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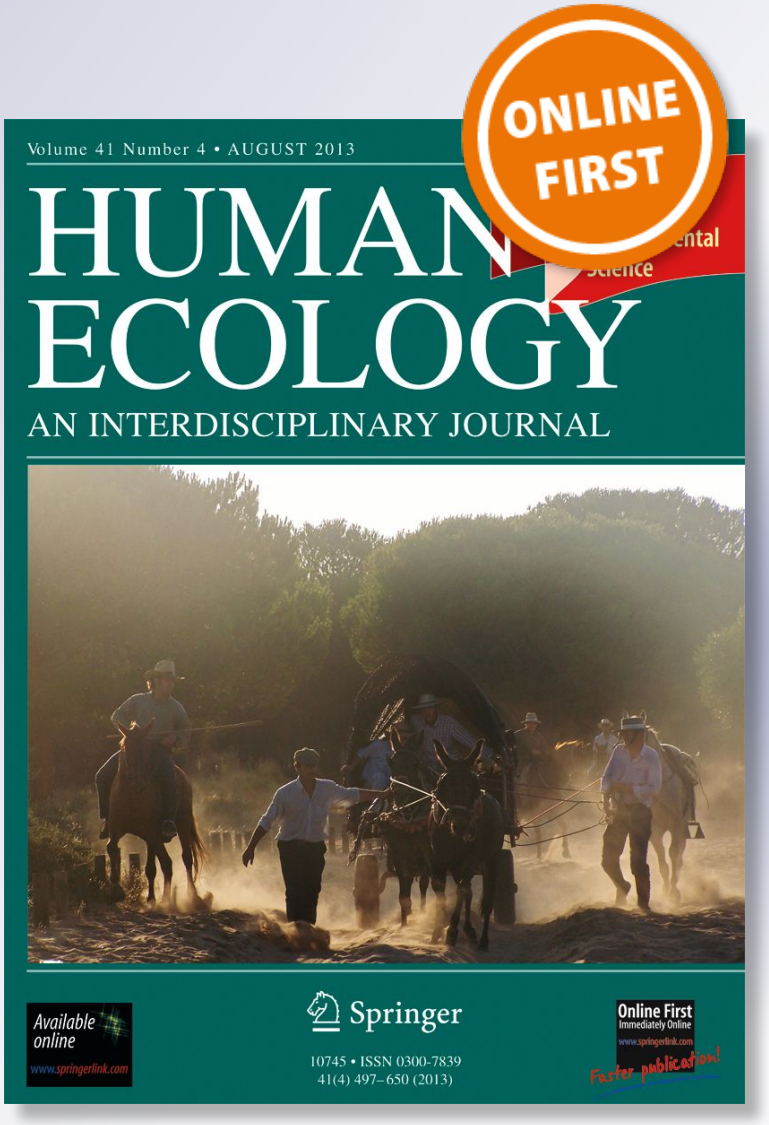

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Gobi Herders' Decision-Making and Risk Management under Changing Climate

Tserennadmid Nadia Mijiddorj[1,2] · Ariell Ahearn[3] · Charudutt Mishra[4] · Bazartseren Boldgiv[2]

Abstract
Our research examines herder livelihoods strategies in a region of the South Gobi desert that is heavily affected by both formal and informal/illegal mining and is exposed to natural hazards such as dzud (lethally severe winters) and drought. The term 'herder' encompasses a wide range of animal-related activities and households correspondingly utilize a complex range of strategies to respond to environmental, political, and socioeconomic conditions. We conducted semi-structured interviews with local herders as well as with individuals who had abandoned herding practices. We discuss how climatic factors such as dzud and drought can affect herders' livelihood decision-making, including engaging in informal/illegal mining, becoming a contracted herder or opening a small business in settlements. We also demonstrate that both social aspirations and climate-related economic vulnerability play a role in the decision to pursue alternative livelihoods.

Keywords Gobi herders · Climate change · Informal/illegal mining · Livelihood strategies · Dzud · Risk · Decision-making · Pastoralism · South Gobi · Mongolia

Introduction

Pastoralism, practiced in arid environments by many millions of households worldwide, plays an important role in food security, the economy, and ecological services worldwide (Krätli *et al.* 2013; Seid *et al.* 2016). It is considered one of the most climate-vulnerable livelihoods (Thornton *et al.* 2009). A number of studies have documented coping strategies adopted by pastoralist societies since the 2000s in their attempts to adapt to global environmental changes and mitigate their exposure to climate hazards (e.g., Adger *et al.* 2003; Burton *et al.* 2002). Often, vulnerable communities attempt to diversify their livelihood opportunities in order to maximize income sources (Ashley and Maxwell 2001; Ellis 2000). However, adaptation strategies are also influenced by social aspirations, government policies, and economic opportunities. We seek to refine this discourse by illustrating how a combination of factors influences herders' livelihood adaptation strategies.

Very few studies have addressed herder-decision making on grazing and herding strategies in Mongolia (Jamsranjav 2009; Lee *et al.* 2015). Additionally, the term 'herder' (*malchin* in Mongolian) can refer to a diverse range of households who practice various forms of mobile animal husbandry. We focus on the diverse livelihood strategies of herders living in Gurvantes *soum* (a county subdivision) in the South Gobi, Mongolia. While many studies have focused on the emigration of herders from the Mongolian countryside to the capital city of Ulaanbaatar, our research focuses on households who continue to own livestock but engage in other forms of work, such as informal/illegal mining (ninja mining) and small business ownership. Additionally, we investigate the immigration of households from other regions into Gurvantes who act as contracted herders. On the basis of this research, we develop a typology herder types reflecting the range of practice in this region.

Under current changing climatic conditions, natural hazards are expected to increase in frequency and intensity (Angerer *et al.* 2008; Batima *et al.* 2013), leaving herders more vulnerable to uncertain levels of risk (Debela *et al.*

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2015). In Mongolia, pastoralism is the prevailing form of land use outside of the growing mining sector, and the agricultural sector is a key element in the country's economy (Batima *et al.* 2013). However, occurrences of natural hazards such as severe winters (dzud) and droughts can cause damage to the livestock sector in addition to impacting the national socioeconomic situation of the country (Batima *et al.* 2005). Dzud is defined as livestock mass mortality caused by combination of starvation and exposure to extreme cold temperatures, and can be devastating to pastoralist households without access to external support or already in debt (Ahearn 2017; Begzsuren *et al.* 2004; Fernandez-Gimenez *et al.* 2012; Morinaga *et al.* 2003). Thus, a range of social, economic, and environmental factors contribute to herder decision-making and choice of livelihood strategies.

