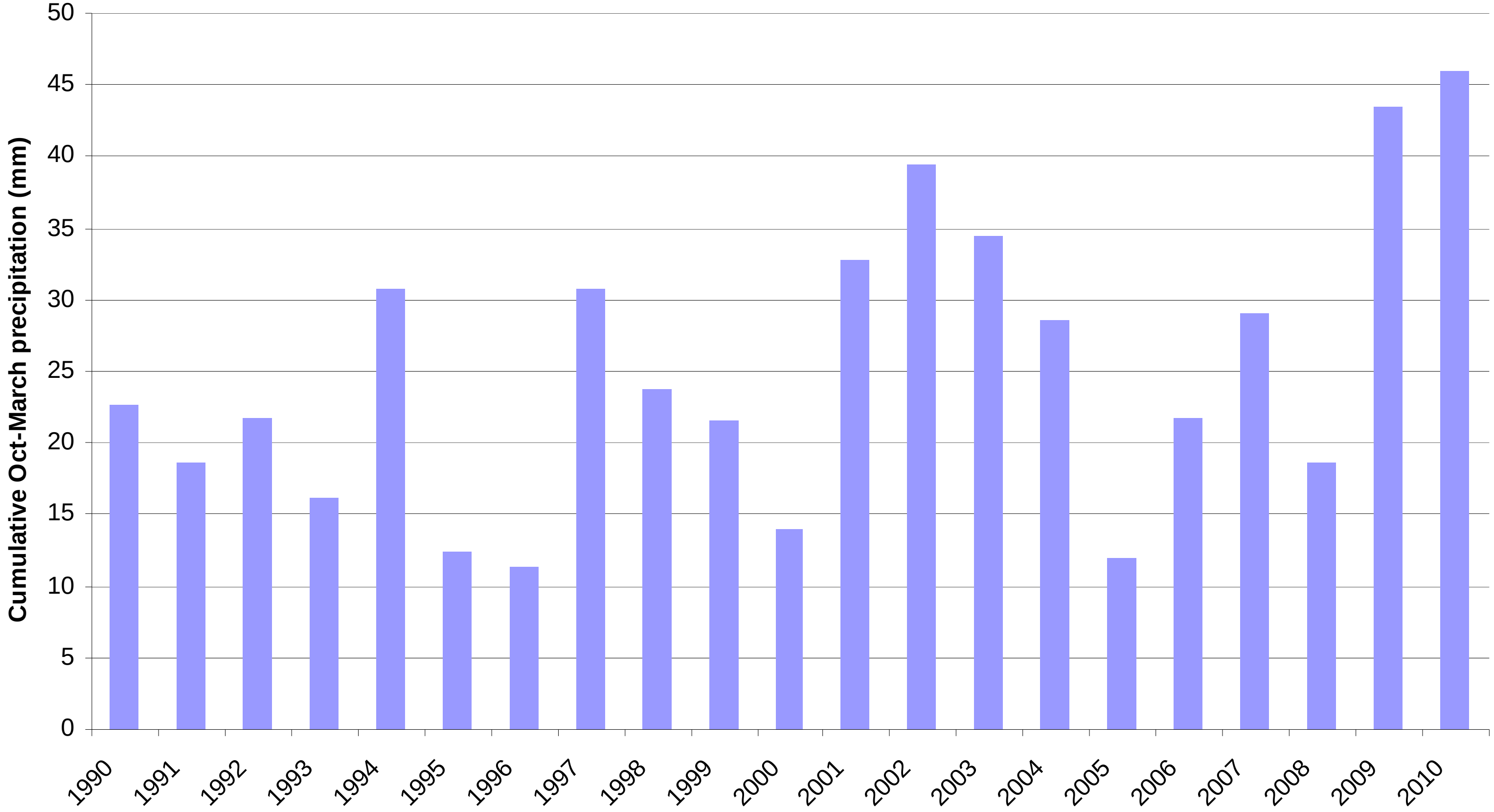


Figure 4-4 Total precipitation from October to March in Bulgan *soum* for the 1990 – 2010 period. High October to March precipitation totals tend to coincide with *dzud* periods.

4.3.2 Forage

Dynamics

The Mongolian Gobi Desert climate produced a total standing crop that could be considered predictable or unpredictable, depending upon the scale examined. The relatively high annual precipitation coefficient of variations between years (1990 to 2010) (Figure 4-3) suggests that the forage resource should be relatively unpredictable to herders. Whilst this was generally the case, the interaction between precipitation and temperature meant that some types of forage availability, such as intra-annual patterns, were more predictable than might be expected. Between 1990 and 2010, total standing crop peaked towards the end of summer (August), with forage availability being low from the end of autumn until the beginning of the next spring (March), regardless of a year's total annual precipitation (Figure 4-5).

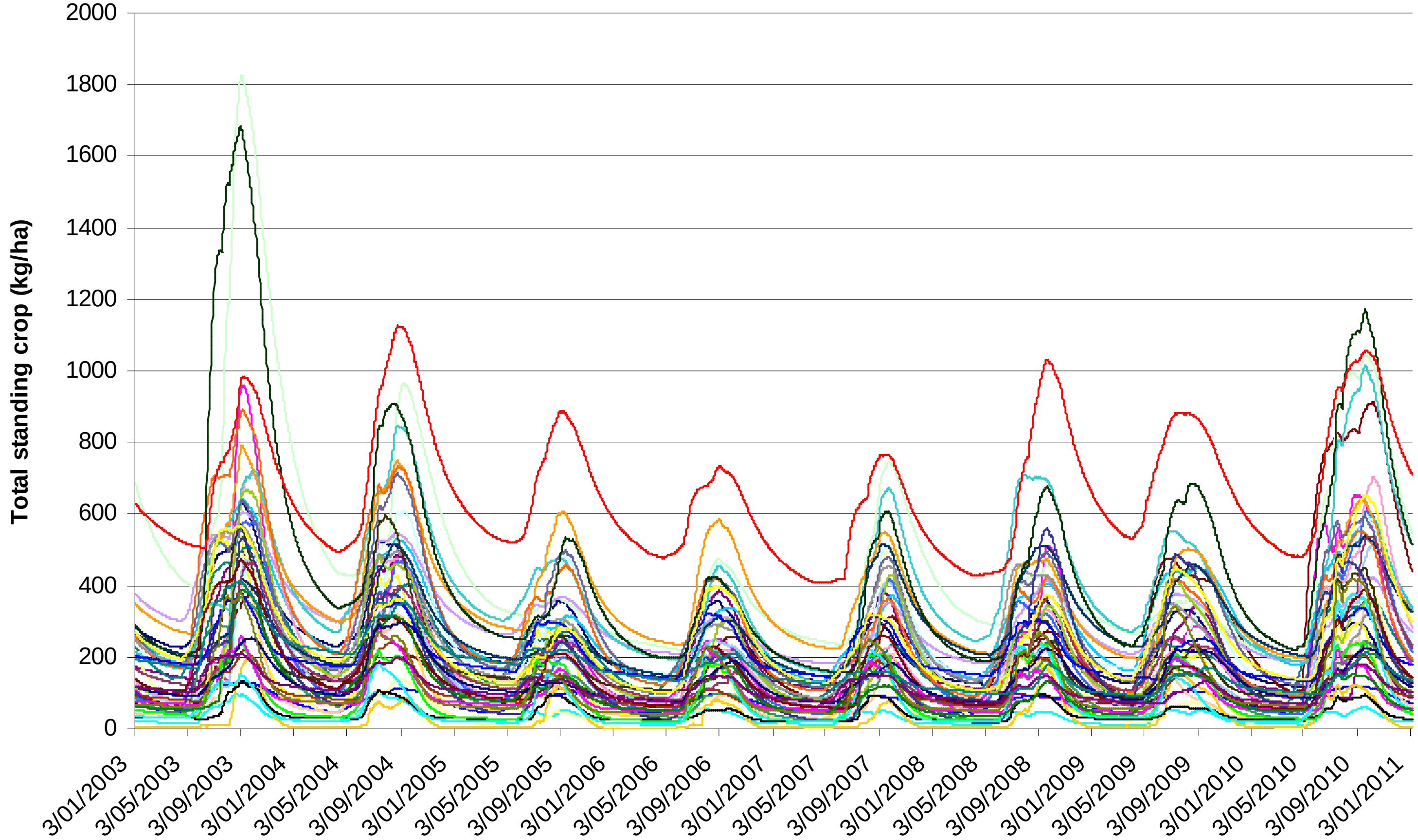


Figure 4-5 Total standing crop for all modeled sites. Total standing crop peaked in late summer/early autumn each year, with peak height varying between years. The legend is not shown for clarity's sake due to the large number of sites, and the figure being used for illustrative purposes only.

Figure 4-5 suggests that some sites are consistently more productive than others, regardless of localised precipitation dynamics. Two modelled sites, one in a steppe-like landscape and one in a gobi-like landscape, were examined in more detail to explore spatial variability between sites (this chapter) and to test claims made about the types of landscapes more suited to PUG institutions (Chapter 8). These sites were UG0014 (along the Gobi Gurvan Saikhan mountain range in Bayandalai *soum*, Omnogobi *aimag*) and UG0017 (northern Bulgan *soum*, Omnogobi *aimag*) (Figure 4-6).

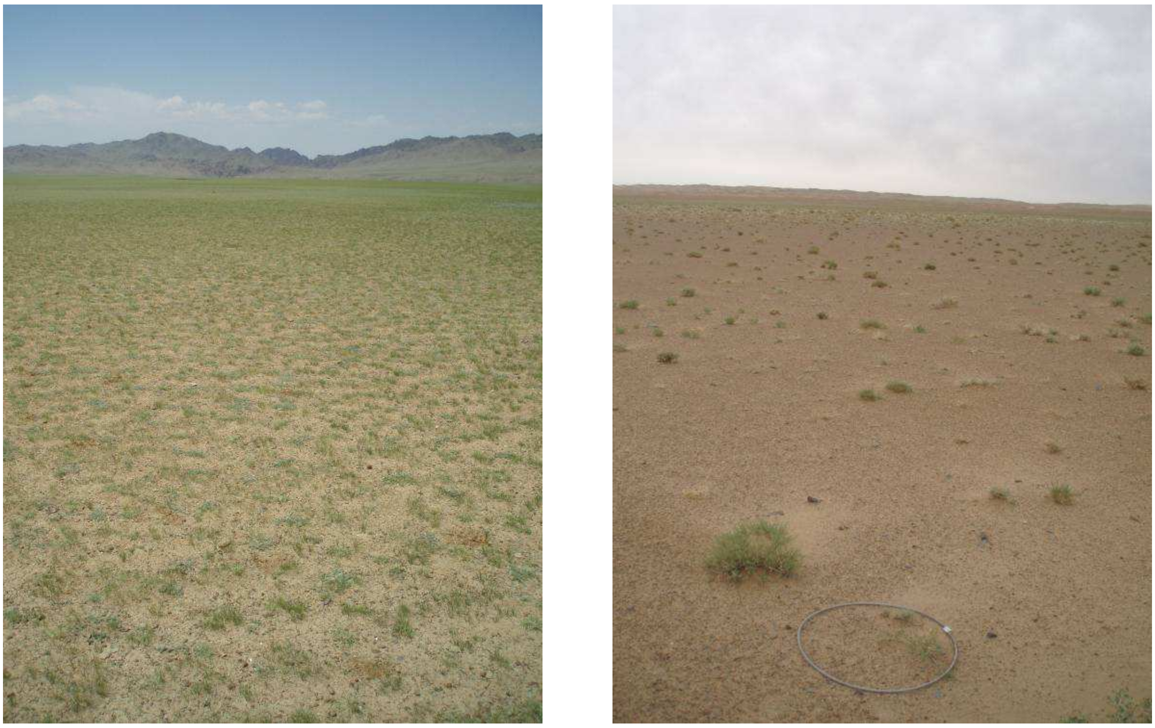


Figure 4-6 Omnogobi *aimag* sites UG0014 (steppe-like, on the left) and UG0017 (gobi-like, on the right). Steppe-like landscapes tend to be at a higher altitude, have a greater proportion of perennials herbs and grasses, and have fewer shrubs than gobi-like landscapes (Table 3-1).

At both sites, the heights of the total standing crops peaks were more variable than the heights of the troughs (Figure 4-7, Figure 4-8). The steppe-like site, UG0014, was far more variable through time than the gobi-like site, UG0017. For example, the coefficient of variation for peak biomass was 0.77 at steppe-like UG0014 compared to 0.25 at gobi-like UG0017.

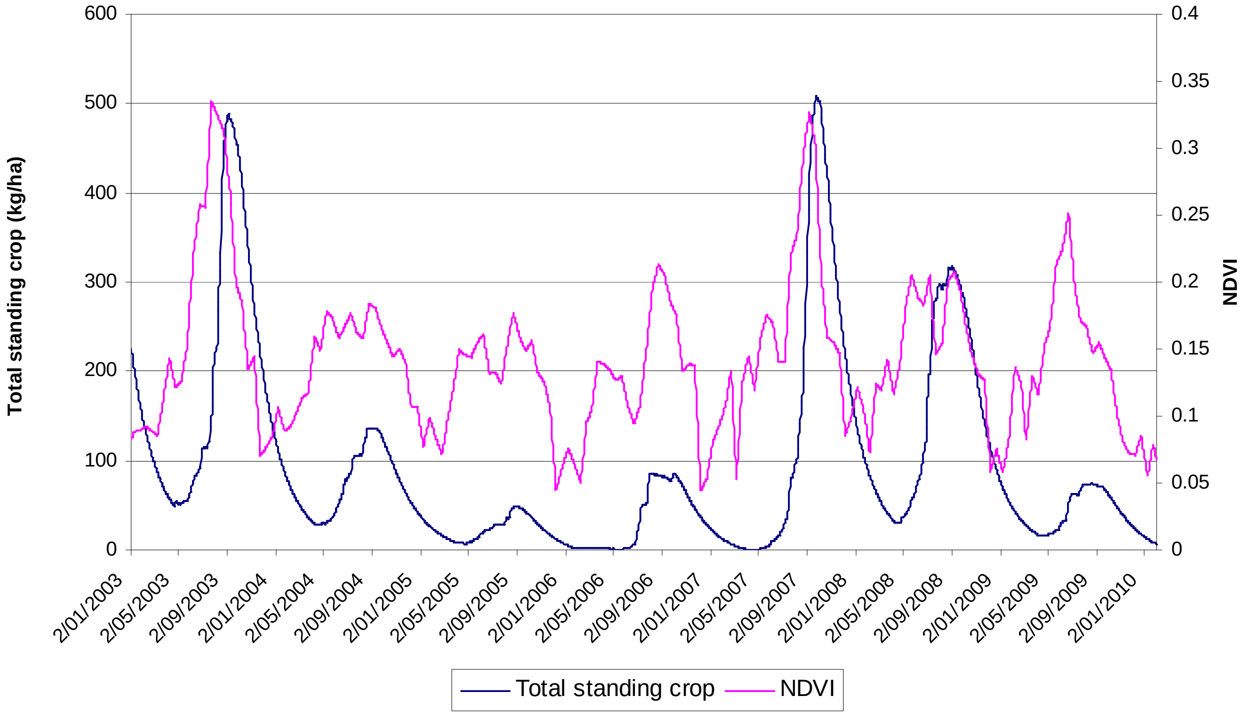


Figure 4-7 Gobi Forage sites UG0014 in the steppe-like landscape showing total standing crop (modeled) and NDVI (actual). Discrepancies between NDVI and modeled total standing crop, particularly in spring, may be explained by the presence of unpalatable species such as *Peganum nigellastrum* Bunge being detected by NDVI that are not included in model are not included in model predictions.

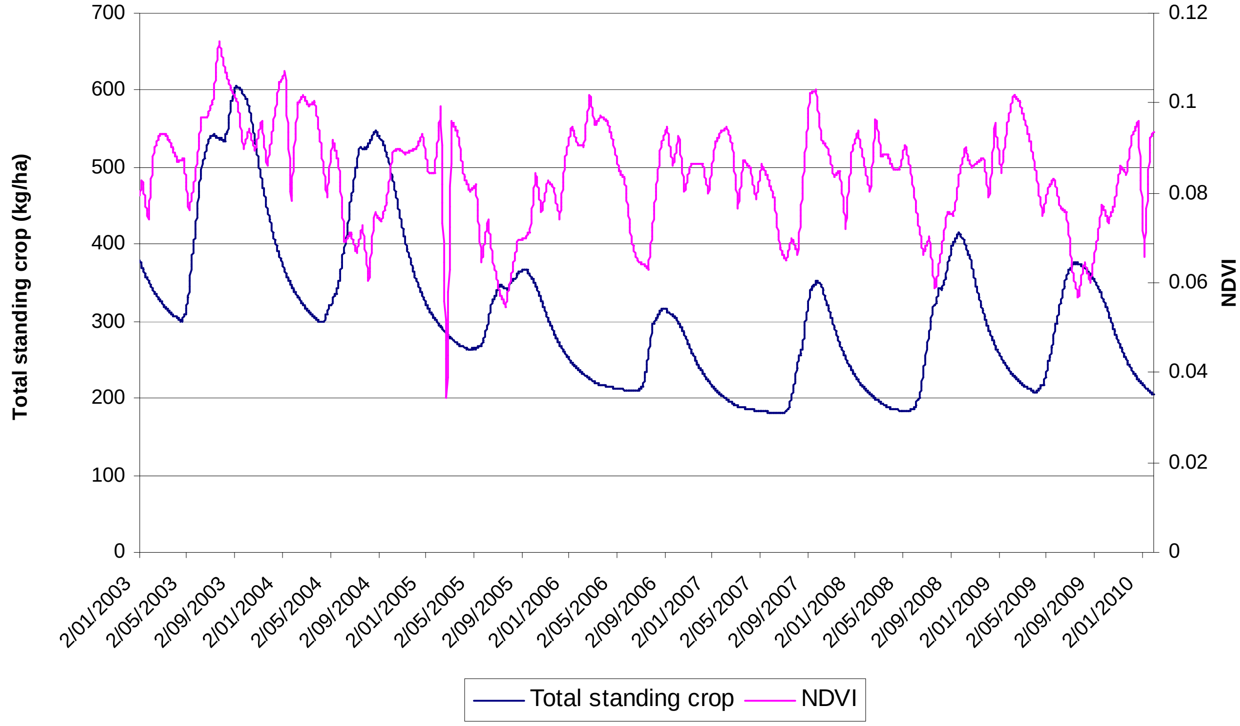


Figure 4-8 Gobi Forage sites UG0017 in the gobi-like landscape showing total standing crop (modeled) and NDVI (actual). Discrepancies between NDVI and modeled total standing crop, particularly in spring, may be explained by the presence of unpalatable species such as *Peganum nigellastrum* Bunge being detected by NDVI that are not included in model are not included in model predictions.

The greater variability of peak biomass in the steppe-like UG0014 when compared to the gobi-like site UG0017 was largely due to a greater proportion of *Stipa glareosa* P. A. Smirn. (Figure 4-9). The shrub *Artemisia frigida* Willd. was the most predictable forage resource at this site between years, probably due to its lower level of reliance on short-term summer precipitation patterns. *Stipa glareosa* P. A. Smirn. became more dominant in terms of standing crop than *Artemisia frigida* Willd. during high precipitation, warm periods.

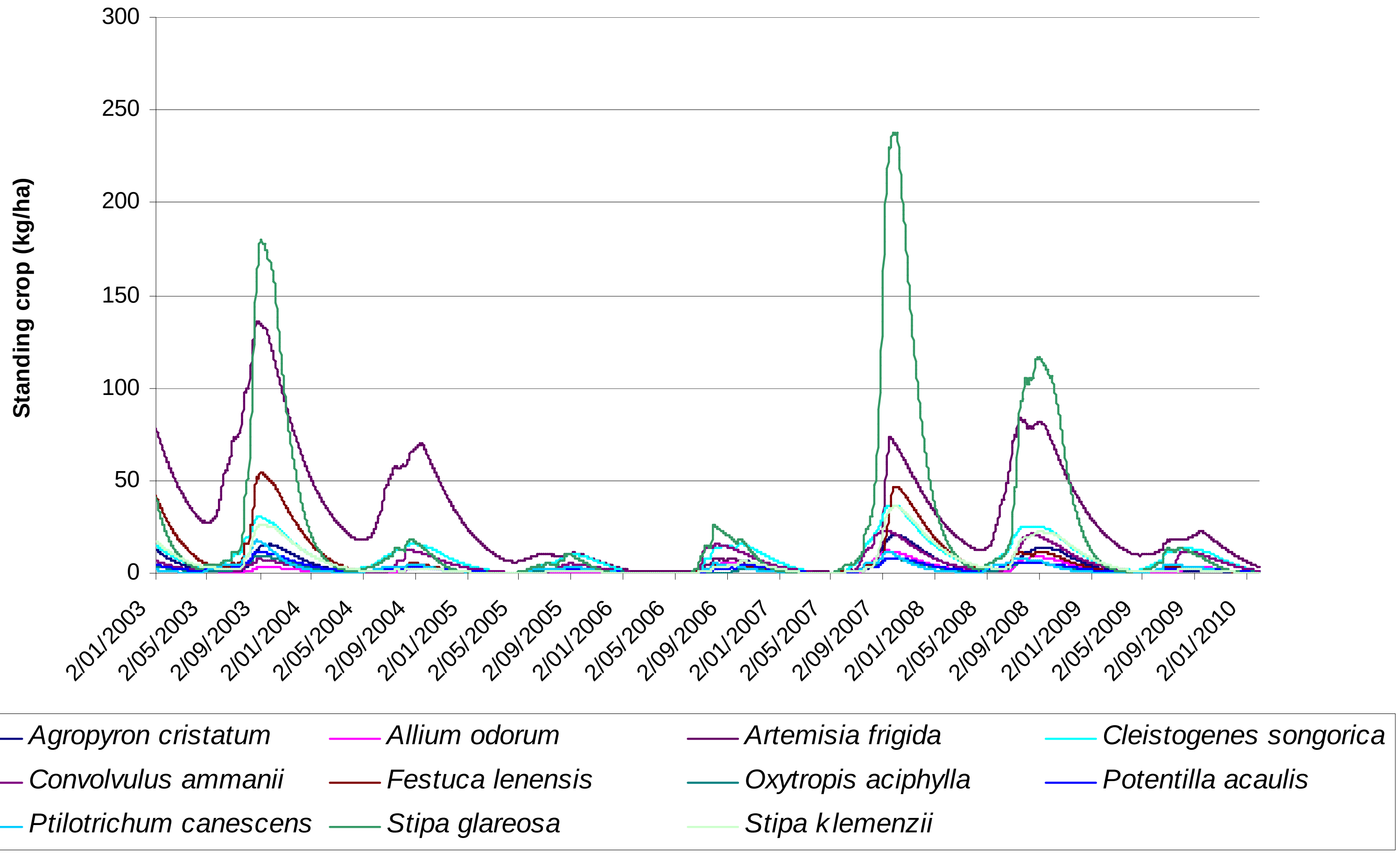


Figure 4-9 Standing crop of steppe-like site UG0014. The site was relatively variable between years, with summer grasses creating relatively more standing crop than in gobi-like sites.

The dominance of sub-shrubs and shrubs like *Calligonum mongolicum* at the gobi-like site UG0017 smoothed forage variability between both seasons and years (Figure 4-10). *Stipa glareosa* P.A. Smirn. was present at UG0017 (Figure 4-10), as it was at UG0014 (Figure 4-10), but was less dominant. Whilst it peaked during the same periods as UG0014, the lower proportion of grasses in UG0017 meant that grasses like *Stipa glareosa* P. A. Smirn contributed a relatively smaller amount to peak total standing crop during warm, wet periods. In both sites, only two or three species contributed the majority of standing crop during cool periods. These were all shrubs.

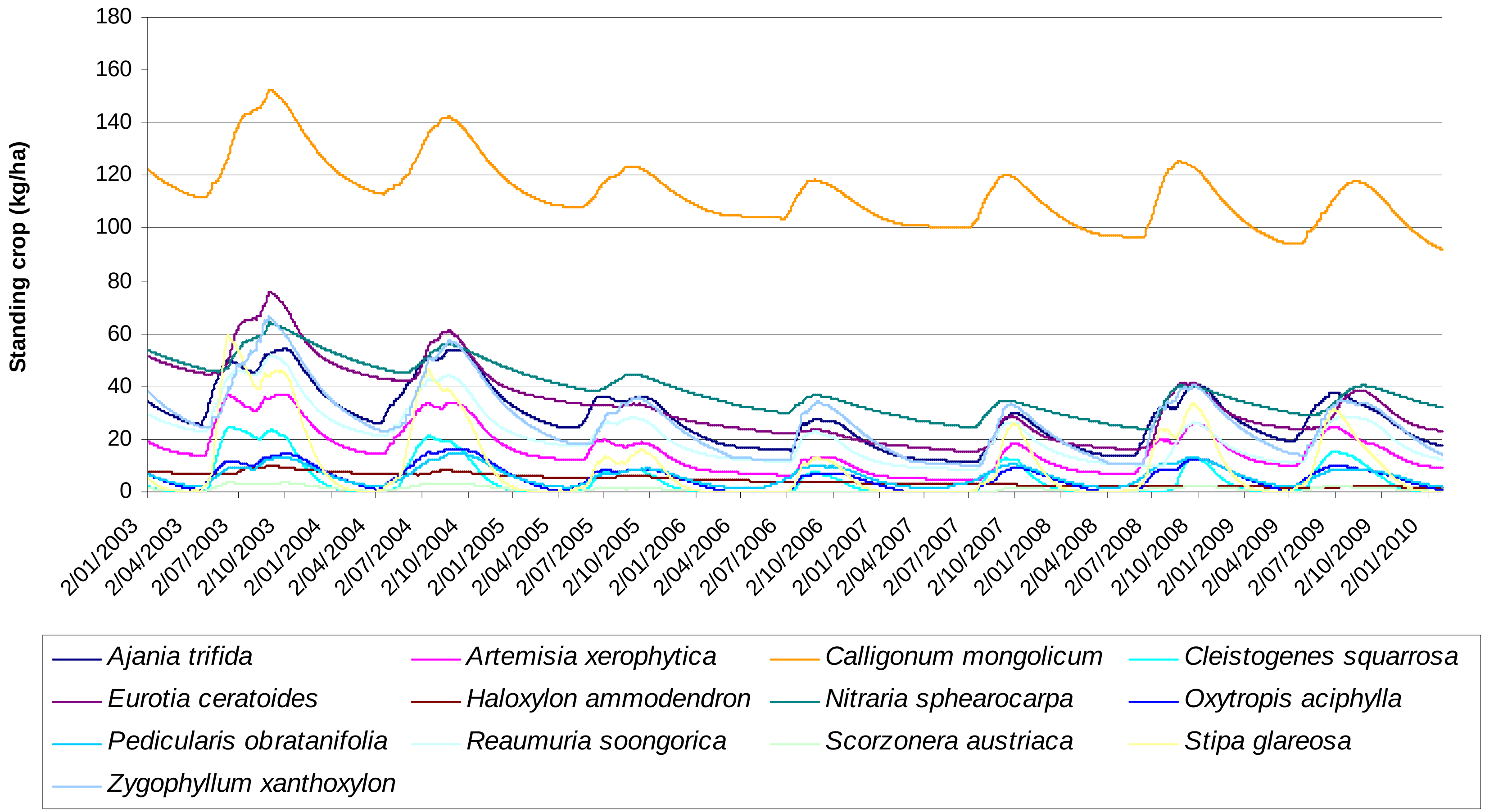


Figure 4-10 Standing crop of gobi-like site UG0017. The shrubs dominating this site showed less fluctuation through time than the grasses and perennial forbs of the steppe-like site UG0014.

The rate of change in forage availability was also greater during warmer periods than periods when temperatures were sub-zero. During the forage modelling period, the palatable forage resource switched from being more unpredictable in warmer months to exhibiting relative stability with a gradual, predictable decline in total biomass from winter until the end of spring (Figure 4-11). This forage pattern suggests that it is difficult for herders to estimate the summer/autumn peak biomass, but they could be certain that biomass would remain relatively constant during the first half of each year. The territoriality model shown in Figure 2-1 suggests that this has important implications for the institutions later discussed in Chapters 5 and 6.

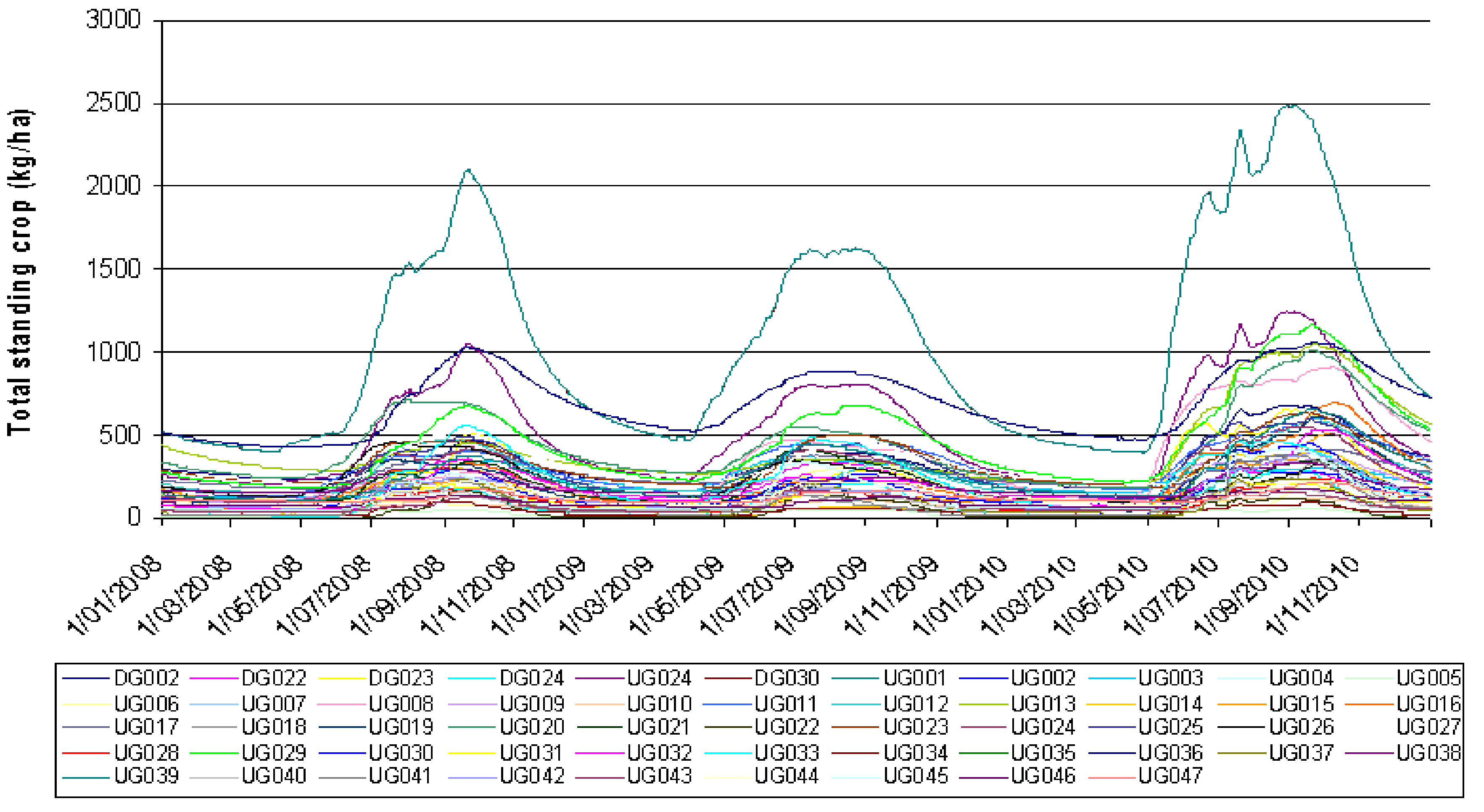


Figure 4-11 Total standing crop of all modeled forage sites for a good year (2008), bad year (2009) and the period after the 2009/2010 *dzud* (see Section 4.2 for descriptions of good and bad years).

Precipitation between about November and March accumulated on the soil surface once temperatures dropped so low as to prevent snow melt. When temperatures rose to above zero, winter's cumulative precipitation became accessible as soil moisture and plant growth was triggered. Vegetation patches have a greater ability to accumulate snow during winter than interpatch areas (see Tongway and Hindley 1995, and Section 3.4.3). Consequently, there may be increased soil moisture available to individual plants that were present aboveground over winter. Perennial shrubs, particularly those with sand accumulated around their base, may have been more significant obstructions to water and nutrient flows than perennial forbs or grasses (Figure 4-12).

Figure 4-12 In the foreground, *Reaumaria soongorica* Pall. in a gobi-like landscape accumulates snow. The ability of landscapes obstructions to capture moisture and nutrients concurs with the rationale for the rangeland condition methodology described in Section 3.4.3. In the background, the Gobi Gurvan Saikhan mountain range also obstructs winter precipitation (the orographic effect), particularly on its northern side (the side photographed). November, 2009. Near Dalanzadgad, Omnogobi *aimag*.

Forage modelling for the post-*dzud* period of 2010 (Figure 4-11) showed a standing crop spike from about May. This spike was of all species, and was steeper at many sites than in the previous two years. Visual assessments in Ulziit *soum*, Dundgobi *aimag* and Omnogobi *aimag* towards the end of May and early June of 2010 supported model predictions that the spike was disproportionally composed of shrubs at thus time, with palatable species including *Caragana* spp. and *Zygophyllum xanthoxylon* (Bunge) Maxim, flowering at that time.

The Bulgan *soum* centre and meteorology station is located between UG0014 and UG0017. Monthly precipitation at this station during May and June of 2010 was higher than the 1990 – 2010 mean. The relatively small lag time between precipitation, standing crop and flowering in shrubs found in late May/early June suggests that this precipitation may not have accounted for the spike in standing crop. Soil moisture from the preceding autumn's precipitation may also have frozen until the following spring, creating a lag time between autumn precipitation events and spring/summer forage availability. Total precipitation between the *dzud* period of October 2009 and March 2010 was 45.9 mm. This compares to the 1990 - 2010 average of 24.9 mm (Figure 4-4). A forage spike the following spring/summer of 2010 ensued. The additional snow melt immediately after the *dzud* period may therefore also be important for reproduction by plant species that require relatively high levels of soil moisture.

<u>Implications for rangeland condition</u>

The forage modelling shown in this chapter has two implications for rangeland condition. Firstly, non-equilibrium theory (Ellis and Swift 1988, Von Wehrden 2012) predicts that a higher level of precipitation/forage variability through time decreases the risk of overgrazing if livestock numbers are not artificially supported (e.g. through supplementary feeding). The relationship between climate, vegetation and grazing pressures described here broadly concur with non-equilibrium theory at the regional scale.

In the current Mongolian Gobi Desert system, *dzuds* may be more important than summer drought in buffering the rangeland against overgrazing. Perennial grasses and forbs that are both palatable and preferred by livestock, such as *Allium* spp. - *Stipa* spp. (see Table 8-2), dominate many areas of the Mongolian Gobi Desert. These perennials are mostly deciduous or retreat to rhizomes as a strategy for surviving long winters or dry summers. Winter and spring is when the demand for feed by livestock is at its greatest due to cold temperatures and gestation increasing the metabolic requirements of the herd. This coincides with the period when these deciduous or geophytic plant species are least available to livestock. This coincidence can be a livelihood shock to herders (see Chapter 9). However the adaptations of these species for surviving winter and dry periods may also increase their resilience to overgrazing during this period.

The second implication of this chapter to rangeland condition is that landscape scale theory cannot be easily applied to smaller spatial or temporal scales. A key reproductive opportunity for species like *Allium* spp. and *Stipa* spp. may be when rain falls (or snow melts) in the months following a *dzud*, providing sufficient soil moisture and a lack of grazing pressure after high livestock mortalities. A *dzud* that kills livestock due to a 'cold snap' early in winter, rather than a *dzud* that allows livestock to starve due to a lack of available forage in winter/spring, may increase the likelihood of vegetative reproduction in spring. A key risk period for the overutilization of vegetation by livestock in the present Mongolian Gobi Desert system may therefore be when livestock numbers have built for some years, followed by a mild winter when livestock mortalities are low, and then a spring period when temperatures and soil moisture are high enough to trigger vegetation growth whilst grazing pressures are still high.

Sites dominated by shrubs are less variable/more 'equilibrial' than sites dominated by grasses and forbs. Forage modelling illustrates that gobi-like sites, with their greater dominance of shrubs, are more stable than the volatile steppe-like shrubs with their greater dominance of grasses/perennial forbs. Consequently, the gobi-like landscapes are more likely to be overgrazed than the steppe-like landscapes if livestock mobility is restricted. This initially appears to be somewhat counter-intuitive. Gobi-like landscapes have a higher precipitation coefficient of variability than steppe-like sites (Table 3-1), and non-equilibrium theory consequently predicts that steppe-like landscapes should be more susceptible to overgrazing than gobi-like landscapes. However it is important to note that the prediction does not consider other abiotic variables, such as soil type or relief, which can buffer the affects of short-term precipitation patterns on vegetation growth. Winter/spring pastures, with their slow incremental change in biomass and greater shrub dominance, are also predicted to be more likely to be overgrazed than summer pastures.

4.4 How do the accounts of herders and officials compare with biophysical data?

4.4.1 Climatic data

Temperature data between 1990 and 2010 generally reflected herder assessments of good and bad years. The average monthly maximum temperature during the six month period from October 2009 to March 2010 of the last bad year was colder than for the period 1990/91 to 2008/09 in all the six Mongolian *soums* for which meteorological data was available (Table 4-2). Similarly, the average monthly maximum temperature during the six month period from October 2008 to March 2009, an oft-cited good year, was warmer in all six Mongolian *soums*.

Table 4-2 Average monthly maximum temperature between October and March in Mongolian *soums*. Temperatures in a mean, good and bad year are included.

Year	Khanbogd (°C)	Bulgan (°C)	Bayandalai (°C)	Sevrei (°C)	Ulziit (°C)	Tsogtseggi (°C)
1990/01 – 2009/2010	-3.7	-5.5	-8.5	-7.0	-8.8	-7.8
2008/09 (good year)	0.9	-4.3	-7.3	-5.3	-7.3	-6.7
2009/10 (bad year)	-8.8	-7.7	-11.6	-12.2	-13.2	-13.2

.

Precipitation data in the summer preceding winter periods of good and bad years reflected herder assessments of bad years, but there was less relationship to good years (Table 4-3). This suggests that herder assessments of good years were less consistent than bad years. *Soums* had far lower summer precipitation in years herders described as bad than the mean of all years 1990/01 – 2009/10. However only two of the four *soums* assessed had much higher levels of summer precipitation than the mean in good years, whereas the other two had similar or lower precipitation.

Table 4-3 Total precipitation June, July and August in the period prior to that stated by herders as being a good/bad year. Precipitation in a mean, good and bad year are included. *Soums* with precipitation data missing in either a good year or bad year have been excluded. The dash represents data missing for at least one month.

Year	Khanbogd (mm)	Bulgan (mm)	Bayandalai (mm)	Ulziit (mm)
1990/01 – 2009/2010	77	83	69	54
2008/09 (good year)	126	98	69	39
2009/10 (bad year)	51	19	17	-

The variability of herder responses as to what constituted a good year may reflect the more spatially local nature of precipitation patterns that produce relative high levels of forage in warmer months. Herders equate precipitation quantity and spread through time with good years, but temperatures are more important in determining bad years (Table 4-1). Summer precipitation is more variable through space than cold temperatures. The high level of consistency between herders about the timing of the last bad year may reflect the larger spatial scale at which extremely cold winter temperatures occur (Guirguis *et al.* 2011). Temperatures affects livestock mortalities directly (see Chapter 7) in addition to producing short-term feed gaps.

Variation in monthly precipitation was greatest between *soums* during autumn and early winter (September, October, November and December) (Figure 4-2). In contrast to herder concerns that institutions granting exclusivity to summer pastures would be inappropriate because of the high level of precipitation variability during summer (see Chapter 9), summer months (June, July and August) had the lowest level of variation of precipitation between *soums*. However herder concerns are more likely to relate to between year, temporal variability in precipitation in summer months rather than spatial variation. The relatively small number of forage modelling sites per *soum* also meant that variability within *soums* could not be meaningfully tested.

The high level of variation in the precipitation of late autumn/early winter (Figure 4-2) may not create an immediate risk of feed gaps to herders. Vegetation is usually in its senescent stage during this period. However late autumn/early winter variability may increase the risk of spring feed gaps via the soil moisture ‘memory’ (Shinoda and Nandintsetseg 2011) when a dry autumn contributes to delayed spring burst.

The decade beginning in 1990 was wetter in five of the six *soums* assessed than the decade beginning 2000 if the annual precipitation of each year in the decade is summed.

This supports the statements made by many herders that the 1990s had more good years than the 2000s.

4.4.2 Forage availability

Variability in biophysical features (such as localized precipitation events) between individual sites meant that some sites had greater modelled forage in herder-cited bad years than good years. However, herder claims that 2008 (a good year) had greater forage availability than 2009 (a bad year) were supported when every forage model site's total standing crop was summed. The field based data of mean livestock-available biomass also supported the comparative assessment of good and bad years as made by herders (Table 4-4). The last good year had greater mean livestock-available biomass than the last bad year in three of the six *soums*, the same amount in one *soum*, a lower amount in another *soum* and could not be compared due to missing data in the final *soum.*

Table 4-4 Mean livestock available biomass during the growing period between 1990 and 2010. Biomass in a mean, good and bad year are included. Converted from *tsenter* into kg/ha.

Soum	Khanbogd	Bulgan	Bayandalai	Sevrei	Tsogtseggi	Ulziit
1990/01 – 2009/2010	247	200	187	234	179	170
2008 (good year)	215	33	10	93	120	12
2009 (bad year)	65	17	10	-	0	25

The mean biomass between 1990 and 2010 was substantially higher than the year that herders cited as the last good year (2008) in all *soums*. This supports many herders' opinions that good years were less frequent in the 2000s than the 1990s, as herders were prepared to accept 2008 as a good year despite it having a mean livestock-available biomass that was less than it had been the previous decade. Unverified forage modelling (data not shown here – see Chapter 3 for the rationale) in the 1990s also showed multiple years in which the peaks of total standing crop were greater than the post-*dzud* period in 2010. This unverified forage modelling is aligned with herder descriptions of the 1990s as good years than the hypothesised effect of the above average winter/below average summer precipitation pattern described in Section 4.4.

The unverified forage modelling for the 1980s indicated greater levels of total standing crop than the 1990s, supporting the assertion by some older herders that the forage was better during the *negdel* period than it has been since the 1990s. The modelled standing crop of *Stipa* sp. and *Allium* sp. at UG0015 in the early 1980s compared to the early 2000s may conflict with Tsogtbaatar and Baasandorj's (2009) findings based on real, rather than modelled, data. They found that the number of palatable *Stipa* sp. and *Allium* sp. in a 100 m^2 desert steppe plot increased from 11 to 19 between 1981 - 1982 and 2001 – 2005. However this comparison is limited by the lack of methodological information provided by Tsogtbaatar and Baasandorj (2009), including study location, the unknown relationship between species densities and standing crop, and the lack of model verification during this period. The unverified total standing crop dataset modelled for the 1970s implies a decade of very low total standing crop but the 1970s were outside the period of herding for most herders interviewed so no conclusions can be drawn.

4.5 Variability, spatial scale and institutions

Five sites along an altitudinal gradient within the 9-Erdene PUG area, Bulgan *soum*, Omnogobi *aimag*, were modelled for total standing crop through time (Figure Figure 4-13). Total standing crop within the PUG area showed similar patterns through time to all modelled sites (Figure 4-5), but with less between-site variability. This can be explained by the higher level of autocorrelation between sites at the smaller scale of the PUG, as these sites are more likely to have similar topographic and precipitation features.

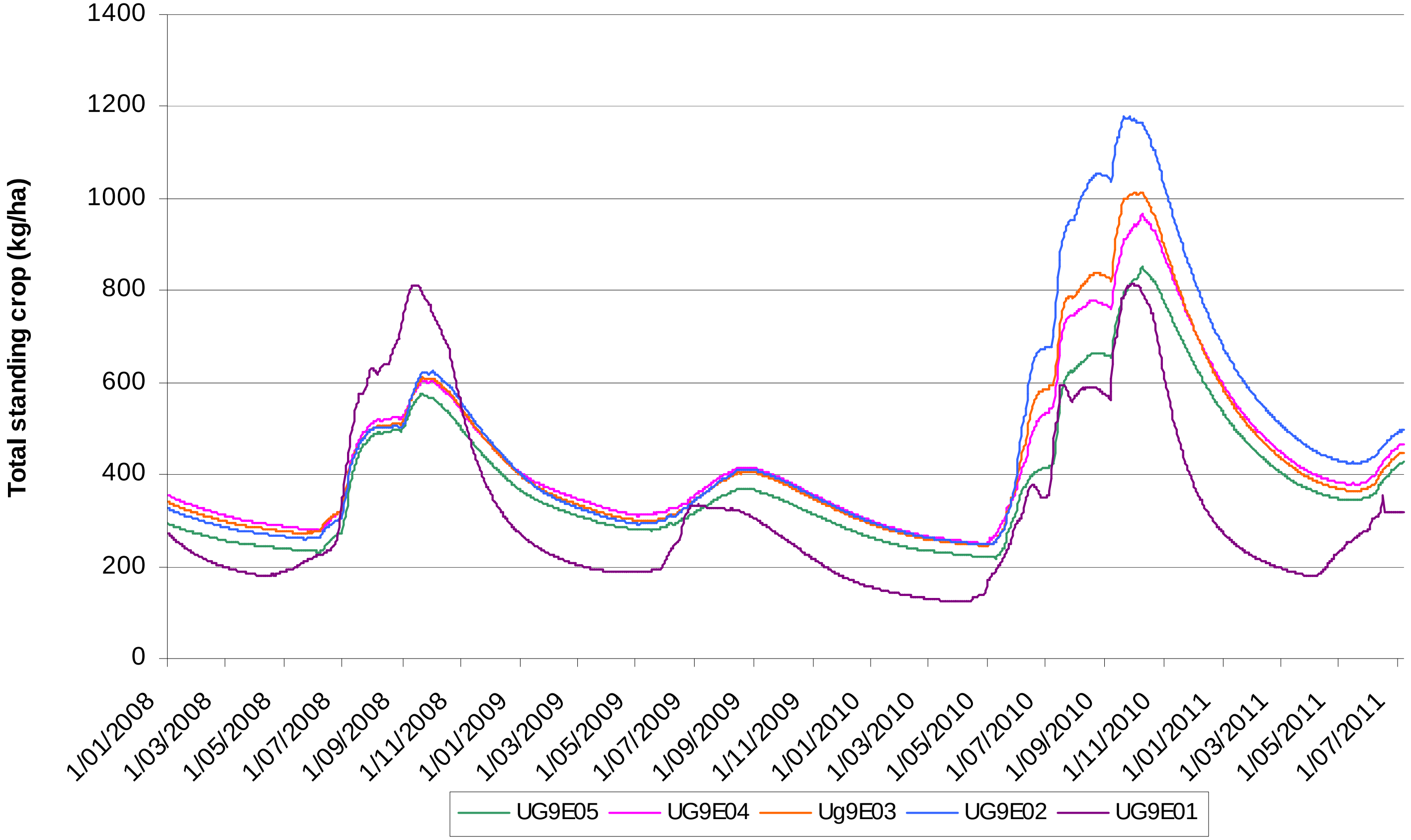


Figure 4-13 Total standing crop of five sites, each 5 km apart, within 9-Erdene PUG. UG9E01 is at greatest height above sea level, with UG9E05 at the lowest.

Five randomly selected forage modelling sites from within Bulgan *soum*, and five with Omnogobi *aimag*, were also modelled for total standing crop at peak and trough biomass in herder cited good and bad years (Table 4-5). Mean total standing crop in Bulgan *soum* and Omnogobi *aimag* were generally similar to each other except during peak total standing crop in the last bad year where the gap between them was larger (total standing crop in Omnogobi *aimag* was 20% higher than in Bulgan *soum*). This may partially explain why most 9-Erdene PUG and Bulgan *soum* herders stayed within their *soum* in the last good year, and why when they did leave PUG areas or Bulgan *soum* boundaries, it was more likely to be during the summer of the last bad year (see Chapter 6).

Table 4-5 Peak and lowest total standing crop for five randomly selected forage model sites at three nested spatial scales in Mongolia. Sites used in the table are as follows. 9-Erdene PUG = 9EPUG01, 9EPUG02, 9EPUG03, 9EPUG04, 9EPUG05. Bulgan *soum* = UG0015, UG0017, UG0018, UG0020, UG9E01. Omnogobi *aimag* = UG0021, UG00 36, UG0030, UG0032, UG0045.

Total standing crop			**9-Erdene PUG**	**Bulgan *soum***	**Omnogobi *aimag***
Peak[A] (kg/ha)	Good[B] year	Mean	624	442	449
		SD[C]	55	245	323
		CV[D]	0.1	0.6	0.7
	Bad[B] year	Mean	383	273	330
		SD	25	162	271
		CV	0.1	0.6	0.8
Trough[E] (kg/ha)	Good year	Mean	281	183	194
		SD	37	121	220
		CV	0.1	0.7	1.1
	Bad year	Mean	246	146	162
		SD	16	98	179
		CV	0.1	0.7	1.1

[A] "Peak" is the total standing crop on October 1, [B] Good year and bad year are 2008/2009 and 2009/2010, [C] SD = standard deviation, [D] CV = coefficient of variation, [E] "Trough" is the total standing crop on May 1.

Table 4-6 displays the modelled total standing crop available to hypothetical herders if they choose between the three (forage modelling) sites closest to them at four decision days in the year (see Box 1, Section 3.4.2). Hypothetical herders in more 'gobi-like' and more 'steppe-like' landscapes are featured, with the ability to respect or disrespect bureaucratic institutions at a number of scales. In reality, mobility is more flexible and frequent than the four decision days (see Section 6.4), and herders have more than three choices of location, but Table 4-6 allows a simple comparison between the availability of forage at the different spatial scales of bureaucratic institutions.

Table 4-6 Modeled total standing crop for hypothetical herders moving to maximize access to forage. All figures rounded to whole numbers. Box 1 describes how figures were calculated.

	Good year[E] (kg/ha)	Bad year[E] (kg/ha)
Nomgon *soum* (more 'gobi-like')		
Soum-defined[A]	831	780
Not defined by *soum*[B]	2031	1678
Bulgan *soum* (more 'steppe-like')		
9-Erdene PUG-defined[C]	1820	1042
9-Erdene PUG-defined[C], no out of season grazing[D]	1232	734
Soum-defined	1824	1206
Soum-defined, no out of season grazing	1438	1206
Not defined by *soum*	1268	1477

[A] '*Soum*-defined' = mobility for a hypothetical herder was restricted to the *soum*, [B] 'Not defined by *soum*' = mobility for a hypothetical herder was allowed outside of the *soum*, [C] The definitions for 'PUG-defined' are as per *soum*-defined, [D] 'No out of season grazing' = herders avoid high mountain areas in summer/autumn, [E] Good year = 2008, bad year = 2009 (see Section 4.2 for a description).

