Journal of Arid Environments 94 (2013) 37–46

Contents lists available at SciVerse ScienceDirect

Journal of Arid Environments

journal homepage: www.elsevier.com/locate/jaridenv

Do pasture user groups lead to improved rangeland condition in the Mongolian Gobi Desert?

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ARTICLE INFO

Article history:
Received 18 November 2011
Received in revised form
12 February 2013
Accepted 19 February 2013
Available online 29 March 2013

Keywords:
Collective action
Common property
Degradation
Herder groups
Institutions
Variability

ABSTRACT

Pasture user groups have become an important tool by which development agencies have sought to improve rangeland condition and resolve inter-herder conflict. However the ability of these groups to improve rangeland condition in the Gobi Desert is rarely examined. In this paper, three and twelve year old pasture user group areas were compared with non-group areas. Herders and local officials in both group and non-group areas were interviewed to compare activities and institutions that may contribute to degradation through overgrazing. Soil and vegetation based indicators of rangeland condition were also assessed. There were some differences in indicators of rangeland condition between pasture user group and non-group areas, but little evidence of institutions or activities specific to the group that could explain this difference. Herders did not seek to manage grazing pressures for natural resource management aims, nor did they enforce or sanction the external spatial boundaries of pasture user groups. These results suggest that the ability of pasture user group to improve rangeland condition in the Mongolian Gobi Desert may have been overstated.

1. Introduction

1.1. Managing common property resources in the rangelands

It is increasingly recognised that the ability of the State to manage natural resources at the local level is extremely limited (e.g. Agrawal and Gibson, 1999; Swallow and Bromley, 1995). Institutions are rules or norms developed by the shared perceptions of a group of people about proper and improper behaviour (Crawford and Ostrom, 1995; Ostrom, 2005). The creation or recognition of more localised institutions for governing resource use is considered to be more effective at improving natural resource management than State-based institutions (Brosius et al., 1998; Ostrom, 1990). There is some evidence that clearly defined boundaries, self-determination, locally adapted rules governing resource usage and collective-choice arrangements in decision making may contribute to better management of common property resources than control by the State (Ostrom, 1990; Scoones and Graham, 1994). Community based management, joint management, co-management and collaborative management are just a few of the different manifestations of a return to more localised forms of common property management.

International development agencies, in particular, have sought to recreate or strengthen socially embedded institutions for natural resource management (Brosius et al., 1998; Hogg, 1992). 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, resource users have attempted to re-establish weakened socially embedded institutions with the facilitation and support of an external agent such as a development agency. In some countries, these institutional settings are formally recognised by the State, with Swallow and Bromley (1995) noting that they govern the rangelands of countries including Ethiopia (Helland, 1982), Tanzania (Lane, 1991) and Morocco (Gilles et al., 1992).

Despite the renewed emphasis on socially embedded institutions and collective-choice, the purported benefits of these institutional models have been challenged. Defining a local ‘group’ or ‘community’ can be difficult, with definitions of the terms often missing entirely in the documentation of those using these concepts to progress natural resource management aims (Cleaver, 2000; Hogg, 1992). The belief that natural resources were historically sustainably managed by a homogeneous group of local

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0140-1963/$ – see front matter
http://dx.doi.org/10.1016/j.jaridenv.2013.02.009

resource users may be naive (Li, 1996). Institutions may be crafted from pre-existing ones that are no longer relevant to the new social–ecological context, and consequently may no longer be the best institutions for natural resource management (Cleaver, 2000).

Assumptions that community control automatically translates into environmental benefits has been labelled as '*green romanticism*' (Davis and Ruddle, 2010; Vayda and Walters, 1999). Local groups may seek to maximise income, becoming involved in natural resource projects only for economic gain, and prioritising this gain over sustainability (Vayda and Walters, 1999). Local groups may deliberately attempt to become a co-operative community for the purposes of accessing donor resources (Cleaver, 2000), deliberately wielding the power of the dominant culture's environmental rhetoric for their own purposes (Davis and Ruddle, 2010).

Some suggest that common property theory is overly optimistic, an artefact of a particular ideology or an overstatement of success (Hogg, 1992). Hogg (1992) suggested that the development agencies operating in pastoral Africa who 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*'. Collective action can fail to prevent degradation in the face of other social, political and economic pressures (Agrawal and Gibson, 1999; Hogg, 1992; 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.

These issues suggest 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 livelihoods in different biophysical, political, economic and cultural contexts (Cleaver, 2000; Ostrom, 2007). For these reasons, the social-ecological context of the area in which institutional interventions are being introduced and/or examined needs to be understood.

1.2. Institutional change in Mongolia

Institutions that are socially embedded at the local level, as well as those established or facilitated by external agents, have changed the ways in which Mongolian herders and their livestock access the forage resource. From the 1950s, most herders worked for rural collectives. The movements of livestock between pastures were influenced by the rules applied by collectives that had been established by the socialist central government and by pre-existing customary institutions (Sneath, 2003). Collectives also supported pastoralism through the provision of fodder, livestock transport and veterinary care (Sneath, 2003). In the early 1990s, the collectives dissolved; livestock were privatised, and the State retreated from the provision of pastoral services (Murphy, 2011).

Despite little empirical evidence of grazing-mediated degradation (Wesche and Retzer, 2005; Wesche et al., 2010), these institutional changes have been assumed to contribute to declining rangeland condition in Mongolia (Asian Development Bank, 1995; Millennium Challenge Account Mongolia, 2008; The World Bank, 2011; United Nations Development Programme, 2011). A strengthening of institutions controlling access to the forage resource has been proposed as a potential solution for this problem. However changes in national-level institutions have been contentious (Sneath, 2001, 2003; Upton, 2009; Upton, 2010). Although some early advice from international agencies promoted the privatisation of rangelands (e.g. Asian Development Bank, 1995), private ownership of land is constitutionally illegal (Fernandez-Gimenez and Batbuyan, 2004). Further, while the national Law on Land gave herders exclusive use rights to winter/spring shelters, conflict between herders over who has rights of access to pastures has continued (Fernandez-Gimenez and Batbuyan, 2004; Murphy, 2011). Decentralisation of rangeland management to local government might have helped to resolve conflicts and improve rangeland management had it been accompanied by increased funding and capacity amongst officials (Mearns, 2005). Instead, it has consolidated power inequities (Murphy, 2011) and there is little evidence to suggest that it has improved natural resource management.