The movement of pastoralist households into urban centres, particularly the administrative capital of the soum, to pursue diversification of livelihoods is also linked to social aspirations and perceptions, since many herders perceive themselves as engaged in "undeveloped" livelihoods compared to urban dwellers.

The climate change debate has stimulated an increasing interest in measuring and analyzing human vulnerability (Eakin and Luers 2006; Mertz *et al.* 2009; Vincent 2007). The goal of our research was to understand what factors influence herders to shift livelihoods away from herding practices and the degree to which the timing and intensity of climatic changes affects this decision-making process. The analysis of local herders' household characteristics and livelihood choices in response to environmental and social changes will aid in the understanding of their levels of vulnerability and ways this may be mitigated. In Mongolia, pastoralists consider livestock their main financial asset and they are used as collateral for bank loans. Thus, we focus on livestock numbers as a major determinant of vulnerability because this is the way herders themselves express their financial assets.

Our main objectives are to (*a*) determine the major factors (social, economic, climatic, political) that influence herders' livelihood resource shifts, (*b*) understand what factors influence their decision-making, and (*c*) determine current strategies to adapt to changes in climatic variables. An understanding of the interactions among these pathways will assist international and non-governmental aid agencies, which currently treat herders as a homogenous category, to better design and direct their development planning strategies.

Climate Variability and Herder Livelihoods

Pastoralism is closely linked to poverty and environmental stress and thus an inherently risky occupation (Siurua and Swift 2002). Human vulnerability to climate change impacts is the degree to which an individual or household is able to adapt to the adverse effects of climate change (Adger 2006; Solomon *et al.* 2007). The key parameters of vulnerability are the degree of stress to which a system is exposed, its susceptibility, and its adaptive capacity (Turner *et al.* 2003). Thus, the vulnerability of a household will determine its ability to respond to and recover from unanticipated economic or climatic stress.

There are a number of ways to manage the impacts of climate change, but they do not necessarily all fall within a discrete category of measures on "climate adaptation"(Mayer 2015). Understanding and, where possible, predicting the relationship between climate and resource users' response within any particular socioeconomic context will contribute to the design of effective strategies to improve livelihoods and manage unpredictable environments (Addison and Brown 2014). The relationship between socioeconomic factors and environmental factors are rarely examined closely in climate change studies, which often treat household decision-making, environmental governance, and natural hazard risks separately.

Mobility has been cited as a key factor in mitigating economic and environmental risk for pastoralists (Humphrey *et al.* 1999). Increasing poverty together with asset and income inequality among pastoralists in Mongolia (Fan *et al.* 2015; Fernandez-Gimenez *et al.* 2015; Murphy 2014) has led to economic polarization among herders. Rich herders can afford to move more frequently and maintain their wealth while poorer ones often depend on urban settlements (soum centres) as additional income sources (from mining), which further discourages mobility (Fernandez-Gimenez *et al.* 2017).

Materials and Methods

We conducted this research over the course of 2017 in Gurvantes *soum* (county) in rural South Gobi province in southern Mongolia. Gurvantes *soum* centre is approximately 50 km from the Chinese border (Fig. 1). Gurvantes has been the site of a mining boom for the last 10 years, including the South Gobi Sands company, Chinese mining companies, the Mongolian Alt Company, and a variety of joint ventures mining for coal and gold. It is estimated that there are 13 licenses in the soum, with 6–7 mines currently active. Informal/illegal mining by local inhabitants, including herders, is prevalent, particularly after the recent discovery of the presence of a semi-precious gemstone (*ulaan chuluu*) in the area. Additionally, Gurvantes is the biggest soum in Mongolia and encompasses two protected areas - the Tost Toson Bumba Nature Reserve and the Gobi Gurvansaikhan National Park. Parts of Gurvantes are extremely mountainous with steep rock formations and thus not suitable for pastoralism. Inhabitants of the Gobi are highly dependent on their environment as their source of livelihood. After the end of the socialist economic system and before the advent of the