In Nomgon *soum*, there was a large difference in modelled total standing crop between '*soum*-defined' and 'not defined by *soum*' areas in both good and bad years. This difference was not present in Bulgan *soum* in good years, and was small in bad years. If grazing pressures were equal, Table 4-6 therefore suggests that the opportunity cost of accessing forage if *soum* borders were policed appeared to be greater in the gobi-like Nomgon *soum* than in the steppe-like Bulgan *soum*. That is, herders have more to lose in more gobi-like landscapes by fixed spatial boundaries than they do in more steppe-like landscapes.

The 9-Erdene PUG, and steppe like Bulgan *soum*, had higher forage availability than the *soum*-defined Nomgon. However forage availability dropped by about a third if Bulgan *soum*'s winter pastures were not accessible, with Bulgan *soum* increasing in forage availability relative to the 9-Erdene PUG. This explains why herders may be tempted to stay in winter pastures in the mountains during summer, in contravention of both bureaucratic and socially embedded institutions (see Chapter 6).

4.6 Summary and Discussion

Marin (2010) noted that the observations of pastoralists can be used to compensate for the scaling issues inherent in empirical climatic datasets. The descriptions of the last good and bad years given by herders interviewed for this thesis generally related well to the biophysical data. Descriptions also provided climatic observations more directly relevant to the localised pastoral system. Herders were consistent in their view that 2009/2010 was the last bad year they had experienced, with some stating that this was the worst year they had ever experienced as herders. The year was considered to be bad because of a lack of precipitation in the preceding summer combined with very cold temperatures and high levels of precipitation in some areas during winter/spring. The combination of these factors reduced the ability of herders to adequately manage forage feed gaps. Some herders additionally stated that feed gaps alone did not account for high mortalities, and that extremely cold temperatures were enough to kill livestock. This challenges the ability of herders, and interested stakeholders, to manage *dzud* risk by mobility and fodder use alone (see Chapter 7 for risk management tools currently used in the Gobi Desert).

Good years were characterized by climatic events that produced a large quantity of forage. As was also found by Marin (2010), herders stated that a good year had summer rain that began early in the season and was followed by multiple, ‘soft’ rainfall events. Warm winter temperatures were also considered to be beneficial. In general, 2008 was considered to be a good year, although there was more variation between herders as to the timing of the last good year compared to the timing of the last bad year. Consequently, localized precipitation patterns in summer may thus have had more of an effect on herder-cited good years than the bad years. Larger scale meteorological events, like those that produced the cold temperatures of years like 2009/2010, may have more of an impact on bad years than good years.

The finding that the lower the average annual precipitation in the study *soums* between 1990 and 2010 (Figure 4-1), the more variable the precipitation was between years, was expected and conforms to the observations of Von Wehrden *et al.* (2010) and Okayasu *et al.* (2011) at more regional scales. Forage modelling in years such as 2009/2010, with high autumn precipitation and high spring/early summer total standing crop, supports the effect of the soil moisture ‘memory’ described by an interviewed Mongolian herder and Shinoda and Nandintsetseg (2011).

Whilst climatic variability drives forage production, this chapter highlights that smaller scale differences can have a significant impact on forage dynamics. The forage resource in this chapter’s study sites changed in a way that affected its relative defendability. The territoriality model shown in Figure 2-1 suggests that this change has important implications for institutions governing access to the forage resource. The model hypothesised that a landscape with a forage availability that was low but relatively variable (A_LV_L) would select for large, individual home ranges with some degree of overlap between them. When the forage resource was of low availability and highly variable ($A_L V_H$), herders would be more dispersed. The regulation of access to resources would be at the level of the group, rather than the individual was particularly the case if demand for forage exceeded supply. If forage exceeded demand, there would be high levels of mobility, information sharing, flexible boundaries and reciprocal altruism ($A_H V_H$).

Mearns (1993) concluded that a desert steppe area in another Mongolian *aimag* occupied an $A_l V_h$ state where herders will be dispersed, have high levels of nomadism, and will secure access to resources at the group level to limit exploitation.
In general, the modelling of this chapter concurred that Mongolian Gobi Desert study sites produce the $A_l V_h$ state at a broad spatial and temporal scale. However, shifts in the defendability of the forage resource mean that different states of territoriality are selected for depending on the spatial or temporal scale examined. During the summer of good years, the Mongolian Gobi Desert is predicted to shift from a general $A_l V_h$ state to an $A_h V_l$ state for a short period of time. Herders will switch from high levels of nomadism, and will return to their home base and conflict will be minimal. However forage modelling and herder accounts suggest that good years are more spatially variable than bad years. Whilst this chapter found that total standing crop was higher in the last good year than the last bad year (forage availability was higher), total standing crop was more variable in space in the last good year than it was in the last bad year if coefficients of variation of forage peaks and troughs are used as indicator (forage variability was higher). This was largely because the impacts of *dzuds* meant that forage scarcity was spatially widespread.

The types of forage variability described in this chapter also challenge the division of landscape into ‘equilibrium’ and ‘non-equilibrium’ without the acknowledgement of scale. The neglect of scale in non-equilibrium theory has also been noted from other parts of Mongolia (Zemmrich 2007), and globally (Vetter 2005). However a comparison of forage variability in defined contexts can still help predict when and where overgrazing is most likely to occur if grazing pressures were to become less variable through time and space in the Mongolian Gobi Desert. All else being equal, the modelling presented in this chapter suggests that the more stable gobi-like sites, with their greater shrub dominance, are more likely to be overgrazed than the more variable steppe-like sites with their greater grass/perennial forb dominance. Similarly, winter/spring pastures, with their slow incremental change in biomass over winter, are more likely to be overgrazed than summer pastures.

Socio-economic factors ultimately determine how herders respond to the feed gaps created by variability in the forage resource through time and space. Understanding change in the biophysical resource, and how this change interacts with changing socio-economic variables, can help illustrate the mechanisms by which the forage resource may be overutilised, with ultimate implications for rangeland condition and herder livelihoods. This thesis now examines bureaucratic and socially institutional settings (Chapters 5 and 6) and non-institutional factors (Chapter 7) that facilitate or constrain the way in which herders respond to changes in forage availability.

5 Bureaucratic Institutions

5.1 Introduction

Bureaucratic institutions are used by governments to regulate the spatial and temporal access of herders and their livestock to the forage resource. The aim of these institutions is often the promotion of environmental or livelihood outcomes (see Chapter 2 for a more detailed discussion). In this research, bureaucratic institutions are defined using a modified version of Cleaver (2002)'s definition: namely, formalised arrangements based upon explicit organisational structures, contracts and legal rights introduced or mediated by governments or development agencies. In reality, bureaucratic institutional settings rarely manifest as designed. Frequently, hybrid institutional settings, incorporating both bureaucratic and socially embedded institutions, control the actions of natural resource users.

Shocks, stresses and exogenous factors can cause institutions to be permanently or temporarily superseded or modified. Some of the key biophysical shocks, stresses and exogenous factors affecting Gobi Desert pastoralism were described in the previous chapter, Chapter 4. The territoriality model shown in Figure 2-1 predicted that relatively inflexible bureaucratic institutions in variable landscapes, like those modelled in Chapter 4, will fail at times. This is, in part, because high levels of variability change the relative strength of the reward or sanction that herders experience when breaking an institutional rule or norm (Mearns 1993; Crawford and Ostrom 1995; Boesen 2007). The risk of institutional failure has been realised in arid rangelands internationally. Where this has occurred, pre-existing social or environmental problems have been exacerbated, or new problems have been created (see Chapter 2). Understanding interactions between these forage variability and the institutions governing herding in the Mongolian Gobi Desert can therefore help identify the contexts under which feed gaps are likely to be produced, and/or when institutional rules or norms are likely to fail.

Chapter 6 describes the socially embedded institutions governing access to the forage resource. This chapter firstly describes and analyses the bureaucratic institutional settings created to guide the use of the Gobi Desert's forage resource. Bureaucratic institutional settings are first described so that 'rule breaking' can be later assessed in Chapter 6. Description and analysis in this chapter assumes that when policy-makers design policy, they do so with the intention that the policy will be adequately followed and policed. This chapter describes three main bureaucratic institutional settings governing access to the forage resource in the Gobi Desert, and two proposed settings for the Mongolian Gobi Desert. Ways in which Inner Mongolian herders manage higher levels of exclusivity over the forage resource are included for comparison. The chapter then attempts to analyse the institutions of current and proposed policies in relation to their ability to either affect feed gaps or encourage rule-breaking. This is done largely through identifying the relationship between the policies and the characteristics of the forage resource described in Chapter 4 and predicted by the model shown in Figure 2-1.

5.2 Bureaucratic institutional settings of Mongolia

Figure 5-1 summarises the main features of the bureaucratic institutional settings examined in this research.

Table 5-1 Summary of current or proposed institutional settings that manage access to the forage resource in the Gobi Desert. See main text for more detail. Location = study area governed by the particular institutional setting. Exclusivity = legal ability to exclude other herders from access to the forage resource. Transferability = ability to sell, lease or gift grazing use rights. Timespan = length of exclusive use right. Spatiality = spatial dimensions of the grazing use right. Information sources are as follows: Law on Land (Tumur-Ochir 2002), Green Gold (Uzukh *et al.* 2010; interviews), GTZ/NZNI (Hess *et al.* 2010; interviews), Draft Law on Pastureland (United Nations Development Programme 2008), MSRM Law on Pastureland (Mongolian Society for Rangeland Management Unknown Year), Household Responsibility System (Grassland Law 2002; interviews).

Institutional setting	Location	Exclusivity	Transferability	Timespan	Spatiality
Law on Land	Mongolia	Winter/spring camp rights are exclusive, grazing rights exclusive to *bag* unless negotiated	Yes	15 – 60 years[B]	0.07 ha for rights to a camp, grazing areas dependent on *bag* size and what can be negotiated by *soum* and *aimag* governments during bad years
Gobi-like PUGs	Ulziit *soum*, Dundgobi *aimag*, Mongolia	Exclusive to PUG members	Unclear	Unknown	An average of 1,028 km^2 per PUG
Steppe-like PUGs	Bulgan and Bayandalai *soums*, Omnogobi *aimag*, Mongolia	Unclear	Unclear	Unknown	294 km^2 - 367 km^2 although it is unclear how prescriptive PUG boundaries were intended to be.
Draft Law on Pastureland	(Proposed) Mongolia	Exclusive to groups unless negotiated, partly negotiable to others	Yes[A]	15 – 60 years[B]	Group use rights are dependent on how ‘local’ is defined, winter/spring pasture use rights are dependent upon number of livestock and members of family, and carrying capacity
Proposed MSRM Law on Pastureland	(Proposed) Mongolia	Exclusive to PUG members unless negotiated, partly negotiable to others	No	15 years[B]	Group use rights are dependent on how ‘local’ is defined, winter/spring grazing use right is dependent upon number of livestock and members of family, and carrying capacity
Household Responsibility System	Inner Mongolia, China	Exclusive to household or group[C]	Yes[D]	Variable[E] e.g. 30, 50, 70 years	Dependent upon number of livestock and members of family, and pasture type (about 4.86km^2 on average)

[A] Unclear if membership of the group is transferable, as opposed to grazing use rights within the group. [B] Extension to 40 years. [C] The Grassland Law (2002) provides for grazing use rights exclusive to the individual household or to the group. In this research’ study sites, herders had exclusive rights to the level of the individual household, although the legal status and exclusivity of the additional land in which some of them grazed was not explored further in this research. [D] The sale of lease rights is prohibited. [E] In Inner Mongolian study areas, the lease timespan was 30 years.

5.2.1 Law on Land

The Mongolian Law on Land (Tumur-Ochir 2002) is the main legislation currently governing use of pasture in Mongolia's Gobi Desert rangelands. The law was developed '*to regulate possession, use of land by a citizen, entity and organisation'* (Article 1.1), defining land as '*a piece of space including the land surface, its soil, forests, water and plants'* (Article 3.1.1.).

Under the Law on Land, pasture use largely remains collective as '*summer and autumn settlements and rangelands shall be allocated to* bags *and* khot ails *(neighbouring families) and shall be used collectively'* (Article 52.2). Mearns (1993) proposed that the administrative boundary of the *bag* may be the most appropriate territorial unit in desert steppe areas. All else being equal (like livestock numbers), Chapter 4 found that resource density was low during bad years and in winter in the Gobi Desert, and may even be considered low in a good year. This low resource density explains why Mongolian Gobi Desert herders do not generally form the *khot ails* that are provided for under Article 52.7 of the Law on Land, whereby herders may '*jointly possess land under winter and spring settlements through their* khot ail *communities.'* Murphy (2011) also suggests that the term '*khot ail'* has been misunderstood, and that herders see a *khot ail* as a household plus an area to its south for livestock, rather than a collection of herders' *gers*. Regardless, the pluralism implicit in Article 52.7 conflicts with this alternative meaning of the term, and creates confusion as to whether singular *khot ail* can legally possess winter/spring settlements.

Possession rights for winter/spring camps are inheritable (Article 30.2). '*Certificate holders may transfer their certificates or put them as collateral in a legally allowed manner'* but only to '*Mongolian citizens, companies and organisations*' (Article 38.1). Possession rights are for 15 – 60 years, with the possibly of extending possession for a maximum of 40 years (Article 30.1). The size of land that can be possessed is 0.07 hectares (700 m^2) for private *gers* and houses for the purposes of household needs (Article 29.1). The Law on Land makes provision for exclusive lease rights for this immediate area of land. Exclusive rights cannot be obtained legally for the pasture surrounding the registered household area, but the socially embedded institutions described in Section 6.3 create additional de facto rights around winter/spring camps.

The State Central Administrative organisation in charge of land issues has responsibility to '*formulate and implement methodology, guidelines and regulations for definition of land degradation and damage levels and desertification types for combating those damages and land rehabilitation'* (Article 19.1.9). *Soum* governments are required to create annual land management plans that are consistent with more general plans created by higher order governments (Article 20.1.2). Government also has the power to '*make decisions on eviction of persons who caused significant degradation of land based on conclusion of authorized professional organisation'* (Article 20.2.6). Indicators of degradation are not defined or described further. Given the shifting understandings of degradation described in Chapter 2, this lack of definition may facilitate a local interpretation that is more influenced by, for example, the power relations described by Murphy (2011), than rangeland science.

Fernandez-Gimenez *et al*. (2012) noted that as mobility and reciprocity are critical for reducing vulnerability to *dzud*, strong cross-boundary and cross-level institutions are needed that designate reserves at a variety of spatial scales, with their specific conditions and terms of agreements be respected. Pasture use at the local level is not prescriptive under the Law on Land, and is largely up to the discretion of lower order officials as 't*erms for letting or prohibiting animals graze in winter and spring pastures shall be set forth by soum and district* [bag] *Governor taking into account citizen's proposals and hay yield of the particular year'* (Article 52.2). The responsibility of determining 'soum-*level reserve rangelands to be used in the events of natural disasters,* dzud *and droughts, including its boundaries and limits'* is at the *aimag* level, as is 'aimag-*level reserve rangelands*' (Article 52.9). Inter-*soum* and inter-*aimag* movement is facilitated through Article 52.8, which states that '*in the event of a need of evacuation or a movement to territories of other* aimags *or* soums *due to natural disasters or other emergencies, the relevant level governments shall make a decision to reach an agreement.'* This institution is a higher order equivalent of the herder-to-herder negotiation discussed in Chapter 6. However a number of herders interviewed stated that *otor* agreements did not always ameliorate conflicts between local herders and those from further away that have moved into their pastures (herders on *otor*) at more localised scales (Chapter 6).

Whilst the Law on Land is not entirely prescriptive and provides for some level of local control, interpretation of the Law on Land by local officials varied between *soums* in ways that may overextend intended levels of flexibility. A lack of institutional specificity, historical legacies of bureaucratic institutional settings and emerging structural adjustments appear to be important reasons for this overextension. The following description of two *soums* illustrates how local interpretations of the Law on Land can manifest.

Bulgan and Bayandalai are two neighbouring *soums*, are of similar distance to the Omnogobi *aimag* capital of Dalanzadgad. They are geographically similar with both including sections of the mountainous Gobi Gurvan Saikhan Strictly Protected Area. Despite these similarities, interviews found that the timing, interpretation and implementation of the registration of winter/spring camps in these two *soums* was different. In Bayandalai *soum*, registration began in 1995/1996. The registration of camps was almost complete by the 2010 survey period. In Bulgan *soum*, registration was completed by 2009. Prior to 2006, both spring and winter camps could be registered for each herding family in Bulgan *soum*. A herder from Manlai *soum* also believed this to be the case in their *soum,* and additionally stated that they had a registered summer camp (Law on Land, Manlai *soum*, Omnogobi *aimag*, > 30 years herding). Since 2006, only one camp has been allowed to be registered per household in Bulgan *soum*, although possession rights over multiple camps were not cancelled for herders that registered prior to 2006. In Bayandalai *soum*, it was local policy to register only one camp per family although some herders with large numbers of livestock were officially granted more than one camp. The rationale given for this was that larger herds needed a larger area to rotate. There was little biogeographical reason for the difference in interpretation between Bulgan and Bayandalai *soums*; it is probable that the differences were simply due to the way in which the local officials in each *soum* read the law.

Officials from both *soums* noted factors unique to their local context that made it difficult to interpret, establish or enforce the Law on Land institutions. Herders from Sevrei *soum* had historical rights to winter camps in Bayandalai *soum*. These rights were formalised during the *negdel* period, although many *negdel* institutions were also based upon pre-existing socially embedded institutions (see Chapter 2). However the *bag* governor fines them 8,000T each winter for accessing the camps that they customarily used during the *negdel* period. It is unclear under which article of the Law on Land these herders are fined under, but Articles 28.1.1 to Articles 28.1.4 stipulate that persons allowing their livestock to trespass protected or possessed land can be fined between two and ten times the minimum wage by the governor or state inspector. The 8,000T figure was not considered to be enough to prevent these Sevrei *soum* herders from continuing to enter the *soum*, with the average monthly earnings of a Mongolian working in the agriculture, hunting and forestry sector in 2009 being 175,200 T (National Statistical Office of Mongolia 2010).

A *soum* official in Bayandalai believed that many more herders were interested in registering their camps to prevent others from entering their winter area after the 2009/2010 *dzud* than prior to it. They also stated that there were many fights over winter camps due to there being so few suitable sites relative to the number of herders registered in the *soum*. Articles 35.1.4 and 35.1.6 of the Law on Land appear to provide for sub-leasing arrangements over winter/spring camps, but both Bulgan and Bayandalai *soum* officials considered that the Law on Land made no provision for such an arrangement. Despite this, herders often stated that the sub-leasing of winter/spring camps was a common occurrence (see Chapter 6). Local officials may therefore have passively accepted sub-leasing as a way resolving conflict, or for providing livelihood security for herders who were already established.

5.2.2 Pasture User Groups

Pasture User Groups (PUGs) are similar to the draft Law on Pastureland and MSRM's proposed Law on Pastureland in that they were designed with the assumption that land degradation and herder conflict over access to the forage resource is significant, and that both are caused by unregulated access to pasture by livestock (see Chapter 2). The underlying premise of PUGs is that environmental and economic benefits will result from collective action amongst herders. The Swiss Development Corporation's (SDC) Green Gold Programme uses the term 'pasture user groups' to describe multiple herders in a defined geographical area that it has encouraged to engage with collective action to meet pasture management and other livelihood goals. For reasons of simplicity, all herder groups that have been established with the assistance of development agencies for environmental and livelihoods purposes are described in this research as PUGs.

Development agencies facilitate PUG establishment and design, generally using participatory methods. This creates an opportunity for herders to transform socially embedded institutions to formalised rules under the PUG institutional setting. However, the overarching aims of PUG development are pre-defined by development agencies, hence their involvement. These aims are generally related to natural resource management and livelihoods aims, but may not always align with herder perspectives (see Chapter 8 for examples). Development agencies often have quite clear ideas about how these aims can be achieved. For instance, the participation of women and poor herder households, collective action and a democratic structure are often emphasised. Aid money also often accompanies the establishment of PUGs. These factors may, indeed are designed to, influence rule-making in ways that were not previously socially embedded (Murphy 2011). Because of these influences, PUGs are referred to as a bureaucratic institutional setting in this research.

The operating arrangements of PUGs vary between region and the development agency facilitating their establishment. PUGs vary in terms of aims, membership size, or legal recognition, making it difficult to easily define them. Some have spatial boundaries, with the general expectation being that herders will regulate grazing pressures within that spatially defined area. Others are designated community managed areas only spatially defined to determine membership eligibility. In general, however, members agree to provide mutual assistance to each other in activities such as providing labour for maintaining winter shelters or long distance migration, and to work towards sustainably managing the pasture resources of their PUG area. Eligibility for PUG membership is generally based upon a herding household having pre-existing formal or informal rights to a permanent winter/spring camp within the project area. Development agencies typically provide funding and other support for activities of the PUG, including fencing of winter/spring pastures, community centres, business loans and information sharing workshops (Usukh *et al*. 2010).

In this thesis, areas in Mongolia without PUGs are referred to as having a ‘Law on Land’ institutional setting, and areas with PUGs (or a history of PUGs) are referred to as having a ‘PUG’ institutional setting. This is for comparative reasons. Although Article 52.2 of the Law on Land provides for some level of collective action, the institutions of Mongolian Gobi Desert’s PUGs are not specifically formalised under the Law on Land. Some PUGs have formal agreements with *soum* governments. It is unclear whether the legality of these agreements has been tested, or what the implications of these agreements are for use of the land as collateral for loans etc.

It is also unclear how the spatiality of collective action provided for under the Law on Land reconciles legally with the spatiality of PUGs. This has the potential to be an issue. For example, 9-Erdene and Ireedui PUGs in Omnogobi *aimag* are smaller than the *bags* provided for under the Law on Land, but the *khot ails* provided for under the Law on Land are rare in the Mongolian Gobi Desert. In some cases, the institutions of PUGs, the Law on Land and socially embedded institutions (see Chapter 6) merge, although the manifestation of this tripartite merger can vary in space and time. Consequently, PUG institutions can be considered to exist in addition to, or as an extension of the institutions of the Law on Land, rather than as a bureaucratic institutional setting that totally replaces them.

The PUGs in Ulziit *soum* were established in 2007 as part of the SDC's Green Gold Programme (Green Gold Project Officer, personal communication, June 2009), and SDC still actively supported the PUGs during the 2010 interview period. SDC's aim was to '*address the most demanding task of adapting the number of animals to the carrying capacity of their pastureland*' (Usukh *et al.* 2010). This was to be done via an initial learning period whereby herders implemented '*increasingly complex pasture-management activities that require*[d] *collective actions of increasing complexity'* (Usukh *et al.* 2010). In this research, the data from PUGs in Ulziit *soum* have been combined due to their similarity in landscape type and establishment history. They are here termed 'gobi-like PUGs'.

Gobi-like PUGs were designed with the intention that they would regulate and facilitate seasonal rotations and inter-annual movements, allocate use and possession rights to pastures, ensure respect for reserve pastures in conjunction with local government and regulate the number of animals in line with carrying capacity (Usukh *et al.* 2010). The Green Gold PUG project officer stated that members agreed upon where not to herd each year, and kept aside *dzud* emergency pasture to be rested, but more in-depth details about how these agreements were made was outside the scope of this research.

Clearly defined boundaries (of both the natural resource and group with rights to it), and locally adapted rules governing resource usage and collective-choice arrangements in decision making (Ostrom 1990) have been emphasised for locally managed resource use. There is a large body of theoretical literature around these design principles that are thought to have strong, practical implications (Cleaver 2000; Campbell *et al.* 2001).

PUGs were largely designed in line with these principles. For example, the gobi-like PUGs were defined within the boundaries of the *soum*, a bureaucratic boundary although one accepted by herders. Fifteen PUGs, entirely covering Ulziit *soum*, signed agreements with the *soum* government (Green Gold Project Officer, personal communication, June 2009). According to the Green Gold PUG project officer, herders defined the territorial boundaries of Green Gold PUGs, but the *soum* Citizens' Assembly validated them. It is unclear whether the Assembly also kept a written record of, for example, the number of households involved, or other PUG attributes.

Usukh *et al.* (2010) stated that membership of Green Gold PUGs was mandatory for those registered within the *soum.* This was pre-determined by the Green Gold project to avoid conflicts between members and non-members. Annual agreements outlined each PUG's geographical area, with yearly agreements as to where and when different pastures could be grazed, the number of livestock each PUG was allowed, and the way in which herders would assist each other with heavy labour. Whilst the Green Gold Project Officer stated that each PUG consisted of 10 to 25 families, one herder interviewed (PUG, Ulziit *soum*, 30 years herding) stated that there were about 100 households in her Green Gold PUG (a translation error, where the herder's 'households' should have been translated as 'individuals,' may account for this).

PUGs were supported by an association of PUGs and a small number of staff who provided technical support and liaised with local government. An active member of the PUG (PUG, Ulziit *soum*, 35 years herding) said that the Green Gold programme lent money to PUGs for the development of wells and the fencing of winter/spring pastures, and that the PUG lent money to individual members. The leader of a PUG group (PUG, Ulziit *soum*, Dundgobi *aimag*, 5 years herding) specified this further, stating that each member paid 7,000T into an account, with the Green Gold programme giving an additional 50%. This money was then lent to members with an interest rate of 5%. As of the time of interview (August 2010), the fund had a total of 5 million T (a profit of 800,000 T) that the group planned to spend on a new well.

On behalf of the GTZ, The Initiative for People Centered Conservation of the New Zealand Nature Institute (NZNI) established a total of 6 PUGs in the along the Gobi Gurvan Saikhan Strictly Protected Area in Omnogobi *aimag.* The objectives of these PUGs were similar to the gobi-like PUGs, but had more of a participatory, community driven focus in order '*to enable local communities to use natural resources in the project area sustainably, in cooperation with local government and the private sector*.' GTZ/NZNI used '*community organisations'* as *'its main tool for achieving its goal of improving pasture conditions and halting further desertification'* (Hess *et al.* 2010). Due to their similarity in landscape type and establishment history, PUGs established by NZNI are considered together as 'steppe-like PUGs' in this research.

In consultation with herders, a 367km^2 area was selected for the 9-Erdene PUG in Bulgan *soum*, and a 294km^2 area for the Ireedui PUG in Bayandalai *soum*. Some herders stated that there was a strict, exclusive spatial boundary for the groups, but a NZNI staff member stated that such a boundary was never intended as herders emphasised the need for mobility (Sabine Schmidt, personal communication). Active involvement by GTZ/NZNI had finished by the 2010 interview period, and the involvement of numerous development agencies in the region made it difficult to ascertain what assistance herders had received both prior to, and after, the establishment of the GTZ/NZNI PUGs.

In contrast to the gobi-like PUGs, membership was not mandatory. An estimated 14% of the project areas' total number of households had become members by the time project funding had ceased (Hess *et al.* 2010). It is not clear how member/non-member conflict was proposed to be avoided, but it is possible that a 'fuzzy' spatial boundary and the dominance of socially embedded institutions that overrode any bureaucratic institution that bounded resource use (see Chapter 6) may account for the lack of conflict cited by herders during the 2010 surveys. It was hoped that the groups would be self-sustaining, continuing after the end of the GTZ/NZNI's facilitation/funding. According to group leaders, PUGs had agreements with the *soum* government similar to those of the Green Gold PUGs in Ulziit *soum*, Omnogobi *aimag*. The 9-Erdene PUG leader stated that the group had 15 herder households as members, 80 people in all. The 9-Erdene PUG leader also stated that the group met each year, and agreed to leave their winter camps between March and mid-April.

By 2010, PUG membership was low across both PUG types (Table 5-2). This was despite the aims of development agencies for the institutions of PUGs to endure, and the emphasis on participatory planning and rule-making.

Table 5-2 Characteristics of herders interviewed, by institutional setting.

	Steppe-like PUG (n=10)	Gobi-like PUG (n=15)	Law on Land (n=25)
Active members [A] of an active PUG (%)	20%	40%	-
Inactive members of an active PUG[B] (%)	10%	13%	-
Members of a no-longer active PUG (%)	30%	20%	-
Not members of the steppe-like/gobi-like PUGs (%)	20%	0%	100%
Not members of any PUG (%)	0%	20%	-
Not from PUG area (%)	20%	7%	-

[A] An active member was a herder that had very recently been involved in PUG activities, or planned to be in the near future, [B] An active PUG was one that a herder directly stated was active, or was a PUG in which activities were completed relatively recently or were being planned for the near future.

Only three herders (n=15) in the gobi-like PUGs stated that they were active members three years after group establishment, although active membership in gobi-like PUGs was higher than in the older steppe-like PUGs. Herders of steppe-like PUGs may have been members of herder groups that preceded the groups facilitated by NZNI/GTZ, however. Encroachment by Law on Land herders into PUG areas was greatest in the steppe-like PUG, with two interviewed herders (n=10) stating that they were not from the PUG area.

A low level of active membership in PUGs does not necessarily indicate PUG failure if the institutions it established had already become socially embedded. Herders of gobi-like PUGs commonly stated that their PUG had been active in the past or planned to be active in the future. However these activities had been challenged by the overriding need for mobility to prevent feed gaps, particularly during dry summers and the 2009/2010 *dzud* when forage availability was particularly low (see Chapter 4):

'*I am the leader of* [one of the gobi-like PUGs]. *The group was founded in 2007 but most herders have left since then and moved to* [another *aimag*]. *We plan to build a new well but we're waiting until all herders are here*.' (PUG, Ulziit *soum*, 30 years herding)

As analysis in Chapter 6 shows, both PUG and Law on Land herders commonly left their *soum* and *aimags*. By default, this means that PUG members also frequently left their PUG area. Leaving the *soum* was twice as frequent as leaving the *aimag* in both good and bad years. Herders were 2 - 3 times more likely to leave in a bad year than a good year. Nearly half of the herders left their *soum* in the 2009/2010 *dzud*. Gobi-like PUG herders were more likely to leave the *soum* in a bad year than steppe-like PUG herders. This was not the case in good years, with steppe-like PUG herders more likely to leave both the *soum* and *aimag*. All steppe-like PUG, gobi-like PUG and Law on

Land herders moved greater distances in bad years than in good, with this difference more notable in Law on Land herders. Gobi-like PUG herders moved further distances in bad years than in good years when compared to steppe-like PUG herders. Law on Land herders moved shorter distances, more often, in good years than bad years.

PUG members emphasized high levels of forage variability as being the primary reason for moving in and out of PUG areas. PUGs were not considered to be inherently inappropriate by herders. Some herders accepted that they may be appropriate to areas outside the Gobi Desert, but were unsuitable to Gobi Desert conditions:

'*This area belongs to a PUG but we are not a member. PUGs only work in areas with large* [highly productive] *grass – in other areas they're OK, but not here'* (PUG, Ulziit *soum*, Dundgobi *aimag*, 25 years herding).

Members of both PUGs frequently asserted that the spatial boundaries of their PUGs' area existed, but were not enforced in practice. PUG members did not govern the timing or frequency of each other's seasonal movements within the PUG area, nor did they seek to control movements in and out of the PUG area:

'*This area belongs to a PUG. We are members. There is a boundary but because of the climate it does not work. People move out, sometimes people move in. The timing of leaving winter camps is up to the individual*.' (PUG, Bulgan *soum*, Omnogobi *aimag*, 30 years herding)

The perceived reasons for why PUG boundaries were considered porous differed slightly between officials and herders. Movements as a group (that is, all PUG members physically relocating to areas near each other in seasons when forage variability was low within the PUG area) may not have been an initial intention of PUGs. However a local official from Bayandalai *soum* suggested that:

'*The philosophy of such groups is that if they stay together they will benefit. But moving in groups in hard times is bad. It creates more conflict in new areas – it is easier to negotiate access to forage if there is one family only.'* (Bayandalai *soum* official, Omnogobi *aimag*)

The capacity of groups to be self-sustaining was questioned by the same official. The official suggested that whilst groups were active initially when there was external funding and support (see earlier for examples), activity quickly declined when projects were completed and development agencies withdrew:

'Herder groups, like [the steppe-like group], *were originally established for pasture protection. These groups were active when there was funding, but became inactive when funds ended. They have not been sustainable. The groups work whilst there is someone full-time organising activities. When these* [organisers] *leave back to Ulaanbaatar, their role is transferred to a herder who is too busy with other work to organise such activities.'* (Bayandalai *soum* official, Omnogobi *aimag*)

Another *soum* official implied that PUGs were more viable in steppe-like landscapes where movement patterns are more predictable than they are in gobi-like rangelands. This perspective is supported by standing crop modelling in Table 4-6. The same official also suggested that groups may be more effective if they provided a function, such as marketing, rather than managing pasture access:

'Groups near the mountain have an annual meeting to decide when they will leave their winter camp. But these groups were already doing this unofficially before-hand anyway. Other non-mountain groups cannot have such an agreement. Herder groups would be good in the 'gobi' area if they co-operated in other, non-livestock/forage [tasks].*'* (Bulgan *soum* official, Omnogobi *aimag*)

5.3 Proposed bureaucratic institutional settings of Mongolia

5.3.1 Figure 5-1Draft Law on Pastureland

The Mongolian draft Law on Pastureland (United Nations Development Programme 2008) is defined in Article 1.1 as '*the legislative basis for* [regulating] *relations of possession, utilisation and protection of pastureland*.' The version discussed here is from 2008, as this was the only English language version available.

The draft Law on Pastureland extends upon the Law on Land (Tumur-Ochir 2002) by being more explicit in linking pasture access to defined herder groups that resemble the PUGs described in Section 5.2.2. Under Article 13.1, '*pastureland possession rights* *shall be given to herder communities… solely for the purposes of livestock husbandry'*. A herder community is defined as a '*volunteer organisation of local herder families formed…. with* [the] *purpose of possession, utilisation, protection, rehabilitation and improvement of pastureland*.' (Article 3.1.5), which is similar to that of the PUGs described earlier. Like the gobi-like PUGs, possession rights are exclusive to the community and cannot intersect with pastureland possessed by others (Article 13.5.1).

The United Nation's translated version suggests that the reference to the word '*local*' does not necessarily imply that the families are resident (United Nations Development Programme 2008). However it is difficult to discern on what other basis the draft Law on Pastureland intends for communities to be formed. Whether herder communities are to be formed based on *bag* membership is unclear. The legal ability of *bag* leaders to control the activities of herder groups that may only partially overlap with their *bag* if herder community membership is not based upon *bag* boundaries is similarly unclear. Article 13.2.3 requires herder community members to '*live locally where they are able to utilise and monitor pastureland in possession.*' Monitors accountable to the group are believed to be important for common property institutional settings (Ostrom 1990). The low forage resource density in the Gobi Desert (see Chapter 4) questions the practicality of strong monitors as herders are often dispersed, and local officials are under resourced (Mearns 2005). However in not explicitly defining either 'community' or 'local', there may be greater flexibility for herder dispersion in bad forage years than under the Law on Land.

Transferability of community possession under the draft Law on Pastureland is guaranteed under Article 18.1.3 as per the Law on Land, the '*land possessor shall enjoy* [the right] *to give'* (Article 35.1.6) or *'transfer the certificate'* (Article 35.1.4). It is unclear whether transferability of membership of a group is permissible. Length of tenure also references the Law on Land, stating in Article 30.1 that possession may be given for '*15 to 60 years…* [and] *may be extended for not longer than 40 years at a time'*. The area of land that herder groups can possess is determined by the '*number of members of* [the] *herder community over* [the] *age of eighteen and* [the] *area of land allowed for* [the] *number of sheep units owned by the community'* (Article 4.1.3).

By emphasising livestock carrying capacities (e.g. Article 3.1.2; 4.1.2; 25.1.1), the draft Law on Pastureland assumes that current grazing pressures are having a significant impact on the forage resource. By making provisions for inter-*aimag*, *soum* and *bag otor* reserve areas (e.g. Article 7.1.5, 28.1.2), it acknowledges that summer drought is a recurring feature of Mongolian rangelands. Whilst the risk that drought at a variety of spatial scales can also affect reserve areas at a variety of spatial scales, the tiered reserve system may have been designed to offset some of this risk.

The draft Law on Pastureland does not make provision for the dynamics of livestock numbers in response to climatic variability, only that the '*number of livestock… registered in* [the] *annual livestock census'* (Article 15.3.1) must be used in determining possession area. Whilst 'r*egional specifics, traditions of pastureland utilisation'* as well as '*carrying capacity*' (both Article 4.1.3) are to be considered when designating winter and spring camp pastures, it is unclear whether winter/spring pasture sizes can change if livestock numbers increase and there is adjacent land that is not already possessed. The draft Law on Pastureland does not stipulate at what point in time a herder's baseline herd size would be chosen in order to calculate ticketed (grazing use right) areas. This is important. For example, immediately after a *dzud,* herd sizes are at a comparative low (Chapter 8) and herder livelihoods may be under severe stress (Chapter 9). Fixing possessed areas based on a post-*dzud* herd size may not allow herders to build themselves out of an unviable herd size.

The draft Law on Pastureland more explicitly references aligning grazing pressures with seasonal carrying capacities than the Law on Land (e.g. Article 4.1.3, 15.3.1, 25.1.1). In its references to carrying capacities, the draft Law on Pastureland assumes that forage availability is more static between years than does the Law on Land. However this thesis demonstrates that the forage resource Gobi Desert area differs between seasons, years and landscape types (see Chapter 4). Consequently, placing a static carrying capacity on an individual or spatially defined area, as is provided for under the draft Law on Pastureland, may create feed gaps in bad forage years or opportunity costs in good forage years. Similarly, the draft Law on Pastureland also does not stipulate the minimum or maximum number of herder community members, or whether there is any flexibility in possession right areas as the number of community members change over time.

Herder communities have a responsibility to '*have an action plan or programme for activities on pastureland possession, utilisation, protection, rehabilitation and* *improvement'* (Article 13.2.2) for their possessed area. However this may conflict with the ability of various tiers of government to control what occurs on possessed land. That is, the creation of localised institutions may be superseded by higher order, bureaucratic institutions. Governors of *soums* and *bags* have the authority to '*establish precise dates for pasture rotation and release the pasture for sheep and goats by sending* [cattle], *horse and camels to distant pastures*' (Article 11.2.6) and '*make a decision on building new winter and spring shelters'* (Article 11.2.7). It is not clear whether they can opt out of giving precise dates, but the assumption that precise dates could be established ahead of time and then enforced implies a forage resource that is more predictable than that found by Chapter 4.

It is also unclear how the pastureland management plans (Article 9.2.1) that *aimags* have the authority to develop can be reconciled with the smaller scale plans of the herder communities. '*The state central administrative organisation in charge of agriculture shall develop methodology… for protection and rehabilitation of pastureland, and organize and ensure its implementation'* (Article 24.1) and yet it is the responsibility of the herder group to '*maintain reproductive capacity of pasture unit area in possession, including vegetation growth, seeding and other biological capacities'* (Article 18.2.2), 'c*ombat plant diseases, insects and rodents… at its own expense'* (Article 18.2.4) and '*take all possible measures in case of distribution of extremely harmful insects and rodents'* (Article 18.2.5). Article 27.2 states that '*disputes over pastureland at* [the] *local level shall be settled by bagh* [leaders]*'* but it is higher order tiers of government that control who gets possession of pastureland, the area of land and how herder communities are to manage these areas.

The draft Law on Pastureland states that '*the pastureland shall be under State control regardless of possession status'* (Article 4.1.1). Actions that are deemed to infringe upon these rights of control are prohibited, with the draft Law on Pastureland expressly exerting rights over palatable vegetation. The '*protection, rehabilitation and improvement of pastureland'* aims of the draft Law (e.g. Article 3.1.5) are protected by punitive measures – something currently absent under existing PUG models. Herder communities that do not fulfil their obligations can be fined between two and fifteen times the minimum wage, presumably per month (Article 28).

'*In order to avoid deterioration of pastureland characteristics and quality…* [the] *grazing number of animals exceeding carrying capacity'* (Article 25.1.1) is prohibited. So too is '*breaching of rotation and resting schedules set by an authorised body'* (Article 25.1.2), and '*collecting and cutting vegetation in desert and desert steppe zones'* (Article 25.1.3). These provisions are similar to stated, development agency aims for the gobi-like PUGs. A main difference is that under the draft Pastureland Law there is more opportunity for these institutions to be punitively enforced. Allowing '*livestock to enter inter*-aimag, soum *and* bagh *otor reserve areas without permission'* (Article 28.1.3) is a fineable offence under the draft Law on Pastureland, as is the construction of '*fences, shelters, winter and spring settlements… in common utilisation pastureland without permission*.'

A number of additional rights and responsibilities for herders with grazing use rights are stipulated under the draft Law on Pastureland. There are guaranteed rights to '*possess and utilise pastureland… solely for livestock husbandry purposes'* (Article 18.1.1), '*fence and protect pastureland'* (Article 18.1.2) and exercise the rights of the draft Law on Pastureland, which largely involve damage compensation, transfer of certificate or its use as collateral and extension of possession (Articles 35.1.2 – Article 35.1.6 draft Law on Pastureland). Explicit responsibilities include '[submitting] *an annual report… on implementation of a plan or programme'* (Article 18.2.1), '[maintaining] *reproductive capacity of pasture unit area in possession including vegetation growth, seeding and other biological capacities'* (Article 18.2.1), '[rehabilitating], [improving], [irrigating] *and* [establishing] *new water points, fence*[s] *and* [protecting] *pasture'* (Article 18.2.3), '[combating]' and '[taking] *all possible measures*' against plant diseases, insects and rodents (Article 18.2.4 and 18.2.5), and administrative tasks such as paying land fees on time, and registration if the certificate is transferred. An additional responsibility is implied by Article 22.2.1 that states '*if no rehabilitation work has been done on pastureland in possession and/or pastureland condition was the same as before possession or deterioration*,' the possession may be terminated prior to expiration. Under the Law of Land, responsibilities like creating an annual plan lay with the *soum* government (Article 20.1.2 Law on Land). Consequently, the draft Law on Pastureland represents a decentralisation of bureaucratic responsibility, but not necessarily of rights, to the herder group.

5.3.2 Proposed Mongolian Society for Rangeland Management Law on Pasture Land

The Mongolian Society for Rangeland Management (MSRM) is a non-government organisation that evolved from Swiss Development Corporation (SDC) funding. As a result, there are organisational links between the MSRM and the Green Gold programme that established the gobi-like PUGs (see Section 5.1.2). MSRM has been very active in engaging with Mongolian policy makers in relation to the draft Pastureland Law, and have proposed their own version. Given the potential political influence of the group, and that the draft Pastureland Law was still in draft form at the time of writing, elements of MSRM's proposed Law may well be adopted. The MSRM version of the draft Pastureland Law is therefore considered here.

The draft Law on Pastureland (United Nations Development Programme 2008) and MSRM's proposed Law are broadly similar. They both more explicitly link access to the forage resource with herder groups, with MSRM's version including more specifics about the functionality of the herder communities that it names as PUGs. The purpose of MSRM's proposed Law is similar to that of the draft Pastureland Law, with an emphasis on sustainable pastureland use, but additionally clarifies the rights/responsibilities of '*herders' self-governing organizations on pasture land*,' and regulates a '*pasture use fee'* (Article 1.1).

Like the draft Law on Pastureland, MSRM's proposed Law obliges possessors of grazing use rights '*not to deteriorate biological capacity of vegetation growth, aftermath and seed maturity '* (Article 13.2.3), to use PUG funds for '*protection and rehabilitation of pastureland'* (Article 15.2) , not to '*keep stocking rate that exceeds the carrying capacity of winter and spring pasture land'* (Article 17.1.5) or '*collect and cut plants in desert and desert steppe and in the pastureland where the soil erosion and desertification processes are occurring'* (Article 17.1.2).

Both laws provide for exclusivity of access to a specified herder group. Neither version defines the spatiality or temporality of 'local,' with Article 7.4 of MSRM's version stating that '*herder households living within the boundaries of pasture use units and using pastureland, herders of training and research institutes and budget organisations shall become members of PUGs'* and 'pasture use units' being defined as simply '*an area restricted by a boundary with the same* [purpose] *of possession and utilisation, with the same* [possessors] *and users'*.

Winter/spring pastures that are denied to law-breaking herders can be contracted out to '*other herder households to use the non grazed areas of winter and spring pastures'* (Article 7.8.8). Rights are for access, rather than ownership, with '*the pastureland* [remaining] *under state ownership*' as per the draft Law on Pastureland. However, grazing use rights may or may not be ultimately transferrable; Article 17.1.1 prohibits '*collateriate, sell and make a gift the Certificate of Rights on possession and utilisation of pastures allocated within the boundaries of an area for managing pastoral livestock husbandry*' while Article 16.1 allows for transferability of use rights if land-use has been intensified through cropping, for example.

Grazing use rights are given for 5 years in the form of inherited rights, with the period for the one time extension of the pasture use certificate not exceeding 60 years (Article 10.3). The initial time period is shorter than the draft Law on Pastureland (cf. 15 to 60 years), but the maximum extension period is longer (cf. 40 years). The reason for having a shorter time period is unclear.

MSRM's proposed version of the draft Law on Pastureland introduces a novel permit system for accessing winter/spring pastures. Herder households and *khot ails* that have not followed '*internal rules and bylaws, fulfilled plan, kept number of livestock in accordance with the carrying capacity of winter-spring pasture land and made payment for pasture use fee in time'* (Article 7.8.6) are denied access to their winter/spring pastures and winter shelter that many currently have effectively permanent lease rights to under the Law on Land.

Given that '*in establishing boundaries of winter-spring pastures… number of livestock'* are considered (Article 6.6.5), initial winter/spring pasture sizes, by definition, should be large enough to accommodate the number of livestock herders owned at the time the permit was issued. Like the draft Law on Pastureland, it is unclear whether winter/spring pasture sizes can change if livestock numbers increase and there is adjacent land that is not already under permitted. This is important given the high volatility in livestock numbers in the Mongolian Gobi Desert (see Figure 8-1). However, the emphasis on winter/spring carrying capacities is a strong institutional acknowledgement that winter/spring pastures are less variable than summer pastures. These pastures are more at equilibrium than summer pastures, and they thus may be more vulnerable to overgrazing (see Section 4.3.2.) Carrying capacities defined by this time of year are likely to have more effect on rangeland condition than carrying capacities based on forage availability during summer.

MSRM's proposed version of the law includes a pasture user fee, and a polycentric, federation structure that Ostrom (2005) suggests would increase the likelihood of sustainability. The pasture use fee requires that '*10% of* [the] *pasture use fee revenue shall be put to* soum's *or district's budget, 20% to local PUG Association and 70% to local PUGs for using for protection and rehabilitation of pastureland and other measures*' (Article 15.2). MSRM's proposed version makes a general reference to the Law on General Taxation and Law on Land Fees (Article 15.1), but as it is unclear which part of these laws are being referenced, and the exact amount of the fees is also unclear.

MSRM's version gives far more detail about the internal functioning of PUGs, and their embeddedness within a greater administrative and spatial hierarchy, than the draft Law on Pastureland. MSRM's version stipulates that PUGs '*in their internal functioning shall have to follow principles such as democratic decision making, equitable benefit sharing, equal rights and opportunities for men and women, solidarity with poor and disadvantaged members'* (Article 7.2). The contracting out of possession rights also requires the vote of two thirds of PUG members under Article 7.8.9. PUGs are given greater levels of independence from current government administrative structures in MSRM's version than in the draft Law on Pastureland. It outlaws the action of '*a governor of* soum *or district who* [interfering] *in internal affairs of PUGs and* [abusing] *his/her authority'* (Article 19.2). In doing so it at least partially resolves the uncertainty created by the institutions of the draft Law on Pastureland that allow higher order governments to interfere in PUG institutions.

Both the draft Pastureland Law and MSRM's version require high levels of administration on the part of herders. The both require annual reporting by herder groups. MSRM's version creates additional levels of bureaucracy, accountability and/or reporting by creating Pasture User Group Associations (Article 7.7), Temporary Pasture User Groups (Article 7.9.4), *soum* pasture co-management committees (Article 7.12) and *aimag* and national level associations of PUGs (Article 7.10). Punitive fines are generally greater in MSRM's version than those in the draft Pastureland Law, with an additional fine for elected officials if they interfere in the internal functioning of PUGs

(Article 19.2). The transaction costs associated with the level of reporting and enforcement required by both proposed laws are likely to be high. However, whilst the MSRM version gives herder groups more responsibility, it also grants them more rights than the draft Pastureland Law.

5.4 A comparison with the institutional settings of Inner Mongolia

The desert steppe areas of Inner Mongolia, China, share many biophysical similarities with those of Mongolia (see Chapters 3, 4), and have a common institutional history (see Chapter 2). In more recent years, bureaucratic institutional settings governing access to the forage resource in Mongolia and Inner Mongolia have diverged. Inner Mongolian institutional settings are far more complex than those governing the Mongolian rangelands. For example, multi-levelled institutions do not have equal influence on the pastoral system across space and time (Waldron 2009). An in-depth description of the institutions governing access to the forage resource in Damao and Urat Rear Banner, Inner Mongolia, is therefore not attempted here. Rather, some of the ways in which herders incorporate or modify more exclusive bureaucratic institutions in a similar biophysical context to Law on Land and PUG institutions are considered. The aim of this comparison is to inform the broader discussion about institutions in the Mongolian Gobi Desert.

As with the Law on Land in Mongolia, different local administrations have adapted national laws to suit their local context. In China, there is an implicit appreciation by higher level governments that policies will be adapted to suit local conditions in ways that are sometimes outside the scope of national level policies. Consequently, understanding the local manifestation of the laws pertaining to rangelands is likely to be more useful than understanding the written intent of bureaucratic institutions applied to/in Inner Mongolia.

The Household Responsibility System is the overarching umbrella institution governing access to the forage resource in Inner Mongolia, but a number of laws and decrees formalise management of the forage resource at a variety of administrative levels. Like the bureaucratic institutional settings in Mongolia described earlier in this chapter, they typically emphasise the ‘rational’ utilisation of the forage resource in order to prevent declines in rangeland condition. For example, the aim of the national Grassland Law

(2002) is ‘*protecting, developing and making rational use of grasslands, improving the ecological environment, maintaining the diversity of living things, modernising animal husbandry and promoting the sustainable development of the economy and society'* (Article 1). Article 61 of the Agriculture Law (2002) emphasises the protection of grassland vegetation, as well as *'preventing the grasslands from degeneration, encroachment by sand and salinization.*' Article 1 of the Decree of the Ministry of Agriculture's (2005) reinforces the aim of the Grassland Law (2002), and further stipulates that the State shall apply a '*fodder-livestock balance system'* that keeps '*a dynamic balance between the total amount of the usable fodder available to a grassland user or contracting operator of the grassland or through any other channel and the amount of fodder required for the livestock'* (Article 3).