Development agencies in Mongolia have responded to these issues by encouraging the formation of herder groups (Sarantuya and Nyamdorj, 2003; Schmidt, 2006; Hess et al., 2010; The International Development Research Centre, 2007; Usukh et al., 2010). Over 2000 herder groups of varying types, through more than 12 different programmes, have been established by development agencies (Mau and Chantsalkham, 2006, cited in; Fernandez-Gimenez and Kamimura, 2008). The Swiss Development Corporation's Green Gold Programme uses the term 'pasture user groups' (PUGs) to describe multiple herders in a defined geographical area that it has encouraged to engage with collective action to meet pasture management and livelihood goals. We use the same term in this paper to distinguish these types of groups from groups of herders that cooperate in livelihood strategies without the involvement of an external agent (such as *khot ail*), or those that cooperate for the exclusive purpose of marketing commodities such as cashmere, with or without the involvement of an external agent.

Development agencies typically provide funding and other support for PUG activities, including fencing of winter/spring pastures, operation of community centres, business loans and information sharing workshops (Usukh et al., 2010). They also assist with PUG design, including facilitating the strengthening of antecedent socially-embedded institutions that might regulate access of livestock to the forage resource. PUGs vary in their aims, membership size, and legal recognition depending on the region they are located in and the approach of the development agency that has facilitated their establishment. In general, however, members agree to provide mutual assistance to each other, such as providing labour for maintaining winter shelters, and to work towards sustainably managing pasture resources. In some cases, there is an expectation that members will regulate grazing pressures within a spatially defined area designated for the PUG. However in other cases there is no such expectation and PUG areas are only spatially defined for the purpose of determining herders' eligibility for membership. This eligibility is generally based on a herding household having pre-existing rights, arising from either formal or socially-embedded institutions, to a permanent winter/spring camp within the PUG area.

There has been some empirical assessment of the ability of PUGs to benefit livelihoods in the Mongolian Gobi Desert. Hess et al. (2010) described the benefits of PUGs as perceived by members, including empowerment of women and better communication between herders. Upton (2009) supported the claims of development agencies that PUG membership brought social benefits to members. However, she also suggested that the creation of PUGs may have contributed to feelings of exclusion amongst herders who could not be members of a PUG due to their relative poverty and/or lack of labour to contribute to collective activities. Upton (2009) also suggested that the devolution of power from the State to PUGs may have exacerbated inequality, a finding supported by Murphy (2011) in a different PUG. There has been less independent assessment of the ability of PUGs to benefit rangeland condition. Assessments of PUG efficacy are generally conducted by development agencies immediately upon project completion, a time frame that is poorly matched to the high level of climatic variability exhibited by the Gobi Desert (Von Wehrden et al., 2010).

Despite a lack of empirical assessment of the ability of PUGs to benefit rangeland condition, the PUG model is influencing changes to Mongolian policy at the national level. One of the many versions of the draft Pastureland Law, debated by the Mongolian Parliament for some years, proposes to create a series of spatially-bounded PUG areas encompassing the entire country, albeit with provision for herders to continue to undertake long-distance migrations in extreme seasonal conditions (United Nations Development Program, 2008). The growing influence of the PUG model at the national level makes it timely to assess the role of PUGs in improving rangeland condition.

This paper examines how the institutions and activities of PUGs, whose formation has been facilitated by the development agencies, affect rangeland condition in the Mongolian Gobi Desert. Addison et al. (2012) found that the rangelands of the Mongolian Gobi Desert were generally in better condition than believed by policy makers and development agencies. This paper extends that analysis by using both biophysical and social surveys to compare rangeland condition in PUG and non-PUG areas. The applicability of herder groups that rely upon exclusive pastoral institutions is explored in relation to the dryland rangelands of Mongolia, and elsewhere.

2. Methods

2.1. Site description

The research was conducted in two *aimags* (states) in the Mongolian Gobi Desert. This area is characterised as desert steppe (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 Geo-ecology, Ulaanbaatar, 2007). Vegetation is dominated by shrubs such as *Reaumuria soongorica* Pall., *Salsola passerina* Bge. and *Anabasis brevifolia* C.A. Mey., and perennial forbs and grasses such as *Allium polyrrhizum* Turcz. et Rgl., *Artemisia frigida* Willd. and *Stipa* spp.

Precipitation in the Gobi Desert mostly falls between May and September as rain. 80% of Bulgan *soum*'s (district) total annual precipitation between 1990 and 2010 fell within this time period (Institute of Meteorology and Hydrology, Ulaanbaatar, 2010). The rest mostly fell as snow. Precipitation is variable in space and time, and is often described as non-equilibrium (Wesche and Retzer, 2005; Wesche et al., 2010).

Temperatures show significant, predictable variation within years. The minimum monthly average temperature between 1990 and 2010 was −24 °C and the maximum 27 °C (Institute of Meteorology and Hydrology, Ulaanbaatar, 2010). Rarer *dzuds*, a multi-faceted term implying atypical winter conditions, such as extreme cold or deep snow, challenge the coping strategies of herders by adding a level of unpredictability to the pastoral system. *Dzuds* are sometimes preceded by a dry summer that limits pastoral production.