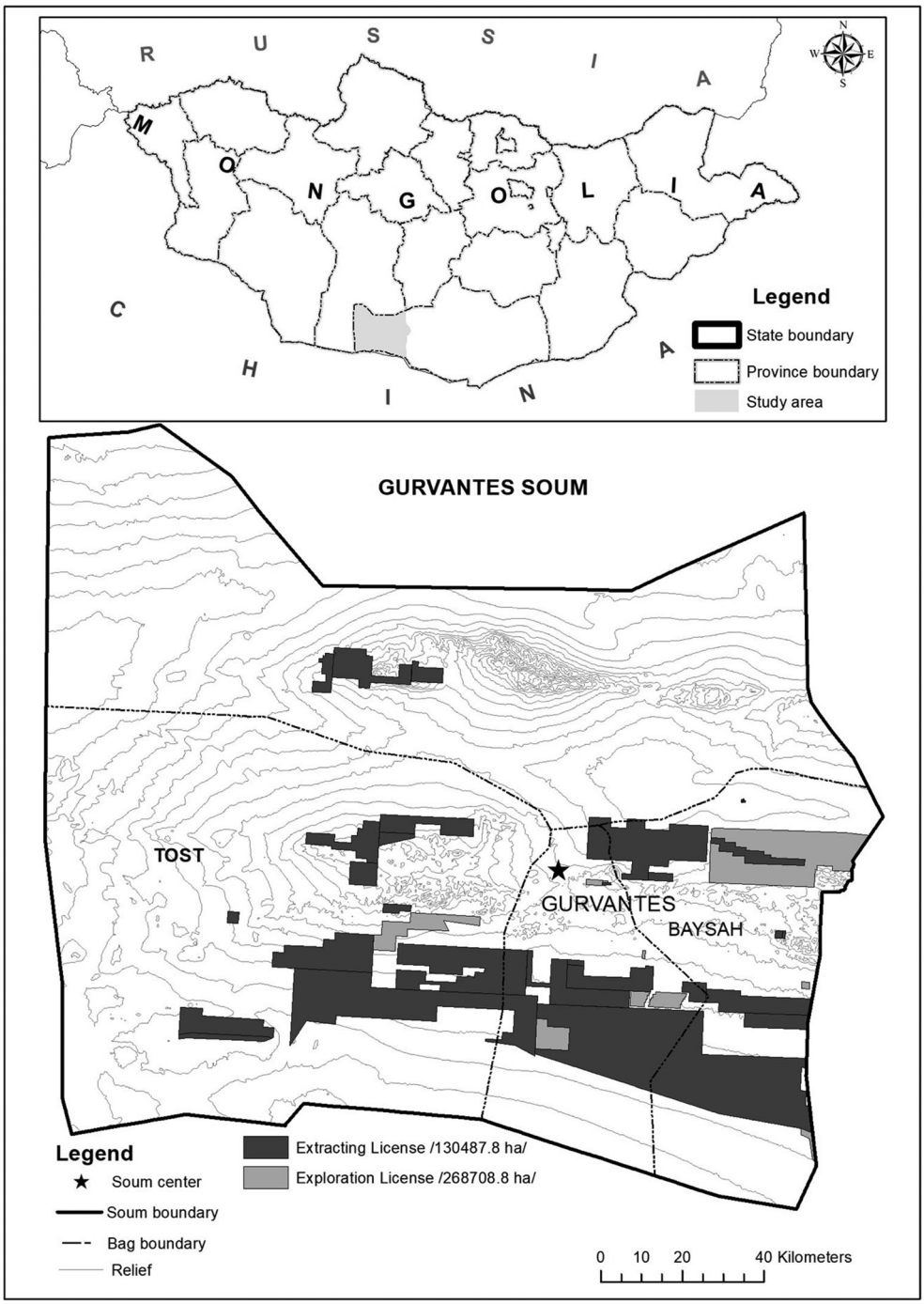

Fig. 1 Study area with mining licenses in and around Gurvantes soum for extracting and exploration

gold mining rush, people were dependent entirely on livestock and the sale of livestock products (i.e. fibre, dairy products, meat). Pastoralism as a livelihood strategy was soon impacted by the environmental degradation caused by climate changes as well as the exploration and exploitation of legal and illegal mineral resources, which started in 2005 and has since expanded rapidly.

In total 42 respondents aged from 38 to 65 years were interviewed using semi-structured and informal interviews. First, active herders were interviewed in Tost, one of Gurvantes's *bag* (subdistrict), to establish their general socio-economic situation, most significantly the number of livestock they own, and obstacles they face as well as the factors influencing their household decision-making. The Tost herders comprise approximately 90 households in total (Johansson *et al.* 2015); we randomly selected 30 herder families for interviews based on their current livelihoods. Of these, two households were absent and were not interviewed. In addition, we interviewed households who had abandoned herding practices (10 "ninja" miners or artisanal miners,

selected using the snowball method (Goodman 1961), and four shop keepers) to understand the dynamics involved in their livelihood shift to Gurvantes soum centre. Since ninja mining is illegal and thus often clandestine, the snowball method is well suited for finding potential interviewees. The four shopkeepers interviewed maintained herder campsites in field. The first author has been working in this area since 2008 on issues related to snow leopard-herder interactions. This research thus also involved significant periods of observations and follow-up visits.

Interviewees were grouped according to the size of their livestock holdings.[1] The semi-structured interviews (see Appendix) were audio-recorded (except for four ninja miners) and the main points were documented for data analysis. Typology analysis was developed by R software. The responses were analyzed following (Auerbach and Silverstein (2003) to identify recurrent ideas and themes.

For data analysis, all quantitative information was converted into MS Excel and the data were triangulated by key informants (Moon *et al.* 2016). We subsequently transcribed and further analyzed additional relevant interviews.

Results

Range of Livelihood Strategies

All of the households interviewed determine their own livelihood strategy. Sometimes environmental shocks such as dzud and economic opportunities lead households to change or create new strategies (Fig. 2).

Since the advent of mining, this study region also experienced a number of severe natural hazards, namely dzud and drought, especially during the post-1990 period, when Mongolia was also undergoing major economic restructuring after the collapse of the centrally planned economy (Table 1). Although a large number of livestock were lost during the 2009–2010 winter, meteorological data revealed that the weather was not extreme in terms of the snow depth and temperature.

In the following section we discuss pastoralist livelihood strategies in more detail and address the use of the term 'herder,' which is often used as a blanket term, ignoring the nuances and diversity of livelihoods. Disaggregating the term 'herder' helps us to more clearly understand the relationship between environmental climate change conditions and changes in work choices based on number of livestock owned as wealth category.

[1] In the study area, pastoralists predominantly herd goats (90%) in order to maximize their income from cashmere yield and because grazing in the mountainous terrain is especially suitable for goats. The remaining 10% of their herd consists of sheep, horses, camels, and cattle (Nadia Mijiddorj *et al.* 2018). Therefore the term "livestock" generally refers to goats.

Ninja[2] Mining

Most of the herders who currently practice "ninja" mining as their main source of income are younger people aged 35–44 (with the exception of one 60-year old man who occasionally goes for mining). All ninja miners reported that they had lost too much livestock due to dzud and unfavorable climate conditions to be able to maintain their pastoral livelihoods, but half ($n = 5$, 50%) said their livelihood shift to illegal activities in order to survive was entirely due harsh climatic events. The remaining 50% reported that a combination of factors, including economic, political, social, and environmental circumstances, as well as mining opportunities, contributed equally to their decision (Fig. 3). In many cases, ninja miners work on sites that have already been mined by large companies. Two households reported that they resorted to ninja mining because they had no other way of raising money. Ninja miners usually still keep a small number of livestock, which are temporarily given to other families to herd in their absence. The average livestock number for these households was 83.6 heads of livestock (SD = 58.9). One ninja miner, aged 38, reflected on his experience, citing not only environmental factors but perceptions of success: "I remember that over ten years ago herder situation was much better we had enough grass to feed livestock and climate was pleasant. Year by year situation was getting worse and it is getting harder to live with livestock (including dzud). A few other people that I knew of started doing ninja mining and seemed to be doing great. I wanted to be one of the lucky people to take a chance to become a ninja miner. Now, I have no way to go back as herder."