In general, exclusive use rights over the forage resource are viewed as an important mechanism by which the aims of 'rational usage' of rangelands in Inner Mongolia can be met. The Grassland Law (2002) provides a mechanism for the granting of exclusive pasture use rights to individual herders. Article 13 of the Grassland Law (2002) states that grasslands '*may be contracted for management by households individually or jointly.*' Article 14 gives the general stipulations of the contract, including the need for the contract to include '*the rights and obligations of both parties, the four boundaries, area and grade of the contracted grasslands, the term of the contract and the starting and expiration dates, the purpose of use of the grasslands and the liability for break of the contract.*' Responsibility for '*protecting, developing and rationally using the grasslands*' is also stipulated in the contract (Article 14). Herders with contracts over the land must '*make rational use of the grasslands' (*Article 33) and '*may not exceed the stock-carrying capacity verified by the competent administrative department*' (Article 33; 45).

In Damao and Urat Rear Banner, rangelands are still ultimately possessed by the collective, rather than individual households, and there is room for local interpretation of national laws. Nevertheless the emphasis on exclusivity in Inner Mongolia is greater than that of the Mongolian Law on Land. During map drawing exercises (explained in Chapter 3), herders in Damao knew the total area and boundaries of their exclusive grazing use rights, and were clearly able to illustrate them (see Figure 5-1 for an example). In contrast, the possibility of exclusive grazing rights to the level of the individual household does not exist under the Law on Land (Tumur-Ochir 2002), draft

Law on Pastureland, proposed MSRM Law on Pastureland or in PUGs. When Mongolian herders were asked to draw a hypothetical area that they would need to graze their livestock under an exclusive institutional setting, they frequently said it was 'impossible' or drew only the area they would need for a very short period of time (for example, the area they would need for a three week period before needing to move again).

Bureaucratic institutions in Inner Mongolia are also more prescriptive than Mongolian institutional settings, and provide greater support for an intensified land-use. For example, under the Grassland Law (2002) the State encourages and supports '*development of man-made grasslands, improvement of natural pastures and development of bases for forage grass and fodder… to… increase the yielding capacity'* (Article 27) and '*rearing livestock in pens'* (Article 35). In contrast to this emphasis on intensification, herders with contracts over land in pastoral regions are also simultaneously encouraged to '*practise regional rotational grazing'* (Article 34).

There is also a legal mechanism for a grazing ban under the Grassland Law (2002) if local officials deem it necessary for all grazing to cease for environmental reasons. Article 48 states that '*the State supports… prohibition against grazing and closed grazing*.' Where grazing is prohibited '*the State gives grain or funds as subsidies to people who raise livestock in pens*' (Article 35). Some of the Mongolian bureaucratic institutions described earlier provide a similar mechanism for grazing bans (though not compensation) if local officials decide that overgrazing has occurred. Herders and local officials were not asked directly if this legal mechanism had ever been exercised in the Mongolian Gobi Desert, but the lack of ability to police it makes it unlikely. In contrast, grazing bans in Inner Mongolia have been widespread, including in the Damao region during the 2010 interview period.

In Damao, herder households had use rights over discrete parcels of land, with land ownership ultimately retained by the collective. Grazing use rights were exclusive but not transferrable in that herders could not individually sell their use rights. Fees were not paid for grazing use rights. Three herders stated that the contracting of grazing use rights from the collective was voluntary. That is, herders were not required to formalise grazing use rights when the system was introduced, and could continue grazing, regardless. However all herders interviewed except one (n=24), had grazing use rights provided for under the Household Responsibility System.

Herders were able to gain grazing use rights at a number of different stages. The reasons for these stages, or why herders chose to gain grazing use rights at any particular stage, were not ascertained as part of this research. The local Damao government completed the first round of pasture possession contracts in 1983. One herder stated that s/he had received a contract in 1984 that was initially for 50 years. A second round of contracts was completed by around 1997, and the contract length was changed to 30 years. Like the draft Law on Pastureland and MSRM's proposed Law on Pastureland in Mongolia, land was allocated to herders based on the size of their household and number of animals that they had at the time of registration. Each of these factors had about a 50% weighting in the decision-making of local officials.

The government allowed 30 mu (about 2 hectares) for every SFU that a herder owned at the time that the contract was drawn up. This area was judged to be the per SFU carrying capacity of the Damao rangelands. Whilst such a prescriptive carrying capacity is not present in the Mongolian institutional settings examined, policies like the draft Law on Pastureland also allow such a carrying capacity to be set.

It is unclear how the spatial dimensions of possession rights were calculated in Damao. One herder's grazing use rights had a dimension of about 500 m by 5 km. The grazing use rights possessed by others were rhomboidal or triangular; the triangular area was despite the Grassland Law (2002) requirement (Article 14) that four boundaries should be registered for a grazing use area. In general, grazing use rights covered a single area. This single area, the permanent dwellings situated within the grazing use rights area (as opposed to the mobile *gers* of Mongolia) and the lack of fencing in both Damao and Urat Rear Banner suggest that livestock mobility and levels of forage utilisation partitioning were probably much lower than in Mongolia.

Fourteen herders interviewed also had use rights to up to 100 mu of irrigated crop land (mean = 29 mu). In general, these areas were used for growing fodder crops for livestock, but the reliability and quality of the water source was not ascertained as part of this research. Rights to irrigated crop land were not transferrable; that is, they could not be sold to another individual. One herder stated that s/he had gained rights over their irrigated crop land in 1987, and that these rights were valid for 30 years. In contrast to grazing use rights, cropping possession rights were sometimes geographically separated from each other. They were also sometimes outside of the areas covered by grazing use rights; one herder stated said that the distance between his irrigated crop land and pasture land was 5 km.

Prior to the granting of grazing use rights, Damao herders had communally grazed an area of 620,000 mu. This area was that of the entire Bayanbulag *gaacha* (an area north of Damao). The size of their grazing use rights now varied between 0 and 29,000 mu (mean = 9,014 mu, n = 23). Herders stated that their contracts allowed them between 20 and 30 mu per SFU (mean = 22 mu, S.D. = 6.8). This figure was generally less than that which the local official had stated was allocated per herder household, based on the perceived carrying capacity of the land.

A local official stated that, since about 2007, grazing had been banned on all land, both allocated and not allocated under the Household Responsibility System. Herders stated that this ban was imposed between 2003 and 2009, with some stating that the peri-urban villages for herders affected by the grazing bans were built by 2004. The cited reason for the ban was that rangeland condition was very poor, and that rangelands needed to be rested. Grazing bans were considered to be legal under the Grassland Law (2002) as poor rangeland condition was considered a breach of the contract between the government and herders. In general, grazing bans were widespread through China's pastoral regions. In Damao, the ban was planned to continue for another seven years, making it a ten year ban in total.

As of July, 2010, the majority of the Damao herders had moved to peri-urban resettlement villages at the edge of Damao's capital. By August, it was anticipated by local officials that all herders would have been relocated. Herders were expected to sell their livestock, replacing them with a smaller number of newly purchased dairy cows housed in the pens adjacent to their new dwellings. Nearby irrigation areas were expected to provide the fodder for penned cows. Some herders also maintained a reduced herd that freely roamed around the resettlement villages, the legality of which was not ascertained as part of this research.

Each year, 'transferred' (*zhuanyi*) herders received 5 Yuan for every mu of land over which they had grazing use rights (about 0.79 USD per hectare as of June 2012). This was considered to be financial compensation for no longer being able to graze. In addition, compensated herders received free health insurance, and financial subsidies for education. A local official stated that the resettlement villages had been built specifically for herders whose grazing areas had been banned, and this housing was provided at a highly subsidised rate to herders.

As in Mongolia, institutional arrangements for managing climatic variability were reasonably common despite exclusive grazing rights. About 28% of Inner Mongolian herders interviewed indicated that they shared or rented land, or accessed common areas. This is a similar figure to the proportion of Mongolian herders that stated that they had previously rented land (21%, see Chapter 6). The arrangements described by Damao herders were not long-term, instead generally being short-term responses that matched the fluctuations in forage availability described in Chapter 4. For example, one herder had an ongoing arrangement with neighbouring properties. If the year was bad, he moved his livestock to a pasture that was as far away as some of the long distance *otors* occurring in Mongolia (see Chapter 6):

'*We don't share land with our neighbours but every summer, every year, we rent land for the whole summer. The area we rent depends on what our neighbours have available – if they have 3,000 mu* [200 ha], *we will rent this much. We rent it exclusively. Usually we use our neighbour's land, but sometimes we use land 40 to 50 miles away*.' (Char Gar Handa, Inner Mongolia, 25 years herding)

Other herders only sought to meet feed gaps through arrangements with other herders in bad forage years:

'If there's a bad forage year, I will rent or use someone else's land. If there is grass, I generally pay about 10,000 yuan for exclusive use of a few thousand mu belonging to a neighbour.' (Char Gar Handa, Inner Mongolia, 30 years herding)

In making arrangements with others, Inner Mongolian herders sought to effectively expand their property size rather than exploit distant areas that had received greater levels of precipitation. Presumably, the price of use rights would have reflected changes in the economic defendability of the forage resource through time, but this was not investigated further.

Whilst it was atypical amongst herders interviewed in Damao, one herder stated that he did not have bureaucratically sanctioned grazing use rights. Instead, he had recognised socially embedded rights to graze, and used his dispersed, bureaucratic rights over cropping land to exert socially embedded rights over the 620,000 mu of communal grazing land in between:

'I have [bureaucratic] *contracts over three separate tracts of cropping land, each of which is 20 mu* [1.33 ha]. *I don't have a* [bureaucratic] *contract* [from the collective] *under the Household Responsibility System as I believe that a herder needs to rotate their herd so that the grass will regenerate. I utilise the 40,400 mu* [2,693 ha] *of common land surrounding my house and farm to the north, west and south.'* (Nai En *sumu*, Inner Mongolia, 25 years herding)

Other herders in Inner Mongolia deliberately combined the area over which they had grazing use rights to effectively increase their property size, or willingly accepted fuzzy borders with their neighbours. There was no monetary exchange with these agreements:

'I have pasture rights to an area of land that I share with my brother and neighbour. The total area of land is 9,900 mu [660 ha]. *Each of the three households has 10 mu* [0.67 ha] *of farming land, a well and a home, but livestock roam freely over the combined possession area.'* (Bulag, Inner Mongolia, 20 years herding) and,

'I have a contract over 16,800 mu [1,120 ha]. *The land is not fenced, which means that livestock belonging to neighbours often comes onto our land. Livestock in our area will move up to 10 li* [5km away]. *This means that about ten families in their area share land.'* (Halishuu, Inner Mongolia, 30 years herding)

As well as the evolution of informal institutions to effectively expand access to the forage resource, other mechanisms had also evolved in response to practical difficulties associated with the introduction of more exclusive grazing rights. The shape of their grazing use right area created difficulties for some herders. Combining use right areas was one mechanism by which herders reduced the costs of exclusion associated with fixed area boundaries. One herder described his solution to a grazing use right with a large boundary length that would have made livestock management more onerous:

'A group of four related families decided to share our land in 1997 when we signed a contract under the Household Responsibility System. We decided to share our combined 20,000 mu [1,333ha] *of land because our contracted land was extremely long (about 10 km) and thin. This would have made livestock management extremely difficult to do separately. Because the group consists of three brothers and a neighbour, we have good relations. If one family decides to increase their number of livestock, this is allowed by the group. This productive area does not cross all of the four individual properties, but all families have access to it under combined possession rights.'* (Bayanbulag, Inner Mongolia, 25 years herding)

The four families described above additionally benefited from a greater variety of landscape types.

Figure 5-1 illustrates the increased averaging of the forage resource that each of the Bayanbulag families (referenced above) could access after combining their pasture use rights. The benefits from the area marked as 'productive in bad' years are shared between the four families, rather than the one or two families that would have benefited if the exclusivity of grazing use rights had been at the level of the individual herder household.

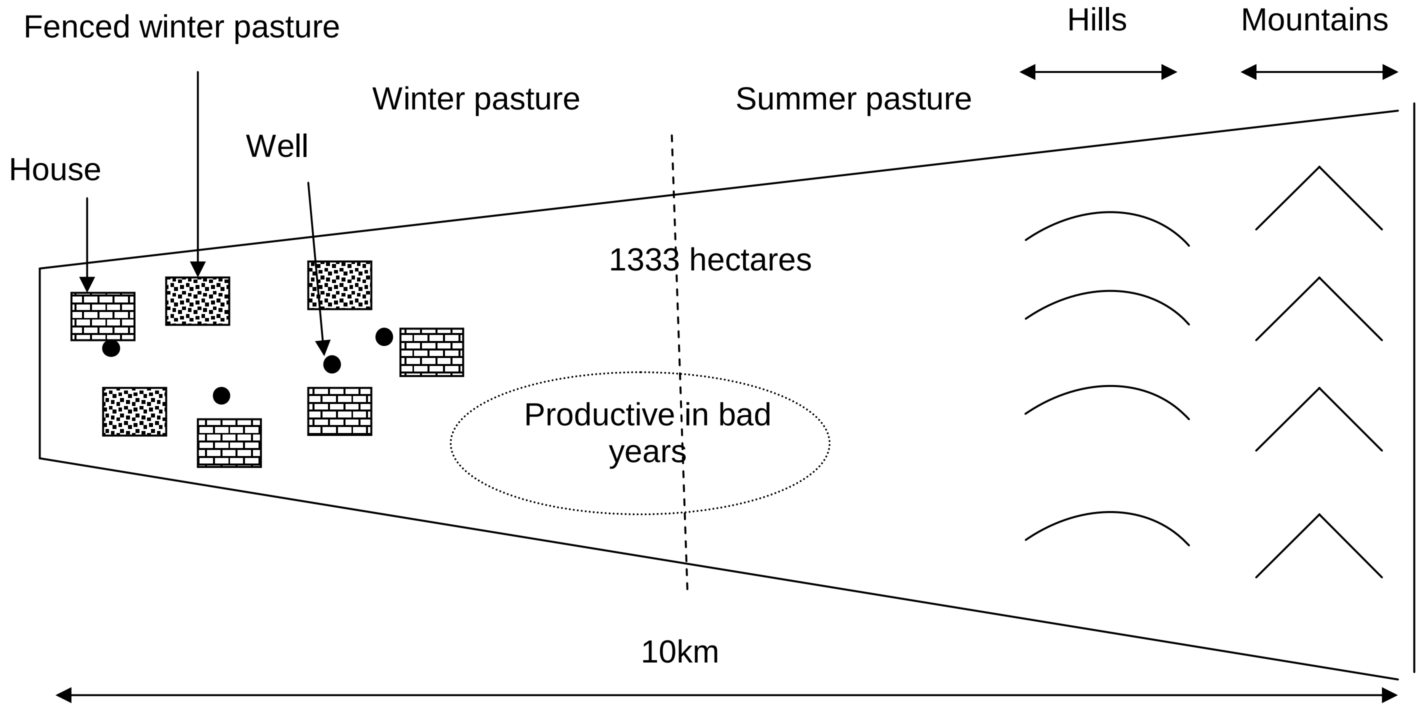


Figure 5-1 The grazing area of a herder from Bayanbulag, Inner Mongolia, when combined with three other families. Houses are located on the left of the figure, with wells situated reasonably close. Although the left side of the figure is designated as a winter pastures, areas of pasture near houses are additionally fenced to prevent uncontrolled grazing. An area at the centre of the figure is considered to be productive even in bad years. This area marks a division between winter and summer pastures. Summer pastures are found in the hills and mountains to the right side of the figure.

5.5 Bureaucratic institutions and the potential for feed gaps

Bureaucratic institutions can affect feed gaps by placing spatial and temporal restrictions on access to the forage resource. In areas like the Gobi Desert, where forage availability is generally low and variability is generally high (see Chapter 4), feed gaps may occur periodically if institutions governing access to the resource are too inflexible through space and/or time. If non-institutional tools for managing this risk are not affordable or available (see Chapter 7), and vegetation is present for a long enough period before livestock numbers collapse, these feed gaps may lead to overutilization and declines in rangeland condition.

The overall likelihood that any of the Mongolian bureaucratic institutional settings examined here would contribute to significant levels of overutilization was not high. This was largely because none gave exclusivity over small areas of land to individual herder households. There was generally flexibility around accessing summer pastures, and the provisions of inter-*soum* or inter-*aimag* forage reserves effectively expanded spatial boundaries.

Forage modelling in Chapter 4 suggested that winter/spring pastures, or those dominated by shrubs, are more likely to be overgrazed. Mongolian bureaucratic institutional settings probably produce a low or low to moderate likelihood of overutilization of the forage resource during winter. The likelihood of overutilization in the proposed MSRM Law on Pastureland is probably low because it uses annual winter/spring forage to prescribe carrying capacities. Consequently, it recognises that this time period has both the lowest resource density, and the most equilibrium vegetation characteristics. The draft Law on Pastureland more explicitly referenced winter/spring livestock carrying capacities, and aligning grazing pressures with forage availability, than the (potentially soon to be superseded) Law on Land but appears to be more spatially confined than the proposed MSRM Law on Pastureland. The Household Responsibility System produces a much higher likelihood of overutilisation.

The likelihood of overutilization in summer was more variable between bureaucratic institutional settings. This was because spatial boundaries generally ignored the higher forage variability during this period. The steppe-like PUGs (assuming an exclusive, fixed spatial boundary) and the draft Law on Pastureland produced the highest likelihood of overutilization. The steppe-like PUGs had a higher likelihood due to small spatial boundaries, and because forage variability in summer in the steppe-like PUG areas was higher than in the other institutional settings (Chapter 4). The draft Law on Pastureland did not stipulate a boundary size, but the definition of its ‘local’ term implies that PUG sizes would need to small enough so that herders could monitor and enforce rules effectively. It is assumed that areas would therefore be small, as it is difficult task if members were spread over a much larger area.

General carrying capacities ignored the high levels of forage variability within and between years as well as the significant international literature critiquing the concept (see Chapter 2). As predicted by Dyson-Hudson and Smith (1978), ‘superabundant’ periods of forage availability may also lead to an underutilised forage resource in a context of fixed carrying capacities. Indeed, levels of forage utilisation were very low during rangeland condition surveys after the *dzud* of 2009/2010 (Chapter 8). The ability of local officials to fix dates for pasture rotation under the draft Law on Pastureland, if enforced, also implied a resource that was less variable than shown in Chapter 4. Rule-breaking, via herd sizes larger than an estimated carrying capacity and the crossing of delineated pastures outside of delineated dates, may be likely in desert steppe areas under the draft Law on Pastureland.

The Household Responsibility System produced a higher likelihood of feed gaps then any Mongolian bureaucratic institutional setting if grazing use rights were considered to be exclusive and there were no alternative tools for managing feed gaps. This was largely due the higher likelihood of feed gaps during the highly variable summer period, and because of the small, exclusive land areas. This higher likelihood is further illustrated when livestock carrying capacities permitted for individual herder households under the Household Responsibility System are compared with actual stocking rates. Although many herders did not give sufficient information during interviews to calculate allowed and actual sheep forage units for their grazing leases, Table 5-3 shows that most herds were larger than that which was permitted.

Table 5-3 Comparison of permitted sheep forage unit s under the Household Responsibility System prior to the grazing ban, and actual numbers of sheep forage units. Permitted SFU is the allowed number of SFU per hectare cited by the local official, multiplied by the total area of leased land cited by the herder. Grazing areas are labeled as overutilised if actual SFU exceeds permitted SFU. This does not imply that they are permanently degraded.

	Total SFU		Permitted SFU v Actual SFU[A]
Herder	**Permitted**	**Actual**	
1	100	350	Overutilised (x3.5)
4	600	3,000	Overutilised (x5)
10	200	400	Overutilised (x2
11	730	460	Underutilised (x0.6)
12	870	1,025	Overutilised (x1.2)
13	330	770	Overutilised (x2.3)
17	200	575	Overutilised (x2.8)

[A] Figures should be viewed with caution as Inner Mongolian herders have reasonable access to commercial fodder to supplement potential feed gaps (see Chapter 7).

5.6 Summary and Discussion

Good rangeland management was emphasized in all policies examined. However the mechanisms by which this was emphasised generally assumed that the Gobi Desert forage resource was more equilibrial than was found in Chapter 4. For example, the assumption in all policies was that grazing-mediated degradation had occurred and that matching livestock numbers to perceived carrying capacities were the primary mechanism through which feed gaps could be met. This was despite the international literature (Von Wehrden *et al*. 2012) suggesting that zonal degradation is generally not reported from landscapes with a precipitation coefficient of variation of more than 33% (as was the case for most study sites - see Figure 4-1), and that the carrying capacity concept in such landscapes is flawed (e.g. Ellis and Swift 1988; Scoones 1989; Leeuw and Tothill 1990).

In the Mongolian Gobi Desert, responsibility for governing access to the forage resource under the Law on Land in Mongolia's Gobi Desert was largely devolved to local officials. The weak exertion of this localised authority parallels other areas of the country (Mearns 2005; Murphy 2011). This thesis did not attempt a more in-depth analysis of whether the exertion of responsibility under the Law on Land particularly benefited the powerful and/or well connected, as was found by Murphy (2011). However the risk was present; the Law on Land was primarily used by herders to strengthen pre-existing socially embedded institutions that regulated access to the forage resource, rather than being a suite of institutions that were adhered to in their own right. It remains to be seen how herders respond to the increase in local bureaucratic institutions and funding anticipated by the Mongolian Livestock National Program (2010).

Spatial administrative boundaries were generally only adhered to by herders if forage and water availability was perceived to be adequate within their own registered area (also see Chapter 6). Bureaucratic institutions that prevented herders from accessing forage and water resources were largely ignored, although the bureaucratic registration of winter/spring camps at least partially reinforced socially embedded institutions regulating access to winter/springs camps and pastures. Bureaucratic administrative boundaries under the Law on Land were weakly, and indirectly, exerted by a surrogate institution whereby herders 'chased away' other herders that were not registered within the *soum* or who had not made one-on-one agreements with a herder registered within the *soum* (see Chapter 6 for more details). The administrative boundaries of the PUGs sponsored by development agencies were similarly not respected, particularly during bad years. As such, high resource variability challenges the design features for sustainable common property institutions that are commonly cited in the international literature (Ostrom 1990; Cleaver 2000; Campbell *et al.* 2001).

The two policies proposed to replace the Law on Land in Mongolia were more specific about rights of exclusivity than the Law on Land. These policies did not grant exclusivity at the level of the individual household, but more specifically defined the temporality and spatially of collective grazing use rights. The draft Law on Pastureland devolved many of the responsibilities of good pasture management to herder households, but herder rights could be more easily superseded by these interventions from higher order governments. A significant difference between the MSRM version of the draft Law on Pastureland and the draft Law on Pastureland was the addition of a layer of bureaucracy managing collective use rights. However the MSRM version also attributed more agency to herder groups.

In the absence of other interventions, tt is difficult to know what effect granting more or less agency at the local level would have on the ability of herders to manage feed gaps. Internationally, decentralised agency over natural resource management has a strong theoretical basis (e.g. Ostrom 1990; 1999; 2005). However, Murphy (2011) argues that in Mongolia it also represents neo-liberal thinking and can privilege the local elite, in turn increasing the vulnerability of the most disadvantaged herders. Whether a strengthening or weakening of local power dynamics is likely to improve or negatively affect rangeland condition remains untested.

Turner (2011) noted that conservation and development programs significantly influenced by common property resource management in the Sahel generally had a negative impact on livestock mobility and rangeland management. This may also be the case in PUGs in the Mongolian Gobi Desert if current boundaries were adequately policied. Neither of the two policies proposed to replace the Law on Land are likely to increase the risk of feed gaps, but neither they are likely to reduce the risk. Consequently, their institutions may provide little benefit to herders in the absence of providing alternative tools for managing forage variability.

The Household Responsibility System of Inner Mongolia differed from Mongolia’s Law on Land largely due to its granting of more exclusive grazing use rights to herders. Despite these more exclusive rights, herders still employed strategies that were less exclusive. They did this to minimize the increased exposure to climatic risk that accompanied exclusive grazing rights over a smaller area of land than what they had accessed previously. To meet feed gaps, and for more efficient herd management, herders made agreements with herders at relatively large distances away during key feed periods, or shared land with immediate neighbours. Whilst at a smaller scale than in Mongolia, these strategies share similarities with the socially embedded institutions of the Mongolian Gobi Desert (see Chapter 6) and the bureaucratic institutions of PUGs (this chapter), respectively. However the costs of these strategies are likely to be significantly higher in Inner Mongolia than Mongolia given the increased transaction costs and risks associated with a greater level of exclusivity over the forage resource (Li and Huntsinger 2011; Dalintai *et al.* 2012).

The likelihood of feed gaps being produced by bureaucratic institutional settings in the Mongolian Gobi Desert was generally low to moderate. This likelihood could be further mitigated by herders rule-breaking these bureaucratic institutions, the presence of socially embedded institutions, or tools such as imported fodder. This thesis now turns to ways in which herders govern the access of livestock to forage at a more local scale. The rule-breaking of bureaucratic institutions in order to meet feed gaps and the presence of socially embedded institutions are now discussed.

6 Socially Embedded Institutions

6.1 Introduction

Despite the increased attention to bureaucratic institutions in Mongolia (Chapter 2), two matters have remained little examined in the Mongolian Gobi Desert. Firstly, what socially embedded institutions that may affect rangeland condition already exist? There has been little analysis of the contemporary practices of herders relevant to the sustainability of the forage resource. This is needed given that socially embedded institutions in arid rangelands have been under-recognised in the development of bureaucratic institutions elsewhere. Secondly, do existing socially embedded institutions produce good rangeland condition outcomes? The ability of existing socially embedded institutions to maintain or improve rangeland condition, particularly in comparison to proposed bureaucratic institutions, has been little examined. This knowledge gap could be important given the potential for socially embedded institutions to be maladapted to broader natural resource aims (see Chapter 2).

Cleaver (2002) defined socially embedded institutions as those based upon culture, social organisation and/or daily practice. In the absence of alternative tools for managing risk (see Chapter 7), the forage variability described in Chapter 4 encourages mobility as herders attempt to manage livestock feed gaps to best meet food security and income aims. Like the bureaucratic institutions described in Chapter 5, socially embedded institutions may create boundary rules around mobility, and constrain where herders and their livestock can move, and when.

At times, the ways individual herder households negotiate access to the dynamic forage resource manifest as strategies or norms common to all herders. A shared strategy is an aspiration of resource users that is not regulated by the group (Ostrom 2005). Norms are shared concepts of what must, must not, or may be appropriate actions or outcomes in particular types of situations (Ostrom 2005). This contrasts to institutions that are explicitly sanctioned or agreed upon by groups of herders. These rules have an ‘or else’ component that specifies a range of possible punishments, or sanctions, for rule-breaking (Ostrom 2005).

As Murphy (2011) noted, post-socialist state-society relations are complex, contradictory and context-specific. Nevertheless, this chapter explores the general ways in which Mongolian Gobi Desert herders regulate their own and each other's access to the forage resource at both a daily and seasonal scale, and at spatial scales varying from very local to inter-*aimag*. The ways in which herders regulate access to the forage resource are described and assessed in this chapter to see if they can be defined as institutions as per Ostrom's (2005) typology. Their ability to contribute to feed gaps and overgrazing is then discussed.

6.2 Daily controls over access to forage

In the Mongolian Gobi Desert, interviewed herders brought back most livestock to their *ger* each night. Herders stated that livestock in Law on Land systems moved an average of 7.7 km away from the *ger* each day on average, whilst livestock in PUG areas moved a similar 8.5 km away from the *ger* each day. Seven herders distinguished between 'large' livestock (primarily camels and horses) and 'small' livestock (goats and sheep) in terms of the distance moved each day. 'Large' livestock moved an average of 12 km per day, with the 'small' livestock moving about 5 km. 'Small' livestock returned, or were herded, back to camp each night. 'Large' animals were sometimes left for several days to access forage in ways that were not as controlled:

'*We normally bring the camels back every 3 – 4 days for water. The horses we bring back once every second day. We just check on them to make sure they're not lost, and have water*.' (PUG, Ulziit *soum*, Omnogobi *aimag*, herding 15 years)

Many herders controlled where their livestock went within their daily grazing radius. Stated reasons for livestock control, irrespective of seasonality, included preventing livestock from moving into an area recognised as another herder's winter/spring pasture, livestock too close to another's *ger*, or to minimise the chance of livestock being attacked by wolves or stolen by thieves. Law on Land herders were slightly more likely than PUG herders to control day to day movements of their livestock to specifically prevent encroachment of their livestock onto neighbour's pastures (Table 6-1). However in general herders did not prevent encroachment of their livestock onto pastures near the *gers* of other herders.

Table 6-1 Daily control over livestock movement in each institutional setting in Mongolia.

	N	Controlled?[a]	Due to neighbours?[b]
PUGs (combined)	20	60%	17%
Law on Land	20	75%	20%

[a] 'Controlled?' = the percentage of herders that controlled the day-to-day movement of their livestock, rather than allowing their livestock to roam at will. [b] 'Due to neighbours?' = the proportion of all herders that stated that they specifically controlled their livestock so they would not encroach on the territory of another herder.

Given the lesser control on larger livestock, it is likely that they were more likely to encroach on winter/spring pastures, or close to the *gers* of other herders, than smaller livestock.

Distances that livestock moved each day depended upon a number of factors other than herder control. Forage availability was one of these factors, although herders gave conflicting accounts of the effect of forage availability on distance. For example, some herders stated that livestock did not need to move far during periods of high forage availability in order to access adequate levels of feed:

'*Our livestock will move almost 10km if there is nothing to eat, and only 5km if it's green.*' (Law on Land, Sevrei *soum*, Omnogobi *aimag*, 30 years herding) and

'*They don't go so far in autumn* [when there is a lot of feed].' (PUG, Ulziit *soum*, Dundgobi *aimag*, 30 years herding)

Others stated that forage availability affected distances moved in the opposite way:

'*In autumn they move further because it's warm and there are more grasses so our animals must get fat.*' (PUG, Ulziit *soum*, Dundgobi *aimag*, 25 years herding)

Some herders cited weather characteristics as a factor affecting the distance that their livestock moved each day:

'*They stop when it's windy.*' (Law on Land, Tsogt-ovoo *soum*, Omnogobi *aimag*, 20 years herding);

'*Our livestock move 10 km per day. We stop them or they stop themselves when they're hot. We get them up and force them to eat*.' (PUG, Bulgan *soum*, Omnogobi *aimag*, 30 years herding);

'*When it's cold our animals don't want to move*.' (PUG, Ulziit *soum*, Omnogobi *aimag*, 25 years herding).

Other herders stated that in pastures new to livestock, livestock would roam further than in pastures that they had spent more time in because the territory in newer pastures was unfamiliar to them. Livestock were considered to be easier to control in familiar pastures as livestock knew the location of key resources, as well as the location of the *ger* to which they were to return to each night. This acted as an incentive for some herders to return to familiar pastures if water and forage were available.

6.3 Accessing winter/spring camps and pastures

Forage availability becomes more predictable when the temperature drops below 0°C (see Chapter 4). This means that the relative benefit to an individual herder of defending the resource against the grazing pressures of other herder's livestock is likely to be higher during this period than in warmer periods. Winter/spring camps, and surrounding pastures, are therefore likely to have different institutional arrangements than pastures where the maximum forage resource is less fixed by temperature. Relative forage shortages are also likely to be most evident during the winter/spring period.

In 2010, the availability of winter/spring camps were seen to be limited relative to the number of herders in the Mongolian Gobi Desert study sites. New or younger herders were experiencing difficulties in obtaining suitable camps:

'*We'd like to build a new one and register it, but all the nearby areas are already owned*.' (Law on Land, Manlai *soum*, Omnogobi *aimag*, herding 8 years)

The limited number of suitable winter/spring camps combined with use rights under the Law on Land to increase exclusivity over these camps. This, in turn, facilitated the evolution of a market for the informal renting (sub-leasing) of these camps. Whilst the Law on Land facilitated structural adjustment by strengthening rights to winter/spring camps, the legality of subleasing was not addressed (see Section 5.2.1). The Law on

Land did not fully account for the implications of increased exclusivity over key forage resources by legalising the market forces that were subsequently created. Additionally, the Law on Land stipulated that only the immediate winter/spring camp infrastructure can be formally leased from the State, not the surrounding pasture (see Chapter 5). However, the market price for informal renting appeared to include socially embedded rights of access to surrounding pastures.

Some 21% (n= 40) of herders stated that they had rented a winter/spring camp at least once. In some cases, herders with lease rights over winter/spring camps had moved to the *soum* centre for a variety of reasons: they had a job in the *soum*, their children were at school there, or their livestock had died/been consumed and they were destitute. This freed up winter/spring camps that they had registered under the Law on Land to be sub-let to others for the short-term (generally only a few months):

'*Renting of camps started after the registration of* [the Law on Land] *winter/spring camp system'* (PUG, Ulziit *soum*, Dundgobi *aimag*, 15 years herding).

Levels of renting were highest amongst herders (n =15) in the gobi-like PUG (six herders renting), followed by non-PUG herders (four herders renting, n = 21) and steppe-like PUG herders (one herder renting, n = 7). The frequency of renting varied amongst those herders that had ever rented a camp. Some had only rented infrequently:

'*Only once have we rented someone's winter/spring camp. That was* [in the] *last* [bad] *year*.' (Law on Land, Tsogtseggi *soum*, Omngobi *aimag*, 25 years herding),

Renting was more common for other herders:

'*We use other people's winter/spring camps sometimes when they move to the* soum*. We do agreements, give livestock, and have done so for the last 2 of 5 years*.' (Law on Land, Tsogt-ovoo *soum*, Omnogobi *aimag*, 25 years herding).

The small proportion of respondents who cited the frequency with which they rented winter/spring camps, and how this frequency had changed over time, makes it difficult to ascertain whether winter/spring camp rental was becoming more common, who was most likely to be renting and why. However a number of herders cited bad forage years in the location of their registered winter/spring camp as being the reason they rented:

'*We've rented someone's spring camp once or twice because of the* dzud. *We paid 50,000T/month to a friend of ours*.' (PUG, Ulziit *soum*, Dundgobi *aimag*, 25 years herding).

'*We sometimes rent others' winter/spring camps. Everyone in the* soum *does it. Three of the last 5 years we did this. Our winter place this year is not good so we won't stay here*.' (PUG, Ulziit *soum*, Omnogobi *aimag*, 25 years herding)

'*Last year and the year before we rented someone else's winter/spring camp, in this* soum. *It's not common. This winter we will use ours.*' (PUG, Ulziit *soum*, Omnogobi *aimag*, herding 7 years)

'*We have rented someone else's winter/spring camp in another* aimag/soum. *We used to go every year but this and last year there was autumn rain so we stayed.*' (PUG, Ulziit *soum*, Omnogobi *aimag*, herding 30 years).

The herder-cited increases in the number of 'bad forage years' (see Chapter 4) and the herder belief that the forage resource has been declining (see Chapter 8) suggests that Mongolian herders may view the rental of winter/spring camps as an increasingly important tool by which they manage climatic variability in the Gobi Desert.

Arrangements between lessees and sub-lessees varied between herders, but generally involved a payment of cash or livestock for a fixed period of time. Monthly rental prices varied from 50,000 T to 100,000 T per month for the exclusive use of another herder's registered winter/spring camp. Prices for the entire winter/spring period varied from 100,000 T to 1,000,000 T. To put these figures into context, the average monthly earnings of a Mongolian working in the agriculture, hunting and forestry sector in 2009 was 175,200 T (National Statistical Office of Mongolia 2010).

One herder in Ulziit *soum* stated that access to pastures during summer must be paid for (PUG, Ulziit *soum*, Omnogobi *aimag*, 30 years herding) but it is unclear whether this meant access to winter/spring camps or access to summer pastures. One herder who *otor*ed to Dornogobi *aimag* from Omnogobi *aimag* paid 80,000T in total for access to pastures between October and July, stating that this money went to both the government and the winter/spring camp lessee (Law on Land, Tsogteggi *soum*, Omnogobi *aimag*, herding 30 years). Another herder in Bayandalai *soum* (PUG, Bayandalai *soum*, Omnogobi *aimag*, 10 years herding) paid five animals to access the winter/spring camp of an ex-herding family that had moved to the *soum* centre.

A market for permanent rights to winter/spring camps also existed:

'*When people lose all their animals they move to the* soum *and sell their camp for about 1,800,000T*.' (Law on Land, Sevrei *soum*, Omnogobi *aimag*, herding 25 years);

The illegality of selling the rights to winter/springs camps under the Law on Land (as opposed to short-term subletting) was cited as creating a barrier to new herders accessing appropriate shelter for their livestock in *soums* where all appropriate winter/spring camp sites were already registered, although not necessarily used:

'*We don't have a spring camp but we want to get one. There's one spring camp that we want but it's in someone else's name. They haven't used this camp for 10 years. It's for sale for 6 – 700,000T. We've heard the land can't be sold but the shelter can be. You can change the name but you can't sell. We'd like to build a new one and register it, but all the nearby areas are already owned*.' (Law on Land, Manlai *soum*, Omnogobi *aimag*, herding 8 years)

Absentee herding existed, although it was rare. It is defined here as an arrangement that was purely for financial gains between otherwise unconnected/unrelated parties. This distinguishes absentee herding from similar, more common informal arrangements between closely related family members, such as sharing winter/spring camps or splitting households. Sharing winter/spring camps or splitting households assisted herders to maximise the forage available to their livestock during winter/spring, at relatively little cost. Consequently, these institutions can be considered to be a mechanism for managing climatic risk in a way that that is internal to the local pastoral system and does not directly engage with the greater market. Conversely, absentee herding can be considered a mechanism that manages the short-term effects of failed climatic risk management in a way that is at least partially integrated with an external market economy.

Where present, absentee herding generally involved an arrangement between financially marginal herders and livestock owners based in the local *soum*, rather than non-related livestock owners based in large urban centres. The reason for one interviewed herder household to become involved in herding for an absentee owner was that they had been made destitute by the 2009/2010 *dzud*. The livestock owner chose to live in the *soum* centre, with the destitute household then paid to herd the owner's livestock:

'*We don't have a spring camp but we want to get one. We are currently looking after other people's animals, people who have a job in the soum and kids in school there. We did have animals but we lost them in the dzud… We're getting paid 500T/month per animal (so 100,000T total plus we get to keep 30% of the babies).*' (Law on Land, Manlai *soum*, Omnogobi *aimag*, herding 8 years)

The arrangement of livestock owners paying their livestock managers in young livestock, rather than cash, was typical. This arrangement presumably aimed to act as an incentive for good herd management. The arrangement may also have a social welfare function by allowing households without a livelihood to build their own herds. One PUG herder (PUG, Bulgan *soum*, Omnogobi *aimag*, 30 years herding) owned about 1,000 head of livestock. He had split his herd, paying another herder 20 young livestock for every 100 mature adults in the herd.

Herders were more likely to share winter/spring camps or split households than absentee herd, perhaps due to the relatively small number of herders wealthy enough to pay (through cash or livestock) for herd management (see Chapter 9). There was no monetary exchange in these arrangements. However shared benefits, such as shared fuel costs during trips to the *soum* centre, shared labour or child-care arrangements, were present. The smaller herd sizes after the 2009/2010 *dzud* also meant that there was excess labour in the pastoral system, and grazing pressures per herd were lower. In many cases, combining relatively small herds would not have increased mobility requirements when compared to pre-*dzud* herds, and using excess pastoral labour for other purposes (such as seeking alternative income or child-rearing) may have become more viable. It is likely that trust was particularly important in these arrangements.

Family members combined rights to their individually registered winter/spring camps and shared the use of the camp that had the best available forage during the 2009/2010 *dzud*. In Bulgan *soum,* two sisters, who were members of a PUG but were residing outside of the PUG area during the 2010 survey, had one registered winter/spring camp each. They had combined their herds and chose each year's winter/spring leased camp based upon whichever of their registered camps had the most available forage by the end of autumn. They did not state the distance between the two camps, but both were within Bulgan *soum*.

In an example of household splitting, two related Law on Land households in Manlai *soum* had winter/spring camps that were about 20 km apart. They were pooling their livestock at the time of the interview, with one household moving to the *soum* centre to help school both households' children over the winter school term. The other household planned to remain herding, accessing the registered winter/spring camp that had the best available pasture at the time. Another gobi-like PUG herding household planned to move near the *soum* where their children were about to leave for boarding school to begin the new school term. Their younger brother, who did not belong to the same PUG, had a winter/spring shelter near the *soum,* and which they used in exchange for looking after his few livestock.

Winter/spring camps registered under the Law on Land gave socially embedded possession rights to the pasture surrounding the camps even though the Law on Land did not allow exclusive use of these areas. This appeared to occur irrespective of whether the camp was contained within a PUG boundary or not. Socially embedded possession rights were 'fuzzy' and did not equate to a set distance from the winter/spring camp, although one Ulziit *soum* herder (PUG, Ulziit *soum*, Omnogobi *aimag,* 5 years herding) said that socially embedded rights to exclude other livestock generally extended to a distance of about 500 m from the registered camp. In a demonstration of socially embedded rights over winter/spring pastures around registered camps, some herders stated that they were unhappy when the livestock of others' encroached upon their sphere of socially embedded possession rights, or that herders that were encroached upon tried to prevent this from occurring:

'*Other herders don't often come into our winter area, but sometimes big animals will come into our winter camp area on their own. We don't like it, but it's rude to chase them away*.' (PUG, Bulgan *soum*, Omnogobi *aimag*, 25 years herding)

'Chasing away' was most common when a herder and their entire herd had encroached upon pastures that were within the sphere of socially embedded possession around registered or unregistered winter/spring camp areas. 'Chasing' was particularly common if herders were not registered in the *soum* into which they had moved:

'*We went to Bayandalai* [soum] *once in 2007. But there were some problems. It was summertime and we were told that we our livestock were grazing in other herders' winter places. We stayed a few weeks then moved back*.' (PUG, Bulgan *soum*, Omnogobi *aimag*, 25 years herding)

6.4 Mobility

Livestock mobility smooths temporary feed gaps by moving grazing pressures in space to where forage is available. Turner (2011) noted that mobility is rarely functionally defined when links are made between between mobility and governance. The following section explores several defined types of livestock mobility in the Mongolian Gobi Desert – those driven by daily, seasonal and climatic patterns.

One (n = 8) steppe-like PUG herder was in a pasture, named by them according to the usual seasonality of its utilization, that did not match the season of interview. This compared to seven (n = 15) of herders in a gobi-like PUG, and six (total number of respondents = 24) of herders not in a Law on Land area. The lower level of mobility (Table 6-2) in the good years described by herders across both PUG and Law on Land rangelands also supports the view that herder mobility was a product of forage availability.

In the Mongolian Gobi Desert, livestock mobility in response to forage variability was relatively unconstrained by bureaucratic institutions. Paired sample t-tests showed that the maximum distance moved by all herders in the last good years was significantly less than the last bad year ($p=0.004$). The average frequency of livestock movements and the distance moved per herder household in the different institutional settings are shown in Table 6-2.

Table 6-2 Comparisons between the frequency at which administrative boundaries were crossed during the last good and bad years[A].

	Left *soum*?		Left *aimag*?	
	Mean (%)	N	Mean (%)	N
Good year				
Law on Land	0	18	0	18
Steppe-like PUGs	36	11	27	11
Gobi-like PUGs	20	5	0	7
Mean	14	35	8	36
Bad year				
Law on Land	50	20	33	18
Steppe-like PUGs	18	11	0	11
Gobi-like PUGs	71	7	0	5
Mean	45	38	18	34

[A] 'Left *soum*? Left *aimag*?' = positive response to the question 'In the last good/bad year, did you leave the *soum/aimag*?' See Section 4.2 for the definition of 'good' and 'bad' year.' N = number of respondents.

Whilst averages are useful for comparing mobility between tenure systems, they mask the smaller scale patterning of mobility. The frequency of livestock movements could not be assessed quantitatively as part of this research because some herders included summer movements in their responses and some did not. However, if questioned further, most herders stated that short movements in summer were frequent, with some moving every '*three days to a month, depending on rainfall*' (Law on Land, Sevrei *soum*, Omnogobi *aimag*, 25 years herding). One herder stated that they moved so many times in the last bad year that they could not remember the number, but they estimated that they had moved about 400 km in total (Law on Land, Tsogtseggi *soum*, 25 years herding). Some herders regularly moved shorter distances, but were occasionally required to move much longer distances to manage feed gaps:

'*In the last three years we have moved through three* soums *in two* aimags *(Omnogobi and Dundgobi), the longest being 230km at once*.' (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 30 years herding)

Patterns of mobility in Mongolia were also variable between landscape types. Herders registered in the same *soum*s did not always have similar patterns of movements. Nevertheless, in general herders in gobi-like landscapes had less predictable movement patterns than those in steppe-like landscapes where transhumance was more commonly practised along an altitudinal gradient. This was largely because forage productivity was greater in steppe-like landscapes than gobi-like landscapes (see Chapter 4): similar herd sizes could utilise forage for a longer period in steppe-like landscapes before herders had to move.

Figure 6-1 shows a typical mobility pattern of the same herding household in a year they said was bad, and in a year they said was good. This household was registered in a *soum* dominated by a gobi-like landscape. The household, whilst having the same winter/spring camp in both the good and bad years, had multiple, different summer camps in the two years. Figure 6-2 shows a pattern more typical of a household registered in a *soum* dominated by a steppe-like landscape. This household had two main camps, which were the same in the last good and bad year, but had one additional *otor* (long distance movement) in the last bad year.

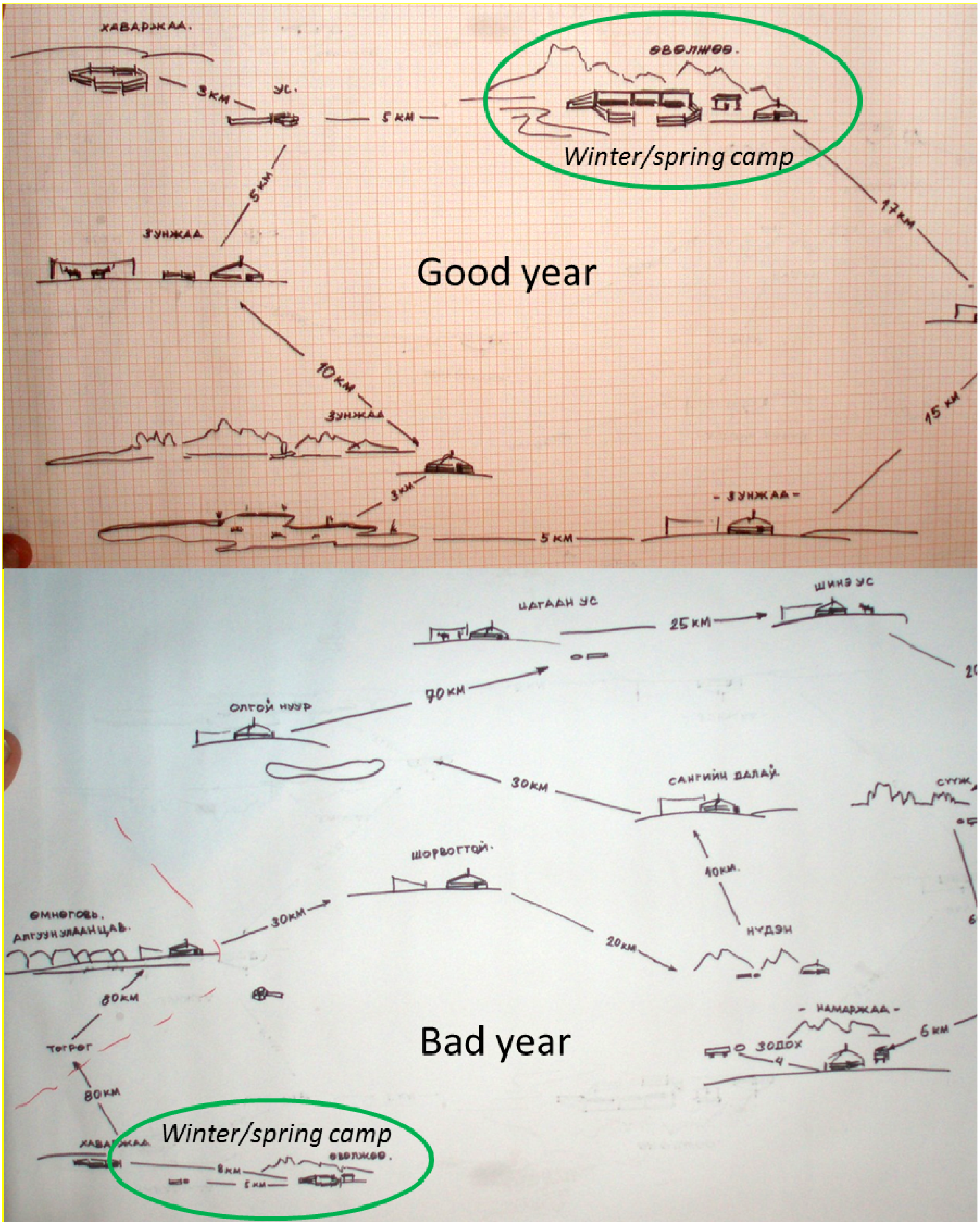


Figure 6-1 An example of mobility patterns for a gobi-like landscape in good (top) and bad (below) forage years. The illustration was produced by a PUG herder, Ulziit *soum*, Dundgobi *aimag*, > 30 years herding. The *ger* represent seasonal camps, with lines between them signifying the distances between camps (not to scale). Seasonal camps are translated as follows: Намаржаа = autumn, Эунжаа = summer, Өвөлжөө = winter/spring. The terms "ус" (water) or "нуур" (lake) signify the name of a waterpoint. The red dashed line on the left of the bad forage year signifies an *aimag* boundary (Dundgobi – Omnogobi *aimag*s). In these two figures, the winter/spring camps (highlighted by the circle) were the same in the last good and bad years.