2.2. PUG and non-PUG area sampling strategy

The herders interviewed identified two distinct types of landscape in the study region, which we refer to as 'steppe-type' and 'gobi-type'. We selected five PUGs for study: two in steppe-type landscapes and three in gobi-type landscapes. Precipitation is higher in the steppe-type landscape than the gobi-type landscape, and less variable. The two meteorological stations closest to the steppe-type PUGs recorded average annual precipitation of 94 and 132 mm between 1990 and 2009 over the last 20 years (Institute of Meteorology and Hydrology, Ulaanbaatar, 2010). The precipitation coefficient of variation is about 0.3 during the forage growing period (Institute of Meteorology and Hydrology, Ulaanbaatar, 2010). Compared to the gobi-type landscape, steppe-type areas have more kastanozem soils, are at higher altitudes and have more mixed perennial forbs and grasses such as *A. polyrrhizum* Turcz. et Rgl., *A. frigida* Willd. and *Stipa* spp.

The meteorological station nearest to the gobi-type PUG areas recorded an average annual precipitation of 72 mm between 1990 and 2009 (Institute of Meteorology and Hydrology, Ulaanbaatar, 2010). Stations located in the gobi-type landscape have coefficients of variation (CVs) for precipitation of up to 0.53 during the forage growing period (Institute of Meteorology and Hydrology, Ulaanbaatar, 2010). Compared to the steppe-type landscape, gobi-type areas have a greater proportion of calcisol soils and more sub-shrubs such as *R. soongorica* Pall., *S, passerina* Bge. and *A. brevifolia* C.A. Mey.

Establishment of each of the steppe-type PUGs was facilitated by the same development agency (Agency A), from about 1995. Each of the gobi-type PUGs was established in 2007 by a second development agency (Agency B). Data from the PUGs in each landscape type were combined for analysis. This was justified by the selected PUGs in each landscape type having a similar history and being in similar landscapes. We refer to the amalgamated samples as steppe-type PUGs and gobi-type PUGs. We recognise that the former have a much longer history than the latter.

A mixed methods approach was used with both PUG and non-PUG areas assessed for rangeland condition, with herders and local officials being interviewed in both areas. The spatial distribution of herder interviews and rangeland condition surveys is shown in Table 1. In order to compare PUG areas with pasture areas where no PUGs had been established by development agencies, we sampled herders and rangeland condition in areas adjacent to the selected PUG areas, in both gobi-type and steppe-like landscapes. These herders we sampled were not members of a PUG and the sampled areas were not within the spatial boundary of any PUG. We refer to these areas and herders as non-PUG. We assumed that historical grazing use, before the formation of the PUGs, had been the same in our PUG and non-PUG areas. We also assumed the same institutions operated in PUG and non-PUG areas except for those rules and norms associated with the existence of the PUGs. The sampling strategy and methods for herder interviews and rangeland condition are presented in detail below.

Table 1
Spatial distribution of interviews and rangeland condition surveys.

Aimag	*Soum*	No. of herder interviews		No. of rangeland condition surveys	
		PUG herders ($n = 25$)	Non-PUG herders ($n = 25$)	PUG areas ($n = 25$)	Non-PUG areas ($n = 25$)
Dundgobi	Ulziit	15	0	15	0
Omnogobi	Tsogt-ovoo	0	6	0	2
	Manlai	0	7	0	7
	Bulgan	5	0	5	3
	Bayandalai	5	0	5	0
	Tsogttsetsii	0	5	0	2
	Khanbogd	0	1	0	0
	Sevrei	0	4	0	3
	Noyon	0	0	0	1
	Nomgon	0	0	0	1
	Bayan-ovoo	0	0	0	1
	Khankhongor	0	0	0	3
	Mandal-ovoo	0	2	0	1
	Khurmen	0	0	0	1

2.3. Interviews with herders and local officials

Ten herding households were randomly selected from the steppe-type PUG areas and 15 from within the gobi-type, a total of 25 households. A further 25 herding households were randomly selected from non-PUG areas (see Table 1). Herder households were approached in August or October 2010 and asked if they would participate in an interview. Most of these herders classified that summer season as fair to good, due to good pasture growth. They classified the preceding winter season as bad due to extremely cold temperatures. Indeed, the Gobi Desert had experienced a significant *dzud* during the 2009/2010 winter with major livestock loss for many herders (Sternberg, 2010).

Herders were interviewed in their *gers* (mobile tents) with the help of a translator. The interview was in a structured format. Apart from basic demographic information, herders were questioned about their membership of a PUG and how active they were as a member; the activities and functionality of the PUG; their household's mobility patterns; and their perceptions of change in rangeland condition. Herders were also asked about the appropriate season for grazing the pasture in their current location. Not all households responded to all questions.

Eight local government officials (from both *aimag* level governments and from the smaller *soums*) were also interviewed. These officials had responsibilities across both PUG and non-PUG areas. They were asked about the presence and effectiveness of PUGs in their administrative areas, and how these groups may have affected rangeland condition. Development agency documents and discussions with staff based in or near the PUG areas or in Ulaanbaatar were used to understand each agency's aims for the PUGs and establishment methods.

2.4. Analysis of interview data

The lead author worked with a Mongolian–English translator for all interviews with herder and local government officials. Notes were taken in English during each interview, and interviews were audio-recorded if consent was given for recording. As a check on the accuracy of notes and translations, a random selection of interviews was transcribed into English and a second transcriber was used to cross-check a subset of interviews.

Descriptive statistics were generated for demographic data from herder interviews and data on herding characteristics. Information from development agencies and local government officials on PUG aims, institutions and functionality was compared with that from herders. Interview responses were coded, identifying themes of interest, and categorised. Mechanisms that might directly promote improvement or maintenance of rangeland condition were identified. Representative quotes were selected.