Another, aged 40, stated: "Ninja mining is not a fun job. But you have to do it in order to survive. I lost most of my livestock during one harsh winter and there was hardly any choice for former herders. Also I had to do it, with pressure from my wife, who wanted to live in an urban area."Both of these ninja miners' observations illustrate the combination of lack of livestock wealth security and aspirations for higher income and a settled livelihood (i.e., living in an urban area).

For illegal miners, there are many different factors associated with the decision to engage in this practice. Due to dzud trigger in combination with unfavorable conditions of livestock herding, the number of the livestock is not enough to sustain livelihoods (financial impacts 50%) and households seek other alternatives for the main income source of their livelihood. For them it's easier to leave families in soum centre to access the equipment and basic needs wanted to be closer to the "development" or social services. Those social impacts play a certain role (14% of responses) to contribute to

[2] The name "ninja" arose from the appearance of the miners as they carry a green plastic pan tied to their back which resembles a "Teenage Mutant Ninja Turtle" character (Grayson 2006).

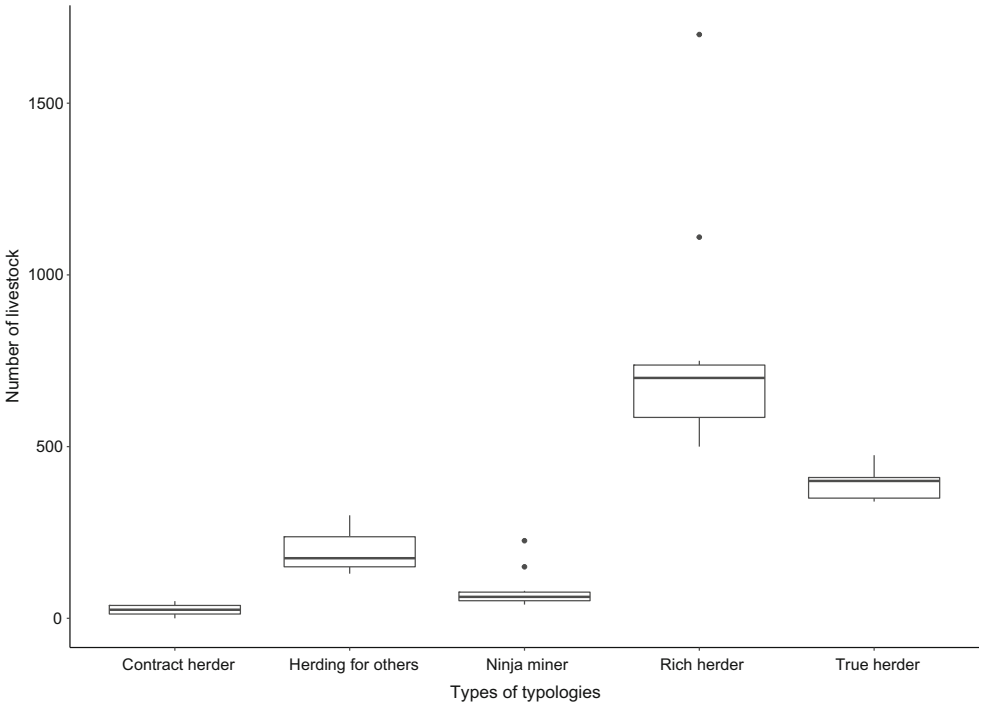

Fig. 2 Different types of typologies (livelihood strategies) based on the number of livestock

changing livelihood resources. Social impacts include easier access of basic amenities and, furthermore, taking care of the children who are schooled in the soum centre.

Contract Herding

Other herders who lost their livestock due to dzud started working as "contracted herders" (age 20–50 years). Households with a small number of animals ($n = 25$, SD = 18.7) are hired as contracted herders by richer herders, often on the basis of a verbal contract to fix the terms of payment**.** Some may receive cash while others agree to a specified number of livestock, and including their offspring. In some cases, the contracted herders comprise an entire household, while in other cases it may be a single man. No contract detailing job responsibilities is made. Therefore, any herd-related decisions such as the timing of rotational movements and/or selecting better grazing lands are made by the livestock owners, who often live in soum centre, rather than by the contracted herders, who live closest to the livestock and are familiar with local environmental conditions.

Table 1 Frequency of drought and dzud occurrences and their impact on livestock losses in Gurvantes soum; data from local government records

Observations by local herders	Livestock mortality due to severe weather by number of head	Livestock losses by percentage	Official records of annual average meteorological information
1944–45: Drought+dzud	no data available		No data available
1954–55: Dzud	no data available		No data available
1956–57: Dzud	no data available		No data available
1967–68: Drought+dzud	no data available		No data available
1976–77: Dzud	no data available		No data available
1981–1982 Dzud+drought	2562	83.4%	No data available
1986–87: Dzud	3621	14.8%	No data available
1993–94: Dzud	3321	11.3%	No data available
1996–97: Dzud	1621	4.6%	winter precipitation /snow 9.8 mm and temp −14.4 °C
1999–00: Drought+dzud	2221	6.1%	drought: precipitation 46 mm in summer time. Dzud: winter precipitation /snow 13.9 mm and temp −9.4 °C
2000–01: Drought+dzud	7294	26.8%	drought: precipitation 22.9 mm in summer time. Dzud: winter precipitation /snow 9.5 mm and temp -11 °C
2009–10: Dzud	11,127	28.3%	winter precipitation /snow 5.3 mm and temp −10.4 °C