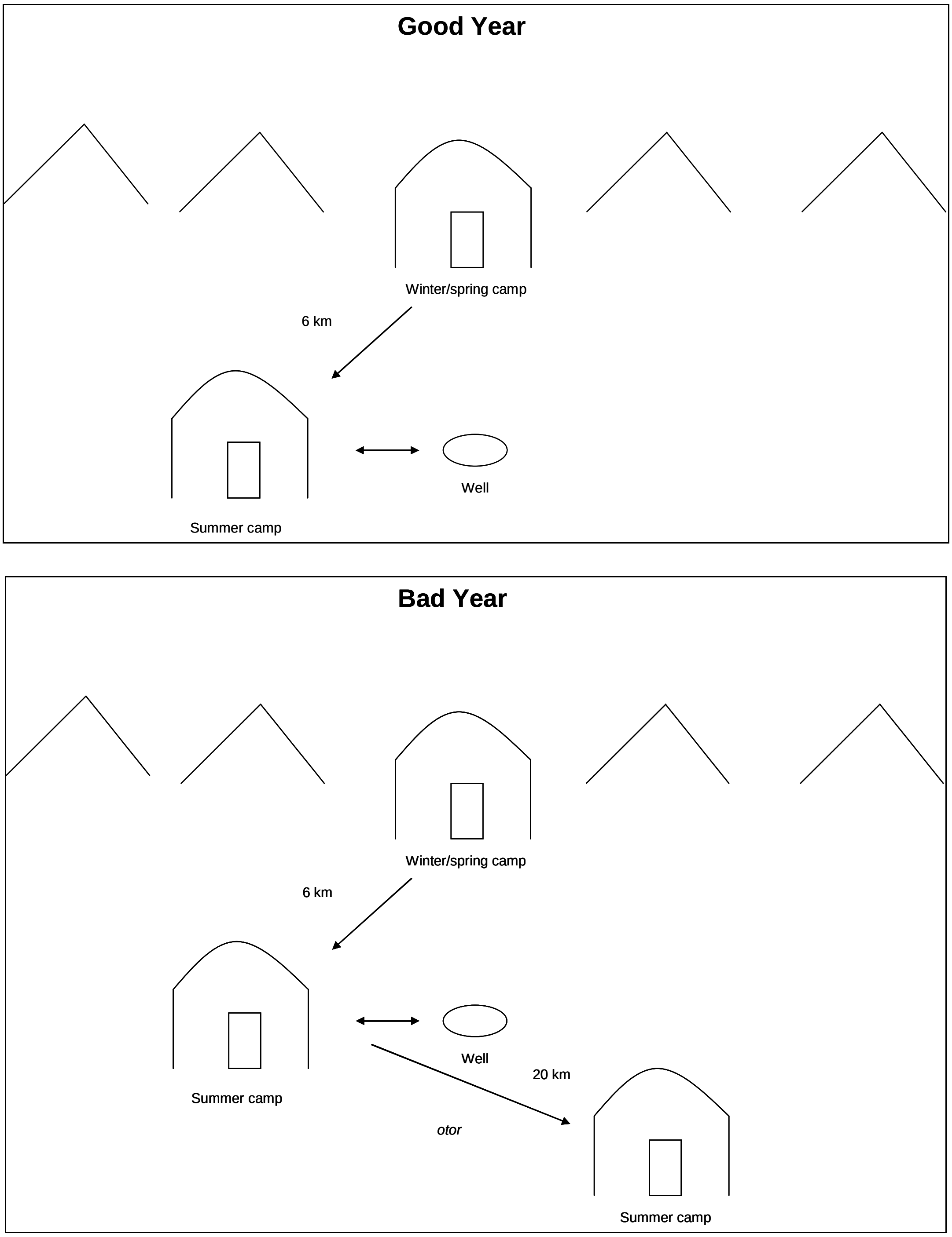


Figure 6-2 Mobility patterns for a steppe-like landscape in good (top) and bad (below) years, based on an image was produced by a PUG herder (Bulgan *soum*, Omnogobi *aimag*, 30 years herding) that was not of high enough visual quality for inclusion here. The *ger* represent seasonal camps, with lines between them signifying the distances between camps (not to scale). The winter/spring camp is in the mountains, with summer camps on the mountain pediments. In these two figures, the winter/spring camps are the same. Mobility was slightly less for this herder household than others in the same landscape due to the presence of irrigation in an area typically used for summer pasture, but movements down the altitudinal gradient and a summer *otor* were typical.

Herders cited a number of biophysical or socioeconomic factors that were important in the decisions they made about where they would move themselves and their livestock. The presence of both water and pasture was overwhelmingly the main factor in herders' decisions about where they relocated. Many herders said that:

'*Only grass and water are important in terms of us choosing where we move our livestock to*.' (PUG, Ulziit *soum*, Omnogobi *aimag*, 30 years herding)

Available pasture and water far outweighed other factors, such as registration of winter/spring camps, in importance:

'*Winter/spring possession* [grazing use rights of winter/spring camps under the Law on Land] *has no effect on where we go. If there is no grass, we will move*.' (PUG, Bulgan *soum*, Omnogobi *aimag*, herding 25 years).

When prompted for factors secondary to pasture and water availability that influenced mobility decisions, proximity to the *soum* centre was considered to be important for some herders. For other herders, proximity to the *soum* centre was not important at all:

'*In regards to how we move, being close to the* soum *isn't important. Pasture and water access are important*.' (Law on Land, Tsogt-ovoo *soum*, Omnogobi *aimag*, 25 years herding)

Herders most likely to cite proximity to the *soum* centre as being important were those that had a child or children at school there:

'Grass and water are the most important things for us when deciding where to move. We have many kids at school. We try and stay close to the soum *for them*.' (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding)

Proximity to the *soum* centre was less important for these herders during summer/autumn school holidays, a period that coincides with the greatest level of spatial variability in the forage resource (Section 4.3).

Some herders preferred to move with family members or friends, or move near where family members or friends already were. Reasons for this included access to additional labour, for emergency assistance, for companionship or to guard against 'being chased away':

'*Grass and water are the most important things in choosing where to go. It's also important to move with friends and relatives as a* khot ail*. It's difficult to move alone. It's hard if there's an emergency. A new place for animals increases the labour requirement. It's a problem if the herders there are not so nice*.' (PUG, Bulgan *soum*, Omnogobi *aimag*, herding 15 years)

Several herders suggested that finding '*somewhere not too windy* [for their livestock] *is good*' (PUG, Bulgan *soum*, herding 25 years), and that '*shelter is important in winter for the babies*' (Law on Land, Tsogt-ovoo *soum*, 25 years herding). Only one herder, when prompted, stated that being near a set of hills was important to gain mobile phone coverage, and was therefore important for emergencies (PUG, Ulziit *soum*, Dundgobi *aimag*, 5 years herding).

6.5 Conflict over pasture

Of the 14 Mongolian herders who described the presence/absence of conflict between herders over access to the forage resource, seven stated that '*there are no arguments'* (PUG, Ulziit *soum*, Omnogobi *aimag*, herding 20 years). An additional two said there was conflict but that a mutually beneficial deal could be negotiated between herders. Four said that conflict occurred outside of the *soum:*

'*This* soum *(our* soum*) is OK to move in, there are no arguments. But if we go to another* soum*, people will fight us there.'* (PUG, Ulziit *soum*, Dundgobi *aimag*, herding 25 years)

Only one herder stated that there was conflict within their own *soum*:

'*There is chasing everywhere. We wanted to move close to one place but we got chased. It has become difficult to move now. If there is no rain we must move but if we get chased, we have to move again*.' (Law on Land, Manlai *soum*, Omnogobi *aimag*, herding 20 years)

No Mongolian herder directly stated that the presence of another herder and their livestock would prevent them from moving near them if pasture and water were available in that location. Indirectly, however, herders made choices to avoid 'being chased' by staying in their own *soum* if water and pasture were available; making arrangements via a monetary or livestock exchange with herders in winter/spring pastures that they did not have bureaucratic or socially embedded rights over to legitimise their occupancy of pasture; or moving with or near friends or family. In one of the pilot interviews in Ulziit *soum*, an older relative of a herder household had been left alone in a small *ger* with very few livestock in a winter camp area as a way of asserting occupancy rights, and guarding against the intrusion of others' livestock into winter pastures.

Although many herders reported widespread 'chasing', a few herders stated that 'chasing' does not occur at all in the Gobi Desert. These herders indicated they were obligated to accept other herders into their areas when conditions were bad elsewhere:

'*In the 2009/10* dzud*, most of this area was dry but many herders came here. This decreased the grass but there were no arguments. There's an unwritten rule to accept them*.' (PUG, Bulgan *soum*, Omnogobi *aimag*, herding 15 years)

Others suggested that whilst levels of conflict were higher during bad years, levels of conflict were generally within manageable levels:

'*People argue sometimes, especially in August* [when] *people try to keep the places they are going to stay during the winter time. Such issues make them argue, although there are no designated camps for households as managed by government. But in fact, there is no heavy argument between our people. To stop arguments we need to receive rain that can cover whole area, so there will be enough grass everywhere. That's the main fact of the argument.*' (PUG, Ulziit *soum*, Omnogobi *aimag*, 15 years herding).

6.6 Mobility and bureaucratic institutions

No herder directly stated that bureaucratic administrative boundaries of the Law on Land regulated where they moved. Nor did any herder state that their movements were influenced by PUG boundaries. Herders would cross any administrative boundary if water and pasture were absent. Table 6-2 shows the proportion of herders who crossed *soum* or *aimag* boundaries during the last good and bad year. One herder specifically stated that:

'*Grass and water are the most important things when we are deciding where to go. We can take our livestock anywhere. We know where the* bag *boundaries are but ignore them depending on the grass availability*. *Bureaucratic* bag/soum/aimag *arrangements are not important when deciding where to go.*' (PUG, Ulziit *soum*, Omnogobi *aimag,* 20 years herding)

Both PUG and Law on Land herders commonly left their *soum* and *aimags* in bad years (Table 6-2). The percentage of herders that left the *soum* in a good year was significantly lower than the percentage that left in a bad year (p=0.005). The percentage of herders leaving the *aimag* was not significantly different for herders in good or bad years. Small sample sizes for herders that left the *soum*/*aimag* during the last good year, and for herders that left the *aimag* make it difficult to assess the relationship between livestock wealth and mobility patterns, but there appeared to be little difference between the herd sizes of herders who left the *soum* in the last bad year (mean = 275) compared to those that did not leave (mean = 266) (n = 33). The most marked difference in herd sizes was between herders that had left the *aimag* in the last bad year (mean = 122) and those had left in the last good year.

One way ANOVA tests showed that there was a significant difference between institutional settings in the likelihood of leaving the *aimag* in both a good year (p =0.019) and a bad year (p=0.038). Gobi-like PUG herders were more likely to leave the *aimag* during good years, and Law on Land herders were move likely to leave the *aimag* in bad years. The chance of leaving the *soum* in a good year was significantly different between institutional settings in a good year (p=0.019) with gobi-like PUGs > steppe-like PUGs > Law on Land in terms of herder's likelihood of leaving the *soum* in a good year. There was no significant difference between institutional settings in bad years (p=0.069).

In the 2010 summer/autumn interview period that most herders classed as having fair to good forage conditions, only one herder was interviewed outside of their registered *aimag* (n= 50). Only two were interviewed outside of their registered *soum* (n = 50). This is surprising given the frequency at which herders stated they left their *soum*/*aimag* during the bad year of 2009/2010 (Table 6-2). However, by the time of interview, many herders may have already returned to their well vegetated, home *soums* which by then had good forage following the bad year of the 2009/2010 *dzud*.

Herders were not specifically asked about their mobility patterns in relation to artisanal mining opportunities because mining is illegal. Other indicators of mining such as disturbed soil in gullies within the Gobi Gurvan Saikhan Strictly Protected Area (SPA), the presence of gold detectors in the *gers* of interviewees and the self-described activities of some herders suggest that mining opportunities influence where some herders decide to move to regardless of administrative boundaries. I observed many more herders and their livestock in the Ireedui PUG area (Bayandalai *soum*) in 2010 compared to 2009 when the area was visited for verifying forage modelling. An increased herder density, plus visible evidence of artisanal mining along gullies, suggests that the prospect of discovery of gold ore drew in herders and their livestock from outside the Ireedui PUG area. A number of herders also volunteered that either artisanal or company mining had impacted mobility patterns in their local areas, or that the opportunities that mining presented affected mobility choices:

'*Many herders who lost all their animals in the last* dzud *are now doing artisanal mining here in Ulziit. Some people have come from outside the* soum *to do this*.' (PUG, Ulziit *soum*, Omnogobi *aimag*, 15 years herding)

The presence of large international mining companies also influenced mobility choices for some herders. Firstly, mining companies offered employment opportunities to herders registered within the *soum*.

'*The population of our* soum *has increased drastically since the Oyu Tolgoi* [mining] *project. Some* [people came] *to work at the mine.*' (Law on Land, Khanbogd *soum*, Omnogobi *aimag*, 30 years herding)

Secondly, a large mining company in Tsogtseggi *soum* provided free fodder during the 2009/2010 *dzud* to herders registered within the *soum*. These combined to create a 'pull' factor for some herders, drawing them into the area. One herder household was interviewed in Tsogtseggi *soum*, Omnogobi *aimag*, but was registered in the north of Dundgobi *aimag*. They were so mobile that they had not returned to their registered winter/spring camp since 2007. They had suffered significant livestock losses during the 2009/2010 *dzud* (from 700 to 100 head). As a consequence:

‘*We moved to Tsogtseggi* soum *[*in Dundgobi *aimag] because the* [mining] *company here has been giving away free things – my wife is now in Dundgobi trying to transfer our registration papers to this soum… This year our kids are going to school in Tsogtseggi, which is possible because the* soum *government has an* otor *agreement*.’ (Law on Land, interviewed in Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding).

Mining activities had also affected mobility choices amongst herders by excluding them from available pasture. Whilst large proportions of the Mongolian Gobi Desert are covered by mining leases, the area of pastureland affected by active mining is unclear. One herder stated that a frequently visited summer area was no longer available to them due to the presence of a mine, and that a lack of effective bureaucratic institutions governing rights to summer pastures meant that they could not be compensated for a loss of access to the resource:

‘*Our summer camp now has mining in it because we couldn’t prove that that area belonged to us. It’s difficult because herders must move but we need to be able to prove to mines that that area belongs to us*.’ (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding)

One herder household sold livestock to a mining camp at a price that was higher than what they could source elsewhere (Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding) (also see Chapter 7), but there was no evidence that the ability to sell livestock to a mining camp had influenced the mobility patterns of this or any other household.

Nevertheless, herders generally preferred to be in their winter/spring camp registered under the Law on Land than an area to which they did not have bureaucratic rights. Herders gave a variety of reasons for this preference. These included the ‘comfortableness’ of their larger winter *ger* and the more substantial furniture that they often stored at their registered winter/spring camp. The need to rent another’s camp or face the prospect of being ‘chased away’ were other important reasons for returning to their registered camp; in addition, herders said that livestock were more ‘used’ to the registered camp, reducing the labour required to manage their movements. This was important as:

'*Labour is an issue when deciding when/where to move – if there's only one adult in the family it is difficult to move*.' (Law on Land, Manlai *soum*, Omnogobi *aimag*, 25 years)

Despite these factors, herders still preferred to be in their registered *soum* than another *soum*. They were more likely to have family and friends in their registered *soum*, preferred to be near them if water and pasture were available, and to stay as close as they could to their registered winter/spring camp. These preferences were enhanced by the additional expense and inconvenience associated with accessing services such as medical treatment outside of one's registered *soum*, as noted by two herders during interviews (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding; Law on Land, Manlai *soum*, Omnogobi *aimag*, 25 years herding).

6.7 Socially embedded institutions and the potential for feed gaps

The interviewed herders had a common understanding of what was, and was not, appropriate behaviour for accessing the forage resource. Table 6-3 lists the norms, shared strategies and rules of herders that defined appropriate behaviour for accessing the forage resources, as summarised from the interview data described above. The table splits the different herder understandings into the components suggested by Crawford and Ostrom (1995) to highlight the institutional components of each, and to guide discussion.

Table 6-3 Shared strategies, norms and strategies governing access to the forage resource in the Mongolian Gobi Desert. Institutional components are defined as per Crawford and Ostrom (1995). Attribute = who the rule applies to. Deonic = type of permissibility. Aim = action or outcome. Condition = when/where the action is regulated. Or else = consequence of rule-breaking. Institutions have been ascertained through interviews with herders.

Institution	Attribute	Deonic	Aim	Condition	Or else	Relative likelihood of feed gaps[a]
Rule 1	Herders	Must not	Graze their livestock	Outside their *soum* (that is, herders outside the *soum* in which they are registered, or are not registered in but may have birth or familiar rights to that are recognized by their peers).	They may be 'chased away' by other herders.	Moderate to high (without negotiation, herders stay within their low forage *soum*) Low (with negotiation, herders can move outside *soum*)
Rule 2	Herders	Must not	Use	A winter/spring shelter that is recognised as belonging to another herder through the Law on Land or through historical precedence.	The registered herder may 'chase them away' if discovered.	Low (but livelihood implications for herders without rights to a shelter)
Rule 3	Herders	Must not	Graze their livestock	Within a few kilometres of another herder's registered winter/spring camp area.	The registered herder may 'chase them away' if discovered.	Low (but livelihood implications for herders without rights to a shelter)
Norm 1	Herders	May	Graze their livestock	Wherever forage is available during summer/autumn. 'First in, first served'. Administrative boundaries other than the *soum*, such as Strictly Protected Areas, can be breached, as long as this does not then override other rules in this table. Rule #1 overrides this norm.	-	Low
Rule 4	Herders	Must	Graze their livestock	At a distance as far from another herder's *ger* as the forage allows so that herds do not become confused, or the forage within a few kilometres of the *ger* is quickly consumed.	The pre-established herder may 'chase them away'.	Low
Norm 2	Herders	May	Graze their livestock	Within a few kilometres of a *soum*/*aimag* centre at any time of year	-	Moderate to high in the area immediately adjacent to a *soum/aimag* centre
Rule 5	Herders	Must	Allow access of any livestock	To permanent water points.	They will be 'frowned upon' if discovered not allowing access.	Moderate to high in the area immediately adjacent to a water point.

Shared strategy 1	Herders	Must	Maintain mobility	In response to forage variability, to the best of their financial ability. Herders with fewer livestock, or specific reasons for reduced mobility (such as the desire to be near the *soum* centre where children are at school), may be less mobile.	-	Low
Rule 6	Herders	Must not	Graze	Winter or spring pastures at times other than winter or spring. It is more acceptable for herders with few livestock to graze winter/spring pastures than those herders with more livestock.	They may be 'frowned upon'.	Low to moderate
Norm 3	Herders	May	Split	Households, with livestock being pooled and one household being freed up for other activities	-	Low
Norm 4	Herders	May	Share	Registered winter/spring camps with other herders	-	Low to moderate
Norm 5	Herders	May	Rent	Winter/spring camps from absent herders with rights to that camp under the Law on Land	-	Low

[a] Likelihood of feed gaps assumes that herders adhere to the institution in question, that stockings rates and dynamics are at present levels and that there are not alternative tools for managing feed gaps

Most of the institutions listed Table 6-3 are classed as rules. The first four rules are highly flexible. They can generally be acceptably overridden with herder-to-herder negotiations, particularly during *dzuds* or bad years.

Crawford and Ostrom (1995) generally require that for an institution to be a rule, "*a collective decision must have been made in a relevant collective-choice arena to determine the consequence.'* The rules in Table 6-3 were not designed by collective choice. However two other requirements are fulfilled to varying degrees. The first is the sanction of social stigma. A secondary sanction in the first rule is that a lack of negotiation /strong enforcement of the rule may decrease the ability of the prohibiting herder to access distant pastures during the next bad year in their own *soum*. A similar sanction against herders denying other herders access to water during future bad years may be evident in the fifth rule.

The second requirement is the presence of a monitor. In the examples provided in Table 6-3, monitors 'chase away' rule-breakers. Shared strategies or norms do not have such a sanction but at times these rules may be better classed as norms as the strength of the 'or else' sanction changes through time and space with the shifts in forage availability/variability described in Chapter 4. The presence/absence of monitors is also problematic. In Law on Land systems, monitors tend to be herders with pre-established rights over the forage in question rather than any other herders. This is an issue that PUGs have attempted to address through collective action/sanctioning, with the 'or else' sanction in the second and third rules possibly being stronger in PUG areas than Law on Land areas. However the overriding need for herder dispersal during bad years, discussed in Section 4.3.2, challenges the efficacy of monitors who are also local herders.

If adhered to, these socially embedded institutions generally produced a low livelihood of feed gaps. An exception was the areas surrounding key resources such as waterpoints or settlements. Indeed, Sasaki *et al*. (2011) demonstrated biophysical change around waterpoints in desert steppe areas. Socially embedded institutions were better aligned to the forage availability and variability described in Chapter 4 than the bureaucratic institutions. Consequently, the likelihood of feed gaps was slightly lower in socially embedded institutional settings than those found across Mongolian bureaucratic institutional settings.

6.8 Summary and Discussion

The territoriality model shown in Figure 2-1 predicted that a greater degree of flexibility in movement is observed where forage distribution (modelled in Chapter 4) is unpredictable. This was largely supported by the socially embedded institutions described in this chapter. Murphy (2011) and Upton (2012) found that only herders with high levels of financial and social capital could *otor* in desert steppe sites, meaning that the Figure 2-1 model would not be realized. In this thesis, there did not appear to be a substantial difference in livestock wealth between herders that left the *soum* during the last bad year, and those that did not. However some herders stated that labour limitations (an indicator of low social capital) may have reduced the mobility of some households. Regardless, Mearns' (1993) statement that "*the period of decollectivisation and postsocialist economic transition has seen the partial return to patterns of territorial behavior more directly influenced by ecological factors and less by public policy*" appears to still hold in the Mongolian Gobi Desert.

Whether the socially embedded institutions of Table 6-3 can be classed as norms or rules governing access to the forage resource is unclear due to the potentially weak 'or else' sanction. It is also likely that the 'or else' sanction varies in strength between seasons and years as forage availability changes (see Chapter 4), with the 'or else' sanction being stronger during bad years. PUGs have attempted to increase the strength of the socially embedded 'or else' sanction (see Chapter 5). There is some indication that they may have been successful with this in gobi-like PUGs when the forage resource was more at equilibrium (see Chapter 4); a number of PUG members stated that one PUG institution was preventing other herders from accessing the winter/spring pastures belonging to members. However the practical ability of herders to monitor and police this institution, particularly during bad years, was not further explored: it may be that this institution is only monitored and policed sporadically.

Upton (2012) found that during times of climatic stress in a steppe-like PUG, herders reverted from group to family networks for support. One herder argued that 'nukhurlul [a form of PUG] *can work together in the better times, but may be it is better for each of us to focus on our own work in difficult conditions.'* The devolution from a spatially confined, collectivist livelihood strategy to a spatially dispersed, individualist livelihood strategy during stochastic stocks is predicted by the model shown in Figure 2-1. In these circumstances, PUGs may be useful for strengthening collectivist or socially embedded institutions in good years, but may provide little benefit during bad years or during periods of livelihood shocks. Given that the forage resource is in surplus during good years (see Chapter 4), the strengthening of institutions during good forage years may have little impact on feed gaps and forage overutilization.

Mearns (1993) noted that periods of rapid socio-political change can reduce the relative cost to a herder of not adhering to norms. High rates of internal migration can reduce the likelihood that a herder may twice meet a herder upon whose winter/spring pastures they have trespassed. The secondary 'or else' sanction of a herder being denied access to winter/spring pastures may be weakened by rapid herder turnover. Migration also reduces the number of herders available to sanction the trespasser. Social stability may be important for cementing the evolution of post-*negdel*, socially embedded institutions and resolving issues of conflict between herders. The importance of this stability may have been under recognised by those proposing new, bureaucratic institutions in Mongolia.

Other factors can also change the relative defendability of the forage resource. Increased levels of poverty increase the relative benefit of accessing a pasture in comparison to the potential social stigma cost (Mearns 1993). This can encourage the breaking of socially embedded institutions. Structural adjustment associated with poorer herders leaving the pastoral system after stochastic shocks, like *dzuds*, may similarly reduce rule-breaking of socially embedded institutions over time. However, local elites are less likely to suffer from social stigma due to their good connections to government and ability to provide herders with social security during times of stress (Murphy 2011). Factors such as these can transform the mobility patterns predicted by Figure 2-1.

In contrast to the relatively high levels of conflict between herders found in higher precipitation areas of Mongolia (e.g. Fernandez-Gimenez and Batbuyan 2004; Murphy 2011), levels of unnegotiable conflict in the Mongolian Gobi Desert were found to be low to moderate. It is possible that the reluctance of herders to discuss conflict may have influenced responses, a factor also noted by Murphy (2011). However, Dyson-

Hudson and Smith (1978) noted that East Africa herders engaged in conflict only in times of extreme forage shortage, when their individual survival would be jeopardized by sharing the forage resource. The higher level of conflict in bad years found in this research concurs with this finding, and suggests that the forage resource is not usually in severe shortage in the Mongolian Gobi Desert. However, see Chapter 9 for the contrasting perspective of herders.

Chapters 5 and 6 explored the ways in which bureaucratic and socially embedded institutions can interact with climatic variability to affect feed gaps. In situations where institutions make feed gaps worse, alternative tools can mitigate this risk. This thesis now explores the non-institutional tools that herders use to manage forage variability, as well as other types of volatility that may affect herder livelihoods.

7 Managing Risks

7.1 Introduction

Gobi Desert pastoralism is affected by a variety of stresses and shocks. The unpredictable climatic variables shown in Chapter 4, such as very low temperatures or low precipitation levels, are important examples of shocks. As well as affecting herder livelihoods, feed gaps associated with climatic variability can also contribute to overutilization of forage in the short term and declines in rangeland condition in the longer term. Social, political, and economic stresses and shocks also create risk. Each of these stresses and shocks occurs at a variety of spatial and temporal scales, interact in different ways, and can create or modify production and price risk.

When making decisions about herd management, herders consider the likelihood of different forms of risks occurring, and estimate their probable severity based on prior experience, 'word of mouth' or government reports. The relative costs and benefits of options for reducing the impact of short-term feed gaps are considered by herders within the constraints of these social, political and economic variables. Risk management options are also considered in relation to sometimes competing aims, such as the desire for food security versus the need to generate cash to pay for medical bills and the education of children.

Broad-scale social, political and economic factors can further constrain or promote options for managing feed gaps through their interaction with bureaucratic and socially embedded institutions. Socially embedded institutions evolve in response to uncertainty. Bureaucratic institutions are engineered in an attempt to assist herders manage the risks produced by uncertainty, and for a variety of other reasons (see Murphy 2011). Changes in socially embedded institutions regulating access to pasture can increase or decrease the reliance of herders on other tools for managing the risk of feed gaps. Socially embedded institutions can be ineffective at managing risks that are generated at broader scales. Understanding the social, political and economic factors that affect the ability of herders to manage risk, and the relationship between these factors and bureaucratic institutions, can therefore explain why some bureaucratic institutions have lower levels of 'rule-breaking' than others. It can also highlight what factors are most likely to reduce the risk of overgrazing, and potential declines in rangeland condition.

This chapter focuses on some of the key tools available to herders for managing the risk of feed gaps, allowing them to maintain a herding livelihood in the short and medium term. Gobi Desert pastoralism does not have a fixed or impermeable spatial, economic or cultural boundary (Mearns 2004). Options for managing risks to herder livelihoods can come from outside the immediate pastoral sector. Two examples of this include flows of resources, such as those that culturally obligate kin in urban and rural areas (Mearns 2004; Sneath 2006), and the two-way mobility of herders between the pastoral and non-pastoral sector with changes in natural and/or social capital (Fernandez-Gimenez 1999). These options are outside the scope of the thesis. Mobility was discussed in Chapters 5 and 6. The use of supplementary fodder, herd management, financial tools and government/non-government agency support, are now discussed in relation to their relative availability, affordability, uptake and efficacy through time and space. Particular emphasis is given to the relationship between risk management tools and the forage variability described in Chapter 4.

7.2 Fodder

Supplementary fodder was considered by herders to be an important tool for managing feed gaps in all three institutional settings. This belief was supported by empirical data from a steppe region that found that households that fed their livestock hay lost a smaller proportion of their herds during *dzud* (Fernandez-Gimenez *et al*. 2012). In the Mongolian Gobi Desert, this tool was used during winter/spring when forage availability was lowest and mobility was physically difficult. The ability of herders to collect and store fodder in preparation for the winter and spring period depended upon both climatic conditions and socioeconomic factors at the level of the household. Market prices and availability were additionally constrained the accessibility and affordability of commercial fodder.

7.2.1 Self-prepared

Mongolian herders either prepared their own fodder or purchased it, depending on local forage availability (Table 7-1). Whilst the frequency of fodder use was high amongst Mongolian herders, the volume of fodder fed to livestock was relatively low as a proportion of the yearly feed consumed by herds. To put Table 7-1 into context, small livestock (goats and sheep) in Mongolia consume about 1 kg of dry forage a day (Retzer 2007). The average percentage of dry matter of desert vegetation is 70 – 90% (Erdenbileg and Stewart 2006). Assuming an average herd size (see Table 3-5), the supply of fodder described in Table 7-1 therefore equates to only about 7 – 10 days of dry matter per head of livestock if fed exclusively.

Table 7-1 Weight of fodder and/or hay prepared or purchased by Mongolian herders during the last good or bad year, per household per year

	Purchased (kg)	Prepared (kg)	Total (kg)
Good year	820[A] (n = 10)	1984 (n = 28)	2804
Bad year	2006 (n = 15)	537 (n = 32)	2543

[A] Estimated per household weight of fodder prepared or purchased by Mongolian herders during the last good or bad year. Weights are estimates and are for comparative purposes only as units given by herders varied and had to be standardised, and individual weights may include either wet or dry weights.

In a good year, about 29% of fodder by weight was purchased and 71% was prepared. In a bad year, this ratio reversed with about 79% being purchased and 21% being prepared. In good years, Mongolian herders routinely collected fodder during the vegetation growing season (particularly in August at peak biomass, see Chapter 4). This was in preparation for winter/spring when forage availability was low. Valued species with high levels of protein, such as *Allium polyrhizium* Turcz. ex Regel, and other species such as *Artemisia* spp. and *Atriplex sibirica* Linnaeus (Figure 7-1), were collected by hand or with a scythe. Alternative fodder sources were also used, with one herder stating that:

‘*We can use tea and horse dung to feed animals. The horse dung is very good fodder for livestock.*’ (Law on Land, Sevrei *soum*, Omnogobi *aimag*, 30 years herding)

Figure 7-1 Stored, self-prepared fodder (left) and a fodder crop that was cultivated with the assistance of irrigation (right). Khanbogd and Bulgan *soums*, Omnogobi *aimag*. August 2010.

Some herders were also able to cultivate Chenopodiceae or Fabaceae species with the aid of irrigation established with funding from a non-government organisation (Figure 7-1). Irrigated fodder production in 9-Erdene PUG was described as follows:

'*We established a water pipeline and dripped water to the water tank that is used for watering animals. This was established through the herder group named 9-Erdene. That water tank has a capacity of 25 tonnes, but on really hot days it is not enough to water all animals. In autumn there is one family that stays here and uses the water. They are not from our herder group but if we have some water, we have to share. My family, as a member of this group, stays here when the pasture is available to look after all these facilities. Because we need to plant forage plants we cannot move too far from here.*' (PUG, Bulgan *soum*, Omnogobi *aimag*, 30 years herding).

Self-preparation of fodder was more common in good years than bad years due to the greater availability of forage. The reduced ability of herders to self-prepare fodder in bad years, and financial constraints at the level of the herder household, probably accounts for why herders were able to obtain more fodder in good years, when they had lesser need for it, than bad years (Table 7-3).

Apart from affordability, there were a number of other reasons why herders preferred to prepare fodder themselves rather than purchase it commercially. Several herders reported that the advertised weight of commercial fodder was often greater than the actual weight, with a Law on Land herder stating that in 2009/2010, '*some packets were*

12 – 15 kg [but were supposed to be 20 – 25 kg] – *when I weighed them, they were always underweight'* (Manlai *soum*, Omnogobi *aimag*, 10 years herding). Another herder stated that *'I don't like to buy fodder because it may have infections. The grasses on the market are low quality and they cost a lot*.' (Law on Land, Sevrei *soum*, Omnogobi *aimag*, 30 years herding)

Ninety-five percent (n=42) of Mongolian herders prepared fodder in years that they described as good, a figure that did not vary between PUG and Law on Land herders. The weight of fodder prepared by herders in the last good year was difficult to quantify due to variation in units – the number of Russian vans' worth of fodder was a common unit used. If one Russian van carries 1 tonne of fodder, the average Mongolian herding household prepared 1984 kilogrammes of mixed fodder (wet or semi-dried weight) in the last good year.

Some herders were able to prepare fodder in a bad year:

'*I prepared* [fodder] *by myself when I went to pasture my livestock. I collected 5 kg of grass on the way back home. Little by little I prepared fodder and put it into the bags and stored it in a pin* [storage shed]. *The* Elymus *sp. we cut and collected here*.' (Law on Land, Sevrei *soum*, 30 years herding)

It was common for herders to state that they did not prepare fodder in a bad year:

'*We could not prepare* [hay] *because there was no grass*.' (Law on Land, Manlai *soum*, Omnogobi *aimag*, 10 years herding).

In bad years, 29% of Mongolian herders (n=34) prepared fodder. This is less than the proportion of herders in steppe and mountain-steppe sites who prepared fodder during the bad year of 2009/2010 (28 – 56%) (Fernandez-Gimenez *et al.* 2012). The likely reason for this difference is that the lower levels of forage availability in the Mongolian Gobi Desert altered the cost/benefit ratio of collecting and storing fodder.

Unlike in good years, there was a difference between the proportion of PUG and Law on Land herders that prepared supplementary fodder in bad years. Only 12% of Land on

Land herders prepared fodder in the last bad year (n=17), whereas 47% (n=17) of PUG herders prepared fodder. Due to low forage availability (see Chapter 4), households that prepared fodder in a bad year prepared only 537 kg (n=17) of fodder, but this figure was not representative of all herders. Five of the six Mongolian herders that prepared fodder in the last bad year were PUG herders from along the more productive Gobi Gurvan Saikhan Strictly Protected Area, rather than in Ulziit PUGs. Two of these were able to prepare fodder using the irrigation system established by the 9-Erdene PUG (described earlier). They prepared an average of 2,583 kg each (n=6). This figure is larger than the average amount prepared by all Mongolian herders in a good year. Gobi-like PUG members were not more likely to prepare fodder than Law on Land herders.

7.2.2 Commercial

Commercial fodder was often available in the Mongolian Gobi Desert as an option for herders to fill feed gaps. This fodder generally came from northern Mongolia, but in 2009/2010 some herders reported that Chinese fodder was available for the first time. It is unclear whether this was because demand rose whilst supply stayed fixed, or if fodder production in northern Mongolia had been compromised by the same factors that created the bad year in the Gobi Desert. Whilst translation issues made it difficult to elicit the exact nature of the commercial fodder, Chinese fodder was probably corn, or wheat husks (translated as '*residues of wheat left after processing'*). Mongolian fodder was often wheat residue (*bagsarmal,* translated as '*wheat and grass residues'*) (Figure 7-2).

Figure 7-2 Commercial livestock feed. Ulziit *soum*, Dundgobi *aimag*. October 2010. Photo: Margaret Friedel.

Whilst Mongolian herders preferred self-prepared fodder, commercial fodder was still seen as an important tool for managing feed gaps, particularly in bad years. Only 38% of herders (n=37) purchased fodder in a good year. This was probably due to the larger amount of self-preparation that was possible and the lesser need for it given the warmer temperatures of bad years (see Section 4.2.2). The proportion of PUG herders that purchased fodder in a typical good year was higher than Law on Land herders, 59% (n=16) cf 20% (n=21).

All Mongolian herders who responded to questions about fodder (n=36) said that they had purchased fodder during 2009/2010, the last bad year. A similar proportion of herders purchased fodder during 2009/2010 in steppe and mountain steppe areas (Fernandez-Gimenez *et al*. 2012). This suggests that the supply and accessibility of commercial fodder during bad years may have a significant impact on how well Mongolian herders can meet feed gaps at key times. In contrast, commercial fodder is less important during good periods, with herders pragmatically preparing fodder from available forage as a form of insurance, and when the relative benefits of preparation outweigh the costs.

Some herders gave the quantity of fodder that they had purchased in terms of tugrik, whilst others gave the figure in kilogrammes or packets of fodder purchased. Approximately 435,714 tugrik per household was spent on fodder during the bad year of 2009/2010 by herders that gave fodder quantities in terms of tugrik, whilst about 2006 kg of mixed grass/protein fodder was purchased by herders stating quantities by weight. The tugrik value equated to about 3 months of the average monthly earnings for someone working in the agriculture, hunting and forestry sector in 2009 (National Statistical Office of Mongolia 2010). In general, the demand for fodder during the last *dzud* lasted for about 5 to 6 months. This pattern appeared to be similar between *soum*s. For example, fodder was purchased from November to May in Manlai and Tsogtseggi *soum*s. In '*May the animals were still weak so we had to give fodder. Starting from the end of May they could graze by themselves'* (Law on Land, Manlai *soum*, Omnogobi *aimag*, 10 years herding).

7.2.3 Availability and accessibility issues

During the *dzud* of 2009/2010, when feed gaps were significant, herders stated that they would have preferred to have purchased more fodder than they did. A lack of commercially available forage in the market during times when forage was most needed was a constraint to the use of commercial fodder for managing feed gaps. However it is unclear whether there were supply constraints or whether demand was low due to the inability of herders to afford it.

In the Dundgobi *aimag* centre, Mandalgobi, fodder was available for sale during most months in the period from January 2007 to June 2010 (secondary data sourced from Media for Business, 2010). However it was unavailable in Mandalgobi during January 2010, a key period when it was needed (see Chapter 4 regarding the low forage availability in Dundgobi *aimag* during this period). In this case, a lack of commercial fodder directly contributed to herders being unavailable to manage climatic shock.

The Omnogobi *aimag* capital of Dalanzadgad had a less reliable supply of fodder than Mandalgobi. Fodder was unavailable at the market in Dalanzadgad for about 57% of the weeks (n=168) between January 2007 and June 2010. Commercial fodder was usually available over winter and spring when feed gaps and demand were greatest, and absent during summer and autumn. Given that fodder is usually harvested at the end of autumn during peak biomass (see Chapter 4), the absence of commercial fodder during warmer months probably reflects a lack of demand during this time rather than supply constraints. An important exception was January 2010, the *dzud* period, when no commercial fodder was available. Unavailability during this period probably reflects supply constraints, despite high demand.

Other supply constraints were present during this the 2009/2010 *dzud*. Despite the availability of fodder in the *aimag* centres, the accounts of herders suggest that fodder was often unavailable in the *soum* centres where herders preferred to purchase fodder; '*towards the end* [of the *dzud* spring] *the fodder got less available*' (Law on Land, Manlai *soum*, 25 years herding). Herder accounts of shortages were widespread across *soum*s, including Bulgan (PUG, Bulgan *soum*, Omnogobi *aimag*, 15 years herding), Bayandalai (PUG, Bayandalai *soum*, Omnogobi *aimag*, 25 years herding) and Manlai (Law on Land, Manlai *soum*, Omnogobi *aimag*, 25 years herding). This research did not ascertain the reason for distribution problems. However such distribution problems may provide an incentive for herders to move closer to *aimag* centres to better access resources, exacerbating conflict or feed gaps around those areas.

7.2.4 Fodder prices

Fodder prices were generally higher in winter/spring during times of peak demand when natural forage availability was lowest (Figure 7-3; Figure 7-4). An exception was prices during the post-*dzud* period of 2010. Official fodder prices supported herder accounts that prices were particularly high in the *aimag*s during the *dzud* period when compared to other times of the year, or other years. There was also an overall trend towards increasing prices between January 2007 and May 2010, regardless of season.

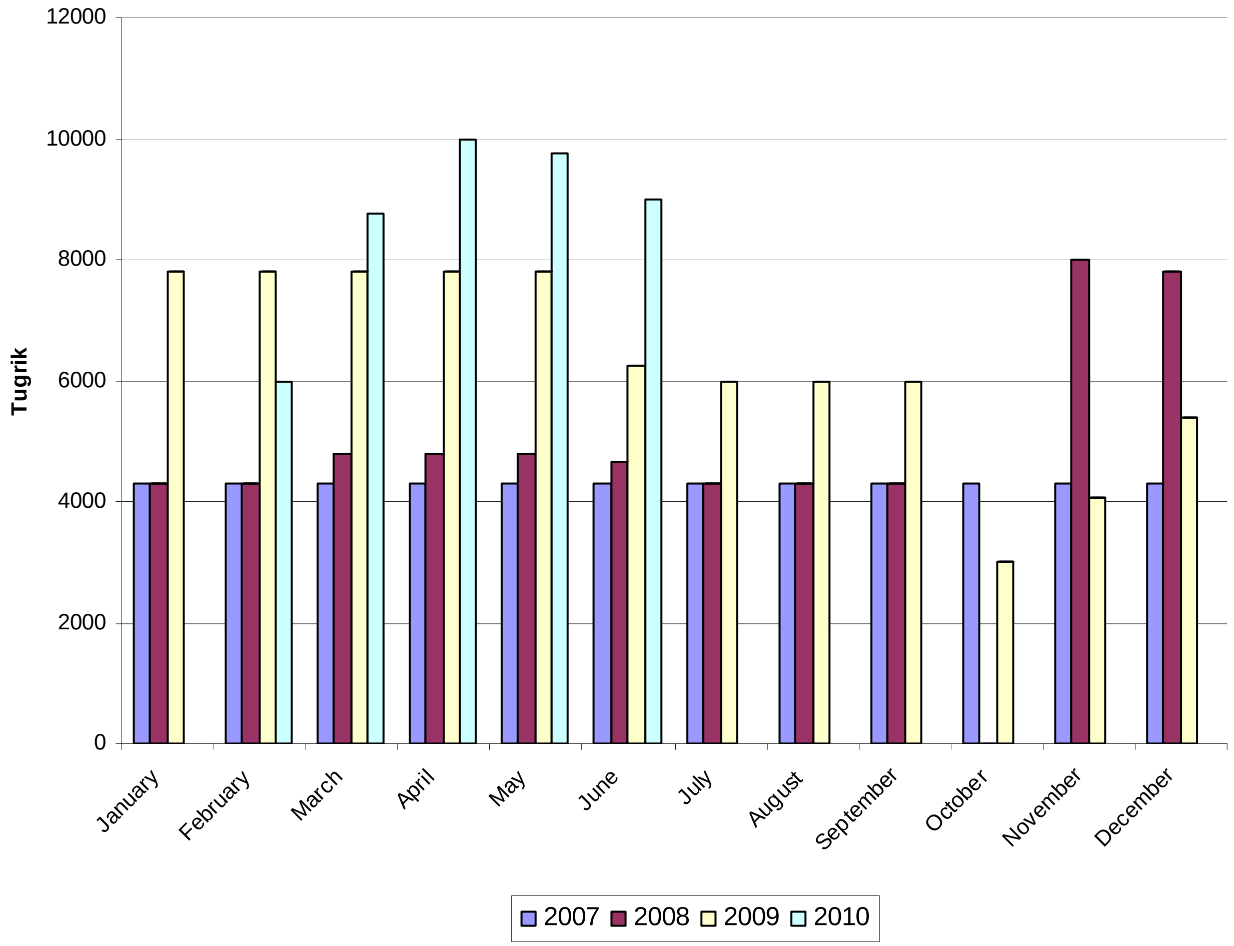


Figure 7-3 Average Dundgobi *aimag*, unsubsidised fodder prices 2007 – 2010 (data sourced from Media for Business, 2010). Prices are in Tugrik per 25 kg packet. Missing data implies that fodder was not available in the market during the month. Data was sourced until June 2010.

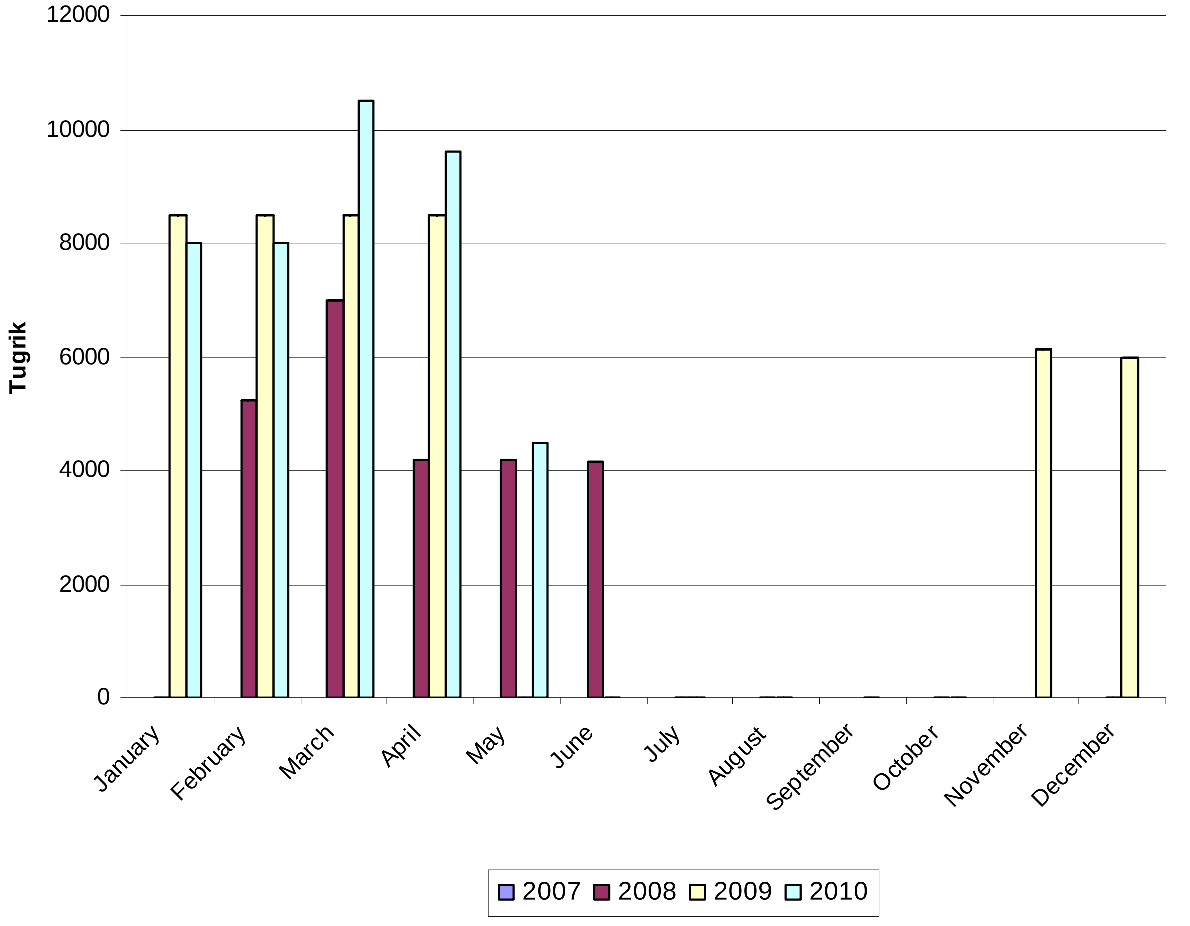


Figure 7-4 Omnogobi *aimag*, unsubsidised fodder prices 2007 – 2010 (data sourced from Media for Business, 2010). Prices are in Tugrik per 25 kg packet. Missing data implies that fodder was not available in the market during the month. Data was sourced until June 2010.

Most Mongolian herders purchased fodder in their local *soum* centre. Only two herders volunteered that they had purchased fodder in their *aimag* centre rather than their local *soum* (Law on Land, Ulziit *soum*, Dundgobi *aimag*, 30 years herding and PUG, Bulgan *soum*, Omnogobi *aimag*, 30 years herding). Another stated that they had fodder delivered from the *aimag* directly to their *ger*. Prices that herders said they were paying for fodder in the *soum* centres during the *dzud* tended to correlate with the *aimag* prices provided by Media for Business (2010). Prices in *soum* centres did not appear to include a significant mark-up in price when compared to prices in *aimag* centres, and prices fluctuated in similar ways to *aimag* prices, with increases in winter and spring:

'*In a good year fodder is usually 2,500-3,500T, a maximum of 5,000T. During the* dzud*, the market price was 5,000T at the beginning of winter, increasing to 10,000T per packet*.' (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding).

In addition to the belief that '*forage was in deficit'* during critical periods (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding), commercial fodder was often considered to be expensive, sometimes prohibitively so. Herders often believed that their longer-term food security depended upon the purchase of fodder. Consequently, they went to great lengths to pay for what fodder was available during the last *dzud*:

'*Because we were in need, we had to buy it one by one. Even though it was expensive, we had to buy it. If it were available and cheaper, of course we would have bought more*.' (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding)

Some herders created income for fodder from livestock as they died during the 2009/2010 *dzud*. Hides were sold opportunistically to purchase fodder. A sheep skin could earn 2,000T – 5,000T (about one packet of fodder) whilst a goat hide could earn 14,000T – 15,000T (Law on Land Sevrei *soum*, Omnogobi *aimag*, 30 years herding). Many herders also went into debt to purchase fodder.

Government subsidies for fodder during the 2009/2010 *dzud* dampened price volatility across all *soum*s. One herder in Tsogseggi *soum* stated that, in a bad year, a packet of hay normally cost 8,000T – 12,000T at the market, while a packet of protein costing 8,000T – 15,000T (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding). *Soum* government subsidies during the 2009/2010 *dzud* reduced this to 4,000T and 5,000T, respectively, a price that was not dissimilar to the prices in good years. There was minor variation between *soum*s, with a Mandal-ovoo *soum* herder stating that a packet of protein in a bad year normally cost them 6,000T, with a government subsidy during the 2009/2010 *dzud* reducing this to 3,000T (Law on Land, Mandal-ovoo *soum*, Omnogobi *aimag*, 30 years herding). A Sevrei *soum* herder stated that the market fodder price during the *dzud* was 12,000T per packet, with the subsidized price being 4,000T – 5,000T per packet (Law on Land, Sevrei *soum*, Omnogobi *aimag*, 8 years herding).

Many herders stated that subsidized fodder was limited in quantity. One Bayandalai *soum* herder stated that '*we were only allowed two to three packets of hay and two packets of protein'* (PUG, Bayandalai *soum*, Omnogobi *aimag*, 30 years herding). Subsidised fodder allowances were dictated by the number of livestock that each herder had in Bayandalai *soum*. In Bulgan *soum*, one herder (PUG, Bulgan *soum*, Omnogobi *aimag*, 30 years herding) stated that at the beginning of the *dzud* there were limits on the amount of subsidized fodder available to each herder household. However each household in Bulgan *soum* was allowed a set amount of fodder, regardless of how many livestock they owned. Later on in the *dzud*, the limits were lifted as more commercial fodder was made available and support depended upon the number of animals per family. A herder in Manlai *soum* said that families with 50 livestock were allowed one packet of protein feed, with families with more than 100 livestock allowed two packets. This figure was fixed, irrespective of the relative number of pregnant females in the herd (Law on Land, Manlai *soum*, Omnogobi *aimag*, 10 years herding). Some herders with larger numbers of livestock stated that this was unfair, but in general there were few complaints about the way in which free fodder was distributed. Whilst a number of herders stated that they would have purchased more subsidised fodder if it had been available, it is unlikely that most herders had the financial capacity to purchase the quantity of fodder required to have prevented widespread livestock mortalities.

The high demand for commercial fodder in Mongolia during the 2009/2010 *dzud* can be explained by the additional need to feed weakened livestock that would be considered strong in other years:

‘*We do not* [usually] *buy forage for mature livestock. The young have to be fed* [forage] *in the morning and evening. The matured ones* [usually] *go for grazing but* [during the *dzud*] *were weak so we had to give them extra protein… In May the animals were still weak so we still had to give them fodder. Starting from the end of May they could graze by themselves*.’ (Law on Land, Manlai *soum*, Omnogobi *aimag*, 10 years herding)

Young and weak livestock were preferentially given fodder over stronger livestock in Mongolia. Herders stated that this was largely because stronger livestock were able to access forage over the winter period in years when the standing dead/senescent vegetation remained from the previous growing period and was not covered by deep snow. The desire to reduce overall livestock mortalities to maintain the herd size (see Section 7.3, below) may have also contributed to the decision of herders to prioritize fodder use in this way.