2.5. Assessing rangeland condition

Indicators of rangeland condition were assessed at fifty sites across thirteen desert steppe *soums* between June and October 2010. Twenty five of these were within PUG areas and 25 in areas with no PUG history. A broad, landscape-scale approach to sampling was taken to maximise spatial representativeness. Sites were generally located at least one kilometre from a livestock waterpoint to minimise any localised piosphere effect caused by high grazing pressures (Sasaki et al., 2009). Unrepresentative features in the landscape, such as areas adjacent to *soum* centres, were also avoided.

Tongway and Hindley (1995) argue that functional landscapes minimise nutrient and moisture flows out of the system as obstructive 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 during dry periods, 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. The methods used in this research are loosely based upon this framework, and as follows.

Transects were consistently located to be parallel with the dominant erosive vector. Wind was a more erosive vector than water at the majority of sites. If obvious hummock-lags were visible, the dominant wind direction was calculated based on the direction of sediment deposition. The prevailing spring wind direction was chosen as a default as spring is when vegetation/obstructive cover is lowest, and hence is the most likely time for accelerated soil movement. The lengths of obstructive patches, including rocks and logs more than 1 cm in length and perennial vegetation, and interpatches, being the areas in-between, were measured. The length of the final transect depended upon the patch/interpatch length.

Five 1 m^2 quadrats were also used to assess a range of indicators along each transect. This quadrat size was the maximum commonly used in Mongolian desert steppe areas (Sasaki et al., 2009; Sheehy and Damiran, 2009). Quadrats were classified as per Friedel et al. (1993). Percentage fine gravel, coarse gravel, and bare ground were assessed visually in each quadrat. The existence (presence/absence), severity (1–4, with 4 being most severe) and type of erosion features (rill, pedestals, hummocks, sheets, terracettes, scalds, and gullies) 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 locally derived or foreign in origin was visually assessed. Percentage projected cover was visually assessed. The presence/absence of a biological crust was recorded. Indicators of field texture (score of 1–4 where 1 = clay, 4 = sand), slake-ability of a soil ped (score of 0–4 where 0 = too unconsolidated to create a ped, 1 = slakes within seconds, 4 = intact), and crust-brokenness (score of 0–4 where 0 = no crust, 1 = extremely broken, 4 = intact) were categorised. Major erosive features along the transect were also assessed for breadth and depth. The presence/absence of vegetation utilisation by livestock was visually assessed, with plant species consumed and comparative level of utilisation noted at each site.

2.6. Analysis of rangeland condition data

Indicators of rangeland condition were entered into an Excel spreadsheet, and then imported into SPSS for analysis. They were initially classified and analysed for significant differences according to soil type. This assessed whether differences in rangeland condition could be attributed to soil characteristics rather than to the existence of a PUG. No significant differences were found between soil types.

Indicators with a continuous dependant variable were then assessed for normality. Coarse gravel cover and projected vegetation cover were subsequently transformed via *squr(coarsegravel)* and *log(projectedvegcover)* to meet assumptions of normality. Litter cover was also found to 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. All normal, continuous indicators were compared between PUG and non-PUG areas. One way ANOVA tested whether indicators were significantly different between these areas. If differences were found, Tukey's Honestly Significant Different test was used as a post-hoc test to identify how they were different for that particular indicator. Categorical indicators were tested using the Kruskal–Wallis test. If significant differences were found Mann–Whitney *U* tests were used post-hoc to identify how they were different for that particular indicator.

3. Results

3.1. PUG aims

Both Agency A (which facilitated the formation of the steppe-type PUGs) and Agency B (gobi-type PUGs) expected that the PUGs they helped establish would enhance sustainable management of the forage resource. Agency A saw the strengthening of existing socially-embedded institutions as its main tool for achieving its goal of '*improving pasture conditions and halting further desertification*' and enabling '*local communities to use natural resources in the project area sustainably in cooperating with local government and the private sector*' (Agency A document 1, dated 2010).

Agency A used a participatory approach with local herders to select the PUG areas which covered 367 km^2 in one case and 294 km^2 in the other case. Agency staff said that because herders emphasised the need for mobility, the boundaries of these areas were never intended to be strict boundaries that PUG members must stay inside. A number of herders stated that there were boundaries, however. By the time of fieldwork in 2010, Agency A was no longer actively involved with the PUGs that it had established and was not providing funding to these PUGs. Staff hoped that these PUGs would be self-sustaining.

Agency B helped establish a series of spatially bounded PUGs across an entire *soum*, with each PUG occupying an average of 1028 km^2. Agency B stated that the overall aim of the gobi-type PUGs that it had established was to adapt the number of animals to the carrying capacity of the pastureland (Agency B documentation 1, dated 2010). It was intended that PUG members would develop institutions to regulate and facilitate seasonal rotations and inter-annual movements, allocate rights to use pastures for grazing, work with local government to identify pastures reserved from grazing, monitor their use and sanction rule-breakers, and align the number of livestock to an estimated carrying capacity. Agency B expected that, after an initial learning period, its aim would be achieved by '*the implementation of increasingly complex pasture-management activities that require collective actions of increasing complexity*' (Agency B documentation 1, dated 2010). This agency had worked with local government officials to establish the PUGs. To avoid conflicts between members and non-members, PUG membership was made mandatory for any herders grazing in the clearly bounded PUG areas. The PUGs were supported by an association of PUGs, and staff from the locally based branch of Agency B provided technical support and liaised with local government. Agency B was still actively involved with these PUGs at the time of the research.

There were gaps between the aims of development agencies to use PUGs to improve pasture management, herders' perspectives of PUG institutions and activities, and mechanisms underlying declines in rangeland condition. Development agencies had attempted to take a participatory, devolved approach in the development of PUGs. However their underlying premise was that land degradation had occurred, and that the strengthening of institutions governing access to the forage resource could improve management of the forage resource. They also considered that there had been reduced mobility and increased out of season grazing since the transition to the market economy in Mongolia. They assumed that this had contributed to a decline in rangeland condition, and highlighted the need for new, more effective institutions for sustainability. In contrast, herders did not agree that overgrazing due to unregulated pasture access could be resolved by reducing herd sizes. No herder equated current grazing pressures with degradation.