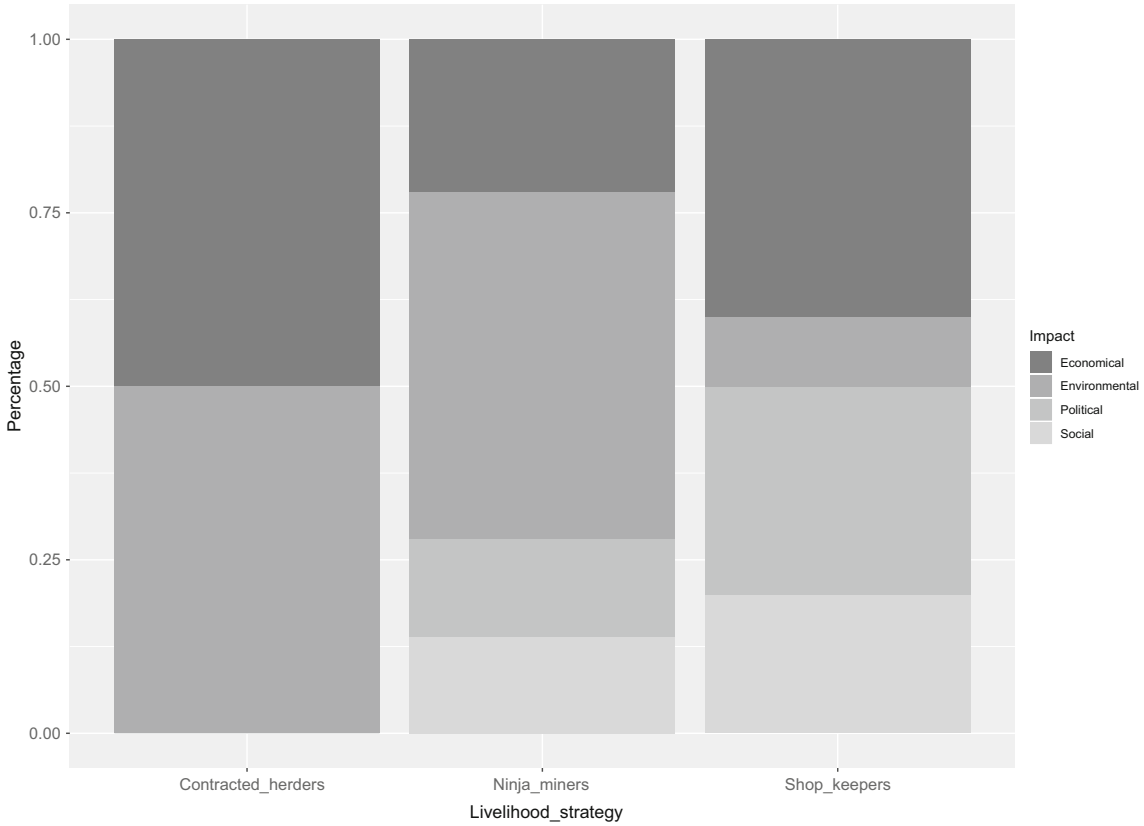

Fig. 3 Major impacts of livelihood change strategies

These households have on average 25 head of livestock (SD = 17.0). One contracted herder, aged 41, described his experience: "I used to be a herder in Jinst soum in Bayankhongor province. After several occurrences of dzud and drought we lost most of our livestock and moved to the province centre to seek work. My aunt told me that there is a possibility that I can get hired as contracted herder in Southgobi. I get my monthly salary and send it to my family in Bayankhongor. If I'm good, the livestock owner will give me several young animals before I go back to my home."

Most contracted herders aim to increase their herds and become independent herders again.

Sharing Labor for Herding

Another coping strategy is for households to join their herds together and alternate herding their livestock (age 35–50) with ninja mining activities for two weeks to a month annually. This strategy to increase income is often adopted by herders who own 150–250 head of livestock. The average livestock numbers for these households is 196 head (SD = 61.0). As one respondent, aged 40, recalled: "My family lives in the soum centre (my wife takes care of children for school). We live off our livestock, but the number was not sufficient enough to feed my family. You will find many people like me and we work together cooperatively to support each other. One round I go to the soum centre to spend time with my family and if an opportunity arises I go mining. Then we switch roles; one has to take care of the livestock while another goes to make additional income (amidralaa deeshluulne) and improve our life."

Herding for Others

Another livelihood strategy for herders owing fewer than 200–300 livestock is to add the herd of an absentee herder to his own, and herd on their behalf (age 43–52). Absentee herders have to pay a specified agreed upon amount to the person who is herding their livestock. This strategy is differs from that of traditional absentee herders in that they pay based on the official verbal agreement rather depending on relatives to voluntarily herd their livestock. In some cases, the herder and the absentee livestock owner may be related but will still get paid officially or unofficially. This scenario is becoming increasingly popular and there is a greater frequency of cash payments rather traditional reciprocity of goods and services (Fernandez-Gimenez 1999). Some households tend livestock for more than four or five families, which at approximately 100 head per household can amount to up to 500 head of livestock. The average livestock number for these households was 321 head of livestock (SD = 53.2). One herder, aged 45,

explained: "I may look rich when you look at my livestock corral (laugh), but many of them are owned by other people. For instance, I herd four different families' livestock. One family who runs business in the soum centre and the other three also settled in soum centre and are doing ninja mining. They have to pay me depending on how many livestock I keep for them. Now the situation has changed, everything is monetarized so that they have to pay us in cash (laugh)."

Respondents reported that most of the absentee herders are ninja miners who settled in soum centre, although some have daily paid jobs. Other herders complain that this strategy is very destructive to the grazing land and livestock health and survival through winter, because larger herds (over 500–600 head) cannot gain as much nutrition from the pasture.

Traditional Herders

Traditional herder households (age 40–63), whose livestock holdings average 391 head (SD = 44.7), rely entirely on livestock-based income rather diversifying revenue from other sources such as mining. Our results indicate that an average of 400 head of livestock is considered adequate to maintain a typical household in this region, which is difficult to do with less than 250 head. Traditional herder respondents often complained that the decreasing quality of pasture is impacting their livelihoods. One traditional herder, age 52, explained: "We don't have any other income source than livestock. I don't consider ninja mining as our type of job to do. If you tend your livestock properly you can live with it without any other demands."