Herders were not specifically asked about the number of livestock that they had lost over the 2009/2010 *dzud* (see Chapter 3 for the reasons). The data collected cannot directly link the use of fodder by individual households and mortality rates but a small number of herders volunteered both mortality figures and fodder use. As well as the irrigated fodder of the 9-Erdene PUG, some Bulgan *soum* herders along the Gobi Gurvan Saikhan Strictly Protected Area buffer zone also received free fodder from the Institute for Animal Husbandry in exchange for grazing the Institute’s livestock (PUG, Bulgan *soum*, Omnogobi *aimag*, 25 years herding). Despite these advantages, one PUG herder with access to irrigated fodder had a herd of 1,000 prior to the *dzud*, and 700 after the *dzud*, a 30% loss (PUG, Bulgan *soum*, Omnogobi *aimag*, 30 years herding). The reason she gave for this was ‘*in cold weather even the fat and strong livestock could not go to graze, I’m not talking about newborns and two year olds. We used all our resources of grass and fodder’* (PUG, Bulgan *soum*, Omnogobi *aimag*, 30 years herding).

A nearby PUG herder stated that they had a 50% loss (400 to 200 head) (PUG, Bulgan *soum*, Omnogobi *aimag*, 15 years herding). One herder stated that ‘*families that had 1,000 livestock now have 500 to 600, families that had 400 now have 100, and families that had less than 400 livestock now have none*’ (PUG, Bulgan *soum*, Omnogobi *aimag*, 25 years herding). These herd losses equate to 40 – 50%, 75% and 100%, and compare to the 54% figure stated as being the *soum* average (Bulgan *soum* official). One herder, in a gobi-like landscape and without support from an organisation such as the Institute of Animal Husbandry, volunteered information on their high livestock loss (250 to 26, a loss of about 90%) (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding). This herder stated that they had not been able to prepare fodder during the bad year, but they purchased 250,000T worth of fodder during the last *dzud*. This figure was lower than the amount that other herders with comparable herd sizes stated they had spent. This may have contributed to the high mortality rate of herds but it cannot be definitely said without knowing more about their herd management. These figures, in total, suggest that a herder household's ability to prepare, or freely access, significant levels of fodder in the last bad year may have reduced mortality rates, but did not remove the risk of livestock deaths altogether.

7.3 Herd management

7.3.1 Selling, culling, and breeding

Culling or selling livestock were options cited by some Mongolian herders for managing expected feed gaps in the short term. Whilst some herders waited for the death of livestock to sell their hides to buy fodder for remaining livestock (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding), others pre-empted feed gaps:

'[If we think the winter will be bad] *we will slaughter and sell* [some livestock] to *buy some fodder. We will try to keep the strong ones.*' (Law on Land, Tsogtovoo *soum*, Omnogobi *aimag*, 30 years herding).

Culling/selling was usually done at the end of autumn, despite the Omnogobi *aimag* prices being relatively low at this time (Figure 7-5). The lower and less volatile Dundgobi *aimag* prices may reflect the greater access of herders to the Ulaanbaatar market, which is both larger and more competitive than the markets of either *aimag*.

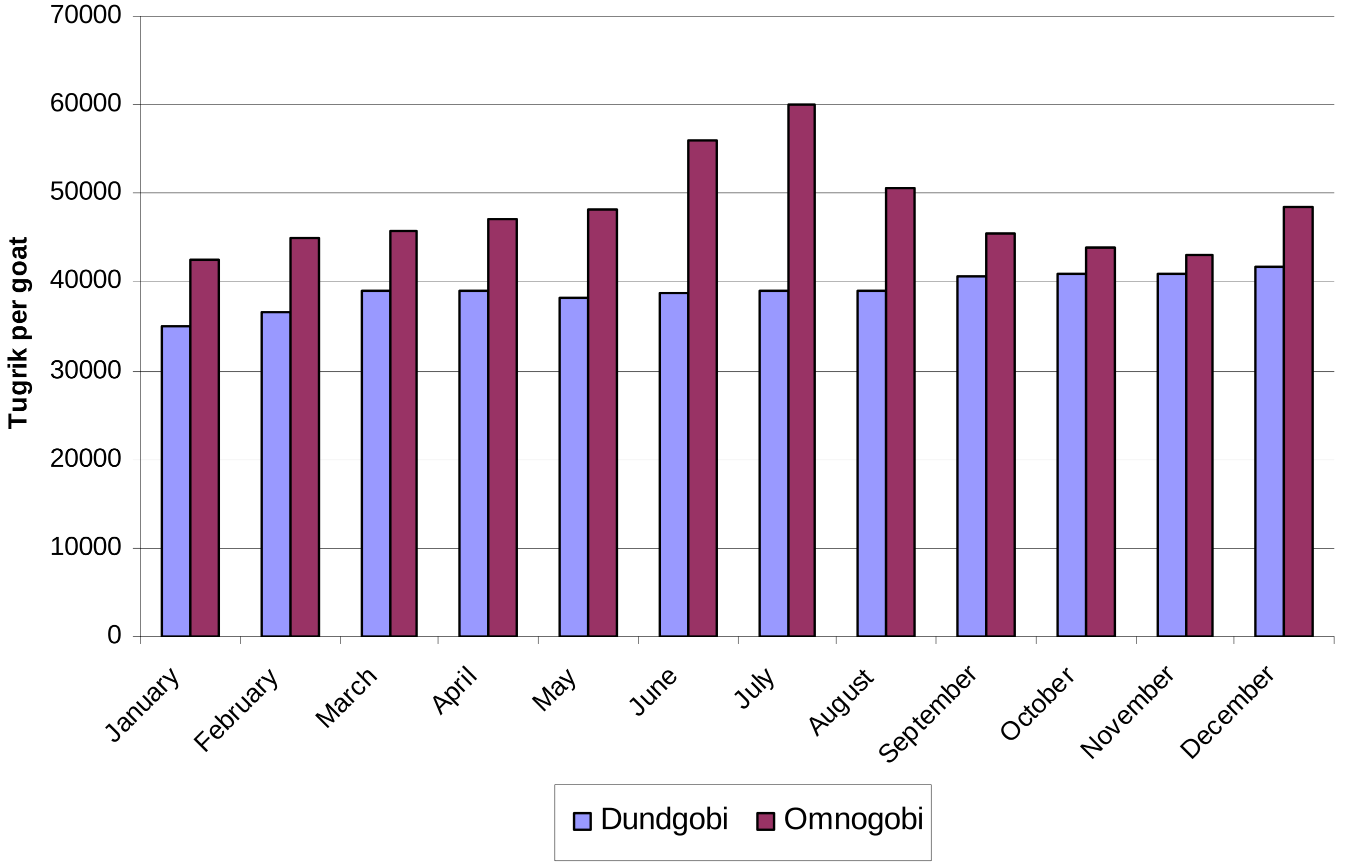


Figure 7-5 Prices of 4 year old goats in Dundgobi and Omnogobi *aimag*s during 2007 (data proved by Media for Business, 2010). Prices are the mean of weekly prices. The weights of goats were not provided with this data. One herder stated that a 50 kg goat could sell for 60,000T (Law on Land, Sevrei *soum*, Omnogobi *aimag*, 8 years herding), but another suggested that 30 kg is the maximum liveweight of goats in Mongolia (Law on Land, Tsogt-ovoo *soum*, Omnogobi *aimag*, 30 years herding).

Herders commonly stated that prices were too low to make selling or culling viable in autumn. Media for Business (2010) prices did not strongly support this statement in Dundgobi *aimag*, but may have weakly supported this statement in Omnogobi *aimag* (Figure 7-5). This suggests that autumn culling may have evolved for reasons other than economic viability, such as subsistence purposes.

Herders culled during autumn because livestock were at their maximum weight and, with forage availability beginning to decline in winter (see Chapter 4), livestock body condition would also be certain to decline. The timing of culling therefore allowed the maximum amount of meat to be stored, either through salting or the 'natural freezer' of sub-zero temperatures, until spring. This allowed herders to convert the forage resource, which was beginning a predictable decline (see Chapter 4), and subsequent decline in livestock production, into a stable meat resource for subsistence purposes:

'*If it is a bad year we slaughter the bad animals as soon as possible. And prepare* borth *(dried meat). And then we keep this until spring with the estimation of how much meat we need for the winter. No, we do not normally sell* [livestock]. *We will try to keep animals, finding ways to save their quality and quantity* [if we know the winter will be bad].' (Law on Land, Sevrei *soum*, Omnogobi *aimag*, 30 years herding)

For some herders, prices that they considered to be low provided a disincentive for sales, even when a bad winter was expected. Livestock were therefore not culled. This was particularly the case for goats, as the additional return from one cashmere clip in spring, if the prices were good, could be lucrative. Herders stated that the price for a live goat could vary between about 30,000T and 60,000T. Media for Business (2010) prices for live 4 year old goats in autumn were similar to these figures at between 38,000T and 52,000T. Media for Business (2010) cashmere prices for any week between 2007 and 2010 were between 18,000T/kg and 54,000T/kg with the higher figure being the price during/immediately after the *dzud* (Figure 7-6). Cashmere prices were probably slightly higher in Omnogobi *aimag* than Dundgobi *aimag* due to greater proximity to the Chinese market.

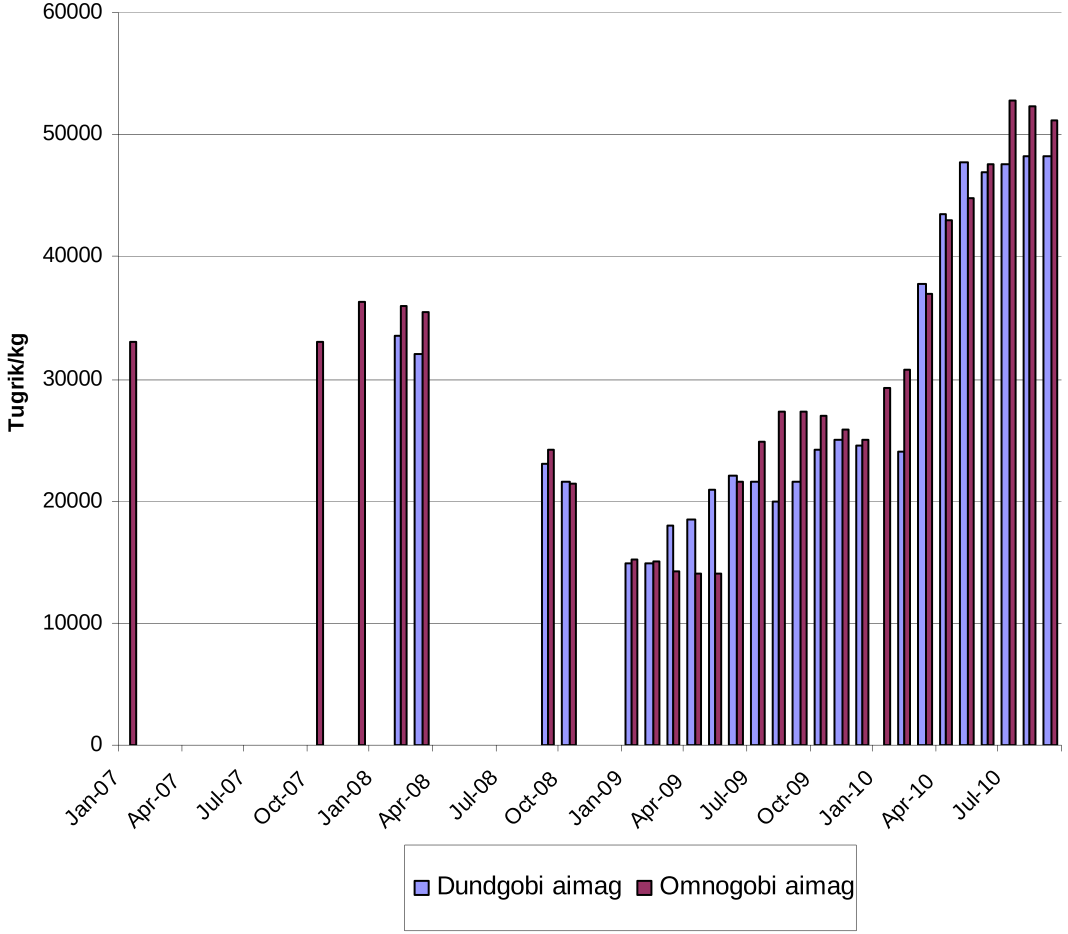


Figure 7-6 Dundgobi and Omnogobi *aimag* white cashmere prices 2007 – 2010. Data provided by Media for Business (2010). Prices are in Tugrik per kg. Weekly data were averaged to produce monthly figures.

One herder stated that an average goat produced about 300g of cashmere per year (Law on Land, Manlai *soum*, Omnogobi *aimag*, 15 years herding), whilst another said the average cashmere production per clip was 500 – 600g (PUG, Bulgan *soum*, Omnogobi *aimag*, 25 years herding). Using these two figures, a herder could receive between 16,200T and 32,400T per clip per goat. The upper figure is greater than the lowest price of a live goat cited by herders. Adult livestock were not usually fed commercial fodder (see previous section), the utilization of standing forage was effectively free, goats provided dung and heating benefits to other livestock through huddling and the skin of a dead goat could still generate income. Consequently, the costs of maintaining goats through winter despite their poor condition may have been very little in comparison to potential gains from cashmere in spring.

The practice of retaining high value livestock, like goats, through winter could produce high returns. However it was still risky. This was particularly true for pregnant females:

'*Last year we all knew that it would be a bad year but the market cost for meat was too low. So, we tried our best to keep our animals by giving more forage but we lost* [our livestock].'(Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 30 years herding)

Price variability changed the way in which herders sold their livestock. A number of herders stated that they could get higher prices for their livestock in the *aimag* centres than *soum* centres. This difference was sometimes significant. One herder stated that they could receive 2,000T/kg – 3,000T/kg more for cashmere sold in the *aimag* centre than in the *soum* centre (PUG, Bulgan *soum*, Omnogobi *aimag*, 25 years herding). Another stated that:

'*At the* soum *markets* [livestock prices are] *cheaper whilst at the* aimag *market you can gain a little bit of a higher profit… There are big* [price] *differences. For example, cashmere prices are 3,000 – 4,000T* [/kg] *different, hide and skin 2,000 – 3,000T* [/kg], *for meat it is about 500T* [/kg].' (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding)

Cashmere traders who travelled from Ulaanbaatar to buy directly from herders when the price was high were said to pay even more than *aimag*s according to one herder (PUG, Bulgan *soum*, Omnogobi *aimag*, 25 years herding). Two Khanbogd *soum* herders interviewed also sold livestock to mining companies (Tavan Tolgoi or Oyu Tolgoi), or to nearby *guanz* (café), where they could ask a higher price. Both stated a similar difference in price between the *soum* and a mining company:

'*We sell some live animals to the* guanz *near Oyu Tolgoi* [international mine] – *the prices are higher than at the* soum. *On average we get about 20 - 30,000T more* [per sheep] *from the Oyu Tolgoi* guanz. *We sell in spring/summer/autumn but the mines are closed in winter*.' (Law on Land, Khanbogd *soum*, Omnogobi *aimag*, > 30 years herding)

Livestock and livestock products were also sold opportunistically, with one herder stating that people would occasionally come from the *soum* to buy one or two sheep for domestic use (Law on Land, Manlai *soum*, Omnogobi *aimag*, 10 years herding). The same herder also stated that local traders would sometimes buy camels and horses directly from them, to be later slaughtered in the *soum* centre.

Preventing livestock from breeding if they were in average to poor body condition prior to winter was common:

'*If the summer was bad or had less rain, we would decide to stop breeding. It is usually time to decide when livestock are at their fattest but there is no grass. Usually in October or November we start to breed, but this year I guess we will not breed*.' (Law on Land, Manlai *soum*, Omnogobi *aimag*, > 30 years herding)

This practice was largely to prevent high mortality rates in females with the additional energy demands of gestation and lactation. That is, the risk of a decline in herd size associated with the death of pregnant females was considered to be a greater risk to future livelihoods than not increasing herd sizes in some years. By reducing grazing pressures in the upcoming spring, it also maximized available forage per head during a period of feed gaps that herders did not usually manage through mobility.

7.4 Income generation versus food security

Two main aims of herd management were apparent during surveys in 2010. These were the generation of monetary income, and food security. The two are somewhat linked, and interviews did not ascertain which was more important to herders. However the choice of feeding scarce forage supplies to young livestock and pregnant females, rather than goats with high levels of cashmere production, suggests that food security took precedence over monetary income when managing climatic shocks in the short-term.

Cash was used for the consumption of goods and services such as fuel and education, as well as for the purchase of emergency fodder. Generating a cash income relied upon expanding the goat herd. The tendency of herders to quote combined figures for sheep and goats made it difficult to assess the proportions of livestock type in the flocks of individual herders. Nevertheless, at the end of 2007 the official Mongolian herd in Omnogobi *aimag* had a flock that was about 70% goat, 21% sheep and the remainder mostly camels and horses (data provided from Omnogobi *aimag* official, Dalanzadgad, 2009). The proportion of goats in the flock has increased since the transition to the market economy (Figure 7-7) as total goat numbers have increased whilst most other livestock types have decreased (see Chapter 8).

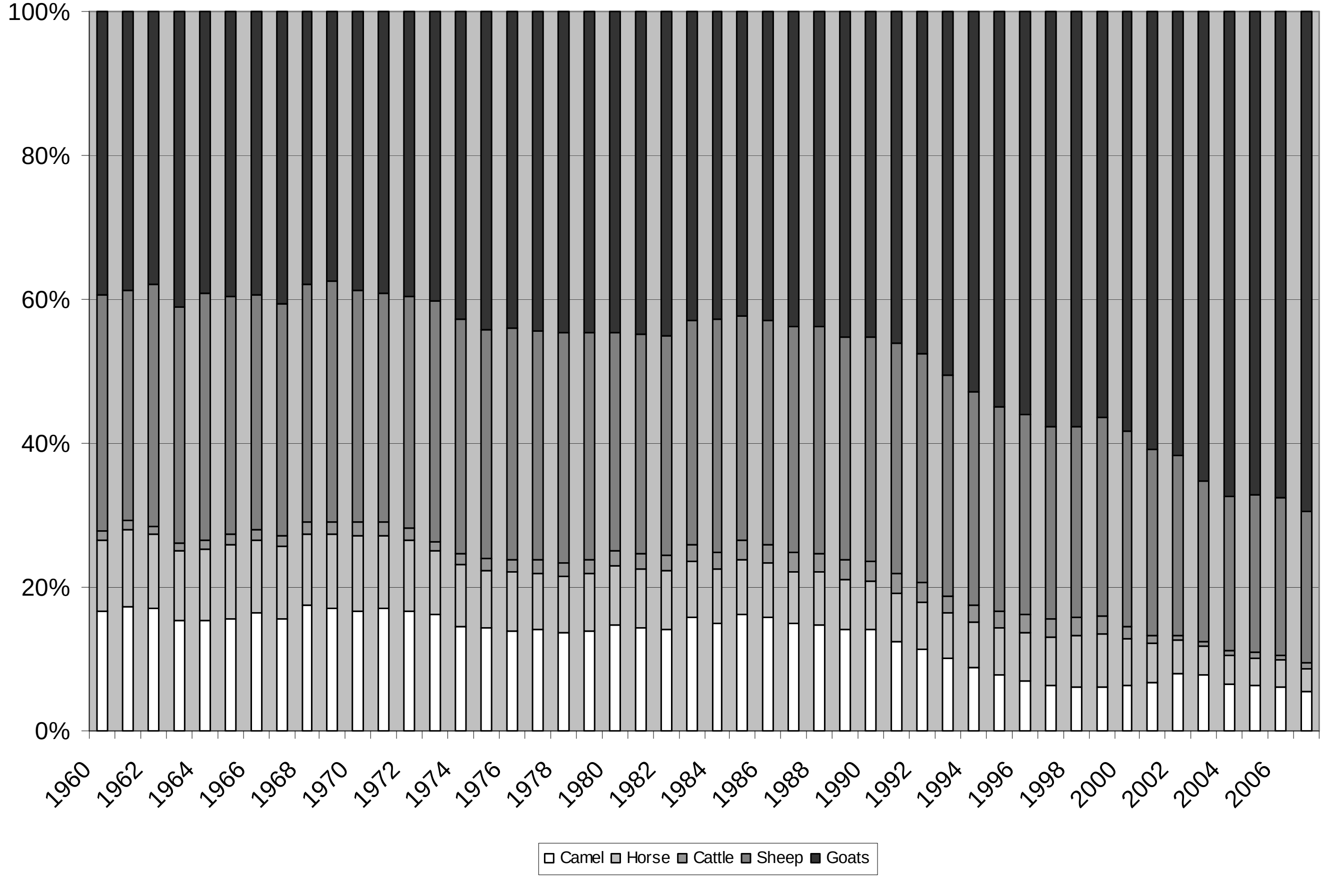


Figure 7-7 Proportion of livestock by type as part of the total Omnogobi *aimag* herd, for each year between 1960 and 2007.

Goats were seen as an important way of generating a cash income. Herders stated that the income generated from cashmere largely went on fuel and education, although fodder also an important expense during the 2009/2010 *dzud*. The need for cashmere to '*pay for* [necessities such as] *food, fuel and clothes'* (PUG, Ulziit *soum*, Omnogobi *aimag*, 25 years herding) in the market economy therefore drove the desire of herders to increase their goat herds. Herders commonly stated that about 70 to 80% (min = 40%, max = 100%) of their total income came from the sale of cashmere, depending on the year:

'*Cashmere is 70% of our total income. It's hard to make money from meat. It's expensive in spring, cheap in summer/autumn. Cashmere is for cash. Other livestock products are mostly for our own consumption*.' (Law on Land, Sevrei *soum*, 25 years herding)

This reliance on cashmere-producing goats created both significant price risk (explained in detail later), and a risk to the second main aim of herders - minimizing production risk to fulfil subsistence needs. One of the ways this aim manifested was through maintenance of a herd that had multiple livestock types, thus buffering the risk posed by climatic variability, and building assets through maximizing herd sizes. A herd of mixed age may have fulfilled a similar purpose, but is not discussed in this thesis. Whilst goat herds were quickly able to rebuild after stochastic shocks, they were considered to be more vulnerable to extreme weather events than other livestock types:

'*We had no young* [kids and lambs] *last year - if we had we could have lost out entire herd. We bred only camels*.' (Law on Land, Manlai *soum*, Omnogobi *aimag*, 10 years herding)

Herder accounts of the vulnerability of goats were verified by pre- and post-*dzud* livestock numbers. *Soum*s in which livestock numbers were sourced both before (2009) and after (2010) the last *dzud* had slightly higher goat mortality rates than average livestock mortality rates (Table 7-2).

Table 7-2 Mortality in goats compared to that of combined livestock types during the 2009/2010 *dzud*. Data provided by local officials. Data rounded to the nearest whole number.

Soum	**Livestock type**	**Livestock number (2009)**	**Livestock number (2010)**	**% decline as a proportion of herd**
Tsogtseggi	Goats	54,547	19,667	
	Total number	88,268	36,782	
	Goat %	62	53	8
Manlai	Goats	66,503	41,643	
	Total number	118,198	85,543	
	Goat %	56	49	8
Ulziit	Goats	79,700	47,900	
	Total number	152,300	102,400	
	Goat %	52	47	6
Tsogt-ovoo	Goats	41,219	16,373	
	Total number	72,940	34,929	
	Goat %	57	47	10

Herders explained that high goat mortalities during *dzud*s were typical, and that whilst any livestock type was at risk of death if their body fat was not adequate, goats were particularly vulnerable to cold temperatures:

"*Sheep have better survival ability than goats because it is very cold in Mongolia's winter time. It becomes about -30 to -40ºC. Sheep have thick wool but goats do not, and they have a different structure of fat. Goat's fat coagulates very easily and that is the main reason why they do not survive in a cold winter*." (PUG, Ulziit *soum*, Dundgobi *aimag*, >30 years herding)

After the *dzud* in which a disproportionally high number of goats died, a number of herders stated they were still able to make 1 to 2 million Tugrik from the 2010 cashmere clip due to high cashmere prices. This was equal to about 3 to 6 months' of the average monthly earnings of a Mongolian working in the agriculture, hunting and forestry sector in 2009 (National Statistical Office of Mongolia 2010), or enough to pay the fees of one to two children attending university in Ulaanbaatar. The global importance of the Mongolian and Inner Mongolian cashmere industry (Waldron *et al.* 2011) meant that high goat deaths during *dzud* periods probably inflated the global price of cashmere. High prices therefore partially buffered the risk caused by climatic variability during the 2009/2010 *dzud*, but this buffer may decline in importance as cashmere markets grow in areas outside of the '*dzud* zone' in Mongolia and China (such as the Iranian or Afghani cashmere industries).

Whilst high cashmere prices during/immediately after a *dzud* period may have buffered income risk it did not buffer the risk of climatic variability on food security. Despite the comparative financial advantages of goats, their vulnerability to *dzud*s meant that herders still valued mixed herds. Livestock other than goats were considered to be useful for subsistence purposes (Law on Land, Manlai *soum*, Omnogobi *aimag*, 30 years herding) as, for example, regarding camels:

'*We use their milk, make camel yogurt, and sell their wool and meat. They are also used for transportation. It is really warm to ride them. The camel is a very fruitful animal*.' (Law on Land, Khanbogd *soum*, Omnogobi *aimag*, 30 years herding)

Sheep were still valued despite '*sheep wool* [etc being] *worth nearly nothing'* at 250 – 650T/kg (Law on Land, Manlai *soum*, Omnogobi *aimag*, 30 years herding). Why herders valued sheep was not specifically identified but their greater ability to survive *dzud*s in comparison to goats and multiple benefits for subsistence and cultural values, such as the dietary preference for mutton, may be possible explanations. Each herder maintained an average of 6 camels per herd, with slightly more maintained in the *soum*s of Ulziit, Mandal-ovoo, Khanbogd and Manlai where a gobi-like landscape prevailed. Camel wool provided a little income to herders, selling for a relatively stable price of 4 – 5,500T/kg. More importantly, and in contrast to goats, camels were the only livestock type to increase in numbers between 2009 and 2010, the *dzud* period, in all *soum*s. Their proportion in the herd similarly increased during the last *dzud* (1999 – 2001) (Figure 7-7). Camels were also able to breed despite the *dzud* winter. Most herders during the post-*dzud* interview period atypically offered my team and I the milk products of camels, as camels were the dominant livestock lactating.

The different vulnerabilities of livestock meant that mixed herds were able to smooth production for subsistence purposes. The use of mixed herds meant milk, an important part of a herder household's diet in summer, was still able to be produced in 2010 despite the lack of kids produced. Food security, in the form of maintaining livestock likely to lactate after *dzud* periods may have had a more important role in herder decision making around herd composition than the relative mortality rates of any one livestock type.

7.5 Financial tools

7.5.1 Insurance

Financial tools can manage climatic risk by converting unpredictable natural capital (the forage resource) into more predictable financial capital (such as insurance pay-outs). However, only three of 38 Mongolian herders who responded to the question of livestock insurance stated that they were covered. One was in a PUG institutional settings, whilst two were not. One herder with insurance stated that:

'[Our livelihoods are] *not safe anymore because* dzud *and droughts have increased. If we lose everything we get compensation from the Mongolian Insurance Company*.'
(Law on Land, Sevrei *soum*, Omnogobi *aimag*, 25 years herding)

Many Mongolian herders knew of insurance schemes being piloted in other *aimag*s by the Mongolian government and the World Bank, and some commented that the piloted schemes would be beneficial:

'*We have no such kind of insurance services. We do not have it in* aimag*. The indexed livestock insurance is implemented within a few* aimags *e.g. Bayankhongor and other 5-6* aimags*. It is broadcast through the radio but is not implemented here. If we had such a thing, why would we sit like this, having lost nearly all of our livestock*? (laughing)'
(Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding)

Fernandez-Gimenez *et al*. (2012) found that whilst one third of herding households in desert steppe areas in Bayankhonger *aimag* had insurance prior to the 2009/2010, like Omnogobi and Dundgobi *aimag* herders, nearly all wanted insurance after the *dzud*.

7.5.2 Loans

Mongolian herders regularly took short-term loans to help them smooth livestock feed gaps. Loans were often sourced from non-bank lenders, such as cashmere traders, and it is unclear whether assets, or the upcoming cashmere crop, were used to guarantee the loan. Herders frequently sought loans towards the end of winter or the beginning of spring. These loans were commonly used to pay for commercial fodder for livestock, and for fuel to facilitate livestock mobility:

'*During the* dzud *we bought 40 kg packets of protein that cost 7,000T in winter but increased to 12,000T in spring. We got a loan from Khan Bank to pay for this supplementary feed, and for moving costs. The interest rate was 3% per month*.' (PUG, Ulziit *soum*, Omnogobi *aimag*, 15 years herding)

Some herders stated that they paid back the loan once the next year's cashmere had been sold. One herder stated that they had sold an unknown number of livestock to pay their loan of 250,000T that was used to purchase fodder/protein. They were able to pay back their loan, but were left destitute with only 26 livestock remaining (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding). Other herders borrowed what they expected could be paid off with the upcoming cashmere clip:

'*We spent 1 million tugrik on protein/grass this last winter. We couldn't buy more because of the snowstorm. We borrowed money to buy fodder, and then paid these loans off with the money we made from cashmere*.' (PUG, Ulziit *soum*, Omnogobi *aimag*, 25 years herding)

Some herders stated that the inability to gain credit affected their ability to use commercial fodder as a way of managing feed gaps:

'*The supply* [of commercial fodder] *was not that much. If they had more we could have bought. We had some cash problems. Some traders did not allow credits.*' (Law on Land, Manlai *soum*, Omnogobi *aimag*, 10 years herding)

7.6 Interactions with external agencies

External agencies, usually governments but also non-government organisations and development agencies, can buffer the risk of feed gaps in ways not related to institutional settings. This can be particularly important when commercial options (such as those described in Section 7.5) are not available or viable. In the Gobi Desert, the way external agencies interact with the management of feed gaps has changed significantly over the last few hundred years (see Chapter 2). Whilst external agencies are not a tool able to be easily manipulated by herders, their relationships to feed gaps are examined here as a potentially important factor that influences the risk of feed gaps.

7.6.1 *Negdel* period

A number of herders talked about the institutions and activities of the *negdel* collectives of the 1980s. Many of these institutions and activities had the explicit aim of managing feed gaps. They are included here to investigate both institutional and non-institutional tools for buffering risk, as well as for interpreting the changes in total grazing pressures described in Chapter 8.

One Tsogtseggi herder described some of the *negdel* institutions that managed the risk of feed gaps:

'*In the 1980s the* negdel *supplied us with forage. Now there is no support, no control and no regulations. If at that time we moved to Dundgobi* aimag *on* otor*, people would allow us to move there and to stay. During the* negdel *they supported everything. The* bag *governor followed all people on* otor *to make sure that less livestock died. In that team would be veterinarians and labour forces. The* negdel *paid for all expenses related to transport. The authorities supplied all fodder for free, as much as was needed.*' (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, >30 years herding).

This account was typical of the responses of other herders; one Manlai herder provided additional information:

'*During* negdel *times they had plans plus every family herded different types of livestock* [rather than mixed herds], *there was huge support. Now there is private ownership of livestock so the owner has to manage by themselves. The government gives support only in critical situations. During the* negdel *time, the* negdel *itself designated the place for livestock to be moved to, and supported this by providing trucks. They transported our* ger, *we had to follow with animals.*' (Law on Land, Manlai *soum*, Dundgobi *aimag*, 25 years herding)

Comparing the assumably more prescriptive institutions of the *negdel* period with the 'institutional vacuum' of decollectivised Mongolia should highlight the power of collectivist institutions to decrease the risk of overgrazing and vulnerable livelihoods. Given that the *negdel* buffered much of the risk associated with climatic variability, it would be expected that livestock mortality was lower during that period. Omnogobi *aimag* livestock numbers (total and goats) were analysed against the national-level *dzuds*, described by Reading *et al*. (2006), between 1961 and 2007. Years in which livestock numbers declined did not appear to match national scale *dzud* periods during the *negdel* period, but did match national scale *dzud* periods after the dissolution of the *negdels*. This suggests that the institutions of the *negdels* helped buffer risk. However it should be interpreted with care; the national scale *dzud* data is probably not suitable to use at more local scales given that *dzud* can occur locally but not nationally (Murphy 2011) or nationally but not locally (Fernandez-Gimenez *et al.* 2012). It also does not highlight which types of institutions were most benefitical. For example, it does not explain whether collectivism *per se* was an important mechanism for managing risk, or whether the increased forage and fuel inputs were more important.

If strong institutions protected livelihoods, herders should prefer the institutions of the *negdel* period. However herders had mixed opinions. The increased flexibility under the current model of private livestock ownership may have offset feelings associated with concerns about increased production risk under the Law on Land:

'*There is no difference* [between then and now]. *If nature is good, we can prepare fodder ourselves. During the* negdel *they supplied us with forage, we had to supply them with product. Now it is our private thing and it depends on us. We can not ask for something more. So of course it is better to have own property, own animals. Nature was better* [during *negdel* times] *but of course there were still some livestock deaths*.' (Law on Land, Manlai *soum*, Dundgobi *aimag*, 25 years herding)

Despite mixed feelings, herders did identify differences between the *negdel* and post-*negdel* period. One respondent who was a herder during *negdel* times stated that most herders in the post-*negdel* period moved less frequently, and shorter distances, than they used to during *negdel* times (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding). Herders generally believed that there were fewer livestock deaths during *dzud*s in the *negdel* period. The livestock deaths previously described were seen to be fewer than during the latest *dzud*, but one herder also stated that he had never experienced a winter so cold (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding). Descriptions of the 2009/2010 *dzud* being the coldest ever were common amongst experienced herders (see Section 4.2.2). A number of herders stated that it was the cold, rather than the feed gap, that killed their livestock during the *dzud*.

This makes it difficult to distinguish between high livestock mortality caused by management and that caused by an atypical winter.

7.6.2 Law on Land

Aimag governments had responsibility for negotiating inter-*aimag* migrations of herders and their livestock under the Law on Land (see Chapter 5). During the 2009/2010 *dzud*, Omnogobi *aimag* made agreements with Dundgobi, Gobi-Sumber and Dornogobi *aimag*s that gave herders legal sanction to move there. The *aimag* also negotiated with border control to allow herders into the Mongolia/China border zone to ‘escape’ the *dzud*. An Omnogobi *aimag* official stated that there was good forage there, though no wells.

*Aimag*s also provided subsidised fodder to herders during the 2009/2010 *dzud* due to concerns over herder livelihoods during this period. About 1,500 tonnes of fodder was given to herders in Omnogobi *aimag*. According to an *aimag* official, one 40 kg sack of fodder normally costs 12,000 – 18,000T, but during the *dzud* herders were only charged 3,000T. *Soum* governments were responsible for organising the logistical side of *aimag* fodder support during the last *dzud*. As herders in some *soum*s stated that they paid more for subsidised fodder than the figure quoted by the *aimag* official (see Section 7.3.4), it is unclear whether *soum* governments charged transportation costs on top of this figure. One thousand tonnes of hay were also provided to herders at 1,000T per sack, down from 8,000T per sack.

*Soum*s attempted to support herders in a variety of other ways. Bayandalai *soum* had a *soum* development fund. During the 2009/2010 *dzud* it used this fund to pay for machinery that cleared snow around people’s winter camps. It also had a livestock protection fund. Initially each herder paid 20,000T into it to create a revolving fund for loans (a total of one million tugrik). By October 2010, this amount was 10 million tugrik, but it is unclear whether herders had used the fund, and if so, for what purpose. A Bulgan *soum* official stated that they connected ex-*soum* people, for example businessmen in Ulaanbaatar, with people in the *soum* for the purpose of aid/development. *Soum* homeland associations in other parts of Mongolia were found to be an important source of support during the *dzud*, especially when someone native to the soum had become a successful businessman or politician (Fernandez-Gimenez *et al*.

2012). During the 2009/2010 *dzud*, the Bulgan *soum* government, with the *aimag* government, organised fodder to be imported from China. In Manlai *soum* (Law on Land, Manlai *soum*, Omnogobi *aimag*, 10 years herding) one herder described a *soum*-sponsored programme for drilling wells. Similar to some of the PUG institutions that encouraged the pooling of financial resources for capital works, a group of herders could pay 400,000 – 700,000T in total to get an automatic well drilled.

Prior to the 2009/2010 *dzud*, herders stated that they were charged an annual tax for their grazing right over their registered winter/spring camp, as well as a general 'land use tax.' The taxes varied slightly between *soum*s and herders were sometimes confused about which tax was which. In general, the annual cost of each tax appeared to be the same as about one hot meal at a *guanz* (cited figures included 1,425T, 1,500T and 2,500T, depending on the *soum*), and as such was not considered burdensome by herders. Herders also paid a 'foot tax' per livestock type. One herder from Mandal-ovoo *soum* stated that they paid 4,000T per head per year to the *soum* government (Law on Land, Mandal-ovoo *soum*, Omnogobi *aimag*, 30 years herding). Both taxes were suspended during the 2009/2010 *dzud*. One herder interviewed described an 80,000T payment they made to a *soum* government in Dornogobi *aimag* for rental of a winter camp from October 2009 to July 2010 (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding).

Herders said that the *soum* government had also supported them during the 2009/2010 *dzud* through providing them with free essentials. One herder household reported receiving 10 kg of rice, 10 kg of flour, tea and candles from the government (Law on Land, Sevrei *soum*, Omnogobi *aimag*, 30 years herding). Herders in Manlai *soum* also reported receiving support from the *soum* government but, as also found by Fernandez-Gimenez *et al*. (2012), evenly dispersed aid was so small as to have little impact on individual households.

On the whole, herders had mixed feelings about the level of support they received from government:

'[This last bad year] *the* soum *government had some* [fodder] *discounts and also supplied some fodder at no charge. I* [also] *received fodder for free. There were limits.*

To supply all families of course it was a small number. If we will count it is not that much, but we cannot say that the government did nothing to help us. They gave some.' (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding)

Whilst still recognising that they would have benefitted from greater levels of support, Mongolian Gobi Desert herders appeared to be less critical of the low level of support they received than the steppe region herders described by Fernandez-Gimenez *et al*. (2012). This is despite what appeared to be the similar level of support offered by the *soum* government.

Non-government agencies, such as international mining companies and development/relief agencies, also provided some support during the *dzud* when feed gaps were at their greatest. Another herder in Tsogtseggi *soum* stated that they had also received assistance from Red Cross, receiving 22 packets of protein for their livestock (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding). A herder in a different *soum* stated that:

'*Once the Red Cross supplied us with tea, rice and flour. They gave some grass and forage*.' (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding)

The Tavan Tolgoi mine had also given them 13 packets of protein, milk powder and medication for their livestock. A third Tsogtseggi *soum* herder said that they had also received free goods from the mine, and subsequently were changing their *soum* of registration from Luus *soum* in Dundgobi *aimag* to Tsogtseggi *soum* in Omnogobi *aimag* to ensure similar support in future.

7.7 Lessons from Inner Mongolia

Risk management tools available to herders from less exclusive institutional settings can be compared with tools available to those in more exclusive institutional settings. This can help highlight what non-institutional tools are needed or available for meeting the increased risk of feed gaps associated with a reduced forage area. Some of the tools for managing the risk of feed gaps were similar between Mongolian and Inner Mongolian institutional settings. Mongolian herders preferred mobility as their main tool for managing feed gaps, Inner Mongolians were more reliant on commercial fodder as mobility was restricted by the bureaucratic institutional settings described in Chapter 5.

7.7.1 Fodder

Locally grown and imported fodder was the primary mechanism by which Inner Mongolian herders managed feed gaps. Most herders used their contracted cropping area to grow corn for feeding to livestock. The Urat Rear Banner official stated that fodder was also sourced from nearby, large-scale irrigated areas along the Yellow River. Fodder was generally corn stalks, a crop by-product rather than a product cultivated specifically for fodder like it was in northern Mongolia. This is an important difference. The supply of fodder in Inner Mongolia is likely to be more reliable than in Mongolia as irrigation from the Yellow River is less exposed to *dzud* and drought conditions in the short-term than the fodder production areas of northern Mongolia.

Before the grazing bans, commercial, cultivated fodder was purchased even in years that herders described as good. In contrast to Mongolia, fodder was purchased at any time of the year rather than only over winter/spring. The weight and cost of fodder was greater in bad years than good years as herders sought to manage the feed gaps caused by climatic variability. Costs increased under the grazing ban, despite the average herd size under the grazing ban reducing from an average of 661 SFU to 203 SFU and about four dairy cows per household (Table 7-3).

Table 7-3 Annual average cost of supplementary feeding per household. n = 16 (good year) and 17 (bad year). Herders gave prices and weights for two types of supplement feed, grass/hay and forage that is more protein-rich.

		Good year	Bad year	Grazing ban
Grass/hay	Mean weight (kg)	2,083	9,516	455
	SD[A]	5,208	12,829	2,236
	Price (yuan/kg)[B]	0.4	0.4	0.4
	Subtotal (yuan)	833	3,806	182
Protein-rich forage	Mean weight (kg)	2,821	7,650	13,222
	SD[A]	4,369	6,928	32,592
	Price (yuan/kg)[B]	1.4	1.4	1.4
	Subtotal (yuan)	3,950	10,710	18,511
Total (yuan)[C]		4,783	14,516	18,693

[A] SD = standard deviation, [B] Prices are based on a fixed price of 0.2 yuan/jin for grass and 0.7 yuan/jin for fodder (prices stated by herders during interviews) but are likely to vary between good and bad years. [C] 1 USD = 6.5 yuan as of June 2012.

The Urat Rear Banner official stated that one SFU needed about 2 kg of corn stems a day. The average Inner Mongolian herd of those surveyed was about 661 SFU prior to the grazing ban. The average herd therefore needed 500 tonnes per year if another feed type was not sourced. If one mu of land produced about 800 kg of corn stems and fruit per year (as cited by the official), and the mean area of irrigated land contracted by Inner Mongolian herders was 21 mu (n=14) (Chapter 5), then only 16 tonnes per year could be produced by the average herder, with the rest needing to be sourced from available forage or bought commercially. These figures cannot be directly reconciled with the figures of Table 7-3 as the nutritional value of corn is not equivalent to grass or forage. Nevertheless, given that corn has a higher calorific value than grass/forage, the remaining feed gap is unlikely to be met by the exclusive supplementary fodder shown in Table 7-3.

Herders did not comment on the relative affordability of purchasing fodder, although Chapter 9 gives the opinions of Inner Mongolian herders about changes in their livelihoods since the grazing ban. The Urat Rear Banner official stated that fodder was cheap for herders in her area, but the author’s driver volunteered that a herding friend of theirs in a different banner could not afford the amount of fodder required to sustain their livestock under the grazing ban, and was trying to leave the pastoral sector.

7.7.2 Herd management

Like in Mongolia, livestock in Inner Mongolia were sometimes sold if feed gaps were expected. Herders sold live or slaughtered livestock, depending on price. The decision whether to do this was made in autumn, a similar time of year to Mongolia:

'*If we think the year is going to be a bad one, we sell livestock and use this money to buy fodder. We sell in October*.' (Household Responsibility System, Car Gar Handa, 30 years herding)

The average Inner Mongolian household surveyed had 540 head of livestock (standard deviation = 96, n=15) prior to the grazing ban. About 97% of the average herd were goats or sheep, with the remainder being cattle. This proportion of goats and sheep was higher than in Law on Land and PUG institutional settings in Mongolia, but only by a few percent. Mongolian herds were also likely to have more camels and horses than Inner Mongolian herds, presumably to assist with mobility and for food security (see Section 7.5). Consequently, herd composition was slightly less diverse than in Mongolia. The reason for this was not ascertained as part of this research. It is speculated that more substantial pens and greater access to commercial fodder in Inner Mongolia may have reduced goat mortality during *dzud*s, thus reducing reliance on non-goat feed sources. Inner Mongolian herders may have also been more reliant on cash income/less subsistent than Mongolian herders.

7.7.3 Interactions between herders and external agencies

No Inner Mongolian herder interviewed stated that they had livestock insurance prior to the grazing ban. Insurance against the death of dairy cows was provided by the government at the time of interview, but herders did not believe that this insurance extended to other livestock types. In Urat Rear Banner, a local official stated that the government supported those herders that lost livestock during the 2009/2010 *dzud* through the provision of a moderate amount of fodder. The official also stated that the area had agricultural insurance, although several herders from Damao stated that whilst dairy cows were covered by government insurance, other livestock types were not.

Some Inner Mongolian herders stated that in bad years, prior to the grazing ban, the government sold them fodder at cost price, and sometimes it was free. Livestock vaccinations were free, but additional veterinarian care needed to be paid for. In Damao, a local official stated that the local government gave 5 yuan per mu of land contracted under the Household Responsibility System per year as compensation to the herders banned from herding (a total of 6 billion yuan). These figures meant the contracted herder households interviewed received between 10,000 and 100,000 yuan per year (mean = 36,486, standard deviation = 29,284, n = 23). These payments were regardless of the type of year and, consequently, the incomes of Inner Mongolian herders may have been less volatile through time than that of Mongolian herders. Inner Mongolian herders were also entitled to free health insurance, and received a pension from the age of 55. Herders' school aged children received free school tuition and three school meals a day. Herders' children also received 3,000 yuan if they went to college and 5,000 yuan if they went to university. No development agencies appeared to be operating in the interview areas, and there did not appear to be any support for herders from mining companies.

7.8 Summary and Discussion

For secure livelihoods, the factors that create risk for one income source should not be the same as those that create risk for another (Ellis 1999). In the Gobi Desert, which produces large proportion of the world's cashmere, the spatial overlap between the cashmere producing area and the area exposed to stochastic *dzuds*, buffers the risk of volatile herd sizes or prices. If a large proportion of the Gobi Desert' goat herd is killed by *dzud*, the international cashmere price will rise, offsetting the decline in herder income from smaller herd sizes. This buffering of income through time is not the case with food security but maintaining a mixed flock with non-lactating livestock minimises the risk for herders in *dzud* and post-*dzud* periods. The need for both an income and food security provides a push for large, mixed herds. Labour shortages, and *dzuds*, constrain the ability of herders to achieve this.

Like income sources, the absence of one type of risk management tool needs to be compensated for by the presence of another. A range of tools used by herders for managing the risk of feed gaps are presented in this chapter. The primary strategy for managing the risk posed by climatic variability in Mongolia across both Law on Land and PUG institutional settings was mobility of livestock. The patterns of mobility reported in this research reflect Mearn's (1993) observation that the high degree of inter-annual variability means that an area of pasture used one spring could be just as easily used during the following autumn. In addition to climatic variability, patterns of mobility were also influenced by factors such as landscape type, cash available for fuel, labour and water supply (also see Chapter 6). There were differences in some indicators of mobility between institutional settings, but these showed no consistent trend. Stakeholders interested in further supporting herder mobility for environmental or livelihood reasons may therefore find value in addressing wealth, labour and water constraints, rather than redesigning bureaucratic institutions.

During cold periods, when mobility was constrained, short-term tools for managing feed gaps included the preparation or purchase of fodder to be fed to young or weak livestock. The purchase of fodder was relatively more important in Inner Mongolia than Mongolia. In Mongolia, the ability of herders to self-prepare fodder was particularly constrained in bad years when forage variability was low. PUG herders in steppe-like landscapes prepared more fodder (probably due to the presence of irrigation), but gobi-like PUG herders prepared similar amounts as Law on Land herders. Demand for fodder appeared to be greater than that which could be supplied commercially during critical periods, and high prices also constrained the use of commercial fodder as a tool for managing feed gaps. Fernandez-Gimenez *et al*. (2012) noted similar constaints to the use of fodder during *dzud*. Consequently, the current ability of supplementary fodder to completely remove the risk of livestock mortality during certain types of *dzud* (such as times of extremely low temperatures, rather than thick snow) is questionable.

In Mongolia, preventing livestock from breeding was a tool for managing expected feed gaps in the medium term. The reliance on lactating livestock for milk products for subsistence in spring/summer, low commodity prices at key times and a reluctance to cull more livestock than was needed for subsistence purposes over winter, constrained the use of this tool across institutional systems. Culling was also employed if feed gaps were anticipated. The purpose of culling was to generate food for subsistence, and for income that was then used to purchase fodder. The decision to cull was based on the body condition of livestock at a key decision period (generally autumn), and was used across institutional settings.

Loans were commonly used to smooth the risk posed by climatic and financial variability in Mongolia in the short and medium term. This tool could be expensive, and could create different forms of risk, such as the risk of debt, default and social obligation described by Murphy (2011). Livestock insurance was desired by some herders, but a lack of availability meant that uptake rates were very low across institutional settings. The uptake of support offered by local government, development agencies or international mining companies were examples of opportunistic strategies for managing the risk of feed gaps. Such support, also noted by Fernandez-Gimenez *et al*. (2012), was unlikely to significantly reduce livestock mortality rates in periods of prolonged feed gaps due to their infrequent and unpredictable nature, and desire to give equal support to all herders despite limited resources.

Longer term strategies for managing the impact that climatic variability had on both income and subsistence aims included maintaining a mixed flock of a minimum size. In Mongolia, a mixed flock was seen to reduce total herd mortalities during cold periods. The emphasis on cold-adapted livestock parallels the return to native, fat tailed breeds from exotic breeds when livestock were privatised in Inner Mongolia during the 1980s (Li and Li 2012). Labour shortages may constrain the strategy of growing herd sizes, but the agistment/absentee arrangements described in Chapter 6 suggests that there are options for managing these labour constraints. Stochastic weather events are probably a greater constraint on herd sizes.

If appropriate institutions (Chapter 5, 6) or risk management tools (this chapter) are not available or affordable to herders during periods of feed gaps, overutilization and declines in rangeland condition may result. The thesis now examines whether this risk has manifested in the Mongolian Gobi Desert in a way that has produced detectable levels of degradation at the landscape scale.

8 Rangeland Condition

8.1 Introduction

This thesis's literature review (Chapter 2) highlighted some of the underlying assumptions prompting a re-examination of institutional settings in the Mongolian Gobi Desert. One of these is the assumption of widespread land degradation associated with overgrazing by livestock. The weakening of institutions managing access to the forage resource is a commonly cited cause for the increase in the number of livestock, particularly goats, and a decline in herder and livestock mobility. However weakened institutions do not automatically lead to land degradation.

Institutional control over access to the forage resource is unnecessary in landscapes of resource abundance (Dyson-Hudson and Smith 1978). The socially embedded institutions shown in Table 6-3 may not have evolved for the specific purpose of utilising the forage resource in a way that preserves rangeland condition in the long-term. However there may still be a relationship between these socially embedded institutions and rangeland condition. When there are low population densities or non-equilibrium conditions, socially embedded institutions that benefit the livelihoods of individual households in the short term may be beneficial or have no affect on rangeland condition in the long-term. In these instances, institutions like those proposed in Chapter 5 may not be necessary for managing rangeland condition at all (Dyson-Hudson and Smith 1978). Testing the validity of degradation assumptions is therefore important.