3.2. Herder engagement with PUG institutions and activities

Few herders were active in PUGs at the time of interview. Only a small proportion of the PUG herders interviewed said they were active members of a PUG and that the PUG itself was active at the time that we interviewed them, in 2010 (Table 2). Active membership in PUGs was higher in the more newly established gobi-type PUGs than in the older steppe-type PUGs. However only three of the ten interviewed herders in the gobi-type PUGs were active members 3 years after the PUGs were established. Despite low levels of active herder group membership, gobi-type PUG herders commonly stated that their PUG had been active in the past and/or was planned to be active in the future.

Institutions that might have a clear impact on rangeland condition include agreement amongst herders to reduce herd sizes, exclusion of non-members by enforcement of PUG boundaries, and rules about when herders should leave their winter/spring pastures. However no PUG herder we interviewed talked about the existence of these institutions. Herders from the steppe-type PUGs talked about four institutions or activities that their PUG had undertaken or was enforcing, and herders from the gobi-type PUGs talked about nine (Table 3). Most of these had potential social benefits, and some had potential economic benefits. Only two of the institutions listed in Table 3 'making agreements not to graze others' winter pastures' and 'preventing others from grazing in member's winter pastures' might have directly modified the timing or intensity of grazing pressures on pastures, hence having an impact on rangeland condition. Some other institutions or activities may possibly have an indirect effect on grazing pressure and ultimately rangeland condition.

3.3. Regulating grazing pressures

The lack of stated, active PUG membership does not necessarily indicate that institutions introduced with the establishment of the PUGs were no longer operational. It is possible that such institutions had become socially-embedded and so were no longer recognised by herders as being associated with a PUG. However, the *dzud* in the preceding winter, and the associated imperative for herders to move to find adequate pasture (see Table 4), had resulted in herders disengaging from the PUGs and PUG or other institutions that prescribed who was allowed to graze where within the PUG or beyond.

PUG herders from both landscape types frequently said that their PUGs had spatial boundaries that were not enforced. They did not try to control movements of other herders and their livestock in and out of the PUG areas:

> '*I am the leader of* [gobi-type PUG]. *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.*' (Gobi-type PUG herder #14, 30 years herding).

> '*This area belongs to a herder group [PUG]. We are members. There is a boundary but because of the climate* [high levels of climatic and forage variability] *it does not work. People move out, sometimes people move in* [to access the variable forage resource].' (Steppe-type PUG herder 3, 30 years herding).

Encroachment by non-PUG herders into PUG areas was greatest in the steppe-type PUGs. Two of the herders interviewed in steppe-

Table 2
Characteristics of herders interviewed, by PUG type.

	All PUG herders ($n = 25$)	Steppe-type PUG herders ($n = 10$)	Gobi-type PUG herders ($n = 15$)	Non-PUG herders ($n = 25$)
Female respondents (%)	48	65	37	53
Mean herd size per household (total head of livestock)	312 (min 56, max 1001)	364 (min 56, max 1001)	280 (min 56, max 490)	182 (min 10, max 440)
Mean time spent herding (years)	21 (min 8, max 30)	21 (min 8, max 30)	21 (min 8, max 30)	23 (min 8, max 30)
Herders with a registered winter/spring camp (%)[a]	96	100	93	96
Average no. of registered winter/spring camps per herder[b]	1.4	1.3	1.5	1.1
Active members of an active PUG (%)[c]	32	20	40	–
Inactive members of an active PUG (%)[d]	12	10	13	–
Members of a no-longer active PUG (%)[e]	24	30	20	–
Members of a non-assessed PUG (%)[f]	8	20	0	–
Not member of any PUG (%)[g]	12	0	20	–
Not from PUG area (%)[h]	12	20	7	–
In an out-of-season pasture during interview (%)[i]	31	14	43	25

[a] Percentage of herders with a formal title over a winter/spring camp under the Law on Land.
[b] The average number of formal titles under the Law on Land held by herders over winter/spring camps.
[c] Proportion of herders who stated that their PUG was active, and that they were an active participant in their PUG.
[d] Proportion of herders who stated that their PUG was active, but that they were not an active participant in their PUG.
[e] Proportion of herders who stated that they were member of a PUG that was no longer active.
[f] Proportion of herders that were a member of a PUG that was not sampled for this research.
[g] Proportion of herders who stated that they were not a member of any PUG.
[h] Proportion of herders who were interviewed in a PUG area, but did not qualify as being members of that PUG because they were from outside the PUG area.
[i] Proportion of herders who were interviewed while located in a pasture that they described as seasonal at a time that was outside the season they described as appropriate to graze that pasture.

type PUGs said they were not from that area. Gobi-type PUG herders were more likely than non-PUG or steppe-type PUG herders to be in a pasture during an inappropriate season. Typically, this involved being located in an area they said was a winter/spring pasture at the time of the interview, which was summer.

Both PUG and non-PUG herders commonly left their *soum* and *aimags* to access forage (Table 4). Given that PUG areas are smaller than *soums*, this also means that PUG herders left their PUG area. Herders left their *soum* twice as frequently as they left their *aimag* in both good and bad years. They were 2–3 times more likely to leave in a bad year than a good year, with nearly half the herders reporting that they left their *soum* in the 2009/2010 *dzud*. Gobi-type PUG herders were more likely to leave their *soum* in a bad year than steppe-type PUG herders. However in good years, steppe-type PUG herders are more likely than gobi-type PUG herders to leave both their *soum* and *aimag*. All herders moved greater distances in bad years than in good, with this difference more notable in non-PUG herders. Gobi-type PUG herders moved further distances in bad years than in good when compared to steppe-type PUG herders. Non-PUG herders moved shorter distances, more often, in good years than bad.