Rich Herders

In general, rich herders (age 48–60) have more than 800 head of livestock, and some have more than 1000 head (mean = 784, SD = 347), which is difficult to manage solely with their household labor. These very large herd owners usually hire contract herders and other workers. Some rich families run businesses in the soum centre. In many cases, rich herders hire labor from other areas because they believe that outsiders will be more likely put their best efforts into their herd to keep it safe and more productive in order to receive full salary to send back home. As one interviewee stated: "When you have livestock over 600-700 head you have to hire someone to help with livestock herding. Otherwise herding is a very labor-intensive job. If a contracted herder is good we often encourage them to support their livelihood. But it's hard to find trustworthy people to herd livestock."

Alternative Livelihoods in Soum Centre

Of the households interviewed, approximately 20 had moved to the soum centre to pursue alternative livelihoods. These households continue to own livestock but are not actively involved in herding them. So, it can be seen that variation among herders determines how they respond to climatic and environmental fluctuations.

Livelihood diversification strategies are linked to natural hazards related to climate change, as well as political and socioeconomic factors (Fig. 3). Our results show that rich herders and livestock-poor herders move to the soum centre to seek alternative income and higher social status urban livelihoods (Martine 2012). For illegal miners, it is easier to leave families in soum centre to access the equipment and basic needs, as well as proximity to social services. Of respondents who had moved to the soum center, 14% cited social impacts including easier access of basic amenities and access to education for their children, as well as greater opportunities for social interaction. Another 14% said their decisions were influenced by social changes (e.g., neighbours or family who had already moved, exposure to new technologies, the desire for urban lifestyles) and political circumstances, and also noted lack of significant governmental support for herders.

After the start of the mining boom there was increased demand for consumer goods and shop keepers and local business owners also explained that since livestock herding is inherently risky, it is important to have an alternative income source to sustain livelihoods, especially for families who have children who go to higher level education. One shop keeper explained: "We were proper herders before the 2010 dzud and the start of mining activities. After the dzud in 2010 we lost 30% of the entire livestock and could not sustain our life by only relying on livestock income sources. Also, one of my daughters needed to attend a university and we need to maximize all the possible income sources. After the mining business started, shop keeping started booming."

Since illegal mining is a risky and labour intensive job, older herders over 60 seem to keep practicing pastoralism out of necessity and in the absence of other profitable livelihood options. Pensions supplement income from pastoralism for some.

Discussion

In their livelihood strategies, herders need to satisfy certain social and economic requirements depending on their basis of assets such as the number of livestock and designated grazing land. A number of studies have found that there are asset threshold points needed in order to maintain livelihoods (Murphy 2014; Zimmerman and Carter 2003). And having more economic assets results in greater resilience to any unexpected set backs, including environmental and economic (Murphy 2014).

Livelihood diversification is becoming more common among pastoralists worldwide, driven by environmental

hazards coupled with land issues and policy changes (Morton 2007). Often farmers shift from pastoralism to crop-livestock mixed farming as a means of coping with climate change (Biazin and Sterk 2013; Goldman and Riosmena 2013; Tsegaye *et al.* 2010).

Livelihood decisions made by households depend on how the available choices are presented to them, as well as their experience of losses or lack of income from herding (Tversky and Kahneman 1992). While the decision-making process seems to be a personal choice of the household, the outcome is often influenced by what family and neighbours are doing, their social status, and how households perceive the success of others (Raafat *et al.* 2009).

As we have noted above, some winters that do not have significantly deep snows or drastically severe low temperatures nevertheless have high numbers of livestock losses (Table 1). Statistics on the annual changes in livestock numbers may not illustrate clearly what the causes of such shifts are. It may be that herders are less prepared for winter as well as that some young, inexperienced herders may not able be well-equipped to cope with even milder winters (Du *et al.* 2018; Fernández-Giménez *et al.* 2015). Natural disasters and bad weather, along with unfavourable socioeconomic conditions often lead to herders making different choices as to necessary precautionary strategies. Most responses, however, are based on informal arrangements to deal with risk (Holzmann and Jørgensen 2001).

It is often hard for young and inexperienced herders to prepare adequately for winter conditions and finding secure and suitable land for winter grazing (*uvuljuu*) is a significant challenge, leaving their herds vulnerable during harsh winters. Their winter camps are often in unsuitable locations, while rich herders are able to secure winter locations and to maintain winter camps at multiple sites.

In many cases, young people who had been herders but have settled in urban areas said that the main reason for their move away from herding was a lack of available or suitable grazing land, which often created a conflict with established herders. Because of climate and environmental constraints, not all pasture is suitable for year-round grazing. Conflicts often arise during drought years when herders are competing for better pasture and access to water. Rich herders have already exploited grazing lands that could be used by several families and there is no pasture for other neighbors to graze their livestock in Mongolian rangeland (Undargaa 2016). The social capital of richer households often allows them to establish relationships with the local government at the expense of smallholders. Also, many established herders inherit summer and winter camp sites (Joly *et al.* 2018). If inequities in access to grazing land increase (Joly *et al.* 2018), as well as pasture losses to mining sites, herders with fewer livestock and young herders not yet securely established will increasingly move to urban areas or engage in ninja mining.

Understanding herder decision-making on livelihood shifts is a very complicated issue and social, environmental, economic, and political factors all interact in the range of choices perceived to be available contribute. Herders have the capability and resilience to take preventive actions and find strategies to manage natural hazards such as dzud and climate risks related to drought in the future (Ahearn 2017), but often such individual behavior and coping ability is in spontaneous forms of unplanned adaptation (Smith *et al.* 2012)especially as the climate becomes more unstable and mining takes over more land in the Gobi region. Additionally, our results demonstrate the significance of socioeconomic issues in herder livelihood decision-making.

Conclusions

Our research was conducted using an asset-based approach for ranking local herders' wealth in relation with their status and resilience in an area of Mongolia in an area heavily involved in mining cases (Fernández-Giménez *et al.* 2015; Murphy 2014). We argue that applying the blanket term 'herder' can be misleading and misrepresent the range and variety of livelihood practices and the complexity of household organization among pastoralists in Gurvantes soum and in other parts of Mongolia.