Firstly, this chapter explores whether there have been broad scale changes in the livestock, climate or forage dynamics that may have contributed to a decline in rangeland condition. Secondly, this chapter explores if the risks of feed gaps associated with the dynamic biophysical, social and economic factors described in earlier chapters have been realised, in turn producing measurably poor rangeland condition. General levels of degradation are explored, and indicators are assessed according to soil type. This assesses whether landscape differences in the different institutional settings have had a disproportionate effect on indicators of rangeland condition. Next, indicators of rangeland condition are assessed in sites under Law on Land and PUGs institutional settings. The aim of this is to assess the ability of PUGs to improve rangeland condition in desert steppe areas. The perspectives of herders and local officials on changes in rangeland conditions in both Mongolia and in Inner Mongolia are included. These perspectives inform and verify the biophysical data, and assess gaps between the understandings of degradation by herders, development agencies and the State.

8.2 Causal variables

It is difficult for the institutional settings described in Chapters 5 and 6 to govern all variables that can affect feed gaps and, ultimately, rangeland condition. An analysis of trends in the biophysical factors contributing to feed gaps may highlight mechanisms leading to changes in rangeland condition other than those that have not, or cannot, be controlled institutionally. The following section explores 20 year trends in forage availability or utilization.

8.2.1 Livestock

<u>Total livestock grazing pressure</u>

Total livestock numbers significantly increased in three of the five assessed Mongolian *soum*s between 1960 and 2010, and significantly declined in one *soum* (Table 8-1). However, none of the five *soum*s showed a significant increase in the recorded total SFU, with Tsogtseggi, Manlai and Tsogt-ovoo *soum*s showing significant declines as the number of large livestock declined. A herder account supported the figures, stating that the number of livestock in Tsogtseggi *soum* was less in 2010 than it was during the *negdel* period (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding).

Table 8-1 Trends in key rangeland related variables in study soums. p-values are derived from climate data from 1990 to 2009 (Institute of Meteorology and Hydrology 2010) and livestock data from 1960 to 2008 (Omnogobi *aimag* official 2009). (↓) = significant decline over time, (↑) = significant increase over time. *Soum*s that have trends that are not significant are not shown. SFU = sheep forage units, Ppt = precipitation, temp = temperature ***=p<0.001, **=p<0.01, *=p<0.05. NA = data not available. NS = relationship not significant. Other insignificant, such as changes in monthly precipitation totals through time, are not shown.

Soum	**Total SFU**	**Total livestock number**	**Total goats**	**Annual**		**Spring**		**Summer**		**Autumn**		**Winter**		**Annual biomass (kg ha^{1})**
				Ppt (mm)	**Temp (ºC)**	**Ppt (mm)**	**Temp (ºC)**	**Ppt (mm)**	**Temp (ºC)**	**Ppt (mm)**	**Temp (ºC)**	**Ppt (mm)**	**Temp (ºC)**	
Khanbogd	NA	NA	NA	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.000***(↑)	NS
Bulgan	NS	0.000***(↑)	0.000***(↑)	NS	NS	NS	NS	NS	0.000***(↑)	NS	NS	NS	NS	0.003**(↓)
Bayandalai	NS	0.000***(↑)	0.000***(↑)	NS	NS	NS	NS	NS	0.005**(↑)	NS	NS	NS	NS	0.00***(↓)
Sevrei	NA	NA	NA	NS	NS	NS	NS	NS	0.003**(↑)	NS	NS	NS	NS	0.028*(↓)
Ulziit	NA	NA	NA	NS	NS	NS	NS	0.013**(↓)	NS	NS	NS	NS	NS	0.00***(↓)
Tsogtseggi	0.036*(↓)	0.035*(↑)	0.000***(↑)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.00***(↓)
Manlai	0.012*(↓)	0.042*(↓)	0.000***(↑)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tsogt-ovoo	0.000***(↓)	NS	0.000***(↑)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

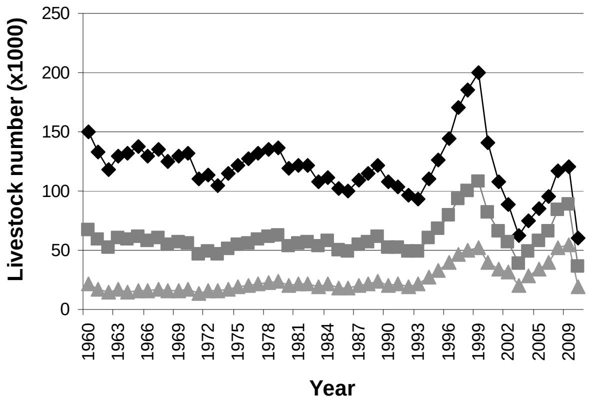
It is unclear what effect the 2009/2010 *dzud* had on livestock numbers, in Inner Mongolia:

'*About 20 years ago there were 1,200,000 animals in Damao. Before the ban there were 1,600,000. Now there are 500,000.*' (Damao grassland officer, 2010).

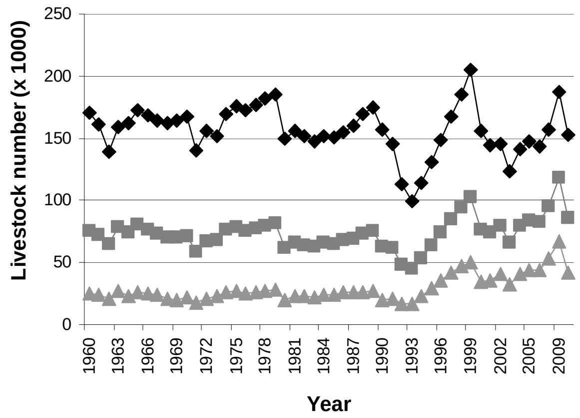
Between 1990 and 2010, officially recorded herd sizes in Mongolia were more volatile in all assessed *soum*s than during the previous three decades. There were large declines following two separate *dzud* periods, the most recent being the winter immediately before the survey period (Figure 8-1). Annual SFU coefficients of variation were between 41% (Bulgan *soum*) and 340% (Tsogtovoo *soum*) greater in the post-1990 period than prior to 1990. Total SFU first declined, and then built throughout the 1990s before crashing during the *dzud*s of the late 1990s/early 2000s. Numbers again built during the 2000s, followed by a sharp decline due to major livestock losses in the 2009/2010 *dzud*.

Five of the fifty sites (10%) surveyed showed signs of vegetation utilisation by livestock at the site scale. At the majority of these five sites, only one of the subsamples had been utilised. Higher than usual livestock mortality rates associated with the 2009/2010 *dzud* may partially explain the low levels of utilisation. *Allium mongolicum* Rgl. was the primary plant species grazed but *Allium polyrrhizum* Turcz. Et Rgl. or *Stipa* spp. were often utilised in subsamples where *Allium mongolicum* Rgl. was not sampled. In subsamples where grazing was apparent, visual assessments revealed that plants had been selectively 'picked' with fully intact individuals mixed in with those grazed, and generally a relatively small proportion of the plant's above ground biomass was taken. Three sites were located within sight of a *ger* or permanent water point but showed no sign of utilisation by livestock at all.

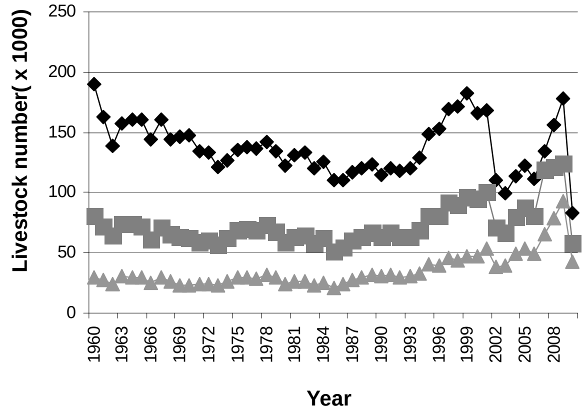
Livestock dung was noted at 26% of sites, in one or more of a site's five subsamples. Hoof marks were noted on 4% of sites. An additional 4% of sites were traversed by a livestock pad/track. None of the 250 subsamples showed any sign of roots excavated by any type of livestock, including goats.



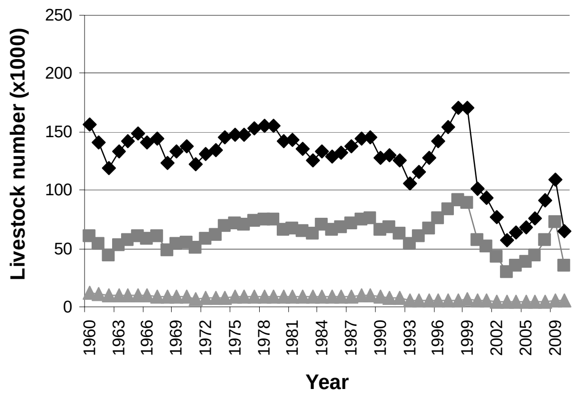
Tsogtseggi *soum*



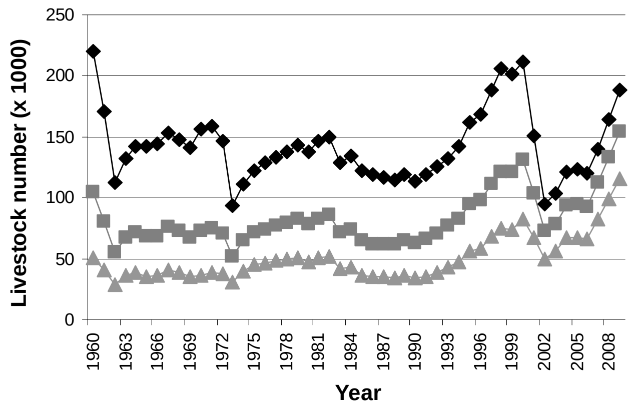
Manlai *soum*



Bulgan *soum*



Tsogtovoo *soum*



Bayandalai *soum*

Figure 8-1 Changes in livestock numbers since 1960. ♦ = total SFU, ■ = total livestock, ▲ = goat. Only *soum*s with significant trends (Table 8-1) are shown. Bulgan and Bayandalai *soum* 2009 figures are extrapolated from the growth in the previous 3 years. 2010 figures assume a 53.8% herd loss (the *soum*-wide loss) for Bulgan *soum* (pers. comm., Bulgan *soum* Food, Agriculture, Trades and Services Officer, 2010), and a loss of 30,000 head (*soum*-wide) for Bayandalai *soum* (pers. comm., Bayandalai *soum* Food, Agriculture, Trades and Services Officer, 2010).

<u>Goats</u>

The proportion of goats has increased in all selected Mongolian *soum*s since 1960 (Figure 8-1). The specific impact that this increase has had on rangeland condition in the desert steppe is unclear, and has not been documented by empirical evidence in English language, peer-reviewed literature. No herder interviewed spontaneously identified goats as the cause of pasture changes during the period that they had been herding. Three were specifically prompted about the likelihood of the oft-claimed practice of goats 'digging the roots of plants, killing them' when time was available for an extended discussion. Of these three, one stated that livestock digging plant roots contributed to decline in rangeland condition (also Table 8-5), but did not specify the livestock type. The second replied that:

"*On the television they say that goats are bad but I disagree. The goats don't eat the plant roots. Horses are far worse. They eat really low to the ground, and dig the roots. They are less efficient…I am glad we are a democracy now and I can say such things that disagree!* (laughing)" (PUG, Ulziit *soum*, Dundgobi *aimag*, more than 30 years herding)

The third herder largely concurred, stating that:

"*Goats don't dig roots in the Gobi. Hungry horses will, though, gazelle also. Pasture changes are not because of the goats, just less rain*" (Law on Land, Tsogt-ovoo *soum*, Omnogobi *aimag*, 25 years herding)

It is still possible that goats contribute to overgrazing in the Mongolian Gobi Desert. For example, the high dietary plasticity of goats (Devendra 1989) may contribute to overgrazing in windows of time when goat grazing pressures are high but the forage resource is declining, particularly amongst plant species that do not have the strategies for avoiding drought or freezing temperatures that also allow they to escape quickly, rather than persist through, grazing (see Table 8-1 and Chapter 4).

Conversely, it is also possible that goats do not overgraze disproportionately to other livestock types in rangelands that are not overstocked. Dietary plasticity in goats may additionally mean sheep at the same moderate SFU as goats have more impact on the average annual plant recruitment and mortality rates of palatable plants than goats, as has been documented elsewhere e.g. (Fletcher 1991). What ‘moderate’ versus ‘high’ goat densities are in relation to rangeland condition in the desert steppe remains untested. The proportion of flowering/seeding species found during the rangeland condition survey, together with the abundance of palatable perennials (Table 8-2), the lack of physical evidence that goats ‘dig the roots’ of plants, and that no herder cited goats as a mechanism of degradation suggests that the risk of severe degradation associated with grazing by goats was not being realised during the moderate to good levels of soil moisture in the 2010 survey. The data presented in this chapter and the literature review suggests that it cannot be automatically assumed that goats are inherently more likely to cause degradation than other livestock types.

8.2.2 Climate

Annual precipitation did not change significantly between 1990 and 2010 in any of the selected Mongolian *soum*s when assessed using linear regression (Table 8-1). The seasonality of precipitation in all *soum*s did not significantly change except in Ulziit *soum*, where summer rainfall significantly declined (Table 8-1). There was also a non-significant trend to declining summer rainfall in other *soum*s. Changes in the timing of the onset of precipitation as rainfall was not examined here as monthly rainfall statistics are not at a suitable temporal scale. Maximum temperatures showed more significant change, with increases in summer (trends in all six *soum*s, significant at the 0.05 level in three *soum*s and nearly significant in an additional *soum*) and winter (significant in one *soum*). In *soum*s where temperature/precipitation data was available, the 2009/2010 winter was far colder for a longer period of time than other years.

8.2.3 Pasture biomass

Five of the six *soum*s for which official livestock-available biomass data were sourced showed a significant decline in pasture biomass between 1990 and 2010 (Table 8-1). This trend was larger attributable to low annual mean livestock available biomass during the 2000 – 2009 time period; in all six *soum*s, the mean annual livestock available biomass was significantly greater between 1990 and 1999 than between 2000 and 2009. Whilst the average maximum biomass in the six *soum*s assessed was less in the 2000 to 2009 period than the previous decade, the earlier 1971 – 1978 period at a similar desert steppe site (Lavenko and Karamysheva 1993) was also less than the 1990 to 1999 period. This suggests a 20 year dataset may not have been long enough to capture longer term trends in the variability of vegetation production. This highlights the risks of determining trends through the use of short-term datasets in environments that are temporally variable.

Vegetation production is closely coupled with annual precipitation in desert steppe areas (Von Wehrden and Wesche 2007). Given that vegetation production has significantly declined in Mongolian Gobi Desert study sites since 1990, the lack of a widespread significant decline in spring, summer and autumn precipitation (Table 8-1) over the last 20 years is surprising. Shifts in the temporality of key precipitation events, discussed earlier, may have been important. Changes in the seasonal distribution of rainfall may also have been important (Munkhtsetseg *et al.* 2007), particularly with the significant increase in temperatures in either summer or winter of four of the six *soum*s.

2.3.3. Seasonal grazing patterns

Chapter 4 suggested that winter/spring pastures have a higher risk of overgrazing than summer pastures. Mobility out of these pastures at key times may therefore have implications for rangeland condition. Around 29% of all herders interviewed during the summer and autumn of 2010 were in pastures that they described as ‘out of season’. That is, the seasonal pasture in which they self-identified as currently being located in was different to the pasture of the season in which they were interviewed. The majority of the 29% had stayed in their winter/spring camp of 2009/2010 into the summer/autumn of 2010, rather than moving away from their winter/spring camp. PUG herders were more likely to be in out of season pastures than Law on Land herders (33% cf 25%, n = 25 for both). It was not elicited whether levels of out of season grazing after the 2009/2010 *dzud* were higher or lower than in other years.

8.3 Indicators of rangeland condition

Indicators of rangeland condition can be used to assess both ‘faster’ variables that rapidly change with short-term precipitation patterns, and ‘slower’ variables that are more able to identify longer term changes in rangeland condition. This research assessed both types of variables, with an emphasis on ‘slower,’ soil based variables for the reasons described in Chapter 3.

For the study areas surveyed, *Stipa* spp. constituted about 32% (Table 8-2) of all vegetation patches recorded. Over 50% of individual plants were preferred or desirable species (Damiran 2005) for sheep, goats or camels, all year round. Approximately 20% were additionally preferred or desirable to most of the three livestock types, most of the year. The 'faster' indicator, aerial perennial cover, was low at between about 11 and 13% (Table 8-3).

The proportion of unpalatable plant species found during the survey was low. Perennial unpalatable species encountered that are commonly recognized as increasing under high grazing pressures (Sodnomdarjaa and Johnson 2003) were: *Artemisia adamsii* Bess, recorded twice (0.28% of perennials recorded); *Peganum nigellastrum* Bunge, also recorded twice; and *Atriplex sibirica* L., was recorded on one site. Although these species were not abundant on sites, they were also observed around winter camps, *soum* centres and areas immediately around permanent water points that had high livestock densities. These areas were not geographically representative and hence were not sampled.

Table 8-2 Palatability of the five most abundant perennial species along all rangeland condition survey lines. Palatability categories as per Damiran (2005). Dashes indicate data missing from this source. P = preferred. D = desirable. T = toxic. C = consumed but not preferred.

			Palatability			
Perennial species	%		**Jan - Mar**	**Apr - Jun**	**Jul - Sept**	**Oct - Dec**
Stipa spp.	32	Goats	P	P	P	P
		Sheep	P	P	P	P
		Camels	P	P	P	P
Allium polyrrhizum Turcz. Et Rgl	21	Goats	D	P	P	D
		Sheep	D	P	P	D
		Camels	D	P	P	D
Anabasis brevifolia C.A. Mey.	8	Goats	D	P	P	D
		Sheep	D	P	P	D
		Camels	D	T	C	D
Allium mongolicum Rgl	7	Goats	C	P	P	C
		Sheep	C	P	P	C
		Camels	-	-	-	-
Caragana spp[A].	5	-	-	-	-	-

[A] Palatability not defined as species not identified to species level.

About 55% of all perennial species were found to have flowered or seeded on at least one site by the time of the 2010 survey. In many areas herders said they had received winter/spring precipitation from the 2009/2010 *dzud* but not substantive spring/summer rainfall. This led to fast-growing *Allium* spp. species flowering or seeding but *Stipa* spp. often desiccating before reaching full maturity (herder accounts and own observations).

Cleistogenes sp. was rarely present, despite being cited as a dominant desert steppe species (Sodnomdarjaa and Johnson 2003).

Litter was neither incorporated into the soil, nor had it obviously been transported from off-site, being local in origin. This suggests that the litter had been deposited very recently, and that older litter had been utilised by livestock, disintegrated rapidly or removed through wind or water to sink zones either outside the desert steppe study area or into areas that were not chosen for study due to their lack of representativeness at the landscape scale.

‘Slower variables’ showed no significant difference, or inconsistent differences, between soil types (Table 8-3). The difference between the relative percentage of fine gravel between the soil types shown in Table 8-3 was weak but still significant at the $p < 0.10$ level ($p=0.064$). However individual post hoc tests using Tukey HSD tests showed no significant difference between soil types at $p \leq 0.05$. All other indicators shown in Table 8-3 did not have significant differences between soil types.

Soils were relatively unstable (as assessed by the slake test) (Table 8-3). There were no biological crusts in any soil type. Despite apparent inherent instability and the presence of a strong erosive vector (wind), there were very few signs of current accelerated erosion at the site scale. Signs of erosion, including rills, pedestals, hummocks, sheeting, terracettes, scalding or gullying were largely absent at the quadrat ($1m^2$) or site (up to 50 m) scale (Table 8-3). Most sites had an intact surface, except for a few sites with depositional features. The high percentage of gravel lag found on sites may have an armouring effect, accounting for the lack of erosional features at the site scale despite the inherently unstable soils. The lack of significant differences in indicators between soil types (see previous section) suggests that potential variations in soil types between institutional settings do not explain differences in indicators of rangeland condition between them.

Table 8-3 Site stability indicators (modified from Friedel *et al.* 1993 and Tongway 2008), presented by soil type (IUSS Working Group WRB 2007). N = number of subsamples (5 subsamples along 50 transects for soil-based indicators and aerial cover). Categorical data are rounded to one decimal point; percentage data are rounded to the nearest whole number. Data are means, with standard deviations in brackets.

Indicator	Description	Calcisol		Kastanozem		Regosol	
Aerial cover	%	11	(9.1)	13	(7.0)	11	(4.8)
Slake test	Score of 0 – 4 (0 = can't slake, 1= slakes within seconds, 4 = intact)	1.3	(0.8)	1.0	(0.2)	1.6	(0.5)
Crust brokenness	Score of 0 – 4 (0 = no crust, 1 = extremely broken, 4 = intact)	1.5	(1.9)	0.9	(1.7)	0	(0)
Texture	Score of 1 – 4 (1 = clay, 4 = sand)	2.8	(0.7)	3.2	(0.9)	2.0	(0)
Deposited materials	Score of 1 – 4 (1 = >50%, 4 = <5%)	3.7	(0.8)	3.8	(0.7)	4.0	(0)
Litter cover	%	1.4	(1.8)	1.2	(0.9)	1	(0)
Erosion extent	Presence = 1, Absence = 0	0.1	(0.3)	0.04	(0.1)	0	(0)
Erosion severity	Score of 1 – 4 (1 = least severe, 4 = most severe)	0.2	(0.5)	0.0	(0.2)	0	(0)
Erosion type	Rilling/Pedestals/Hummocking/Sheeting/Terracettes/Scalding/Gullying	H, S		H		-	
Topsoil intact	%	90	(30.5)	94	23.4)	87	(35.2)
Topsoil eroding	%	1	(12.0)	0	(0.0)	0	(0.0)
Mobile sandy deposits	%	3	(17.7)	1	(12.0)	0	(0.0)
Depositional mobile sand	%	9	(28.3)	4	(19.6)	13	(35.2)
Bare	%	47	18.6)	49	(20.2)	37	(21.4)
Fine gravel	%	40	(20.8)	38.9	18.7)	52	(21.2)
Coarse gravel	%	12	(11.4)	11	(9.1)	12	(5.6)

8.4 Rangeland condition and institutional settings

The lack of difference in soil types (Table 8-3) suggests that soil characteristics should not confound a comparison of rangeland condition indicators in different institutional settings. Rangeland condition had a mixed relationship with bureaucratic institutions settings (Table 8-4). Many indicators of rangeland condition were not significantly different between PUG and Law on Land areas. However there were significant differences between some indicators of rangeland condition when steppe-like PUG, gobi-like PUG and Law on Land areas were compared. Overall, the steppe-like PUG appeared to be in slightly better rangeland condition than either gobi-like PUG or Law on Land areas. There appeared to be no consistent difference in indicators between gobi-like PUG and Law on Land areas.

Utilisation levels of vegetation by livestock were low at the time of assessment, across both PUG and Law on Land institutional settings. Utilisation levels of vegetation by livestock were slightly higher at Law on Land sites, followed by steppe-like PUGs then gobi-like PUGs (12, 10 and 7% of all sites showing defoliation, respectively). The order was the same for the presence of livestock manure (32, 20 and 13%, respectively). Twelve percent of Law on Land sites had livestock pads/tracks, whereas none were found at either of the PUG groups.

Law on Land sites had less aerial cover than steppe-like PUG sites (p=0.000, see Table 8-4 for sample sizes), with steppe-like PUG sites also having higher cover than gobi-like PUG sites (p=0.003). Percentage bare ground was significantly higher in Law on Land sites than steppe-like PUG sites (p=0.022) while gobi-like PUG sites had significantly more bare ground than steppe-like PUG sites (p=0.022). Law on Land sites had less coarse gravel than steppe-like PUG sites (p = 0.049).

Of the categorical indicators, the slake test recorded higher values (p=0.033) for steppe-like PUG sites than Law on Land sites indicating steppe-like PUG sites maintained structure for longer when immersed. This was also the case when compared to gobi-like PUG sites (p=0.008). Steppe-like PUG and Law on Land sites had higher crust brokenness scores than gobi-like PUG sites (p = 0.000 for both). Law on Land sites had more broken sites than gobi-like PUG sites (p=0.000). Gobi-like PUG sites had sandier soils than both Law on Land sites (p=0.000) and steppe-like PUG sites (p = 0.000). Law on Land sites were more sandy than steppe-like PUG sites (p = 0.000).

Law on Land sites had more litter than gobi-like PUG sites ($p=0.003$). Litter was local in origin and was not incorporated into the soil surface at all sites. There were significant differences in the proportion of sites that had a surface of depositional mobile sand ($p = 0.017$). Steppe-like PUG sites had a lower proportion than the gobi-like PUG sites ($p = 0.04$), and Law on Land sites had more surfaces of depositional mobile sand than steppe-like PUG sites ($p = 0.018$). Mobile sand deposits were greater in gobi-PUG sites than either Law on Land or steppe-like PUG sites ($p = 0.023$ and $p = 0.029$, respectively). The erosion extent in gobi-like PUG sites was greater than in steppe-like PUG sites ($p = 0.017$). Erosion severity was similarly greater in gobi-like PUG sites than in steppe-like PUG sites ($p = 0.007$). Biological crusts were absent at all sites. All other indicators were not significantly different between bureaucratic institutional settings.

Table 8-4 Indicators of rangeland condition, separated by institutional setting. Means are presented, with standard deviations in brackets. Asterisked indicators have significant differences between at least two treatment pairs at $p \leq 0.05$. Law on Land n = 125, Steppe-like PUG N = 50, Gobi-like PUG N = 75.

Indicator	**Description**	**Law on Land**	**Steppe-like PUG**	**Gobi-like PUG**
Aerial vegetation cover *	% per site	9.5 (7.5)	15.8 (6.1)	10.4 (5.0)
Slake test*	Score of 0 – 4 (0 = can't slake, 1= slakes within seconds, 4 = intact)	1.3 (0.7)	1.5 (0.7)	1.2 (0.8)
Crust brokenness*	Score of 0 – 4 (0 = no crust, 1 = extremely broken, 4 = intact)	2.0 (1.9)	2.3 (1.8)	0.7 (1.4)
Texture*	Score of 1 – 4 (1 = clay, 4 = sand)	2.7 (0.7)	2.2 (0.4)	3.3 (0.7)
Deposited materials	Score of 1 – 4 (1 = >50%, 4 = <5%)	3.7(0.6)	3.9 (0.3)	3.8 (0.6)
Litter cover*	% per site	1.3 (1.0)	1.3 (1.1)	1.0 (0.5)
Erosion extent	Presence = 1, Absence = 0	0.11 (0.31)	0.02 (0.14)	0.17 (0.38)
Erosion severity	Score of 1 – 4 (1 = least severe, 4 = most severe)	0.14 (0.42)	0.02 (0.14)	0.26 (0.58)
Erosion type	Rilling/Pedestals/Hummocking/Sheeting/Terracettes/Scalding/Gullying	H, Sc	-	H
Topsoil intact	%	92 (90)	98 (14.0)	89 (32.0)
Topsoil eroding	%	0 (0.0)	2 (14.0)	0 (0.0)
Mobile sandy deposits*	%	0 (0.0)	0 (0.0)	9 (29.0)
Depositional mobile sand*	%	10(30.0)	0 (0.0)	6 (24.0)
Bare*	%	49.6 (17.8)	39.8 (18.7)	47 (24.1)
Fine gravel	%	39.9 (18.3)	43.6 (17.9)	42.2 (22.3)
Coarse gravel	%	12.5 (10.9)	14.9 (10.3)	12.8 (11.2)

In terms of proportional length along the transect line, steppe-like PUG sites were about 21% patch and 79% interpatch. Gobi-like PUG sites were 23% patch and 77% interpatch. Gobi-like PUG sites had a larger proportion of rock armouring contributing to patch length than steppe-like PUG sites, (55% of all patch length in gobi-like PUG sites compared to 47%). Law on Land sites had a smaller patch proportion at 13% patch, 87% interpatch. Basal cover was about 11% in both PUG institutional settings, and sprouted perennial vegetation 7% in Law on Land settings. An additional 8% of patches at Law on Land sites were classified as unsprouted *Allium* spp. culms, making the total basal vegetation cover about 15%.

8.5 Changes in rangeland condition

8.5.1 Herder accounts

Mongolian herders were asked ‘has there been any change in the pasture since you started herding?’ Primary respondents (n=50) had spent an average of 22 years herding (minimum of 8 and maximum of 30). Their answers generally did not differentiate between cause and effect as understood by current western rangeland science. Their answers generally depended upon whether they understood ‘change’ to mean that pasture had changed as would, or would not, have been expected with spatio-temporally variable rainfall patterns, and did not substantially vary between demographic features such as the average number of years spent herding. The type of changes most frequently cited were climatic (Table 8-5).

Table 8-5 Reasons cited by herders for change in the rangeland since they had begun herding. % = percentage of total responses by herders. Data is rounded to the nearest whole number, which is explains why cited reasons add to more than 100%.

Categories of change		**Specific change**	**%**
Climate variability	Quantity of rain	No/less rain	33
	Changes in nature of rain	Torrential rains so water doesn't penetrate the soil	9
		Decline in number of rainy days	7
		Late rain	7
		Chinese rain-seeding programme	2
		More 'windy rain' now	2
		Lack of summer rain	2
		More moisture from snow, less from rain	2
Biophysical changes	Vegetation	The roots are dead	2
	Soil	Dust-storms and/or sandstorms and/or dust	7
		More sand	7
		Reduced soil fertility	2
Social causes, not herder mediated		More roads creating dust	7
		Mining (or a named mine), or 'digging the topsoil'[A]	7
		The democratic revolution[B]	2
Social causes, herder mediated	Grazing	Animals eating grass roots	2
	Not grazing	Some grasses stop growing when we cut them for hay	2

[A] ‘Digging the topsoil’ is understood by some Mongolians to cause significant damage via a spiritual pathway, above and beyond localised biophysical affects (Humphrey 1978; Humphrey 1993), [B] It is unclear what was meant by the response.

Vegetation changes were linked to the climatic changes described in Table 8-5. Of the herders who said there had been change, most referred to changes in the quantity or quality of forage available, for example:

'*The grass has changed a lot.* Mongol [Stipa *spp.*] *was here in the past but doesn't grow anymore.* Khazaar [Cleistogenes *sp.*] *has not been growing in the last few years.* Khazaar *and* ders [Achnatherum splendens *(Trin.) Nevski*] *have almost become absent. This year we saw some* ders *for the first time after years of drought*.' (Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding)

Fifty percent of the 39 changes cited by herders in Table 8-5 involved a decline in the abundance or distribution of an individual plant species (Table 8-6). Twelve species were reported to have declined. The key forage species *Stipa* spp. and *Cleistogenes* sp. were the most reported but as this study did not test herder knowledge about plant species, it is difficult to tell whether changes in these two species were most cited because they exhibited the most significant declines, or whether herders were more familiar with these two species due to their physical distinctiveness, importance to pastoralism etc. Thirteen percent (n = 5) of reports involved increases in abundance or distribution, notably Nitraria sp. Twenty six percent (n = 10) of responses referred to a change in the spatial distribution of plant species, with *Allium polyrrhizum* Turcz. et Rgl reported six times. Changes in the abundance, location or frequency of individual plants through time were also noted amongst both *Stipa* spp. and *Artemisia* spp. (5%, n = 2) There were two phenological changes (changes in flowering patterns) noted in *Caragana* spp. and *Artemisia* spp. (5%).

Table 8-6 Herder observations of changes in plant species. Life-form categories as per Sodnomdarjaa and Johnson (2003): XPS = xerophytic perennial grass, XPF = xerophytic perennial forb, LPG = large perennial grass, SU = species unknown, PS = perennial shrub, PH = perennial herb, WF = weedy forb. The 'development cycle' column is left blank if the individual species is not known. The 'herder comments' column is left blank if herders did not elaborate further than the species name and the basic type of change. Years = number of years the herder had been herding livestock. Herders provided the common Mongolian name for a species that they felt had changed in distribution/density since they began herding. This scientific name was then identified by crosschecking them against the common names described by Sodnomdarjaa and Johnson (2003). If appropriate common names were missing from Sodnomdarjaa and Johnson (2003), the Mongolian common name is retained. Common names are often difficult to relate to scientific names and, as such, the scientific names used here should be treated cautiously.

Herder ID	Institutional setting	Location	Years	Species	Form	Development cycle	Type of change	Herder comments
OA8	Law on Land	Sevrei *soum*, Omnogobi *aimag*	30	*Stipa* sp.	XPS	-	Distribution is more temporally patchy	-
				Artemisia sp.	SU	-	Distribution is more temporally patchy	-
OA9	Law on Land	Sevrei *soum*, Omnogobi *aimag*	>30	*Artemisia* sp.	SU	Species unknown	Only just surviving, not reproducing	'*Allium polyrrhizum* Turcz. et Rgl and *Artemisia* sp. are just growing, not more, because there's no rain. *Tsagaald* and *Yahuyaga* are not growing anymore'
				Allium polyrrhizum Turcz. et Rgl	XPF	Initiates growth quickly after rain. Flowers Jul-Aug, seeds late Aug/Sept.	Fluctuates with rainfall	
				(*Tsagaald*)	SU	Species unknown	Decline[A]	
				(*Yahuyaga*)	SU	Species unknown	Decline	
OA10	Law on Land	Tsogtseggi *soum*, Omnogobi *aimag*	25	*Stipa mongolorum*	XPS	Blooms in July, seed matures Aug	Decline	'During the last 2 – 3 years the plants have become rare. During the last 5 – 6 years we have not seen such grasses. Before it was better. Well, almost since the 1990s. This year we saw some *Achnatherum splendens* (Trin.) Nevski for the first time after years of drought. *C. songorica* has changed in the last few years.'
				Cleistogenes songorica Roshev	XPS	Blooms July, seed matures Aug. Growth cycle lasts 90 days.	Decline	
				Achnatherum splendens (Trin.) Nevski	LPG	Growth begins early May, blooms Jul, seed matures late Aug-early Sept	Decline	

Herder ID	**Institutional setting**	**Location**	**Years**	**Species**	**Form**	**Development cycle**	**Type of change**	**Herder comments**
OA17	Law on Land	Manlai *soum*, Omnogobi *aimag*	10	(*Shivee*)	XPS	-	Increase	'I don't know why [these changes have happened]. Maybe because of the late, or less, rain. [Rain usually comes] in late spring/early summer. [Now it comes] in late summer, and there is less.'
				Cleistogenes songorica Roshev	XPS	Blooms Jul, seed matures Aug. 90 days growth cycle.	Decline	
				Stipa mongolicum Rgl	XPS	Blooms Jul, seed matures Aug.	Decline	
				Allium polyrrhizum Turcz. et Rgl	XPS	Grows quickly after rain. Flowers Jul-Aug, seeds late Aug/Sept.	Fluctuates with rainfall	
				'Weeds'	SU	-		
OA23	Law on Land	Tsogtovoo *soum*, Omnogobi *aimag*	30	*Allium mongolicum* Rgl	XPS	Germinate quickly post-rain. Flowers Jul-Aug, seed matures Sept.	Fluctuates with rainfall	'[The rain] used to start in June/July, now [it rains in] August/September. When [the rain is] late, *Allium mongolicum* Rgl and *Allium polyrrhizum* Turcz. et Rgl grow but others like *Stipa* sp. and *Cleistogenes songorica* don't'
				Allium polyrrhizum Turcz. et Rgl	XPS	Grows quickly after rain. Flowers Jul-Aug, seeds late Aug/Sept.	Fluctuates with rainfall	-
OA24	Law on Land	Tsogtovoo *soum*, Omnogobi *aimag*	25	*Allium mongolicum* Rgl	XPS	Germinate quickly post-rain. Flowers Jul-Aug, seed matures Sept.	Proportionally increased	'*Stipa* sp. must have early rain'
				Allium polyrrhizum Turcz. et Rgl	XPS	Grows quickly after rain. Flowers Jul-Aug, seeds late Aug/Sept.	Proportionally increased	
				(*Khiag*)	SU	Species unknown	Decline	

Herder ID	**Institutional setting**	**Location**	**Years**	**Species**	**Form**	**Development cycle**	**Type of change**	**Herder comments**
				Cleistogenes songorica Roshev	XPS	Blooms Jul, seed matures Aug. Growth cycle 90 days.	Decline	
				Stipa sp.	SU	Species unknown	Decline	
UlCMA16	PUG	Ulziit *soum*, Dundgobi *aimag*	15	'Weeds'	SU	Species unknown	Decline	'The plants are growing worse, even the weeds are not growing'
UlCMA18	PUG	Ulziit *soum*, Dundgobi *aimag*	25	(*Tsagaalj*)	SU	Species unknown	Decline	
				Stipa sp.	SU	Species unknown	Decline	-
				(*Khamkhaag*)	WF	Unknown	Increase	
UlCMA19	PUG	Ulziit *soum*, Dundgobi *aimag*	*25*	*Stipa mongolorum Rgl*	XPS	Blooms Jul, seed matures in Aug	Decline	'*Stipa mongolorum* Rgl is rare but it needs rain in spring'
				Caragana sp.	PS	Species dependent	Flowers less often	-
				(*Khamkhaag*)	WF	Species unknown	Increase	
UlCMA25	PUG	Ulziit *soum*, Dundgobi *aimag*	15	'Thorny shrubs'	SU	Species unknown	Decline	'The shrubs with thorns are less because sand covers them and the water can't reach the roots'
BaCMA03	PUG	Bayandalai *soum*, Omnogobi *aimag*	15	*Allium* spp.	XPF	Initiates growth quickly after rain. Flowers Jul-Aug, seeds later Aug/Sept.	Decline	'In my land the *Allium* spp. have disappeared in the last 3 – 4 years due to a lack of rain.'

Herder ID	**Institutional setting**	**Location**	**Years**	**Species**	**Form**	**Development cycle**	**Type of change**	**Herder comments**
BaCMA03a	PUG	Bayandalai *soum*, Omnogobi *aimag*	Herding since the 1990s	*Allium mongolicum* Rgl	XPF	Germinate quickly post-rain. Flowers Jul-Aug, seed matures Sept.	Fluctuates with rainfall	'In my area, there has been no rain, not even late rain, just snow growth. *Allium mongolicum* Rgl and *Allium polyrrhizum* Turcz. et Rgl. have not been growing.'
				Allium polyrrhizum Turcz. et Rgl.	XPF	Grows quickly after rain. Flowers Jul-Aug, seeds late Aug/Sept.	Fluctuates with rainfall	
BuCMA01	PUG	Bulgan *soum*, Omnogobi *aimag*	15	Achnatherum splendens (Trin.) Nevski	LPG	Begins to grow early May, blooms Jul, seed matures late Aug/early Sept	Not growing in the same places	-
				(Yahuyaga)	SU	Species unknown	Decline	
BuCMA02	PUG	Bulgan *soum*, Omnogobi *aimag*	>30	*Allium polyrrhizum* Turcz. et Rgl	XPF	Grows quickly after rain. Flowers Jul-Aug, seeds late Aug/Sept.	Presence	'*Allium polyrrhizum* Turcz. et Rgl is growing this year due to winter snow'
BuCMA04	PUG	Bulgan *soum*, Omnogobi *aimag*	25	*Allium polyrrhizum* Turcz. et Rgl	XPF	Grows quickly after rain. Flowers Jul-Aug, seeds late Aug/Sept.	Needs more rain to grow	'*Allium polyrrhizum* Turcz. et Rgl needs more rain to grow. Before it regrew after 2 – 3 rains, now I'm not sure how much rain it needs before it grows.'
BuCMA05	PUG	Bulgan *soum*, Omnogobi *aimag*	25	*Artemisia xerophytica* Krasch.	PH	Flowers in Jul, seed matures Aug	Decline	
				(*Zeergene*)	SU	Unknown species	Decline	-

[A] 'Decline' should not be read as a permanent loss from the system as the respondent may have meant the species were not present in recent years due to, for example, rainfall.

Most herders who gave an affirmative response to the interview question 'Has there been any change in the pasture since you started herding?' attributed the cause to changes in the amount or nature of precipitation. No Mongolian herder directly associated livestock grazing pressure with changes in rangeland condition (Table 8-5). This perspective does not suggest that herders believed the forage resource to always be in surplus, but rather:

'*Herders can not have any influence* [on the pasture]' (Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding).

Herders who gave a negative response to the question 'Has there been any change in the pasture since you started herding?' also commonly suggested that pasture had not changed because vegetation attributes were primarily rainfall dependent, for example:

'*Depending on the condition of the year, the quality* [of the pasture] *is different. In good years it is good.* [There is] *no change* [since I started herding]' (Tsogt-ovoo *soum*, Omnogobi *aimag*, 15 years herding)

'*The* [forage] *quality is the same,* [but] *the amount is less because there is less rain.*' (Bulgan *soum*, Omnogobi *aimag*, 25 years herding)

The belief of some herders that grazing pressures do not affect rangeland condition conflict with observations by Sasaki *et al.* (2005) of low levels of vegetation cover and a dominance of unpalatable species around permanent water points in desert steppe areas, a disconnect which is further discussed in Chapter 10.

Herders within the Inner Mongolian study sites were also asked about change in the rangeland. Primary respondents for the Inner Mongolian households interviewed had spent an average of 24 years (min 10, max 30). Around 90% of (n=21) herders offered an opinion on whether their rangeland area had changed since they started herding. Of the 19 herders that had noted a change in the rangeland, 79% of these noted a change in the vegetation whilst 11% noted a change in one or more aspects of the soil. Changes in the soil consisted of '*more sand now, desertification*' (Household Responsibility System, Char Gar Handa, 30 years herding), a change that the grazing ban was believed to have ameliorated by one herder (Household Responsibility System, Shont, 25 years herding). One herder stated that:

'*All the pasture is bad* [now compared to when they first starting herding], *not just certain plant species'* (Household Responsibility System, Bayanbulag, 25 years herding)

The forage resource was believed by respondents to be larger in the past. There were mixed opinions from Inner Mongolian herders about whether it had improved or not in with the grazing bans in more recent years. When asked about the time period in which they first started noticing a decline in the forage resource, herders gave varying answers regardless of the length of time they had been herding. That is, when change first occurred was not related to a herder's level of herding experience. For example, compare:

'*The pasture has changed in recent years. It is drier here, the plants are worse. This started happening from 5 – 6 years ago*' (Household Responsibility System, Chargaan choluu tuu, 30 years herding), with

'*The pasture has changed in recent years. There is more sand now, desertification. This has happened since about 1980*.' (Household Responsibility System, Cbar Gar Handa, 30 years herding)

Inner Mongolian herders were more likely to attribute changes in the forage resource to livestock grazing than Mongolian herders. Nevertheless the number of Inner Mongolian herders that cited declining precipitation as at least a partial cause of a declining forage resource (72%, n=16) was still greater than those that cited livestock grazing as a sole or partial cause. About 31% (n=16) of herders that had described a change in the rangeland in recent years directly attributed it to livestock (at least in part), or had stated that the pasture had improved because of the grazing ban. In contrast, no Mongolian herder linking grazing pressures to changes in the rangeland.

8.6 Comparing biophysical data with the perspectives of herders and local officials

Climate information obtained for Inner Mongolia was of too short a time period to compare herder accounts and empirical data, but these two datasets can be compared in Mongolia. There is a partial conflict between precipitation records and herder accounts of precipitation changes in Mongolian study sites. The change in precipitation most commonly cited by Mongolian herders - 'no/less rain' (Table 8-5) - was not supported by changes in monthly precipitation totals over the last 20 years (Table 8-1). 'Lack of summer rain' (Table 8-5) was only significantly supported by Ulziit *soum* rainfall trends although a non-significant decline was found in all *soum*s. 'Late rain' was not supported by trends in monthly precipitation records in selected *soum*s for the 1990 – 2010 period if a decline in spring/summer precipitation and an increase in autumn precipitation is the indicator used. 'More moisture from snow, less from rain' was not supported if an increase in winter precipitation and decline in non-winter precipitation is used. 'More windy rain now,' 'torrential rains so water doesn't penetrate soil' and 'decline in number of rainy days' could not be tested using available secondary data.

Whilst it is tempting to suggest that herders were attributing declines in the forage resource to changes in climatic variables rather than overgrazing, there was a lack of widespread, significant degradation found in this study, and total grazing pressures had declined. The assertion by some Mongolian herders that forage quantity was less in more recent years than when they first started herding was supported by livestock-available biomass data (Table 8-1). This suggests that biophysical changes other than grazing pressures may have affected forage availability.

Biophysical changes may have included changes in precipitation patterns at different scales to that detected by meteorological stations. Herders considered summer rainfall to be the most effective form of precipitation for vegetation growth. It may be that herders believe that this type of precipitation 'is less now' particularly if individual precipitation events had shifted from low to high intensity, reducing the ability of vegetation to convert precipitation into biomass. Indeed, the decline in precipitation and later rain in summer/autumn reported by many interviewees has also been recorded by Marin (2010) in slightly more northern parts of Dundgobi *aimag*. Von Wehrden *et al.* (2010) and Liang *et al.* (2002) additionally suggest that the absence of suitable rain at a key point at the beginning of the Inner Asian growing season may be important in determining vegetation dynamics. The temperature changes described in Table 8-1 and by Munkhtsetseg *et al.* (2007) may also affect vegetation productivity, and it is possible that herders falsely attribute changes in biomass to precipitation changes because they are more familiar with precipitation variability between years than temperature variability.

All five Mongolian *soum* officials interviewed believed that the existence of PUGs had little significant impact on rangeland condition. This was largely due to their perception that PUG institutions fail with time. There were two main reasons cited by herders for why PUG institutions failed and therefore had little impact on rangeland condition. These were the need for groups to disband given precipitation variability, and/or the disintegration of groups once their funding/external support had finished (see Chapter 5).

As the Bayandalai *soum* official explained:

'*Herder groups, like Ireedui* [PUG], *were originally established for pasture protection. These groups were active when there was funding, but became inactive when funds ended. They have not been sustainable. The groups work whilst there is someone full-time organising activities. When these people leave back to Ulaanbaatar, their role is transferred to a herder who is too busy with other work to organise such activities. The philosophy of such groups is that if they stay together they will benefit. But moving in groups in hard times is bad. It creates more conflict in new areas – it is easier to negotiate access to forage if there is one family only*.'

The Bulgan *soum* official believed that PUG institutions are better able to be maintained in areas inside the Gobi Gurvan Saikhan Strictly Protected Area because forage variability was lower in its steppe-like landscape (an assumption that was only partially supported by biophysical evidence – see Chapter 4). However, he also stated that:

'*There isn't any relationship between herder groups and pasture quality.*'

This perspective may conflict with some indicators that suggested rangeland condition was better in the steppe-like PUG area than Law on Land areas (Table 8-4). However Mongolian herders did not equate grazing pressures, or pastoral activities in general, with changes in rangeland condition (see Table 8-5). PUG herders did not attempt to regulate grazing pressures for the purposes of improving rangeland condition (Chapter 6). Herders did not relate bureaucratic institutional settings with changes in rangeland condition.

Local officials in Inner Mongolia believed that the Household Responsibility System had been beneficial to rangeland condition. The Damao grassland officer tended to emphasise environmental benefits, as '*herders now care about and look after their grassland much better. The grassland is now in better condition'* (Damao grassland officer, 2010). In contrast, the grassland officer from Urat Rear Banner, an area with a higher precipitation coefficient of variability (see Figure 4-1), emphasised benefits not related to rangeland condition, stating that '*the nation can protect herder use rights and everyone has their own land. If the government wants to use this land, they must pay compensation*' (Urat Rear Banner grassland officer, 2010). Many Damao herders concurred with the former statement that the grasslands are in better condition now, but they varied in whether they attributed this to the grazing ban, precipitation events or the exclusivity of grazing rights under the Household Responsibility System.

8.7 Summary and Discussion

In contrast to assumptions of widespread degradation, this research found little evidence of widespread, land degradation in the Mongolian Gobi Desert that could be attributed to overutilization by livestock. This finding concurs with the meta-analysis of Von Wehrden *et al.* (2012) that found zonal, grazing mediated degradation (away from waterpoints and riparian areas where vegetation responses are less affected by short-term precipitation events) is rarely reported in landscapes with a CV of precipitation above 33%. Whilst rangeland condition was not surveyed in Inner Mongolia, it is of note that the Damao official in Inner Mongolia (CV < 33%) described rangeland condition benefits associated with bureaucratic institutional settings whilst the Urat Rear Banner official (CV > 33%) did not (Figure 4-1).

The lack of evidence for degradation shown in this chapter, and the relatively low levels of unnegotiable conflict shown in Section 6.5, were despite a decline in both empirically measured and herder-cited livestock available biomass in Mongolia between 1990 and 2010. A significant decline in total grazing pressures in three of five *soum*s assessed (Table 8-1) may have off-set reduced forage inputs after the *negdel* area. The greater volatility in livestock numbers since the 1990s may have also had a positive effect on rangeland condition for the reasons described in Chapters 2 and 4.

Many indicators of rangeland condition were not significantly different between PUG and Law on Land areas. However there were significant differences between some indicators of rangeland condition when steppe-like PUGs, gobi-like PUGs and Law on Land areas were compared. The steppe-like PUG appeared to be in slightly better rangeland condition than either gobi-like PUG or Law on Land areas. Leisher *et al*. (2012) also found that remotely sensed NDVI, an indicator of vegetation production, was higher in steppe-like PUG areas than areas outside the PUG in Omnogobi *aimag*. There appeared to be no clear trend in indicators between gobi-like PUGs and Law on Land areas.

Changes in soil-based indicators may take more time to become apparent in the Gobi Desert than the length of time since the gobi-like PUG was established. It is possible that improvements in indicators of rangeland condition were not yet detectable in the gobi-like PUG that was established only three years before assessement. However it is not clear how the steppe-like PUG's institutions (Chapters 5 and 6) or tools for managing the risk of feed gaps (Chapter 7) may have improved rangeland condition. Chapter 5 found few institutions by which PUGs could have contributed to improved rangeland condition over and above those of the Law on Land. There were no institutions regulating grazing pressures through reduced herd sizes, or prohibiting other herders from accessing PUG areas.

The importance of recognising spatial scale is illustrated by the disconnect between the presence of pan-continental spring dust-storm deposits believed to originate in the Gobi Desert (Heald *et al.* 2006), and the absence of accelerated erosion features observed at the site scale in Mongolia during this assessment. One explanation for this is that accelerated erosion or deposition occurred in areas deliberately not targeted for assessment because they were 'unrepresentative' – that is, large gullies, internal drainage depressions or steep slopes. The lack of litter incorporation found in this study also suggests that older litter had been utilised by livestock (although this is unlikely due to low utilisation rates), disintegrated rapidly or removed through wind or water to sink zones outside the assessed desert steppe area, the latter supporting the idea of a spatial scale mismatch between erosive vectors and rangeland condition surveys.