Herders emphasised high levels of forage variability, driven by climate variability, as being the primary reason for high mobility in and out of PUG areas. The concept of PUGs was not considered to be inherently inappropriate by herders, but was commonly viewed as unsuitable in Gobi Desert conditions:

> *'This area belongs to a herder group [PUG] but we are not a member. [PUGs] only work in areas with large grass* [high levels of forage productivity] – *in other areas they're OK, but not here'* (Gobi-type PUG herder 2, 25 years herding).

As well as accepting that PUG areas had a porous external boundary, PUG members did not strictly dictate movements within PUG areas. At the local scale, a majority of both PUG and non-PUG herders commonly controlled the grazing area that their livestock accessed each day rather than allowing their livestock to roam at will (60 and 75% respectively, $n = 20$ in each case). This distance was generally less than 10 km from camp per day for

Table 3
PUG activities and institutions, as identified by herders.

Activity	
Steppe-type PUG	Irrigation for vegetable/fodder growing[a]
	Assist each other to comb cashmere
	Assist each other with fixing winter camps
	Commodity price bargaining power
Gobi-type PUG	Assist each other with moving to new camps
	Dig new wells
	Assist each other with fixing winter camps
	Make agreements about not grazing each other's winter pastures
	Prevent others from grazing in members' winter pastures
	Money lending for new wells and building fences
	Prepare fodder
	Make protein[b]
	Discuss movements

[a] The benefits of irrigation was unevenly distributed between herders, and there appeared to be a relationship between wealth (as indicated by herd size) and access to the irrigation.
[b] Collecting and processing fodder that is especially protein rich, such as *Allium* spp.

Table 4
Mobility comparisons between good years and bad years.

	Left *soum*?		Left *aimag*?	
	%	*N*	%	*N*
Last good year				
Non-PUG herders	0	18	0	18
Steppe-type PUG herders	36	11	27	11
Gobi-type PUG herders	20	5	0	7
All herders	14	35	8	37
Last bad year				
Non-PUG herders	50	20	33	18
Steppe-type PUG herders	18	11	0	11
Gobi-type PUG herders	71	7	0	5
All herders	45	38	18	34

N = number of respondents to each interview questions. Maximum distance moved is for the longest single movement during the year. 'Left *soum*? Left *aimag*?' = positive response to the question 'In the last good/bad year, did you leave the *soum*/*aimag*?' 'Last bad year' was defined as a year in which their herder livelihoods were most threatened by seasonal conditions, primarily identified as 2009/2010 *dzud* year by respondents. The 'last good year' was far more variable, with 2008 being the most commonly cited year.

small livestock. Herders controlled livestock movement to prevent theft, predation by wolves or simply to prevent losing them. It was far less common for either PUG or non-PUG herders to state that they deliberately controlled livestock movement to prevent encroachment of their livestock onto their neighbours' pastures (17 and 20% respectively, $n = 20$ in each case). Although some PUG members stated that they prevented herders accessing the winter pastures to which other herders had informal or formal rights, their effectiveness may be constrained by this absence of deliberate control of livestock. Further, PUGs did not appear to be effective at preventing livestock owned by herders with pre-agreed rights to winter pastures from accessing those pastures outside winter:

> *"We don't make agreements about when we leave our winter camps."* (Gobi-type PUG herder 6, 21 years herding).

> *"The timing of leaving winter camps is up to the individual."* (Steppe-type PUG herder 3, 30 years herding).

Officials and herders had slightly different perceptions about why institutions for governing access to forage within PUG areas were absent or not enforced. A local official with responsibilities in a steppe-type PUG area suggested that large groups were a disadvantage in bad seasons:

> *'The philosophy of such groups [PUGs] 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.'* (Local official 1, steppe-type PUG area).

She also suggested that PUGs were active initially when there was external funding and support, but that activity quickly declined when projects were completed and development agencies withdrew:

> *'Herder groups [PUGs], like* [the steppe-type 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 organising activities full-time. 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.'* (Local official 1, steppe-type PUG area).

Another *soum* official implied that PUGs were more viable in steppe-type landscapes where transhumance was the typical mobility pattern, rather than the more nomadic movements characteristic of herders in gobi-type landscapes:

> *'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 [i.e. before development agencies facilitated PUG formation]. Other non-mountain groups cannot have such an agreement. Herder groups would be good in the 'gobi'* [type] *area if they co-operated in other, non-livestock/forage activities.'* (Local official 2, steppe-type PUG group).

3.4. Benefits of PUGs as perceived by herders

Herders generally viewed the benefits of PUGs as being livelihood-related, rather than as a way of regulating access to the forage resource. This was true of both PUG members and non-members. One herder in the steppe-type PUG described the increased bargaining power arising from PUG membership. Her PUG was self-initiated prior to involvement by a development agency, but was later provided with financial support by Agency A. Thirty families combined their cashmere for sale, saving on fuel costs. They were also able to negotiate an increased price for their cashmere, with a cited average premium of 2000 Mongolian tugrik/kg (about $2 USD/kg at time of writing).

A leader of a gobi-type PUG, who stated that he had previously been an accountant, described improvements in the financial position of the PUG. He also offered an example of how this improved financial position might impact favourably on resource management:

> *'Everyone pays 7000* [Mongolian tugrik] *into an account and we lend from it. There is 5% interest for a loan.* [Agency B] *gave 50%. Now the fund has 5 million tugrik, and we've made 800,000* [Mongolian tugrik]. *We plan to build a new well… We will fence off an alternative pasture.'* (Leader of a gobi-type PUG, herding 5 years)

Some non-PUG herders also believed that membership may increase income. They felt that PUG membership may be a useful way of sourcing labour for migration during a *dzud* or drought.

3.5. Do PUG areas have better rangeland condition than non-PUG areas?

Many indicators of rangeland condition were not significantly different between PUG and non-PUG areas. However there were some significant differences. Overall, the steppe-type PUG areas appeared to be in slightly better rangeland condition than either gobi-type PUG or non-PUG areas. There appeared to be no clear trend in indicators between the gobi-type PUG and non-PUG areas.