Shortage of labor and lack of government support, as well as environmental challenges, threaten the future of mobile pastoralism in Mongolia. Younger herders and those without sufficient livestock to sustain their livelihood are increasingly moving to urban centres to generate other sources of income. With a preponderance of elderly men and women left in herding communities in Gurvantes, there is almost no future generation to continue herding practices.

This research challenges the dominant narrative of development organizations and the media that dzud is the primary cause of migration to urban areas. We identified a wide range of factors are involved in decision-making processes of herder households to diversify their livelihood options, including economic obstacles and social challenges coupled with environmental climatic uncertainty.

Many pastoralist households move to urban areas to provide their children with better access to higher education, not only in reaction to dzud. These pull factors are complemented by the push factors of climatic change variabilities that contribute to deteriorating livelihoods and resource availability (Sternberg 2010).

Herder decisions are highly responsive to economic and social changes often triggered by environmental impacts. An integrated approach is needed in order to understand the complexity of their existing coping strategies, including their motives for migrating to urban areas, which are rarely merely a response to dzud. This narrative must be refined to deliver

effective investment in rural Mongolia. The development of effective coping strategies and greater engagement of the government to increase adaptive capacity will reduce vulnerability to climatic change and other environmental hazards.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that there is no conflict of interest in subject of matter or materials discussed in this manuscript.

References

Addison, J., and Brown, C. (2014). A multi-scaled analysis of the effect of climate, commodity prices and risk on the livelihoods of Mongolian pastoralists. Journal of Arid Environments 109: 54–64. https://doi.org/10.1016/j.jaridenv.2014.05.010.

Adger, W. N. (2006). Vulnerability. Global Environmental Change 16(3): 268–281. https://doi.org/10.1016/j.gloenvcha.2006.02.006.

Adger, W. N., Huq, S., Brown, K., Conway, D., and Hulme, M. (2003). Adaptation to climate change in the developing world. Progress in Development Studies 3(3): 179–195.

Ahearn, A. (2017). Herders and hazards: covariate dzud risk and the cost of risk management strategies in a Mongolian subdistrict. Natural Hazards: 1–17.

Angerer, J., Han, G., Fujisaki, I., and Havstad, K. (2008). Climate change and ecosystems of Asia with emphasis on Inner Mongolia and Mongolia. Rangelands 30(3): 46–51.

Ashley, C., and Maxwell, S. (2001). Rethinking rural development. Development Policy Review 19(4): 395–425.

Auerbach, C., and Silverstein, L. B. (2003). Qualitative data: An introduction to coding and analysis, NYU Press, New York.

Batima, P., Natsagdorj, L., & Batnasan, N. (2013). Vulnerability of Mongolia's pastoralists to climate extremes and changes. *Climate Change and Vulnerability and Adaptation. London, UK: Earthscan*, 67–87.

Batima, P., Natsagdorj, L., Gombluudev, P., and Erdenetsetseg, B. (2005). Observed climate change in Mongolia. Assess Imp Adapt Clim Change Work Pap 12: 1–26.

Begzsuren, S., Ellis, J. E., Ojima, D. S., Coughenour, M. B., and Chuluun, T. (2004). Livestock responses to droughts and severe winter weather in the Gobi Three Beauty National Park, Mongolia. Journal of Arid Environments 59(4): 785–796.

Biazin, B., and Sterk, G. (2013). Drought vulnerability drives land-use and land cover changes in the Rift Valley dry lands of Ethiopia. Agriculture, Ecosystems & Environment 164: 100–113.

Burton, I., Huq, S., Lim, B., Pilifosova, O., and Schipper, E. L. (2002). From impacts assessment to adaptation priorities: the shaping of adaptation policy. Climate Policy 2(2–3): 145–159.

Debela, N., Mohammed, C., Bridle, K., Corkrey, R., and McNeil, D. (2015). Perception of climate change and its impact by smallholders in pastoral/agropastoral systems of Borana, South Ethiopia. SpringerPlus 4(1): 236. https://doi.org/10.1186/s40064-015-1012-9.

Du, C., Shinoda, M., Tachiiri, K., Nandintsetseg, B., Komiyama, H., and Matsushita, S. (2018). Mongolian herders' vulnerability to dzud: a study of record livestock mortality levels during the severe 2009/2010 winter. Natural Hazards 92(1): 3–17. https://doi.org/10.1007/s11069-017-2893-4.

Eakin, H., and Luers, A. L. (2006). Assessing the vulnerability of social-environmental systems. Annu. Rev. Environ. Resour. 31: 365–394.

Ellis, F. (2000). Rural livelihoods and diversity in developing countries, Oxford University Press, Oxford.

Fan, M., Li, Y., and Li, W. (2015). Solving one problem by creating a bigger one: The consequences of ecological resettlement for grassland restoration and poverty alleviation in Northwestern China. Land Use Policy 42: 124–130.

Fernandez-Gimenez, M. E. (1999). Reconsidering the role of absentee herd owners: a view from Mongolia. Human Ecology 27(1): 1–27.

Fernandez-Gimenez, M. E., Batkhishig, B., and Batbuyan, B. (2012). Cross-boundary and cross-level dynamics increase vulnerability to severe winter disasters (dzud) in Mongolia. Global Environmental Change 22(4): 836–851.

Fernandez-Gimenez, M. E., Batkhishig, B., Batbuyan, B., and Ulambayar, T. (2015). Lessons from the dzud: Community-based rangeland management increases the adaptive capacity of Mongolian herders to winter disasters. World Development 68: 48–65.

Fernandez-Gimenez, M. E., Venable, N. H., Angerer, J., Fassnacht, S. R., Reid, R. S., and Khishigbayar, J. (2017). Exploring linked ecological and cultural tipping points in Mongolia. Anthropocene 17: 46–69.

Fernández-Giménez, M. E., Batkhishig, B., Batbuyan, B., and Ulambayar, T. (2015). Lessons from the Dzud: Community-Based Rangeland Management Increases the Adaptive Capacity of Mongolian Herders to Winter Disasters. World Development 68(Supplement C): 48–65. https://doi.org/10.1016/j.worlddev.2014.11.015.