Despite this potential scale mismatch, this thesis' quadrat size ($1m^2$) was typical of most pasture assessments conducted in the Gobi Desert (see Chapter 3), and the site sampling regime was designed to be representative of pastures at the landscape scale. The spatial scale of rangeland condition assessments used here, and by others, may not target the scale of these erosive vectors, as was found to be the case in other arid or semi-arid rangelands (Friedel 1994; Pringle *et al.* 2006). An alternative explanation for the disconnect between dust-storms and a lack of accelerated erosive features found in this study is that the Mongolian desert steppe areas assessed in this survey are not a significant source or sink of erosive material – that is, they are simply not degraded. Chapter 10 further integrates the results of the thesis chapters to further examine the low level of degradation found in this chapter, and the ability of PUGs to influence rangeland condition.

9 Livelihoods

9.1 Introduction

Patterns of land-use are a product of both livelihood resources and the ways in which these resources are utilised. As Chapter 2 and Scoones (1998) note, analysing aspects of livelihood resources and strategies for their use as separate entities is inappropriate. The institutional processes and organizational structures that link these livelihood resources and strategies must also be analysed. The relationships between institutional settings and herder livelihoods warrant examination in their own right for reasons that Chambers (1987) describe as ethical. However livelihoods and land-use are also intrinsically linked. A dryland herder constrained by institutional settings, and without the financial or social capital to respond to feed gaps, will be forced to overgraze. Thus an analysis of the current livelihoods of the resource users - herders - is needed to complement an analysis of rangeland condition and its causes.

Livelihoods are often defined as the capabilities, assets and activities required to ensure that stocks and flows of food and cash are enough to at least meet basic needs (Chambers and Conway 1992; Carswell 1997; Ellis 1999). The ability to cope with shocks and stresses by finding and making use of livelihood opportunities are included in the term ‘capabilities’ (Chambers and Conway 1992). Equity and sustainability are also important aspects of livelihoods. Equity is measured in terms of the relative distribution of income, assets, capabilities and opportunities (Chambers and Conway 1992). Sustainability refers to the ability to maintain and improve livelihoods whilst maintaining or improving assets and capabilities upon which these livelihoods depend (Chambers and Conway 1992).

A complete analysis of livelihoods, following conceptual frameworks such as the Sustainable Livelihood framework (Chambers and Conway 1991), has substantial information requirements (Krantz 2001). Many aspects of the relationships between institutional settings, livelihoods and rangeland condition are outside the scope of this research. Nevertheless, this research highlight key pastoral system attributes that fit within these conceptual models of livelihoods. Chapters 4 and 8 described the attributes of the rangeland resource, the tangible livelihood asset or ‘natural capital’ identified by Chambers and Conway (1992). Key shocks and stresses (Chambers and Conway 1992) to this asset/capital are described in Chapter 4 and Chapter 7. Chapter 7 also identified some of the ways in which herders managed shocks and stresses. Chapter 5 and Chapter 6 described the institutions of claim and access to tangible livelihood assets (Chambers and Conway 1992).

This chapter further explores i) current pastoral livelihoods, ii) the relationship between bureaucratic institutional settings and livelihoods, and iii) herder perspectives on their current and future livelihoods. The chapter uses key individual indicators of livelihoods, as well as surrogate indicators. The latter sum and weight the many aspects making up an individual's livelihood. The chapter foregrounds relationships between institutional settings and herder livelihoods where livelihood elements can constrain or mediate the choices that herders have for managing feed gaps. In doing so, the potential long-term viability of the current social-ecological system is explored.

9.2 Livelihood indicators

2.3.4. Wealth and food security

Household herd sizes are a key indicator of vulnerability to the types of climatic variability described in Chapter 4 (Janes 2010). Herd sizes are also considered by Mearns *et al.* (1992) to be one of the strongest indicators of household financial wealth in Mongolia and by herders interviewed for this research. This may be, in part, because herders with small herd sizes often lose a larger proportion of their herd than herders with larger herd sizes (Fernandez-Gimenez *et al*. 2012). Some herders in this study noted the importance of good quality livestock. However livestock quantity was generally preferred over quality despite the potential for herders to raise their income through having a smaller number of better quality livestock (not assessed here). Because herders may value large herds for non-economic reasons that were not explored in this study (see Chapter 2 for examples of this reasons), herd size is used as a herder-centred livelihood indicator in this study.

PUG herders had much larger mean, total herd sizes (mean=319, n=24) than Law on Land herders (mean=181, n=24). A greater proportion of Law on Land herds were distributed in the smaller herd sizes classes than were PUG herds (Figure 9-1). With an outlier PUG herd of 1001 head of livestock removed from calculations, PUG herders were still wealthier than Law on Land herders, with an average of 296 head of livestock per household compared to 181.

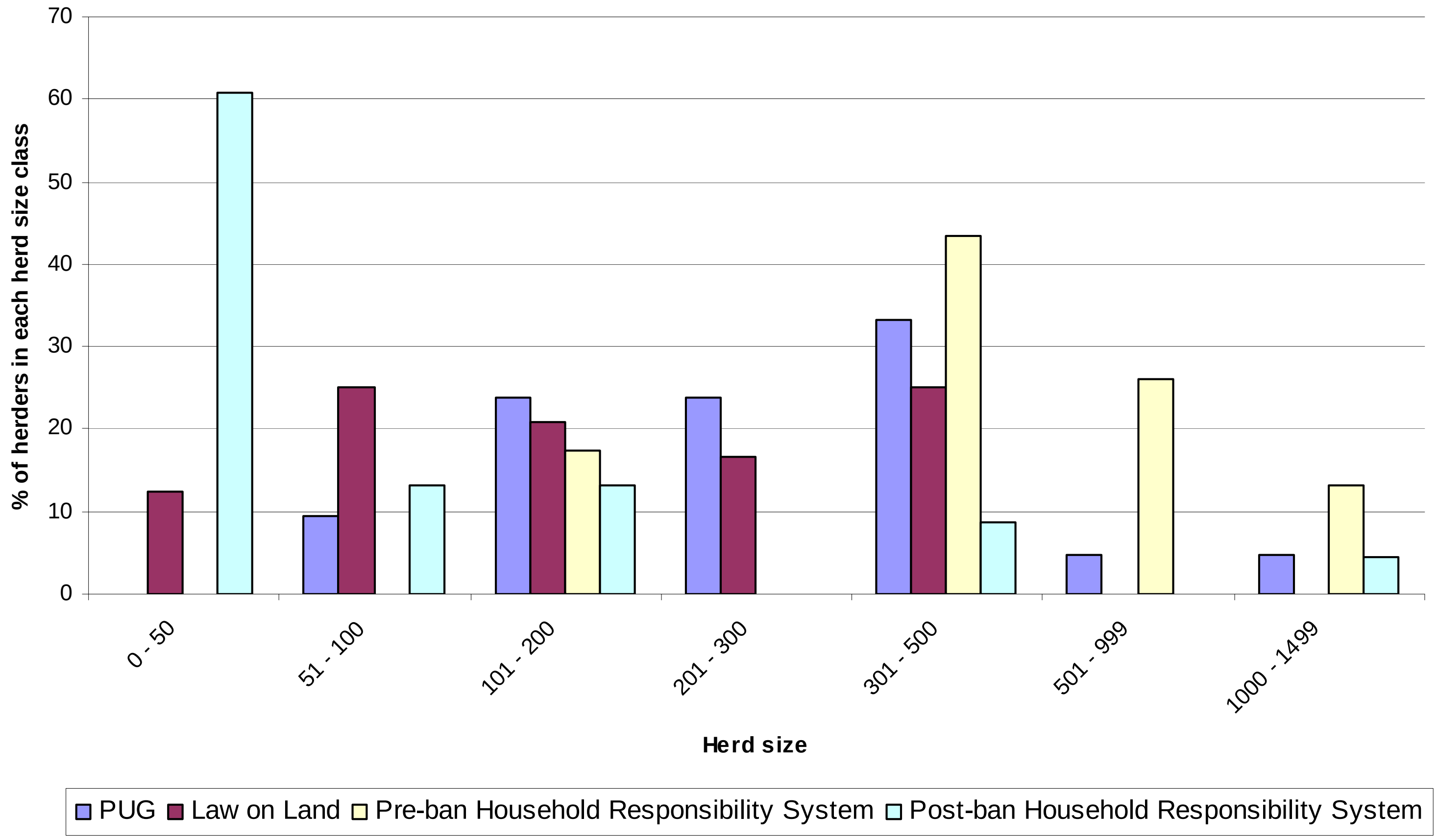


Figure 9-1 Proportion of herds in each size class, by institutional setting. Dairy cows belonging to Household Responsibility System herders since the grazing ban have been excluded from this figure.

PUG herd sizes were slightly less variable (inequitable) than Law on Land herd sizes, with a coefficient of variation of herd size of 0.63 compared to 0.69 (with the outlier retained). No PUG herder was classed as ‘very poor’ using Mearns’ (2004) indicator of a total herd size of 50 or less. No Law on Land herder was classed as ‘wealthy’ using Mearns’ (2004) indicator of a total herd size more than 500.

Prior to the grazing ban, Inner Mongolian herders (n=22) had much larger herd sizes than either PUG or Law on Land herders. Even after an outlier of 2,040 head of livestock was removed from Inner Mongolian data, herd sizes were still much larger (471) in Household Responsibility Systems than in either PUG or Law on Land areas in Mongolia. The Household Responsibility System showed higher levels of wealth inequality between herders than either Law on Land or PUG herders, as indicated by the variability of herd size between herders, with a CV of 0.77.

Mearns *et al.* (1992) found that herd composition was considered by Mongolian herders to be an important indicator of household financial wealth. Herders placed a high value upon self-sufficiency in meat and milk, meaning that a mixture of large and small stock was valued (also see Chapter 7). All three institutional settings were dominated by the goats and sheep that made up over 90% of all herds. Small numbers of cattle, horses and camels (less than 5%) made up the rest of each institutional setting’s herd. Consequently, this indicator suggests that wealth was similar between institutional settings.

Mearns *et al.* (1992) also found that herders saw power and status as a weak, but positive, indicator of wealth. They equated low power and status with a higher level of vulnerability to shocks and stresses. Power and status were not deliberately explored as part of this research, but interviews highlighted anecdotal cases where these forms of power and status may have reduced vulnerability. The following provides an example.

One of the steppe-like PUG herders was exceptionally wealthy by Mongolian standards, with about 1001 head of livestock. The herder’s sister, who also lived within the PUG area, was also very wealthy with about 700 livestock. The herder had been in a position of localised power as a *negdel* leader during the Socialist period. He was nationally recognised as being a successful herder. For example one herder interviewed in a different *soum*, who did not know him personally, stated that he was frequently on television. According to their interviews, this herder and his sister managed the irrigated agriculture plot within the PUG area that was funded by a development agency.

Social capital, and subsequent wealth, can be more easily obtained from a position of already high financial and social capital (Mearns 2004; Cleaver 2005), and the distribution of State assets in Mongolia during the early 1990s was known to be unequal (Mearns 2004). It is possible that the historical social standing of this man and his sister had helped them build their wealth, obtain the funding required to establish the PUG or have more discretion in how funds were managed once obtained. Higher levels of social status or power may have facilitated the establishment of the PUG in their area, and/or increased their access to the additional forage resources produced by PUG funding. This additional forage that they were able to produce as part of this PUG may have, in turn, reduced vulnerability to dry summers or cold winters. The dataset of this research cannot distinguish whether the livestock wealth of PUG herders was subsequent, and attributable, to PUG institutions and funding from development agencies, or whether herders with high levels of social power or status were able to influence the location of the PUG. These factors require more investigation before the greater wealth of PUG herders can be attributed to PUG institutions and activities.

Mearns *et al.* (1992) also associated age/experience with wealth amongst Mongolian herders, irrespective of actual herd sizes. This is because the term ‘wealth’ probably embodies the ability of herders to manage shocks and stresses – an ability that may increase with experience or networks accumulated over time. In contrast to herd size, this indicator of wealth does not suggest a difference in livelihoods between bureaucratic institutional settings. Whilst herders were not asked for their age, there was no difference in the average number of years that herders had been herding in Law on Land, PUG or Household Responsibility System areas.

Income diversity was low, with cashmere dominating household income streams across both Mongolian institutional settings. For many Inner Mongolian herders, the majority of their income came from government compensation (see Chapter 7 for a more complete discussion) but the diversity of their pre-grazing ban income was not ascertained in this research.

9.3.3 Accessing key resources

Secure access to resources is considered to be important for both the sustainable management of a resource, and for livelihoods (Chambers 1987). Vulnerability to *dzud* is a product of the access, entitlements and property (Murphy 2011). Winter/spring camps and pastures are a key resource for herders (see Chapter 4), and make an important contribution to what Chambers and Conway (1992) term the 'tangible asset' underpinning herder livelihoods. The ability to negotiate access to resources like a winter/spring camp, the 'intangible asset', has the potential to affect livelihoods (Murphy 2011). The manifestation of this ability is now discussed.

PUG and Law on Land herders were equally as likely to have a winter/spring camp registered under the Law on Land, with 96% of herders in each institutional setting having at least one camp (Table 9-1).

Table 9-1 Registration rates of winter/spring camps for each institutional settings. N=25 for each institutional setting

	PUG	Law on Land
Herders with a camp registered under the Law on Land (%)	96	96
Average no. of registered camps per household	1.4	1.1

The average number of livestock per household varied according to how many registered camps the herder household had rights over. Wealthier herders (as measured by herd size) were more likely to have legally recognised rights to multiple camps than poorer herders. Wealthier PUG herders were more likely to have more than one registered camp than poorer Law on Land herders. Herders that did not have legal rights to a winter/spring camp had 165 head of livestock on average but the sample size was low (n = 3, standard deviation = 56). This compared to 211 head of livestock for the average herder with legal rights to one winter/spring camp (n = 32, standard deviation = 143), and 373 (n = 15, standard deviation = 256) head of livestock for two registered camps, respectively.

The greater number of registered winter/spring camps for wealthier herders compared to poorer herders may not indicate their greater ability to negotiate access to key resources. The average herd size per registered camp was similar between herders with different numbers of registered camps, and some *soum* officials noted that they interpreted the

Law on Land to mean that more than one camp could be registered for herders with large herds (see Chapter 5).

Whilst bureaucratic rights under the Law on Land do not fully represent the ability of herders to access key resources (see Chapter 6), there was also relatively little difference in livestock wealth between herders that had informally rented winter/spring camps and those that had not. Consequently, the two indicators of the ability of herders to negotiate access to key resources, formally registered winter/spring camps, and the informal renting of winter/spring camps suggest that the wealthy are not any better than the poor at accessing key resources per livestock unit. However, the wealthy are better able to choose between multiple registered winter/spring camps, and are thus have more opportunity to manage the spatial variability of the winter forage resource under the Law on Land (see Chapter 4) than poorer herders.

There was a large difference in herd sizes between herders that were in their seasonal camps versus those that were not. Herders with greater livestock wealth were more likely to be in an ‘in season’ pasture. The average ‘out of season’ herder had 147 head of livestock (min 10, max 380), whilst the average ‘in season’ herder had 248 (min 16, max 1001). If the in-season herder with 1001 head is removed as an outlier, the average ‘in season’ herder had only 222 head of livestock (min 16, max 701). If a second herder with 701 head of livestock is also removed as an outlier, the average ‘in season’ livestock number per household is still greater than the average ‘out of season’ livestock number per household, namely 205 head as opposed to 147 head. There may be a relationship between relative level of poverty (as indicated by herd size – see Chapter 9) and mobility (as also found by Upton 2012). Poorer herders may be less able to afford fuel costs or, as they have fewer livestock, they may have less need to move to access new pastures as their livestock consume less forage than larger herds, or a combination of both. The proportion of livestock located in out of season camps was lower than the proportion of herders in out of season camps because of the lower number of head per herder in out of season camps. Only 24% of livestock were in out of season camps, as opposed to 29% of all herders.

9.3.3 Viability and vulnerability

Chapter 7 described the two main aims of Mongolian herders in relation to herd management of i) generating a cash income, and ii) food security. A tension exists between these two aims. An overreliance on a cash-generating asset (goats) that is vulnerable to cold winters potentially compromises food security. In the absence of other constraints, one way for a herder to resolve the tension between these two aims would be to increase both goat and non-goat herds to a point at which food security (mixed herd) and cash requirements (large number of goats) were both met. When asked whether he would try and increase the proportion of camels in his herd because they had lower mortality rates than goats during the last *dzud*, a Law on Land herder replied:

'*I will try and increase the number of big animals but they are slow to reproduce. We will therefore try and increase the number of small livestock because they are our main income*.' (Law on Land, Manlai *soum*, Omnogobi *aimag*, 15 years herding).

The two aims could be met when a minimum viable herd size was reached. Herders in both Mongolia and Inner Mongolia were asked what they saw as being the minimum number of livestock that their household needed for food security and cash needs (Table 9-2). Law on Land herders had the largest discrepancy between the herd size they felt they needed for subsistence, and the size of the herd they actually owned.

Table 9-2 Livestock wealth and minimum viable herd sizes per household, as stated by herders. Average herd size is the average total number of livestock, of any type, per household. MVHS = minimum viable herd size needed for a herder household.

	Average herd size	MVHS
PUG	326 (n=24)	323 (n = 17)
Law on Land	182 (n=24)	306 (n=18)
Household Responsibility System (pre-grazing ban)	540 (n=23)	435 (n=15)

Mongolian herders often stated that '*the minimum number depends on the household size*' (Law on Land, Manlai *soum*, Omnogobi *aimag*, 15 years herding), other factors or a combination of household size and other factors:

'*More than 300 livestock is needed, depending on family size. Or 200 goats are enough*.' (Law on Land, Tsogt-ovoo *soum*, Omnogobi *aimag*, 20 years herding)

The mean minimum viable herd size per household member was 68 (SD = 26), 71 (SD = 29) and 115 (SD = 46) head for PUG, Law on Land and Household Responsibility

System herders, respectively. Minimum viable herd sizes were only weakly correlated with the actual herd size of a household (r^2=0.0043 for a linear fit).

Although not empirically assessed, household demographics were also seen as important determinants of the minimum viable herd size for Mongolian herders. Fees for one child at university cost about 750,000T per year for teacher training, and 950,000T for agricultural training (PUG, Ulziit *soum*, Dundgobi *aimag*, 15 years herding). These figures can be 50 – 100% of a Mongolian herder household's annual cashmere clip (see Section 7.4), or equal to about 3 months' of the average monthly earnings of a Mongolian working in the agriculture, hunting and forestry sector in 2009 (National Statistical Office of Mongolia 2010). These fees were seen as a particularly significant financial outlay that required a higher initial herd size to manage. This outlay was perceived to be unobtainable for many:

'*400* [livestock] *is enough for us, but if children are at university, these costs… are high. Even without students at university in my bag there is no-one with 400 livestock. They mostly have 100.'* (Law on Land, Tsogt-ovoo *soum*, Omnogobi *aimag*, 15 years herding).

The reasons why herders could not obtain the herd size that they felt was the viable minimum was not specifically asked (see Section 3.4.4 for reasons), but in general Mongolian herders believed that climatic factors were the biggest threat to their livelihoods. One herder volunteered that:

'*The minimum* [viable herd size] *is 250 to 300. We were trying to reach this amount but then there was the* dzud.' (Law on Land, Manlai *soum*, Omnogobi *aimag*, 8 years herding)

A number of other factors constrained increasing herd sizes for all livestock types as a way of improving cash incomes and food security. Some Mongolian herders stated that there was a maximum viable herd size. At times, the margin between a minimum and maximum herd size was very narrow. One Law on Land herder (Manlai *soum*, Omnogobi *aimag*, 8 years herding) gave a minimum viable herd size of 250 – 300. They then went on to state that '*more animals than this can cause problems. 300 is the* *maximum*.' One of the main reasons cited for a maximum herd sizes was labour shortages. One herder stated:

'*A three person family needs 300 animals. Old people can't look after more than this. The maximum number of livestock our family could provide labour for is 200*.' (PUG, Bulgan *soum*, Omnogobi *aimag*, 25 years herding)

Another stated that:

'*A 3 person family needs about 200 livestock. Any more than this and costs for things like fodder start rising too much*.' (Law on Land, Sevrei *soum*, Omnogobi *aimag*, 30 years herding)

The management decisions of some Mongolian herders also suggested that increasing their herd sizes indefinitely was not always their primary aim. One herder described their attempts to stabilize herd size, although they did not cite whether the reason(s):

'*We have 400 goats, so there will be 100 babies. We will sell 100 to equalize the herd size*.' (PUG, Ulziit *soum*, 5 years herding)

Six of the 18 Law on Land herders that were asked about minimum viable herd sizes volunteered that herd sizes could become too large, or too difficult to manage. This compares to only one of the 17 PUG herders (who had larger mean herd sizes) volunteering the same information. It is unclear whether the sharing of labour amongst PUG herders contributed to fewer of them citing labour shortages as placing a restriction on herd sizes. It was also unclear whether such sharing might be due to factors that might have preceded or contributed to PUG formation – for example, higher levels of relatedness amongst PUG herders may have increased labour pooling.

Whilst shortage of labour was generally perceived to be a production system constraint to achieving both food security and cash income aims, the higher labour demands for 'large' livestock were a particular constraint to minimizing production (food security) risk. Only the wealthiest herders were able to split herds or hire labour, and these herders may have had atypically high levels of social power or status that allowed them to buffer the risk of feed gaps at key times since the 1990s (for example, they were ex-leaders of the *negdel*s, were or were connected to local officials, had benefitted from development agencies or had secondary sources of income). *Dzud*s similarly constrained both herder management aims, but the aim of generating a cash income was particularly constrained by the higher vulnerability of goats to cold winters.

9.3 Institutional settings and livelihoods

Herders and local officials in each of the three bureaucratic institutional settings were asked about their perspectives on institutional settings, as a surrogate indicator of the relationship between institutional setting and livelihoods.

9.3.1 Law on Land

Local officials were generally supportive of rights to winter/spring camps that were formalised by the Law on Land. The Bulgan *soum* official considered that winter/spring camp registration had empowered herders by providing more exclusivity so that herders were clearer about who had rights to which camps. More secure, bureaucratic rights were therefore seen to facilitate the socially embedded institution of high mobility in response to climatic variability as herders were less concerned that their winter/spring pastures would be trespassed upon (Chapter 6). The Bulgan *soum* official estimated that the Law on Land contributed to 60% of herders routinely moving out of winter pastures so that those areas were rested, with this figure reportedly being agreed on by the *bag* governor. The official also equated stronger, bureaucratic rights with an increased potential for improved rangeland management.

In contrast to these cited benefits, some local officials also provided examples of problems related to the Law on Land. In contrast to herders (Section 6.5), the Bayandalai *soum* official believed that there were many fights over winter camps because there were so few of them, and that this had not been resolved by the Law on Land. At times, the Law on Land clashed with socially embedded institutions governing access to the forage resource. For example, under the Law on Land it is illegal for herders from Sevrei *soum*, Omnogobi *aimag*, to access the winter camps in Bayandalai *soum* for which they historically had access. Under the Law on Land the *bag* governor could fine herders 8,000 T for grazing outside their designated area but this value was not considered to be high enough to prevent herders from moving there during periods of low forage availability. The Bayandalai *soum* government encouraged these Sevrei *soum* herders to register as Bayandalai *soum* citizens to resolve this, but this would have increased the costs of them accessing services, like the *soum* hospital, in Sevrei *soum*.

Sixty-six percent of the forty-one Mongolian herders who responded expressed positive feelings about winter/spring camp registration under the Law on Land. More herders in Law on Land areas were positive about registration than herders in areas under a PUG arrangement, but this difference was marginal (5%). Some herders thought that winter/spring camp registration was beneficial as an insurance mechanism. If they lost all their livestock during a bad year, they had the option of sub-leasing or selling their lease right (see Chapter 6). A smaller number suggested that winter/spring shelters were better maintained after exclusive rights to the shelter were introduced under the Law on Land. A more typical reason given for the positive feeling towards winter/spring camp registration echoed those given by local officials:

'*Winter/spring possession is good. There is no need to worry about other people taking over our camp. We're close to the Khanbogd* [soum] *boundary here so many herders come into this area – it is good security to have a possessed camp*.' (Law on Land, Manlai *soum*, Omnogobi *aimag*, herding 10 years)

A considerable percentage of herders (29%) felt ambiguous about winter/spring camp registration. Some felt that the Law on Land had merely legalized a pre-existing institution that was socially embedded:

'*Possession of winter/spring camps makes no difference to us, but the government said we have to do it. It makes no difference but the government gets money!* [through winter/spring camp registration fees – see Chapter 5]' (Law on Land, Tsogtovoo *soum*, Omnogobi *aimag*, 30 years herding)

Others took a pragmatic approach to registration:

'*Everyone was getting their winter/spring camp registered so we had to as well to stop others from registering ours'* (PUG, Bayandalai *soum*, Omnogobi *aimag*, 10 years herding).

The 7% of herders who had negative views on the registration of winter/spring camps generally stated that registration meant they could no longer access pastures that belonged to others when their own registered camps had low forage availability, implying that this had a negative impact on their livelihood.

An examination of bureaucratic institutions external to those described in Chapter 5 was outside the scope of this research. However two herders spontaneously identified institutions not clearly stipulated in the Law on Land that may have an impact on their mobility decisions, as well as the livelihoods of themselves and their children. One Law on Land herder (Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding) stated that whilst they were interviewed in Tsogtseggi *soum*, Omnogobi *aimag*, they were registered in Loess *soum*, Dundgobi *aimag*. He stated that if there was an *otor* agreement (see Section 5.2.1) between *soum*s, his children could attend school in a *soum* in which they were not registered. The same herder, and another interviewed in Manlai *soum* (Law on Land, Manlai *soum*, Omnogobi *aimag*, 30 years herding) stated that if they were not in their registered *soum,* they had to pay 50% of any ambulance and hospital cost rather than it being free. The second herder stated that she could not access medicines from a medical clinic that was not in her registered *soum*. The proposed solution to Sevrei *soum* herders accessing Bayandalai *soum* winter/spring camps (described earlier) would create a similar problem.

Herders cited medical costs and illness as being one of the most significant threats to their livelihoods (Mearns 2004). These medical and educational arrangements may either reduce mobility and, in turn, increase the risk of feed gaps, or increase livelihood risk during periods of high mobility when herders are already exposed to production risk. This is particularly the case if *otor* agreements are not done in a timely manner, or when the spatiality of feed gaps that herders experience does not match the spatial criteria that *otor* agreements are based upon.

9.3.2 PUGs and collective action

Mongolian herders had mixed feelings about the ability of collective action, and PUG institutions in general, to improve their livelihoods. Some herders felt that their individual livelihoods were vulnerable to the external shocks and stresses described in Chapters 4 and Chapter 7, and that collective action may improve their ability to manage these. Others were less positive about the ability of collective action to increase their ability to manage shocks and stresses. The following conversation regarding whether the Law on Land herder household would see any benefit from the creation of a PUG in their area illustrates this ambiguity:

"Woman: *Collective action is more suitable for development; individual household's action without collective contributions is not developing well.*
Man: *It is hard for households to develop independently.*
Woman: *Joining in to the group or cooperative is useful for applying for support from the government. As we saw during last winter dzud, it is hard for independent families to receive support.*
Man: *It is doesn't matter if we receive support or not. This winter was a real lesson*."
(Law on Land, Tsogtovoo *soum*, Omnogobi *aimag*, 30 years herding)

Herders who stated that PUGs could improve their livelihoods in general indicated that PUG membership could increase their income. One herder in the Ireedui PUG stated that her PUG was established prior to the involvement of a development agency, but was later provided with financial support by GTZ/NZNI (see Chapter 3 for project description and aims). She described the increased bargaining power associated with PUG membership, when thirty member families combined their cashmere for sale. As well as saving on fuel costs, the group was also able to negotiate an increased price for their cashmere, with a cited average premium of 2,000 T/kg (a 4 to 11% per kg increase based on the prices reported in Section 7.3.1). Some Law on Land herders also perceived that PUG membership could increase income and be a useful way of sourcing labour for migration during a *dzud* or drought. A leader of a PUG in Ulziit *soum* also described the improved financial position of their PUG (see Section 5.2.2), and anticipated that activities paid for from this fund may have a favourable impact on resource management.

No PUG herder described a PUG institution that regulated the spatial boundary of their PUG (see Section 5.2.2). However some PUG herders stated that an institution of the PUG was to police the access of non-PUG herders to winter/spring camps and pastures. Consequently, the presence of the PUG may have strengthened this pre-existing socially embedded institution.

9.3.3 Household Responsibility System

Most Inner Mongolian herders expressed positive opinions about the Household Responsibility System. A typical response by herders to the question about the advantages/disadvantages of the Household Responsibility System was:

'*Having a contract is a good thing because we have exclusive use*.' (Household Responsibility System, Dwa Ama *sumu*, 25 years herding)

This perspective was endorsed by the Urat Rear Banner official who stated that:

'*The nation can protect herder use rights and everyone has their own land*.' (Urat Rear Banner Grassland Official).

The Urat Rear Banner official also cited benefits associated with the exclusive rights over grazing lands. These perceived benefits were similar to those stated by Mongolian herders who wished to formalise rights as a form of insurance for their livelihoods:

"*If the government wants to use this land, they must pay compensation*." (Urat Rear Banner Grassland Official).

The Urat Rear Banner official described the benefits to herders of exclusive use rights over grazing land, but did not state whether they believed there were environmental benefits associated with these rights. In contrast, the Damao local official emphasised the environmental benefits associated with the Household Responsibility System in his more steppe-like Banner. However whilst he appeared to identify the exclusive rights under the Household Responsibility System as being the primary cause of improved rangeland condition, he did not acknowledge the potentially confounding effects of the grazing ban:

"*The Household Responsibility System is a good thing. Herders now care about and look after their grassland much better. The grassland is now in better condition*." (Damao local official)

Only one herder gave a negative opinion about exclusivity of rights under the Household Responsibility System:

'*I don't have a contract over my land because a herder needs to rotate their herd so the grass will regenerate*.' (Household Responsibility System, Nai En *sumu*, 25 years herding)

Herders under the Household Responsibility System were more negative about the impacts of the grazing ban then they were about exclusive rights, although they tended not to criticize the ban directly. The main cited impact was that:

'*My wealth has decreased since the grazing ban has come in*.' (Household Responsibility System, Nai En *sumu*, 25 years herding)

A local 'fixer' (see Chapter 3), who had 4,500 mu of registered land, 400 goats and sheep before the grazing ban, and seven dairy cows at the time of interview (post-grazing ban), explained further:

"*Compensation for the banned grazing land is my main source of income. Compensation* [is] *everyone here's main income. About 80 to 90% of* [resettled herders'] *income comes from compensation. It's not enough. I lost half of my income to move here – most people did*." (Household Responsibility System, Dwa Ama *sumu*, 10 years herding)

This sentiment was given by numerous herders, with some saying that a limited number of livestock and income from the flood irrigation farm were their only forms of income in addition to compensation.

9.3.4 Hypothetical changes in exclusivity

Despite being generally supportive of the registration of winter/spring pastures under the Law on Land, Mongolian officials were more hesitant about supporting changes in bureaucratic institutions that would increase exclusivity over summer/autumn pastures. A number of reasons were given for this hesitancy. The Bulgan *soum* official suggested that:

'*Registration of pastures is good only in winter or spring because herders don't know in summer whether it will rain or not. Herders must be mobile.*' (Bulgan *soum* official, Bulgan *soum*, Omnogobi *aimag*)

The Bayandalai *soum* official supported exclusivity of summer/autumn camps in a similar form to the registration of winter/spring camps under the Law on Land, but did not support complete exclusivity of pastures:

'*I think that autumn and summer camps should be registered. Full privatisation of summer/autumn pastures, like Inner Mongolia where there is one family all year in one area, would not work in the Gobi. There is no point in this sort of ownership without a suitable number of waterpoints, which we don't have*.' (Bayandalai *soum* official, Bayandalai *soum*, Omnogobi *aimag*)

Herder opinions about changes in exclusivity in bureaucratic institutions governing access to the forage resource largely conformed to those found by Fernandez-Gimenez and Batbuyan (2004) and Murphy (2011) in higher precipitation areas of Mongolia. In contrast to the Bayandalai *soum* official, 88% of the forty-four Mongolian herders who responded expressed negative views about the hypothetical registration of summer or autumn camps or pastures. There was less than 4% difference between Law on Land and PUG herders, with PUG herders being slightly more negative about the potential future registration of summer/autumn pastures. The main cited reason was that such a change would cause arguments over pasture between herders:

'*Summer ownership is impossible for Mongolia because of the rain. Sometimes it rains in particular places so we have to move. Every year's summer camp is different; it changes every time, particularly in the Gobi. Ownership would create war amongst herders*.' (PUG, Ulziit *soum*, Omnogobi *aimag*, herding 20 years).

Herder responses to the question of further exclusivity over pasture access suggested that fencing or imported fodder were not realistic ways of managing potential feed gap if exclusivity increased. Most herders accepted that in such a scenario, herders and their livestock would still move to available forage; illegality would not decrease mobility, but would instead increase conflict. If adequately policed, '*Summer pasture ownership* *would not be good because it would be difficult to implement* [and] *would cause overgrazing'* (PUG, Ulziit *soum*, Omnogobi *aimag*, 25 years herding).

Thirteen percent of Law on Land herders stated that there would be benefits associated with the increased exclusivity of summer/autumn pastures. This compared to 5% of PUG herders. These herders still generally acknowledged the difficulties of delineating summer pastures under spatially variable precipitation patterns:

'*Registration of summer camps would be a good thing because mining camps couldn't come in. Our summer camp has a mine now because we couldn't prove that it was ours. Summer possession would be difficult because herders must move in summer, but it would be good proof for the mines*.' (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding)

This statement by the Law on Land herder parallels the opinions of some Mongolian herders under different institutional settings who felt that formalising exclusive rights was largely for the benefit of agents external to those herding, or as a way of managing a relationship between herders and external agents. Establishing rights in a bureaucratic institutional setting allowed herders to legitimise to external agents their socially embedded rights to the forage resource and, in turn, receive compensation from the mining sector that was becoming increasingly dominant in both the Mongolian and Inner Mongolian Gobi Desert at the time of interview (see quotation from the above herder). Comments, such as the earlier comment made by one PUG herder (Bayandalai *soum*, Omnogobi *aimag*, 10 years herding), suggest that some herders saw little benefit in formalising access rights to winter/spring pastures but were pushed to do for fear of being 'left out' of the resource rights process. Interestingly, the local official of Urat Rear Banner, a non-equilibrium rangeland (Figure 4-1), had a similar perspective.

9.4 Expectations and options

Herders across the three institutional settings were asked "Is there a future in herding?" or "Do you want your children to keep herding?" These questions acted as a surrogate for understanding the sustainability of herder livelihoods (see Chapter 3 for why detailed household budgets were not calculated), and to further explore whether institutional settings affected herder perceptions about their viability. There was little difference in responses between Law on Land and PUG herders (Table 9-3).

Table 9-3 Expectations about the future of pastoralism. Rounding accounts for why responses may not add to 100%.

	Positive (%)	Negative (%)	Depends/Unsure (%)
Law on Land (n = 25)	4	54	40
PUG (n = 23)	4	59	33
Household Responsibility System (n = 17)	36	57	7
Total mean (weighted)	11	58	30

It is unclear how the recent *dzud* affected responses, and whether herders would have been more positive, or less unsure, about the future if they had been interviewed prior to the *dzud*. Whilst responses to these expectation-based questions have been combined here, it is also possible that a herder that responded positively to the question 'is there a future in herding?' may still not have wanted their children to keep herding. The following responses give a more nuanced understanding of herder expectations about the sustainability of herding livelihoods.

Herder responses to questions about the future of herding tended to take one of two forms in Mongolia. The first was philosophical in nature, and was more related to a sense of Mongolian identity or responsibility to the greater Mongolian population. Examples are as follows:

'*I think livestock breeding has a future. I never thought that there is no future because Mongolians live on livestock breeding*.' (Law on Land, Sevrei *soum*, Omnogobi *aimag*, 30 years herding)

'*Some grandchildren can move to the city but some must stay. I want others to continue my job of providing meat to people*.' (PUG, Bulgan *soum*, Omnogobi *aimag*, 30 years herding)

These more philosophical responses were also used as a reason as to why the children of herders should find alternative livelihoods:

"*No, we want* [our children] *to be educated people. The world is developing, they need to be educated and the country needs educated people. So they should not be like us*." (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding)

The second type of response tended to be more pragmatic, and took into account perceived changes in the climate, cultural expectations and alternative livelihood options. For example:

'*Oh, maybe no* [future for herding]. *As we can see from droughts,* dzud *and heat over the summer, it is hard to say that herding will be profitable in future. And* [young people should think] *about another future than herding. Animals and herding will go with* [our generation]. *Because, in this land where the desertification is increasing, it is getting hard to think about animal husbandry*.' (Law on Land, Manlai *soum*, Omnogobi *aimag*, 25 years herding)

The ability to diversify within the pastoral sector can make the difference between minimally viable livelihoods and destitution for households at or below the poverty line, as does having alternatives for income generation outside the sector (Ellis 1999). Mongolian herders rarely reflected upon alternative livelihood options for themselves as established adults during interviews as '*it's difficult to keep herding but I have no profession'* (Law on Land, Khanbogd *soum*, Omnogobi *aimag*, 30 years herding) and '*in my experience it is difficult to get a job if you've been a herder. It's better to get a paid job from the start*' (Law on Land, Manlai *soum*, Omnogobi *aimag*, 8 years herding). Despite the lack of perceived alternative livelihood options for themselves, many Mongolian herders wanted their children or grandchildren to attend university or believed that '*work in the* soum *is better*' (Law on Land, Sevrei *soum*, Omnogobi *aimag*, 30 years herding). This was largely because of their belief that climatic uncertainty had increased, making it more difficult to maintain a herding livelihood. The following statement was common amongst Mongolian herders in the immediate post-*dzud* period:

'*I want our children to live in town. Many families have now gone to town. There is less rain, less grass, and herding is getting harder*.' (Law on Land, Mandal-ovoo *soum*, Omnogobi *aimag*, 30 years herding)

Other reasons why herders wished their children not to herd, common to both Mongolia and Inner Mongolia, included the belief that:

'*Herding is hard work. I want my children to go to university instead*.' (Household Responsibility System, Dwa Ama *sumu*, Inner Mongolia, 15 years herding)

Two Mongolian herders also wished their children to be educated because they feared that they would lose all their livestock in a *dzud*, and would have none left to give to their children so that they could establish their own herd.

Whilst many herders wished their children to not continue herding, a lack of alternative options for generating an income was described as being a constraint to this, and a reason why herding would continue regardless of the wishes of herders or their children. Whilst there was some indication that Mongolian herders were willing to invest significant resources into achieving the widespread aim of sending their children to university, the ability to do so was considered to be limited by some herders:

Man 1: '*No* [I don't want my children to keep herding]'.
Man 2: '*Thinking about our grandchildren, it is better to send them to schools.*'
Man 1: '*Sending children to study costs a lot*'
Man 2: '*If you were the owner of 1,000 livestock you could do it* (laughing).' (Law on Land, Mandal-ovoo *soum*, Omnogobi *aimag*, 30 years herding)

Other Mongolian herders acknowledged that a university education did not necessarily facilitate an alternative livelihood, as job opportunities for university graduates in Ulaanbaatar were also limited; a view supported by Yano (2012). Options for an alternative livelihood that did not involve a university education, or that allowed herders to stay in rural areas, were also perceived to be limited.

Two PUG herders along the Gobi Gurvan Saikhan Strictly Protected Area were engaged in small-scale, irrigated agriculture (see Section 7.2.1). The two PUG herders did not rely exclusively on income from this enterprise. These herders were not specifically asked about the relative proportion of income that they derived from irrigated agriculture compared to herding, but had large herd sizes of 700 and 1,000 each. Some of these livestock were agisted out to herders outside of the PUG in response to labour shortages. They stated that start-up costs for irrigation had been paid for by a development agency.

Despite the wealthiest two herders interviewed being engaged in irrigated agriculture, poorer herders in general were more likely to be engaged in irrigated agriculture to produce food purely for their own consumption (Upton 2012). Regardless, it may be that factors such as relatively high infrastructure costs, a short growing season, limited water resources, a small local market (a swamped market in an area in Omnogobi *aimag* was noted by Upton 2010) and a poor transport network to a larger market would limit the opportunities available to most herders for using irrigated agriculture as their sole income source.

Mining in the formal or informal sector was one of the few options available to herders who felt that herding was no longer a viable livelihood for them:

'*There are many young people working for mining and it is a good thing*.' (Law on Land, Manlai *soum*, Omnogobi *aimag*, 25 years herding)

'*Nowadays the mining is developing well and it is very profitable. People there gain much more income*.' (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding)

Age and a lack of professional skills were viewed by some herders as being a significant barrier to their employment by a mining company. Mongolian herders that were aged between about 45 and 55 stated:

'Man 1: *These mines are looking for young labour. So if we will come to them for work, they will slaughter us like an animal!* (Laughing)
Man 2: *They need professionals*.' (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding)

'*The people in old age like us cannot think about working somewhere to receive a salary*.' (Law on Land, Tsogtovoo *soum*, Omnogobi *aimag*, 30 years herding)

Whilst the children of some herders were already working for mining companies, some herders stated that there were significant constraints to mining as an alternative form of livelihood, including for young people:

‘*Now it is hard to keep herding. Maybe* [our children] *will do other things. But working in a different sector is difficult. You cannot be employed that easily*.’ (Law on Land, Manlai *soum*, Omnogobi *aimag*, 10 years herding)

“*If herders will come to* [the mines] *to get a job, they will not hire you*. [International mining company] *Energy Resources announced that they will hire local people. But we registered for employment in January and so far there hasn’t been any response. I’m still waiting*.” (Law on Land, Tsogtseggi *soum*, Omnogobi *aimag*, 25 years herding)

Whilst some herders supplemented their pastoral income with the proceeds from illegal artisanal mining of gold (see Section 6.6), this activity had completely replaced an income from herder for others. For some, this was one of the few alternative livelihoods available to them after an exogenous shock:

‘*Many herders who lost all their animals in the last* dzud *are now doing artisanal mining here in Ulziit* [soum].’ (PUG, Ulziit *soum*, Omnogobi *aimag*, 15 years herding)

For the reasons described above, many herders stated that whilst they may have wished their children to engage in an alternative livelihood if they could, from a pragmatic perspective they acknowledged that their children would probably continue herding because:

‘*I don’t know about my grandchildren* [being herders], *but herding is better than being unemployed*.’(Law on Land, Tsogseggi *soum*, Omnogobi *aimag*, 25 years herding)

‘*I don’t know whether my baby will be able to herd. But for my grown-up children, it is a way to be fed*.’ (Law on Land, Tsogseggi *soum*, Omnogobi *aimag*, 30 years herding)

Other reasons unrelated to a lack of alternative livelihoods that herders gave as reasons why their children should continue herding included:

“*I want my kids to get educated. If they are not intelligent, they can come back to herding*.” (PUG, Ulziit *soum*, Omnogobi *aimag*, 25 years herding)

'*Well nowadays children do not want to herd. They will decide what they want to do. As I can see from other families*' *children that go to university, they come back to their* soums *and do nothing. They cannot even herd. Such children like to do nothing and be unemployed*.' (Law on Land, Manlai *soum*, Omnogobi *aimag*, 10 years herding)

Inner Mongolian herders were more optimistic about the future than Mongolian herders. They were also likely to be less unsure of the future of herding, perhaps because they expected the grazing ban to be temporary and because the grazing ban meant their livelihood was not significantly affected by the 2009/2010 *dzud*. It is therefore unclear whether this lack of exposure, or the better ability of Inner Mongolian herders to buffer the risk of feed gaps posed by climatic variability (see Chapter 7), may have accounted for their more positive views on the future.

Inner Mongolian herders were also asked whether they would return to herding from their resettlement villages if/when the grazing ban was lifted. The majority stated that they would return, largely because their income was significantly lower in the resettlement villages than that which they believed they could gain from herding:

'*If the ban finishes, we will return because we are wealthier when we are herding*.' (Household Responsibility System, Dwa Ama *sumu*, Inner Mongolia, 15 years herding)

Like some Mongolian herders, some Inner Mongolian herders were also pragmatic about the need for them to herd due to a lack of alternative employment opportunities:

'*We plan to return to the grazing area when the ban is lifted. If our son goes to university, we don't want him to be a herder. If he doesn't pass his exams, he will herd*.' (Law on Land, Dwa Ama *sumu*, Inner Mongolia, 15 years herding)

Inner Mongolian herders also felt that their lack of skills in alternative occupations prohibited them from occupations other than herding, even if they had wanted to finish with herding:

'*No-one here has a job because we don't have skills in anything else except herding*.' (Household Responsibility System, Dwa Ama *sumu*, Inner Mongolia, 15 years herding)

9.5 Summary and Discussion

Law on Land herders were poorer than those in other institutional settings if total herd size and herd composition were used as indicators. However it is likely that large herd sizes reduce vulnerability to external shocks and stresses rather than remove it altogether (large herds were still impacted by the 2009/2010 *dzud* – see Chapter 7). Law on Land herders generally also had a much smaller herd size than the minimum viable herd size figure that they cited, whilst the actual and cited minimum viable herd sizes of PUGs were reasonably similar. The smaller herd sizes for Law on Land herders accounts for this difference, rather than a difference in minimum viable herd sizes. However results suggest that PUG herders felt that their livelihoods were more secure than Law on Land herders.

There have been some qualitative and quantitative economic assessments of nation-wide, minimum viable herd sizes in Mongolia. Methodologies for calculating such figures are often scant, but figures that did not rely upon herder accounts include 100 (Ykhanbai 2004), 150 (Reading *et al.* 2006 in Banks 2003), 200 (Agriteam-Canada 1997 in Mearns 2004) and 200-300 (Mongolian Ministry of Finance and Economy and UNDP Mongolia 2004). The cited minimum viable herd sizes for the herders interviewed in this research were, on average, higher than all figures cited in the literature.

The important winter/spring forage resource appeared to be similarly accessible to both Law on Land and PUG herders if the formalised registration of winter/spring camps is used as an indicator. This was similar to the findings of Upton (2012) from a desert steppe area in Omnogobi *aimag*. However it should be noted that Mearns (2004) found that asset and labour rich Mongolian herders were more able to access this key resource than poorer herders due to their greater ability to split families. Murphy (2011) also found that wealthier and better connected herders were more able to access available pastures during *dzud* periods than poorer herders.

Mongolian herders were far less diversified into non-livestock/pastoral activities than African herders. In sub-Saharan Africa, 30 to 50% of income comes from non-pastoral enterprises, with this figure increasing to 80 to 90% of income in southern Africa (Ellis 1999). Alternative income sources appeared to be limited to mining, which favoured the young, or professional occupations that required migration to urban areas for tertiary education and employment opportunities. This research, and Mearns *et al.* (1992), also found labour shortages were a constraint to both herd size and perceived levels of wealth.

Upton (2012) reported that in desert steppe areas of Mongolia, bureaucratic institutions designed to regulate pasture use were criticised by herders. This thesis focussed on the ability of herders to secure or access key winter/spring camps or pastures under the Law on Land. Herders were generally positive about the security that formal registration of their winter/spring camps gave them under the Law on Land. This was because it formalised a socially embedded institutions (Chapter 6) that had evolved in response to forage variability (Chapter 4). The other bureaucratic institutions under the Law on Land which herders were critical of were those that did not recognise forage variability (Upton 2012).

PUG herders were generally ambiguous about the ability of collective action to improve their livelihoods, although some provided examples of financial benefits associated with PUG institutions. The involvement of donor resources during the development phase of PUGs may have improved the ability of some herders to manage climatic variability (see also Chapter 7). However donor involvement may also confound assessments of the institutional efficacy of PUGs, and explain why herders in desert steppe areas sometimes seek to engage with development agencies to create PUGs despite the ambiguous opinions many herders interviewed for this research of them. The 'elite-capture' of resources by herders with already high levels of social capital (Ostrom 2005; Murphy 2011) may have occurred in one of the steppe-like PUGs described earlier.

Most Mongolian herders had a negative opinion of hypothetical, formalised grazing use rights in summer or autumn pastures. The assertion by Mongolian Gobi Desert herders that further exclusivity over pastures would cause 'war' appears to be consistent across the country, paralleling the views of Khentii *aimag* herders (Murphy 2011).Herders did not believe that spatially fixed institutional settings could not account for spatially variable precipitation patterns. In Inner Mongolia, interviewed herders were generally positive about the benefits that exclusive grazing use rights under the Household Responsibility System gave them, primarily because it enabled government compensation when grazing bans were introduced.

Most Mongolian herders, regardless of institutional setting, were negative or unsure about the future of pastoral livelihoods for their children. Some were additionally negative about their own future livelihoods as herders. The perceptions that climatic variability had increased through time (see Chapter 8) was one of the main reasons cited. Inner Mongolian herders were more positive, perhaps because they had greater access to tools for managing the risk of feed gaps whilst they were herders (see Chapter 7), or because they assessed their current situation under the grazing bans to be poorer than their pre-grazing ban situation.

Although the number of interviews with local officials was small, officials in all institutional settings were more positive about the ability of bureaucratic settings to provide benefits to herders and rangeland condition than herders were themselves. The increased levels of conflict over winter/spring camps was a significant negative effect of the Law on Land cited by the Bayandalai *soum* official, but many herders felt that this conflict over pasture was able to be negotiated (see Chapter 6).

In Inner Mongolia, herders were more positive about exclusive rights, stating that it provided them with security. The greater ability of Inner Mongolian herders to access risk management tools such as commercial fodder, hence circumventing the need for mobility, may have reduced feed gaps and contributed to this more positive perspective. However this conflicts with the work of Li and Huntsinger (2011) and Dalintai *et al*. (2012), who found that increased exclusivity over the forage resource had weakened socially embedded institutions such as *otor*, in turn weakening social-ecological resilience.

Inner Mongolian herders also noted that the grazing ban had a significant, negative affect on their livelihoods. Dalintai *et al*. (2012) also found that the significant majority of herders in other parts of Mongolia believed that grazing bans did not improve grassland condition. Regardless, the compensation that herders with exclusive rights received with the grazing ban may have contributed to their more positive perspective on the exclusive rights. The expectation that their livelihoods could only improve with the removal of the grazing ban may also have contributed to an outlook on the future of herding that is more positive than that of the Mongolian herders.

In general, bureaucratic institutions that formalised the pre-existing socially embedded institutions that recognised the variability of the forage resource were viewed favourably by Mongolian herders (or were seen to be relatively benign). Bureaucratic institutions that may not have formalised pre-existing socially embedded institutions, but allowed Mongolian herders to access other, non-forage resources, were also viewed favourably if these resources were considered to be significant enough to increase the net ability of herders to manage the shocks and stresses described in Chapters 4 and 7.

10. Discussion

10.1 Introduction

Policies that seek to govern access to the forage resource upon which livestock subsist are a topic of intense debate in Inner Asia. In Mongolia, about 35% of the country's population is employed in the agricultural sector, primarily as herders (National Statistical Office of Mongolia 2010). The majority of Mongolia's territory is utilized as rangeland. The way in which the debate around institutional settings is resolved is therefore likely to have a significant impact on the lives of a large proportion of the Mongolian population, as well as the condition of its landscape.