Table 5 gives the results of each of the indicators assessed during rangeland condition surveys. Any significant differences between steppe-type PUG, gobi-type PUG and non-PUG areas are asterisked. More specific details on these indicators, and for indicators not shown in Table 5, are as follows. Non-PUG areas had less projected vegetation coverage than steppe-type PUG areas ($p = 0.000$), with the steppe-type PUG areas also having higher cover than the gobi-type PUG areas ($p = 0.003$). There was slightly higher cover in the steppe-type PUG areas.

Utilisation levels of vegetation by livestock were low at the time of assessment, across both PUG and non-PUG areas. Utilisation levels of vegetation by livestock were slightly higher in non-PUG areas, followed by the steppe-type PUG areas then the gobi-type PUG areas (12, 10 and 7% of all sites showing defoliation, respectively). This trend was similar for the presence of livestock manure (32, 20 and 13%, respectively). Twelve percent of the non-PUG areas had livestock pads, whereas none were found in PUG areas.

In terms of proportional length along the transect line, steppe-type PUG areas were about 21% patch and 79% interpatch. Gobi-type PUG areas were 23% patch and 70% interpatch. The gobi-type PUG areas had a larger proportion of rock armouring contributing to patch length than the steppe-type PUG areas, (55% of all patch length in gobi-type PUG sites compared to 47%). Non-PUG areas had a smaller patch proportion at 13% patch, 87% interpatch. Basal cover was about 11% in both gobi and steppe-type PUG areas, and sprouted perennial vegetation was 7% in non-PUG areas. An additional 8% of patches at non-PUG areas were classified as unsprouted *Allium* spp. culms, making the total basal vegetation cover about 15%.

Biological crusts were absent at all sites. Percentage bare ground was significantly higher in non-PUG areas and gobi-type PUG areas than in steppe-type PUG areas ($p = 0.022$ in each case). Non-PUG areas had less coarse gravel than the steppe-type PUG areas ($p = 0.049$).

Table 5
Indicators of rangeland condition, separated by group type. Topsoil intact, topsoil eroding, mobile sandy depositions and depositional mobile sand are defined as per Friedel et al. (1993). Means are presented, with standard deviations in brackets. Asterisked indicators have significant differences between at least two treatment pairs at $p \le 0.05$.

		Non-PUG area $n = 125$ (5 quadrats × 25 transects)	Steppe-type PUG area $n = 50$ (5 quadrats × 10 transects)	Gobi-type PUG area $n = 75$ (5 quadrats × 15 transects)
Projected 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)
Field 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 type	Rilling/Pedestals/Hummocking/Sheeting/ Terracettes/Scalding/Gullying	H, Sc	–	H
Erosion severity	Score of 1–4 (1 = least severe, 4 = most severe)	0.14 (0.42)	0.02 (0.14)	0.26 (0.58)
Topsoil intact	% of sites	92 (90)	98 (14.0)	89 (32.0)
Topsoil eroding	% of sites	0 (0.0)	2 (14.0)	0 (0.0)
Mobile sandy deposits*	% of sites	0 (0.0)	0 (0.0)	9 (29.0)
Depositional mobile sand*	% of sites	10(30.0)	0 (0.0)	6 (24.0)
Bare*	% per site	47.5 (17.8)	39.8 (18.7)	44.2 (24.1)
Fine gravel cover	% per site	39.9 (18.3)	43.6 (17.9)	42.2 (22.3)
Coarse gravel cover	% per site	12.5 (10.9)	14.9 (10.3)	12.8 (11.2)

Of the categorical indicators, the slake test recorded higher values ($p = 0.033$) for the steppe-type PUG areas than for non-PUG areas as soil peds from the steppe-type PUG areas maintained structure for longer when immersed. This was also the case when compared to gobi-type PUG areas ($p = 0.008$). The steppe-type PUG areas had higher crust brokenness scores than in gobi-type PUG areas ($p = 0.000$). Non-PUG sites had more broken crusts than gobi-type PUG sites ($p = 0.000$).

There were sandier soils in the gobi-type PUG areas than both non-PUG ($p = 0.000$) and steppe-type PUG areas ($p = 0.000$). Non-PUG areas were also sandier than steppe-type PUG areas ($p = 0.000$). Non-PUG areas had more litter than gobi-type PUG areas ($p = 0.003$). Litter was local in origin and was not incorporated into the soil surface in all three types of area.

There were significant differences in the proportion of sites that had a surface of depositional mobile sand ($p = 0.017$). The steppe-type PUG areas had a lower proportion than the gobi-type PUG areas ($p = 0.04$), and the non-PUG areas had more surfaces of depositional mobile sand than the steppe-type PUG areas ($p = 0.018$). Mobile sand deposits were greater in the gobi-type PUG areas than in either non-PUG or steppe-type PUG areas ($p = 0.023$ and $p = 0.029$, respectively).

Accelerated erosive features were relatively rare and minor in all three types of area. The erosion extent in the gobi-type PUG areas was greater than in the steppe-type ($p = 0.017$). Erosion severity showed the same pattern ($p = 0.007$) but this was largely attributable to there being more hummocking in the gobi-type PUG areas. All other indicators were not significantly different between the three types of area.

The perceptions of local officials on rangeland condition areas tended to verify the quantitative data. *Soum* officials generally believed that the establishment of PUGs had little impact on the pasture, with one local official explicitly stating that:

> *'There isn't any relationship between herder groups [PUGs] and pasture quality'* (Local official 2, steppe-type PUG area).

Many herders, whether from PUGs or not, perceived that there had been a decline in the quantity of the forage resource since they had begun herding. However none attributed this decline to high grazing pressures or to dysfunction in institutions governing access to the forage resource.