Goldman, M. J., and Riosmena, F. (2013). Adaptive capacity in Tanzanian Maasailand: Changing strategies to cope with drought in fragmented landscapes. Global Environmental Change 23(3): 588–597.

Goodman, L. A. (1961). Snowball sampling. The Annals of Mathematical Statistics: 148–170.

Grayson, R. (2006). The gold miners book-manual for miners, investors, regulators and environmentalists: best available techniques for Placer gold miners, Eco-Minex International, Ulaanbaatar (Mongolia).

Holzmann, R., and Jørgensen, S. (2001). Social risk management: A new conceptual framework for social protection, and beyond. International Tax and Public Finance 8(4): 529–556.

Humphrey, C., Sneath, D., and Sneath, D. A. (1999). The end of Nomadism?: Society, state, and the environment in Inner Asia, Duke University Press, Durham.

Jamsranjav, C. (2009). Sustainable rangeland management in Mongolia: the role of herder community institutions, Land Restoration Training Programme, Reykjavik.

Johansson, Ö., McCarthy, T., Samelius, G., Andrén, H., Tumursukh, L., and Mishra, C. (2015). Snow leopard predation in a livestock dominated landscape in Mongolia. Biological Conservation 184: 251–258.

Joly, F., Lefebvre, G., Sandoz, A., and Hubert, B. (2018). Does the ecological quality of inherited campsites cause persistent inequalities and poverty in pastoral Mongolia? The Rangeland Journal.

Krätli, S., Huelsebusch, C., Brooks, S., and Kaufmann, B. (2013). Pastoralism: A critical asset for food security under global climate change. Animal Frontiers 3(1): 42–50.

Lee, J. H., Kakinuma, K., Okuro, T., and Iwasa, Y. (2015). Coupled social and ecological dynamics of herders in Mongolian rangelands.

Ecological Economics 114: 208–217. https://doi.org/10.1016/j.ecolecon.2015.03.003.

Martine, G. (2012). *The new global frontier: urbanization, poverty and environment in the 21st century*. Earthscan.

Mayer, B. (2015). Managing "Climate Migration" in Mongolia: The Importance of Development Policies. In *Climate Change in the Asia-Pacific Region* (pp. 191–204). Springer.

Mertz, O., Mbow, C., Reenberg, A., and Diouf, A. (2009). Farmers' perceptions of climate change and agricultural adaptation strategies in rural sahel. Environmental Management 43(5): 804–816. https://doi.org/10.1007/s00267-008-9197-0.

Moon, K., Brewer, T., Januchowski-Hartley, S., Adams, V., and Blackman, D. (2016). A guideline to improve qualitative social science publishing in ecology and conservation journals. Ecology and Society 21(3).

Morinaga, Y., Tian, S., and Shinoda, M. (2003). Winter snow anomaly and atmospheric circulation in Mongolia. International Journal of Climatology 23(13): 1627–1636.

Morton, J. F. (2007). The impact of climate change on smallholder and subsistence agriculture. Proceedings of the National Academy of Sciences 104(50): 19680–19685.

Murphy, D. J. (2014). Booms and busts: asset dynamics, disaster, and the politics of wealth in rural Mongolia. Economic Anthropology 1(1): 104–123.

Nadia Mijiddorj, T., Alexander, J., and Samelius, G. (2018). Livestock depredation by large carnivores in the South Gobi. Mongolia. Wildlife Research 45. https://doi.org/10.1071/WR18009.

Raafat, R. M., Chater, N., and Frith, C. (2009). Herding in humans. Trends in Cognitive Sciences 13(10): 420–428. https://doi.org/10.1016/j.tics.2009.08.002.

Seid, M. A., Kuhn, N. J., and Fikre, T. Z. (2016). The role of pastoralism in regulating ecosystem services. Revue Scientifique et Technique (International Office of Epizootics) 35(2): 435–444.

Siurua, H., and Swift, J. (2002). Drought and Zud but No Famine (Yet) in the Mongolian Herding Economy. IDS Bulletin 33(4): 88–97. https://doi.org/10.1111/j.1759-5436.2002.tb00048.x.

Smith, J. B., Bhatti, N., Menzhulin, G. V., Benioff, R., Campos, M., Jallow, B., et al (2012). Adapting to climate change: an international perspective, Springer Science & Business Media, Berlin.

Solomon, S., Qin, D., Manning, M., Averyt, K., and Marquis, M. (2007). Climate change 2007-the physical science basis: Working group I contribution to the fourth assessment report of the IPCC (Vol. 4), Cambridge University Press, Cambridge.

Sternberg, T. (2010). Unravelling Mongolia's extreme winter disaster of 2010. Nomadic Peoples 14(1): 72–86.

Thornton, P. K., van de Steeg, J., Notenbaert, A., and Herrero, M. (2009). The impacts of climate change on livestock and livestock systems in developing countries: A review of what we know and what we need to know. Agricultural Systems 101(3): 113–127.

Tsegaye, D., Moe, S. R., Vedeld, P., and Aynekulu, E. (2010). Land-use/cover dynamics in Northern Afar rangelands, Ethiopia. Agriculture, Ecosystems & Environment 139(1–2): 174–180.

Turner, B. L., Kasperson, R. E., Matson, P. A., McCarthy, J. J., Corell, R. W., Christensen, L., et al (2003). A framework for vulnerability analysis in sustainability science. Proceedings of the National Academy of Sciences 100(14): 8074–8079.

Tversky, A., & Kahneman, D. (1992). Advances in Prospect Theory: Cumulative Representation of Uncertainty. *Journal of Risk and Uncertainty*, *5*(4), 297–323. Retrieved from http://www.jstor.org/stable/41755005

Undargaa, S. (2016). Pastoralism and Common Pool Resources: Rangeland Co-management, Property Rights and Access in Mongolia, Routledge, Abingdon.

Vincent, K. (2007). Uncertainty in adaptive capacity and the importance of scale. Global Environmental Change 17(1): 12–24.

Zimmerman, F. J., and Carter, M. R. (2003). Asset smoothing, consumption smoothing and the reproduction of inequality under risk and subsistence constraints. Journal of Development Economics 71(2): 233–260.