This thesis asked:

i) What is the state of rangeland condition in the Gobi Desert, given different institutional settings?

ii) What biophysical or socioeconomic factors may be contributing to the state of rangeland condition described in the first research question? and

iii) How might institutional settings interact with the broader biophysical and socioeconomic context to affect rangeland condition and herder livelihoods, at present and in future?

This thesis found that the state and drivers of rangeland condition in the Mongolian Gobi Desert had been misunderstood. Bureaucratic institutions had been designed in ways that ignored both the dynamics of the pastoral system, and the forage resource upon which these institutions were based. Policy and programme makers had overemphasised the role that bureaucratic institutions alone can play in promoting rangeland condition and herder livelihoods. This was in part because institutions did not account for complex interactions in a socio-ecological system that provides cross-sectoral constraints and opportunities to herders seeking to manage forage feed gaps.

The three research questions are now addressed in more detail, directly and sequentially, in Sections 10.2 to 10.4. The implications of this research for policy are then discussed. Finally, possible areas that build upon the research in this study are outlined.

10.2 Misunderstanding rangeland degradation in time and space

10.2.1 The Mongolian Gobi Desert: not degraded

This research found that degradation levels in all Mongolian Gobi Desert study sites were relatively low (Chapter 8). Many indicators of rangeland condition were not significantly different between Law on Land and PUG institutional settings. The indicators that were different suggested that the steppe-like PUG may have been in slightly better condition than the gobi-like PUG or Law on Land areas. However there were few institutions unique to the steppe-like PUG that provided an ecological mechanism by which rangeland condition in this PUG could have improved (Chapters 5, 6 and 7).

The majority of assumptions about mechanisms for declining rangeland condition in the Mongolian Gobi Desert were either not supported by the social or biophysical data in this research, require re-examination in terms of scale, or are more complex than is often acknowledged. Chapter 8 showed that there were relatively high proportions of palatable species in Mongolian desert steppe areas during 2010, and these were often found to be reproducing. This suggests that pre-*dzud* grazing pressures had not compromised the ability of palatable plant species to reproduce when soil moisture was adequate (as was the case after the 2009/2010 *dzud*). There were low numbers of accelerated erosion features at the site scale, and high levels of rock armouring that minimises soil loss. Herders did not link current grazing pressures with changes in rangeland condition. These indicators conflict with the assumptions of severe, widespread and permanent degradation attributed to the current overutilization by livestock in the Mongolian Gobi Desert. The indicators also concur with Wesche *et al*. (2010) who found that whilst grazing had effects on both soil nutrients and vegetation floristics in southern/central Omnogobi *aimag* between 2003 and 2005, they did not support the idea that typical grazing leads to severe degradation.

Understanding land degradation in arid rangelands can be difficult (see Chapter 2). It can be tempting to transplant known causes of change from other landscapes or cultural settings, particularly in the context of a complex social-ecological system or in the absence of a scientific consensus. Claims of a decline in rangeland condition are not new in Inner Asia. Nor is the debate around its causes. As far back as the 1930s, Lattimore (1938) gave a succinct example of a "recently fashionable theory" being misapplied to Inner Asia:

"*The spectacular development of a huge dust-bowl in Western America and Canada has made the phenomenon of 'man-made deserts' so popular that it is even being used in attempts to override theories of desiccation in regions that are old favourites of those who believe in 'climatic pulsation*."

The biophysical mechanisms upon which degradation assumptions are based have spatial and temporal dimensions that have been under-recognised. Assumptions like 'too many animals' have been misapplied to the Gobi Desert from central areas of Mongolia where the case for overutilization by livestock may be stronger. Piosphere studies that assess vegetation communities at varying distances from permanent waterpoints suggest that high grazing pressures can, and do, cause significant vegetation change in at least some Mongolian desert steppe landscapes (Sasaki *et al*. 2009b). However the timing and intensity of grazing pressures required for such a change, and whether this change is permanent or not, is not clear. Potential explanations for how the lack of acknowledgement of scaling issues has led to the misapplication of degradation rhetoric to the Mongolian Gobi Desert are as follows.

10.2.2 Issues of scale in the biophysical system

Variations in the understanding of 'degradation' may at least partially account for the mismatch between widespread degradation assumptions in the Mongolian Gobi Desert (as described in Chapter 2) and what was observed during the 2010 survey. The term 'degradation' has both spatial and temporal dimensions. Given the change in temporal and spatial mobility patterns of Mongolian herders since the transition to the market economy (Chapter 2), and the variability of precipitation and vegetation patterns (Chapter 4 and Von Wehrden *et al*. (2012)), it becomes important that the scale of rangeland condition assessments and assumptions are well-defined (Prince 2002).

A clear distinction between the 'normal' effects of low and variable levels of precipitation, temporary and reversible grazing effects and permanent 'degradation' in desert steppe areas has been lacking. Biomass and compositional changes in the vegetation of the Gobi Desert's desert steppes are highly dependent upon short-term rainfall events (Lavrenko and Karamysheva 1993; Von Wehrden and Wesche 2007;

Wesche *et al*. 2010; Cheng *et al*. 2011). Ronnenberg *et al*. (2008) found that *Stipa glareosa* P. Smirm. seedlings in Bulgan *soum*, Omnogobi *aimag*, needed at least 20 mm of rainfall to germinate, an event that did not occur in several years of a germination experiment. Lavrenko and Karamysheva (1993) reported 7–10 year cycles of sexual maturity in *Stipa gobica* Roshev, and that survival of seedlings and juveniles is rarely possible, except when there are two or more favourable years for pasture growth. Rangeland condition indicators that are less susceptible to short-term precipitation patterns may provide more useful information to policy and programme makers.

Small-scale, plot-based assessments based upon vegetation indicators have also been over-relied upon in Mongolia's desert steppe areas. Assessments and indicators more appropriate to the spatial and temporal scale of stochastic events like sandstorms and *dzuds* would provide more useful information upon which to base policy and programmes in the Gobi Desert.

10.2.3 Issues of scale in the socio-economic system

The socio-political reform processes in Mongolia of the early 1990s are often used as a temporal reference point for assessing livestock trends (see, for example, Hess *et al*. 2010). However the increased temporal variability of livestock numbers since 1990 (Figure 8-1) makes it difficult to interpret the effect of livestock numbers on rangeland condition as forage availability also fluctuates through time (Chapter 4). *Soum*-level livestock statistics also ignore the high porosity of *soum* boundaries, changing patterns of use in seasonal pastures and the growing influence of mining on mobility patterns since the early 1990s.

Comparing total livestock numbers between socio-political periods may not be appropriate for other reasons (Ho 2001). In Mongolia, livestock numbers since the 1990s may have had a greater impact on the vegetation per SFU than during socialist times when collectives (*negdels*) buffered much of the climatic risk inherent in the Gobi Desert by importing fodder (Fernandez-Gimenez 1999; Section 7.2). Official livestock numbers may have been inflated during the socialist era to indicate nation-building, or deflated in more recent years as herders underreported numbers to avoid the livestock 'foot' tax. Changes in livestock live weights (Batimaa and Batnasan 2009) and other production factors may also have changed vegetation consumption per SFU, and therefore the relative impact of each SFU on rangeland condition.

The spatial and temporal 'patchwork mosaic' that both biophysical and socio-economic factors create makes it challenging to extrapolate across space and time, or differentiate between manageable and non-manageable changes in rangeland condition. Not recognising these issues directly impacts on the efficacy of policy design. The following provides an example of difficulties that can arise when such biophysical and socio-political complexities are not considered. There were mismatches between the aims of development agencies to use PUGs to improve rangeland condition (Chapter 5), herders' perspectives on the institutions or aims of PUGs (Chapter 5), herders' perspectives on the levels and causes of declines in forage availability (Chapter 8) and the state, and potential drivers of, rangeland condition (Chapter 8). In contrast to the expectations of the Green Gold programme that facilitated the creation of the gobi-like PUGs, herders did not concur that overgrazing due to unregulated pasture access could be resolved by reducing herd sizes (Chapter 8). Development agencies had also assumed that there was reduced mobility and increased out of season grazing since the transition to the market economy, that this had contributed to a decline in rangeland condition, and that institutions were needed to address it (see Chapter 5). However Upton (2010) had found that mobility patterns in an area covered by a steppe-like PUG had not significantly changed since the days of the collectives. In this example, competing perspectives, mostly associated with scaling issues and inappropriate extrapolations across both the biophysical and socioeconomic system, resulted in the PUG achieving few of its anticipated outcomes.

10.3 Institutions and rangeland condition

There are three main explanations as to why land degradation levels were low, and PUG and Law on Land institutional settings showed weak or inconsistent differences in rangeland condition. These explanations are now discussed in order of least to most likely.

10.3.1 Poor baseline rangeland condition in PUGs

Firstly, PUG rangelands may have been in poorer condition than Law on Land areas prior to the establishment of the PUGs. This is unlikely as PUG documentation did not indicate that PUG areas were chosen because they were particularly degraded. If degraded areas were to be targeted, areas around *soum*/*aimag* centres and main access roads would have been more logical places to have located them (see Chapter 2).

10.3.2 The dominance of socially embedded institutions

Clearly defined boundaries of both the forage resource and group with rights to it, locally adapted rules governing resource usage and collective-choice arrangements in decision making have been emphasised for the management of common property resources (Ostrom 1990; Cleaver 2000; Campbell *et al*. 2001). However there are many reasons why clearly defining boundaries in arid landscapes is problematic (see Fernandez-Gimenez 2002). Excluding others from common pool resources is difficult. In arid rangelands, overutilization of the forage resource does not occur when the spatial scale of the resource is greater than the scale of the social group seeking to control it (Campbell *et al*. 2001; Ostrom 2005). As predicted by Dyson-Hudson and Smith (1978) and confirmed in Chapters 5 and 6, these periods of surplus forage weaken ‘or else’ sanctions (Crawford and Ostrom 1995). Strengthened sanctions during surplus times may also have little impact on the condition of non-equilibrium rangelands.

In the Mongolian Gobi Desert, the spatially variable forage resource produced an unclear resource boundary (Chapter 4). A second reason for the lack of difference in rangeland condition between PUG and Law on Land areas, therefore, is that more spatially and temporally flexible socially embedded institutions prevailed over newly introduced bureaucratic institutional settings. Socially embedded institutions were common to both Law on Land and PUG institutional settings. This research found that Law on Land and PUG herders were more likely to respect (and police) institutions that recognised forage availability/variability, or were not directly connected with forage variability at all. Consequently, PUG members did not stay within PUG areas through all fluctuations in climate (Chapter 5, Chapter 6, Upton 2012). Law on Land herders were found within PUG areas. PUG members were clear that they did not police PUG boundaries. Herders considered that PUG exclusivity was neither a useful nor a culturally viable option (that is, exclusivity, if enforced, would have encouraged the rule-breaking of socially embedded institutions – see Chapter 6). For these reasons, grazing effects were probably similar across bureaucratic institutional settings.

Strengthening socially embedded sanctions when forage is limited in time or space can be difficult to police if the likelihood of being caught is relatively low (see Chapter 6).

However externally imposed measures for rule-breaking, such as the extensive list of fines outlined in the proposed MSRM Law on Pastureland (see Chapter 5), are likely to be equally or more difficult to uniformly enforce given the current lack of capacity of *soum* governments (Mearns 2004; Murphy 2011). The lack of tools for managing feed gaps other than mobility (see Chapter 7) also mean that strengthening sanctions during bad years may have significant livelihood consequences for some herders.

The history of institutions governing access to the forage resource in the Mongolian Gobi Desert (see Section 2.5) shows that boundaries have never been defined at the spatial scale of the current PUG or bag boundaries without significant levels of State support. The only time period in which the State offered such levels of support was during the *negdel* period; a relatively short period in Mongolia's long pastoral history. This level of support is no longer present (see Section 7.6). Whilst the Mongolian National Livestock Program is ambitious in its attempts to provide more local resources for the pastoral sector, government support is unlikely to be fully re-instated under a neo-liberal political system (Murphy 2011). However simply increasing the spatial scale of PUGs to better match forage variability is also unlikely to resolve boundary issues The spatial scale of feed gaps in bad years is often regional (see Section 4.3) and consequently there are no stable community groups with socioeconomic functions that are consistent with a stable territorial unit (Mearns 1993).

Participatory processes were part of PUG design (Chapter 5), and a clear distinction cannot always be made between socially embedded and PUG institutions. However support for herder-to-herder policing of socially embedded institutions that does not create exclusivity around unpredictable forage resources (like summer pastures) may increase compliance and provide greater benefit rangeland condition in the long-term (see Chapter 4). For example, the socially embedded institutions of mobility and generally respecting others' winter/spring pastures may be relatively more important for rangeland condition than any other Law on Land or PUG institution. The lower levels of boundary 'fuzziness' in the winter/spring resource (Section 4.3) may also increase the ability of social stigma to be a punitive measure.

Chapter 8 did not find evidence that PUG institutions had a negative impact on rangeland condition for the reasons postulated above. However the funds of development agencies have probably been used in ways that have produced only weak rangeland condition benefits. There may have been some economic benefits but see Upton (2010; 2012) for examples of some of the social problems associated with PUGs. It may be unrealistic to expect that external institutional interventions can simultaneously improve all three of the environmental, social and economic spheres. However for the purposes of accountability, external agents proposing multiple benefits must be transparent about the proposed mechanisms by which these benefits may be achieved. This is particularly the case when negative effects may also be created by their intervention.

This research identified few bureaucratic institutions that produced simultaneous benefits across social, economic and environmental systems in desert steppe areas. The activities that PUG members described as being facilitated by the PUG are outlined in Table 10-1. Estimates of whether each activity would directly benefit social, economic and environmental factors are included in this table.

Table 10-1 Estimated direct benefit of PUG activities. Activities are those PUG members cited as occurring in either the past or at present. Estimated benefits are for the short to medium term only. Social and economic benefits are considered for PUG members only; environmental benefits are for PUG areas only. Only direct benefits are presented. Indirect impacts of feedback loops between social, economic and environmental impacts are not considered, nor are potential direct or indirect costs. ? = uncertain.

		Potential benefit		
Activity		**Social**	**Economic**	**Environmental**
9-Erdene and Ireedui PUGs	Irrigation for vegetable growing	Yes	Yes	?
	Assist each other comb cashmere	Yes	Yes	No
	Assist each other with fixing winter camps	Yes	Yes	No
	Commodity price bargaining power	Yes	Yes	No
Ulziit *soum* PUGs	Assist each other with moving to new camps	Yes	Yes	Yes
	Dig new wells	Yes	Yes	?
	Assist each other with fixing winter camps	Yes	Yes	No
	Make agreements about not grazing each other's winter pastures	Yes	Yes	Yes
	Prevent others from grazing in members' winter pastures	Yes	Yes	Yes
	Money lending for new wells and building fences	?	?	?
	Prepare fodder	Yes	Yes	?
	Make protein	Yes	Yes	?
	Discuss movements	Yes	No	?

Only three of the activities/institutions shown in Table 10-1 have simultaneous benefits across all three spheres. 'Assisting each other with moving to new camps' was also cited as an activity of an additional, anonymous desert steppe PUG by Upton (2012), but she found that this institution was largely ineffective during climatic shocks, like the 2009/2010 *dzud*. Fernandez-Gimenez *et al*. (2012) similarly found little evidence of a steppe PUG providing assistance to herders during *dzud*. The other two institutions with simultaneous benefits (respecting/policing winter/spring pastures) were also common to Law on Land areas, although the establishment of the PUG may have strengthened these institutions. Whilst some herders interviewed for this research described financial benefits associated with PUG membership, Upton (2012) found little evidence of continued cooperation over *nukhurlul* (a form of PUG) marketing in a steppe-like area. She also found that that the processing of dairying products and value adding from raw materials had largely ceased due to herders' lack of access to equipment and a general reversion to household, rather than collective, based strategies. The claim that PUGs can harness collective action to improve both livelihoods and rangeland condition simultaneously, particularly after the withdrawal of donor resources, may therefore have been overstated.

There are mechanisms by which institutions promoting one aspect of the social, economic or environmental spheres have the potential to negatively impact another. The introduction of institutions that require Gobi Desert herders to destock to predefined carrying capacities, or constrain mobility through changing institutional settings, could have substantial, negative impacts on already marginal livelihoods. Herd size per household is often below what is considered by herders to be the minimum required to maintain a reasonable standard of living (Chapter 9). The overriding aim of many herders may still be food security (Edstrom 1993; Sneath 2003; Chapter 7). The additional income from the increased bargaining power attributed to PUG membership (e.g. an increased cashmere sales price of 4 – 11%, see Chapter 9) may be used to build herds due to a lack of secure, alternative investment options, and for other socio-economic reasons. 'Livestock banks' are known from other Mongolian (Edstrom 1993) and international rangelands e.g. (Wienpahl 1985, Livingstone 1986). Increased income from PUG membership may therefore not automatically reduce reliance on livestock numbers, encourage destocking or increase mobility in the absence of other interventions.

Herders in PUG areas had larger herds than those in Law on Land areas. This research did not establish any causality between the two, nor did it assess the ability of herders to 'bounce back' after *dzud*, as a more substantial and multidisciplinary analysis of change over time and space is needed to for these purposes. However, if PUG herders were wealthier because of the existence of the PUG, this may have implications for overutilization of the forage resource during key periods if PUG spatial boundaries were enforced. Conversely, if PUG membership did not contribute to larger herd sizes but instead herds were larger prior to PUG areas, the PUG may not have been established in an area where herders had the most need for it.

10.3.3 Exclusionary institutions have little affect on rangeland condition in a low grazing pressure, non-equilibrium landscape

A third reason for the lack of difference in rangeland condition between PUG and Law on Land areas is that both bureaucratic and socially embedded institutions may have had equally little effect on rangeland condition compared to the exogenous shocks and stresses affecting grazing pressures in the current social-ecological system. There were neither bureaucratic nor socially embedded institutions for capping herd sizes amongst the herders interviewed for this research (Chapter 7). This may be because most herders considered their herd sizes to be only just viable or unviable (Chapter 9), and so they sought to increase herd sizes.

This does not suggest that there was no control on grazing pressures amongst herders. Herders largely adhered to the socially embedded institutions of Table 6-3. None of these socially embedded institution dictated herd sizes. Regardless, a lack of deliberate control over herd sizes does not necessarily equate to declining rangeland condition. When there are low population densities or non-equilibrial conditions, socially embedded institutions that benefit the livelihoods of individual households in the short-term may not necessarily be detrimental to rangeland condition in the long-term. This at least partially accords with the belief of herders that grazing pressures cannot affect rangeland condition (see Section 8.5.1). Climatic events, such as the 2009/2010 *dzud*, had a significant impact on herd sizes per household, herd composition and, ultimately, total grazing pressures. Labour shortages may have provided a similar 'check'.

Law on Land and PUG institutions were unable to buffer the risk of exogenous shocks and stresses, as shown by livelihood indicators (Chapter 7, 9). Whilst PUG herders had more livestock, institutional settings in Mongolia did not appear to offer enough protection to these herders such that they felt that their livelihoods were secure. Herders in both Law on Land and PUG areas believed that their livelihoods were significantly affected by key stresses such as dry summers, and exogenous shocks such as *dzuds* (Chapter 9). Institutional settings governing access to the forage resource may thus have been inadequate for herders dealing with significant climatic variability.

Whilst the inability of institutions to protect livelihoods may be socially unacceptable, this same inability may account for the reasonable rangeland condition found throughout institutional settings (Chapter 8). The relative inability of grazing pressure to influence long-term vegetation metrics of non-equilibrium landscapes like the desert steppe (Fernandez-Gimenez and Allen-Diaz, 1999; Wesche and Retzer, 2005; Wesche *et al*. 2010; Marin, 2010; Von Wehrden *et al*. 2012; Chapter 4) may explain the lack of difference in rangeland condition between Law on Land and PUG areas. At key times, these shocks and stresses may have maintained grazing pressures at levels below those needed to cause significant, widespread, permanent land degradation.

10.4 Reconciling forage variability with institution-making

10.4.1 Territoriality in arid rangelands

Figure 2-1 proposed that, all else being equal, territoriality is a function of both forage availability and variability. It is more efficient (requires less time or energy per unit return) for herders to disperse to mutually exclusive grazing areas when forage has a uniform distribution and is predictable, with territoriality becoming less viable below a certain resource threshold (Dyson-Hudson and Smith 1978; Mearns 1993). Changes in the economic defendability of the resource have implications for the relevance of institutions governing access to that resource (Mearns 1993).

Chapter 4 used both biophysical data and herder accounts to better understand the resource dynamics that may encourage herders to flout bureaucratic institutions, or to develop or favour their own, socially embedded institutions. Patterns of climatic and forage variability were found to be more nuanced than is commonly recognized by the mean precipitation coefficient of variation. The economic defendability of the forage resource, as indicated by resource density and predictability, changed both between herder-defined good and bad years, and between seasons.

The case study in Chapter 4 suggests that the defendability of the forage resource in a PUG in Bulgan *soum* was similar to that of the resource in Omnogobi *aimag* during the last good year. However in the last bad year, the *aimag* had an average of 20% more total standing crop per hectare than the *soum*. The greater likelihood that sites outside the *soum* may have had relatively higher total standing crops may have significantly shifted the relative value of the forage resource, and acted as a significant 'push' for herders to leave their PUG and *soum*. In periods of resource 'super-abundance', like the last good year, herders had less need to migrate to access forage. If their registered *soum* had had insufficient forage due to the higher spatial variability of the resource in a good year, herders were 'pushed' to migrate. Herders in the areas to which they migrated may have gained little from defending a superabundant resource in their area as their ability to utilize and store the resource was limited (demand could not exceed supply in the short-term). Thus it can be argued that herder mobility is highly rational for minimising both the economic and environmental risks associated with climatic variability.

10.4.2 Matches and mismatches between predicted territoriality and bureaucratic institutions

Some of the institutions described in Chapter 5 catered for the nature of forage variability in the Gobi Desert, but others did not. The Law on Land recognised the higher economic defendability of the forage resource during winter/spring by allowing herders to register camps in these pastures. However the assumption that this registration was appropriate for *khot ails* or *bags* ignored the very low forage availability during winter. The interpretation or adaptation or potential rule-breaking of the Law on Land by local officials that allowed herders to register these camps as individual households enabled this to be circumvented to some extent. So, too, did the socially-embedded institution that gave surrogate rights to individual households over pastures within a few kilometres of registered winter/spring camps. Although there were still accounts of trespassing, herders were generally supportive of the way in which this institution of the Law on Land had been interpreted and implemented, including the lack of exclusive rights to summer/autumn pastures.

The collective use of summer/autumn pastures within PUGs, and at the level of a *bag* under the Law on Land, was also supported by herders who recognized the low economic defendability of the resource during this period. However, the large proportion of herders that ignored intended boundaries by moving outside of *bag*/PUG boundaries in bad years (see Chapter 6) suggests that the spatial scale of the *bag* may not sufficiently account for the spatial variability of the forage period during summer/autumn. In other words, herders needed collective use of summer/autumn pastures both within, and outside, the *bag.* As Mearns (1993) noted, '*in the desert steppe zone, it is difficult to identify a stable, cohesive community group at a level corresponding to the spatial boundaries of a viable pastoral resource unit*.'

Mobility, irrespective of legality, is also rational in a context where there are few alternative tools for managing feed gaps. During the last bad year, short-term tools for managing the feed gaps produced by climatic variability were unavailable to herders in the Mongolian Gobi Desert (Chapter 7). Minimal levels of supplementary fodder were collected and stored during good years when forage was available locally (and when herders were less likely to 'rule-break' anyway). In bad years, when supplementary fodder was most needed, it was not considered to be of sufficient density to be worth collecting and storing. Commercial fodder was similarly difficult to access/afford when it was most needed, and herders considered it to be prohibitively expensive for feeding to their entire herd. Herders felt that the relatively low prices for livestock in autumn meant that any revenue from livestock sales did not compensate for the consequent decline in their herd size and herd building capacity (for food security), and the lost opportunity to profit from cashmere in spring (for cash income). Livestock insurance was not available to Mongolian Gobi Desert herders at the time of interview, and direct support from government and other external agents was limited. Where the boundaries predicted by territoriality models and those prescribed by bureaucratic institutions do not match, a lack of alternatives for managing feed gaps other than mobility risks creating overutilization of the forage resource.

10.4.3 An overemphasis on institutions

Governments and, often, development agencies are mandated to improve both livelihoods and the natural resources upon which these livelihoods are based. Proponents of more exclusive institutional settings in Mongolia sometimes suggest that changing institutional settings can simultaneously improve livelihoods and rangeland condition e.g. Millennium Challenge Account Mongolia (2008). However, this may be difficult to achieve in practice as singular interventions can have unpredictable effects on the social-ecological system.

In the absence of alternative tools for managing the risk of feed gaps, the introduction of more exclusive institutional settings is risky for both herder livelihoods and rangeland condition. The ability of local government officials to police these institutional settings in the Mongolian is currently limited but may increase in time. Bureaucratic institutions may become progressively more adhered to be herders. Consequently, the modification of bureaucratic institutional settings in the absence of a suite of other changes risks creating the very environmental and livelihood problems that external agents seek to resolve.

Other interventions that do not recognise interrelationships between institutional settings, rangeland condition and herder livelihoods similarly risk creating or exacerbating environmental or livelihood problems. As an example, climatic events and labour shortages are currently important ‘checks’ on livestock numbers (and herder livelihoods) (Chapter 4, Chapter 7, Chapter 9). Chapter 4 proposed that a risky period for overgrazing may be when i) livestock numbers have built for some years due to consecutive good years, followed by ii) a mild winter when livestock mortalities are low, and then iii) a spring period when temperatures and soil moisture are high enough to trigger vegetation growth whilst grazing pressures are still high. Cold winters may act as a check to this process. Interventions that lessen the impact of these checks (such as better winter housing for livestock) may facilitate a significant increase in grazing pressures during spring, with adverse impact for rangeland condition.

The negative impacts of incomplete interventions have been documented in the Mongolian pastoral sector. Climate metrics and herder accounts (Chapter 4) suggest that the provision of warm shelters during times of *dzuds* should significantly decrease livestock mortality rates. It seems logical to introduce warmer housing for livelihood reasons, but this may create perverse results. Mearns (1993) described winter shelters as being a relatively new phenomenon in the Mongolian Gobi Desert, a product of collectivism from the 1930s onwards. He suggested that these shelters reduced winter mortality rates significantly, but also reduced mobility. This contributed to significant levels of overgrazing and degradation in winter/spring pastures. Whilst the shelters improved herder livelihoods in the short-term, the absence of simultaneous interventions that remediated increases in grazing pressures may have compromised an important livelihood resource in the longer-term. Policy interventions much therefore be holistic rather than piece-meal.

Bureaucratic institutions regulating access to the forage resource are often ineffective in the Mongolian Gobi Desert (Section 5.2.1, Chapter 6). This may also be the case in other parts of the country. The reasonable rangeland condition found in this research (Chapter 8) suggests that externally derived, institutional intervention(s) applied under the auspices of addressing land degradation in are unnecessary. However Mongolian Gobi Desert herders obviously feel that their pastoral livelihoods are extremely vulnerable (Section 9.4), and State and development agencies feel that it is their responsibility to assist.

Agrawal (2001) noted that studies of common pool resources tend to neglect how aspects of the resource system interact with the external social, physical and institutional environmental to affect institutional sustainability. I argue that, in Mongolia, this neglect has been translated into an overemphasis on institutional ‘solutions’ to problems of natural resource management. I also concur with Turner’s (2011) more general criticism that institutions have been over-emphasised as management aims in themselves, rather than as one of many options for reaching management aims. I suggest that policy makers and development agencies may provide more benefit to the pastoral system by designing policies/programmes that focus on improving livelihoods in ways that minimise rangeland condition externalities, rather than seeking to improve rangeland condition per se. The following section opens up the discussion about improving rangeland condition and livelihoods of Mongolia’s Gobi Desert to be more inclusive of the multitude of factors constraining or facilitating natural resource management.

10.5 Policy options

This research found little evidence of widespread, grazing mediated degradation in the Mongolian Gobi Desert, irrespective of bureaucratic institutional settings. The Law on Land may not be as bad for rangeland condition as supposed, and pasture user groups may not be the panacea that was hoped for. Socially embedded institutions may have more of an impact on rangeland condition than bureaucratic institutions. Alternatively, the frequency and severity of exogenous climatic and economic shocks in the absence of tools for managing the risks of these shocks may mean that few institutions are currently effective. These conclusions have important implications for the design of policy at the national level.

In African rangelands, Abel and Blaikie (1989) noted that three options (high off-take, mobility, and 'do nothing') were theoretically available to policy makers seeking to improve both herder livelihoods and rangeland condition in pastoral areas with high levels of forage resource variability. These options recognise the need for policy to be flexible through space and time in response to local forage dynamics. Consequently, they are applicable at the national level. Elements of each can also be combined. Each also has significant financial, ethical or political costs, with none creating a 'win-win' situation. However these options provide a framework through which potential economic, environmental and social benefits and costs associated with interventional changes in pastoral regions of Mongolia can be explored.

10.5.1 Higher returns per head

Interventions that increase economic returns per head of livestock could be one way of meeting many economic, environmental and social aims. Such interventions may include support for value added processing or niche marketing. This option appears to be the approach of the Mongolian National Livestock Program, although the program also advocates institutional changes. With these interventions, the assisted reduction of livestock numbers during, or immediately prior to, periods of feed gaps could convert more volatile livestock capital into less volatile cash. This option could be applied to drought/pre-drought periods and to *dzud*/pre-*dzud* periods when herders are more certain of a declining forage resource (Chapter 4) and already have a tradition of culling or sales (Chapter 7). The provision of warmer shelters for livestock may be appropriate within this option.

Abel and Blaikie (1989) noted that this option was expensive as it required marketing facilities, abattoirs and price incentives. There are a number of other issues that make this option problematic in the Mongolian Gobi Desert, and possibly the rest of the country. Herd sizes are currently below what herders consider to be the minimum viable herd size, and most herders do not have surplus, non-subsistent livestock to sell (Chapters 7 and 9). Herders could theoretically sell young livestock (e.g. 2 – 3 years old) during this period but given the cultural reluctance to cull young livestock, the domestic market may be limited. Herders gain multiple benefits from holding livestock rather than cash (dairy, wool, cashmere, herd warmth, dung for heating, respect, a cultural tradition of giving livestock to newly wed children, sometimes a higher rate of return than cash during periods of high inflation etc). Consequently, the required price needed to induce them to sell may need to be considerably higher than the prices described in Section 7.3. Relatively low livestock prices in the period prior to when off-take (Section 7.3), high fuel prices, a small domestic market, quarantine issues, difficulty in storing excess meat due to frequent power outages, and limited road infrastructure present significant challenges to this option in the short to medium term. The Mongolian Livestock National Program (2010) is attempting to address some of these issues. However, given that the resourcing of decentralised administrations is currently very low in Mongolia (Mearns 2004; Section 7.6), a significant up-scaling of funding would also be required to support the high off-take option at the local level.

The high off-take option bears some comparison to the collective era, when both levels of inputs and off-take were higher than they are in the market economy (see Sections 2.5 and 7.6.1). Problems associated with a lack of infrastructure and government funds for subsidies are therefore not theoretically insurmountable. Whilst some herders were positive about the additional inputs that the collective era provided them with, it is questionable whether such a system is viable in a market economy without a significant investment by government. During the collective era, a significant proportion of Mongolia's GDP came from Soviet subsidies; Mearns (2004) puts this figure at about 33% of GDP, whereas Luvsanjamts (2005) suggests it is about 20%. Luvsanjamts (2005) argues that this amount has nearly been completely replaced by foreign aid since the early 1990s. It is unclear whether the fragmented development interests of donors would be capable of supporting the large upfront and substantial ongoing costs of the high off-take option without a greater level of direction and control by the government over the use of these funds. Mining taxes/royalties may make this option more viable in future. The context under which high off-take is a viable option may require more investigation.

10.5.2 Higher mobility

The second option is supporting higher mobility. This parallels the 'high off-take' option by pre-emptively reducing grazing pressures prior to feed gaps being realised.

The mobility option's spatial partitioning of forage demand may be particularly appropriate in areas like the Mongolian Gobi Desert because transaction costs may be lower than for the high off-take option. As the mobility option also shares similarities with the socially embedded institutional settings that presently dominate the Mongolian Gobi Desert (Chapter 6). It may be more socially palatable than the high off-take option. Herders interviewed in this research commonly stated that mobility was a necessary way of adapting to a spatially and temporally mobile forage resource (Chapter 4), with their mobility patterns generally reflecting this view (Chapter 6). Bureaucratic institutional settings (Chapter 5) also acknowledged this to some extent.

Some of the institutional arrangements for mobility are currently constrained. Some herders suggested that inter-*soum* and *aimag* arrangements did not always assist with negotiating pastures at the more local scale. Murphy (2011) found that this arrangement also manifests in highly inequitable ways. The potential for PUGs to overcome labour constraints was not always realised if wealthier, more labour rich, herders retreated to relying upon kin networks for labour in periods of low resource density, and subsequently did not support labour constrained, poorer herders (Upton 2012). Moreover, PUG institutions could not assist with mobility when PUG herders needed to move between two areas outside their PUG. The establishment of PUGs that were not at a spatial scale appropriate for spatial forage variability (see Chapter 4) could not assist members to negotiate access to forage outside the PUG area when such areas needed to be accessed (see Chapter 5).

Supporting complex reciprocal arrangements between unfamiliar herders controlling grazing territories requires the timely assistance of governments. Institutional prescriptiveness is unlikely to be useful. Instead, clearer rules that assist local governments to make more transparent decisions about who has access to what area of forage, and when, are warranted. Policies that act as a disincentive for mobility, like the *soum* 'red tape' that means herders outside their *soums* pay more for medical treatment (Chapter 9), could be reviewed. Addressing some of these constraints under the second Abel and Blaikie (1989) option may be more a politically palatable form of support that external agents could offer herders.

10.5.3 'Do nothing'

Policy makers and development agencies could also choose the third option, to 'do nothing'. The term used by Abel and Blaikie (1989) to describe this option is unfortunate in that policy makers and development agencies can 'do plenty' in minimising the externalities of this option. However Abel and Blaikie (1989) rightly use this term to illustrate a non-interventionist approach to fluctuations in livestock numbers. As many bureaucratic institutions are currently not monitored and sanctioned by authorities (in the case of the Law on Land) or other herders (in the case of PUGs), bureaucratic institutions in Mongolian pastoral regions effectively 'do nothing' at present. Although *soum* governments attempt to support herders (Chapter 7), their ability to do so is severely limited by financial resource constraints. In effect, the support of herders by both local government and development agencies is relatively minor and largely limited to emergency relief situations (Mearns 2005; Fernandez-Gimenez *et al.* 2012; Upton 2012; Chapter 7). For these reasons, the 'do-nothing' option is likely to continue to result in high levels of livestock mortality during *dzud* periods, equating to a significant loss of national and private capital, potentially significant declines in human welfare and increases in rural-urban migration.

Despite these issues, Abel and Blaikie (1989) considered this opportunistic approach to pastoralism to be a rational strategy in a landscape with highly variable climatic conditions. This is because it is the least risky and most cost effective option for maintaining the forage resource in the long-term. For example, in the Gobi Desert, adaptations to grazing, droughts and sub zero temperatures allow plant species to tolerate or escape high grazing pressures for a certain period of time. However plants may also require conditions that are warm, have high soil moisture and low grazing pressures (a post-*dzud* spring/summer) to recover before herds build again (Chapter 4). The current 'do nothing' situation that has allowed high levels of livestock mortality during *dzud* periods may also have resulted in the relatively intact rangeland condition found in Chapter 8.

The 'do nothing' option does not sacrifice herder livelihoods for good rangeland condition as the two are intrinsically linked; the 'do nothing' option simply takes a longer term view on maintaining them both. However the inefficiencies of the 'boom and bust' system (e.g. lost livestock capital) may be more obvious than the inefficiencies of more exclusive institutional settings, such as those described by Li and

Huntsinger (2011) in Inner Mongolia. Governments and development agencies are more likely to respond to voters facing livelihood shocks than landscapes or livelihoods facing longer term stress. In democratic countries like Mongolia, the longer term benefits of the 'boom and bust' system are therefore at constant risk of being undervalued when compared with interventions that have more obvious short-term benefits.

To manage this, the State could seek to minimize declines in herder welfare during or immediately after *dzud* periods under the 'do nothing' option. That is, it could 'do nothing' in terms of further intervening directly in institutions governing access to the forage resource, but 'do something' about ameliorating the adverse impacts on livelihoods of the 'boom or bust' system. The State could consider both short-term welfare support, as well as assisting with longer term structural readjustment. The migration option proposed by Mearns (2004), where the State supports the exiting of the pastoral system by unviable herders, or the next generation of herders, is one of the ways in which the State could assist. Herders interviewed for this research were certainly supportive of their children engaging with alternative livelihoods, with established poorer herders being less likely to have the necessary skills/training/youth (Chapter 9). Exit options would also mean remaining individual herders would not be required to destock (as may be the case under the proposed MSRM Pasture Law – see Chapter 5). This is important as destocking would be a potentially expensive and politically difficult activity to enforce and, depending upon how the Law was interpreted, may in turn reduce individual herd sizes to levels even further below those which herders perceive to be minimum viable herd sizes (see Chapter 9).

Exit options may also reduce levels of conflict over time as the defendability of the forage resource declined due to the reduced demand of a smaller number of herders. Of course, State support for exit options would depend upon what non-pastoral livelihood options were available. Mining is largely seen to be a potential boom for employment options. Herder accounts (Chapter 9) suggest that a lack of mining-appropriate skills and advanced age may limit the number of herders that could be absorbed by this, but suitable training programmes may assist with this in the longer term.

The sponsorship of an insurance scheme that provides herders with financial capital when their asset (livestock) declines may also be a way in which the State could support herders in a ‘do nothing’ scenario. Such a scheme is already being trialled in non-Gobi Desert *aimags*, and some of the Mongolian herders interviewed for this research (Chapter 7) volunteered that they were supportive of such a scheme being established in their *aimags*. There are complex issues associated with the design of a large-scale livestock insurance scheme. For example, the large spatial scale of *dzuds* (see Chapter 4) suggests that livestock prices would rise significantly during a mass pay-out to herders as demand for livestock increased, and the post-*dzud* supply decreased. It is likely that governments and/or development agencies would need to be involved as such a scheme may not be commercially viable due to widespread *dzuds*. Whilst high post-*dzud* prices may mean that herders would not be able to replace their herds to at least a minimum viable herd size, some may use pay-outs to subsist on until their remaining herds rebuilt. Others may opt to invest financial capital elsewhere, and exit pastoralism altogether, which may be a socially desirable option in the longer-term.

10.5.4 Intensification

A fourth option, not discussed by Abel and Blaikie (1989), is referred to by Mearns (2004) as livelihood intensification - the addition of inputs (like fodder, water and infrastructure) with the aim of increasing livestock production per unit area. This option generally accompanies greater levels of exclusivity over key areas of grazing land or resources, with a decline in livestock mobility accompanied by increased levels of supplementary feeding, livestock penning and higher off-take. The Household Responsibility System in the Inner Mongolian rangelands adopted this option with the greater economic defendability of the forage resource that accompanied an increase in human population density. In Mongolia, this option is also being considered around Ulaanbaatar, Darkhan and Erdenet (northern Mongolia), Dalanzadgad (capital of Omnogobi *aimag*), and the Khanbogd and Tsogtseggi *soum* centres (Omnogobi *aimag*) (see Chapter 2). Some Ulaanbaatar-based development agencies are also supportive of intensification for managing expected changes in the climate (anonymous staff member of an international development agency, personal communication, 2011).

This research did not directly explore the large-scale economic, cultural or political viability of the intensification option. Nevertheless it theoretically has the potential to reduce grazing pressures and dampen livelihood volatility in desert steppe areas. Mongolian herders could be less exposed to the risk produced by climatic variability in the short to medium term, something that this research highlighted as being a significant, and potentially growing, concern to many herders (see Chapter 9). However exposure to climatic variability would only decrease under the intensification option if herders were able to adequately compensate with affordable supplementary fodder.

Herders in Inner Mongolia purchased large quantities of commercial fodder prior to grazing bans (Chapter 7) but the proportion of livestock feed obtained in this manner was not assessed in this research. The long-term economic viability of fodder importation in Inner Mongolian study sites remains unknown. The grazing bans were introduced for environmental reasons. Given that these bans followed increased levels of exclusivity, the ability of herders to be adequately compensated for feed gaps by purchasing supplementary fodder is questionable. For example, the limited commercial fodder market during the 2010 survey period (Chapter 7) suggests that intensification could not be supported at the scale required to provide an adequate livelihood for all herders in the Mongolian Gobi Desert. The opportunity for irrigated fodder to be grown locally may also be constrained by limited water resources and potential environmental impacts. Herders would be more exposed to the price risk associated with increases in the prices of inputs (such as the high prices of commercial fodder during *dzud* periods – see Chapter 7).

Even if the large-scale use of irrigated fodder was economically viable in Mongolia, and intensification was able to improve condition in non-intensified rangelands, the externalities of extractive agriculture would simply be transferred onto other natural resources as they have been in the Inner Mongolian system. The environmental impacts of the small-scale irrigation that some Mongolian herders used to grow fodder were not assessed by this research. However, extraction from Inner Mongolia’s Yellow River, which provides the water used to grow much of the supplementary feed of the Inner Mongolian herders interviewed in 2010 (Chapter 7), has been linked to significant environmental problems (Tang *et al*. 2007).

Intensification may also not generate higher livelihoods in the long-term (Sandford 1983). This is certainly the case if a sufficiently long timeframe is examined. ‘Sustainability’ refers to the ability to maintain and improve livelihoods whilst maintaining or improving assets and capabilities upon which these livelihoods depend (Chambers and Conway 1992). Intensification relies directly upon non-renewable resources, or those produced or extracted by non-renewable resources (e.g. fossil fuels, groundwater, inorganic phosphate, irrigated fodder). This makes it unsustainable by definition. Larger populations or consumption levels can be supported or created by intensification in the short-term. However alternative livelihoods for additional people/more demanding consumers would still be needed in the longer term when any of the extractively harvested resources used in intensification are exhausted.

10.6 Concluding remarks

Society and ecology in the arid rangelands are no more or less coupled than in other landscapes. However coupling is more obvious in arid rangelands where most herders are subsistent and where feedback loops are less buffered. Any one set of interventions cannot resolve all problems related to rangeland condition and herder livelihoods in these landscapes. However some interventions have produced unpredicted, perverse outcomes at very large scales. Interventional panacea based upon theories developed elsewhere can be particularly risky. In the case of the Mongolian Gobi Desert, theories of both the tragedy of the commons and common property have been misapplied. Policy makers are in the difficult position of balancing domestic and international interests that sometimes conflict. However, policy needs to consider the dynamic relationships between biophysical, social, political and economic spheres in ways that are appropriately scaled and recognise non-linearity. Where forage resource boundaries are fuzzy through space and time, institutions must be equally fuzzy through space and time. Environmental degradation holds its own political, economic and cultural currency, but rangelands that are not degraded do not require institutional intervention. Accepting a social-ecological system that is most suited to the long-term sustainability of the resource upon which livelihoods are based may sometimes require accepting that in the short to medium term livelihood and environmental outcomes may appear to compete.

10.7 Further research

The policy options discussed in this chapter are just that – options. The relative benefits of each of these options may be affected by as yet unknown changes in components of the social-ecological system. An outline is presented below of three drivers (or shocks or stresses) that may have a significant impact on the relative merits of these options, and on rangeland condition and herder livelihoods. A full investigation of these three drivers is outside the scope of this study but they warrant investigation in the future. A fourth suggestion for research is that of the gaps between the perspectives on rangeland condition assumptions between herders on the one hand and State and development agencies on the other hand that became evident, but was not explained, by this research. These four suggestions for further research are not exhaustive, and other discipline-specific suggestions have been raised previously in the relevant chapters of this thesis.

10.7.1 Climate change

This thesis has resisted describing the variability in some climate metrics, made apparent by both herders and the biophysical data, as ‘climate change’. Datasets used in this research are not of a long enough timeframe to differentiate between the types of changes herders may have experienced in their (geologically short) lifetime, and what is expected to be evident under more long-term climate change. Nevertheless, climate variability is expected to increase in the Inner Asian region (Intergovernmental Panel on Climate Change 2007). The temporal and spatial scale of these predicted changes are not of a fine enough scale to predict how the social-ecological system will respond. However the datasets explored for this research allow some hypotheses to be developed about how changes in climate metrics may affect the forage or livestock resource.

Spring is an important time for determining livestock mortality rates as it provides forage for livestock that have survived several months without fresh feed (Chapter 4). It is also the final stage of livestock gestation, and the beginning of lactation, a time of high metabolic energy requirement. A delay in spring burst, such as by winter temperatures staying below zero for a slightly longer period, or by declines in autumn precipitation reducing the ‘soil moisture memory’ (Shinoda and Nandintsetseg 2011; Chapter 4), may lead to increased livestock mortalities. Warmer winter temperatures may reduce livestock mortalities over winter, but this may circumvent an important safeguard for keeping grazing pressures down in spring, reducing the ability of important forage species to reproduce.

Shinoda *et al*. (2010) found that *Cleistogenes squarrosa* (Trin.) Keng has a higher sensitivity to drought than *Stipa krylovii* Roshev, and Sodnomdarjaa and Johnson (2003) suggested that *Cleistogenes* spp. requires long wet periods for reproduction. Consequently, the later summer/autumn, or lack of follow-up, rains described by herders in Chapter 8, may select for some species with differing pastoral benefit than those present. Less precipitation over winter may select against shrubs like *Caragana* spp. These effects arguably produce feedback loops but, since they currently remain un-modelled, it cannot be said whether livestock production and/or rangeland condition in the Mongolian Gobi Desert are likely to be positively or negatively affected by climate change.

Understanding likely changes in the biophysical resource is also important for the design of institutional settings. As emphasised throughout this thesis, changes in forage variability and availability can affect the economic defendability of the resource (Dyson-Hudson and Smith 1978). A better understanding of how changes in climate may affect the forage resource should clarify which of the four policy options described earlier are likely to have the most sustainable outcomes. Given the importance of pastoralism to the Mongolian economy, research into the effects that changes in climate may have on the pastoral system is warranted.

10.7.2 The role of China

The pace and spread of China's economic growth, and its impact on the Chinese pastoral sector, has been uneven through time and space (Waldron 2009). However, as an immediate neighbour to the Mongolian Gobi Desert, China has the potential to have a considerable effect on the pastoral system across their relatively porous mutual border. For example, there is some evidence that China is an increasingly important player in the pastoral system of the Mongolian Gobi Desert due to China's growing dominance over the cashmere market chain (Waldron 2009).

The impact of the 2009/2010 *dzud* appeared to be different to the prior *dzud* ten years earlier because commercial fodder from China was available, and a number of Mongolian herders purchased it for the first time. The undeveloped commercial fodder market in Mongolia may well stay that way, with economies of scale and proximity to the border making the purchase of Chinese fodder more viable for many Mongolian Gobi Desert herders than the use of Mongolian fodder. Reduced feed gaps over winter through cheaper or better quality fodder from China may have implications for livelihoods in the short term, but also for the condition of winter/spring pastures in the longer term if mortality rates were to subsequently decline. The demand and supply of fodder in China is also changing rapidly. Consequently, any research into the use of Chinese-sourced fodder would also need to assess the dynamic developments occurring within China.

Similarly, the higher prices for cashmere in Omnogobi *aimag* compared to Dundgobi *aimag*, shown in Chapter 7, may be due to the higher demand associated with proximity to the Chinese border (Waldron *et al*. 2011). As China's demand for cashmere grows, Mongolian herds may become less diversified and food security may decline. If Mongolia's quarantine issues can be resolved, the increased demand for commodities and cheaper supply of inputs from China may make the higher off-take and exclusivity/intensification options presented in this chapter more economically viable. Further research that examines the role of current and predicted market chains between the Chinese and Mongolian pastoral systems appear warranted.

10.7.3 Demographic change

Problems like overgrazing and conflict over pasture may be exacerbated or ameliorated by demographic shifts in the herding population. There are many examples of demographic change in rural Mongolia. The urban-rural migration that increased herder numbers in Mongolia during the 1990s is often linked to overgrazing and increased conflict (see Chapter 2). At the broad scale, this trend has reversed in recent years, and rural-urban migration appears to be on the rise once again (National Statistical Office of Mongolia, 2010).

At the more localised scale, rural-urban migration does not appear to be spatially consistent, with some *aimags* depopulating more than others. Since 2006, the population of Omnogobi *aimag* has increased, probably due to internal immigration associated with growth in mining activities rather than an increase in the herder population (National Statistical Office of Mongolia, 2010). Dundgobi *aimag*'s population decreased over this same period. Herders interviewed in both these *aimags* were keen that their children should seek livelihoods outside the pastoral sector, and others were investing significant resources in university educations for their children.

Social relationships also affect the demand on the forage resource via the ability of herders to manage feed gaps. Important social relationships in rural Mongolia include those that culturally obligate kin in urban and rural areas (Mearns 2004; Sneath 2006) and affect the two-way mobility of herders within and between the pastoral and non-pastoral sector with changes in natural and/or social capital (Fernandez-Gimenez 1999). Like population densities, these also shift through time.

Such factors can have a significant impact on both rangeland condition and herder-to-herder conflict. For example, given that population densities affect the economic defendability of the forage resource, a declining population in Dundgobi *aimag* (and possibly in the herding sector of Omnogobi *aimag*) may lessen issues of conflict and perceived issues of overutilization in the current institutional context. If declining population densities were demonstrated to be an ongoing trend, the case for a change in institutional setting would be weakened. The increased conflict and overutilization of the transition period of the 1990s and early 2010s could be seen as just that – the temporary effects of an economic, political and social transition.

10.7.4 Science, development and policy

Over 20 years ago, Mearns *et al*. (1992) noted that '*the relationship between research and policy-making in Mongolia is an extremely weak one*.' From the early 1990s to 2005, Luvsanjamts (2005) estimated that 17 to 32% of Mongolia's Gross Domestic Product came from foreign aid. Development organisations may have significant influence in the Mongolian rangeland and environment sector (Upton 2010). According to Sneath (2003), Prime Minister J. Narantsatsralt felt compelled to defend his government against accusations of being unduly influenced by donor loan requirements, stating to the Daily Newspaper that '*The ADB loan and the development, approval and implementation of the Law [on Land] are two separate things*.'

The efforts of development organisations to improve the livelihoods of herders and the condition of the resources upon which their livelihoods are based are admirable. They often attempt to work with both the Mongolian government and herders. The development agency-led projects examined for this research were well intentioned and sought to be participatory. However there are large amounts of money involved and development organisations are arguably more accountable to their donor's expectations than they are to the Mongolian people. This creates the risk of projects and policies being implemented that do not have the full backing of either the Mongolian people (particularly in relation to the prioritisation of funds), or empirical research. A better understanding of the relationship between the development sector, science and policy making needs further examination in light of these gaps.

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