4. Discussion

For PUGs to improve rangeland condition in the Mongolian Gobi Desert there must first be a physical link between activities and institutions of the PUGs, and rangeland condition. Activities must be relatively frequent, and institutions must be sustained over critical periods such as the onset of feed gaps. PUG activities and institutions should result in indicators of rangeland condition that are different in PUG and non-PUG areas. We found few active institutions attributable to the establishment of the PUG that regulated the timing or intensity of grazing pressures in the Mongolian Gobi Desert. Subsequently, we found little evidence that PUG institutions substantially improved rangeland condition.

4.1. Non-institutional reasons for differences in rangeland condition

One exception to the finding that there was little difference in rangeland condition between PUG and non-PUG areas was that some indicators of rangeland condition were higher in steppe-type PUGs. Hess et al. (2010) also found that remotely sensed NDVI, an indicator of vegetation production, was higher in a steppe-like PUG area than in a non-PUG area in Omnogobi *aimag*. This is curious given the lack of institutions regulating grazing pressures at the time of research. However there are a number of non-institutional explanations as to why little biophysical difference was found between PUG and non-PUG areas.

Changes in soil-based indicators may take more time to become apparent than the three years since the gobi-type PUGs were established. Alternatively that there are inherent differences in the characteristics of herders in the steppe-type PUGs. For example, steppe-type PUG herders were the wealthiest herders interviewed, using mean herd size as an indicator (see Table 2). Their wealth may allow their mobility pattern, broadly described in Table 4, to be timelier in response to feed gaps than is the case for gobi-type PUG or non-PUG herders. The use of irrigation for fodder production in one of the steppe-type PUGs may also have reduced feed gaps and overutilization of the non-irrigated forage resource. However more research into whether the unequal distribution of benefits from irrigation demonstrates the elite capture of development agency/PUG resources is warranted.

These sorts of non-institutional mechanisms may have a greater effect on rangeland condition in the steppe-type herder group area than in gobi-type areas. The meta-analysis of Von Wehrden et al. (2012) demonstrated that zonal degradation is less likely to occur in rangelands with an annual precipitation coefficient of variation of more than 0.33. The higher annual precipitation coefficient of variation in the gobi-type group area compared to the steppe-type group area means that rangeland condition in the steppe-type area may be more sensitive to both institutional and non-institutional change.

4.2. Conflicts between spatially bounded PUGs and common property theory

A lack of recognition for the inherent characteristics of the common property resource may explain why there is little evidence that the collective action of PUGs has improved natural resource management. The most obvious characteristic challenging PUGs that are bounded at such a small scale is high levels of climatic variability. This challenge is compounded by a social-ecological system with few options for managing feed gaps other than livestock mobility. In the Mongolian Gobi Desert, the spatial scale of feed gaps in bad years is often regional. The ‘high mobility’ of Agrawal’s resource (Agrawal, 2003) leads by necessity to the high mobility of herders. During dry times or *dzud*, PUG members frequently left their PUG area, and also sometimes their *soum* and *aimag*. This indicates that there are no stable community groups with socioeconomic functions that are consistent with a stable territorial unit (Mearns, 1993). It is difficult to delineate meaningful spatial boundaries for the purposes of natural resource management in such a context, and a lack of a clear boundary conflicts with Ostrom’s (1990) principles for common property management. Common property institutions also require a monitor to identify rule-breaking, and to subsequently impose sanctions (Ostrom, 1990). Local monitors are included amongst absent herders. This challenges the ability of the PUG to identify rule-breaking and impose sanctions in a high-mobility context, even if the group did find such sanctions to be a useful.

Common property theory centres the rights and responsibilities of local resource uses (Ostrom, 1990). The development agencies examined in this research used participatory methods to design PUGs. However there were still disconnects between the views of interviewed herders and the PUG institutions described in the project documentation of the development agencies. Whilst concerning, such gaps have been documented from other natural resource management projects that are community based e.g. Agrawal and Gibson (1999). It is of interest that empirical research tends to support the perspectives of herders, rather than project documentation produced by the development agencies. For example, the rangeland condition surveys described here found little accelerated soil erosion. Other peer reviewed research describing vegetation-based assessments in comparable areas of Mongolia suggest that the rangelands are not degraded (Wesche and Retzer, 2005). Upton (2010) also found that mobility patterns in a Gobi Desert area had not significantly changed since the days of the collectives, despite the assumptions that land use patterns had substantially changed since that time. Project design that more carefully considers both the very local dynamics of the resource seeking to be managed, and the land-use that relies upon it, may help bridge this disconnect.

5. Conclusion

Mongolian land tenure policies may become more prescriptive at the local spatial scale but there is little evidence that this is warranted in the Gobi Desert for rangeland condition reasons alone. The institutions of more prescriptive policies are either likely to be ignored by herders or, if adequately enforced, facilitate the over-utilization of the forage resource in the absence of alternative tools for managing the risks of feed gaps. The focus on designing policies/programmes that support herders by prescribing institutions that increase exclusivity over the forage resource detract from a wider ranging analysis of options. For these reasons, policy makers and development agencies may provide more benefit to rangeland condition and herder livelihoods by opening up the development discussion to include the broader range of tools available to support herders.

Acknowledgements

The authors appreciate the dedication of the development agencies referred to in this paper, and their ongoing attempts to improve the livelihoods of Gobi Desert herders. We thank the local officials and herders that agreed to be interviewed for this research. We thank Sue Briggs (University of Canberra, Australia) and Sabine Schmidt (New Zealand Nature Institute, Mongolia) for early comments, and the two anonymous reviewers. This research was part of PhD research funded by the Australian Rangeland Society, an Endeavour Research Fellowship, the Desert Knowledge CRC, the Northern Territory Research and Innovation Board and the South Australian Royal Geographical Society, and was supported by the University of Queensland, CSIRO Ecosystem Sciences, the Mongolian Society for Rangeland Management and MercyCorps Mongolia.

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