This article appeared in a journal published by Elsevier. The attached copy is furnished to the author for internal non-commercial research and education use, including for instruction at the authors institution and sharing with colleagues.

Other uses, including reproduction and distribution, or selling or licensing copies, or posting to personal, institutional or third party websites are prohibited.

In most cases authors are permitted to post their version of the article (e.g. in Word or Tex form) to their personal website or institutional repository. Authors requiring further information regarding Elsevier’s archiving and manuscript policies are encouraged to visit:

http://www.elsevier.com/authorsrights
Adaptation of herders to droughts and privatization of rangeland-use rights in the arid Alxa Left Banner of Inner Mongolia

Chengcheng Zhang, Wenjun Li*, Mingming Fan

College of Environmental Sciences and Engineering, Peking University, Beijing 100871, PR China

A R T I C L E   I N F O

Article history:
Received 31 July 2012
Received in revised form
14 March 2013
Accepted 21 April 2013
Available online 24 May 2013

Keywords:
Adaptation
Adaptive capacity
Arid area
Drought
Institutional change
Rangeland

A B S T R A C T

Residents of arid areas have developed their own adaptive strategies and adaptive capability to cope with an unstable environment that experiences frequent droughts. These strategies and this capability are based on traditional practices that developed from a profound understanding of their environment, but both the strategies and the capability have been affected by institutional change. Specifically, rangeland-use rights in the Alxa Left Banner were privatized in 1996, and the implementation of this policy decreased the ability of local herders to use traditional solutions. In this paper, we describe the change in their adaptive capability after implementation of this policy. Traditionally, local knowledge of the heterogeneity of resources and of key resources based on a deep understanding of the local environment, combined with tight social relationships, let herders use three traditional grazing strategies (seasonal migration, long-distance migration, and raising a diversity of livestock species) to mitigate the impacts of drought. But privatization has nearly eliminated their ability to rely on these traditional strategies and has weakened the forms of social and other capital that supported these strategies and provided a high adaptive capability. We argue that this institutional change has adversely affected traditional practices and undermined the adaptive capability of herders. Consequently, managers of the Alxa Left Banner must find ways to restore the various forms of capital to restore the herders’ adaptive capability, particularly given the growing need to account for future climate change.

© 2013 Elsevier Ltd. All rights reserved.

1. Introduction

IPCC (2007) noted that residents of semi-arid and arid areas will face increasing challenges caused by climate change during the 21st century. People in developing countries will be especially seriously affected because their vulnerability to climate change will be aggravated by other stresses, such as population increases and a lack of access to basic services (IPCC, 2007). In arid areas of China, the climate is characterized by unpredictable precipitation changes and frequent meteorological disasters such as drought (Piao et al., 2010; Zhai et al., 2010; Zhang, 2011). These characteristics directly influence the condition of the rangeland resources that are essential for livestock productivity and for the livelihoods of herders. Despite the frequent environmental fluctuations, such areas have supported livestock and the herders who require these herds for their survival for more than 1000 years (Fernandez-Gimenez and Le Febre, 2006). This is because local herders have developed a profound understanding of their grassland ecosystem and how it sustains livestock production (Li and Li, 2012). Herders have gradually developed their own adaptations and adaptive capacity to cope with recurring droughts (Wang, 2006; Xie and Li, 2008).

However, these strategies and adaptive capacity have been adversely affected by institutional change. Specifically, since 1996, the government of China has implemented a program to privatize rangeland-use rights in the northwestern arid region of China. By ensuring the rights of herders to manage and to benefit from their own rangeland, this policy had two purposes: to stimulate enthusiasm for animal husbandry among herders and to mitigate the “Tragedy of the Commons” (Hardin, 1968). However, this policy drastically changed animal husbandry practices and herder livelihoods (Li et al., 2007), and traditional adaptive strategies that had sustained local herders for many centuries became difficult or impossible to implement. Some studies have shown that adaptation and adaptive capacity can be improved or constrained by government and other social institutions (e.g., Adger and Kelly, 1999), and the privatization policy provides a concrete example. Irrational policy choices and system failures (whether economic, social, institutional, or political) can decrease adaptive capacity and leave a system vulnerable to unexpected situations (Williamson...
et al., 2012). Therefore, in research on how to sustain adaptive capacity in the context of future climate change, it is important to identify improper or outdated institutions (Adger and Kelly, 1999).

Many researchers have discussed the concept of adaptive capacity and have tried to measure this factor (e.g., Eakin and Lemos, 2006; Engle and Lemos, 2010; Williamson et al., 2012). The most common method is to measure this capacity by assessing its determinants (Smit and Pilifosova, 2001; Adger et al., 2007), such as the availability of technology and the quality of basic infrastructures. However, under the influence of changes in current institutions, each determinant of adaptive capacity also changes. Research based on primary data and that was designed to reveal the changes that affect the adaptive capacity in a context of climate change is lacking. There has also been limited research (Coleman, 2011) on specific policies related to the role of property rights in defining adaptive capacity, which is alarming given the obvious importance of these policies and their effects on adaptation under future climate change (Agrawal, 2010; Coleman, 2011). To provide some of the missing information, we undertook a case study in an arid region of northwestern China to reveal the processes responsible for changes in the adaptive capacity of local herders against droughts under the influence of the government’s privatization policy.

According to IPCC (2007) and Adger and Vincent (2005), adaptive capacity represents the sum of the resources and assets that are available to an actor to support their adaptation to some form of change. Based on the characteristics of our study area and the goal of our research, we have defined “adaptive capability” as the available resources that are actually used to adapt to a change, and have defined this term in the context of the resources, knowledge, skills, and assets available to herders and that are used to reduce losses of animals or of their production. Because we focus on the processes that have determined changes in their adaptation, we tried to answer two questions: (1) What were the traditional strategies and adaptive capability of herders before the privatization policy? (2) How did the privatization policy affect their strategies and adaptive capability? Our goals in answering these questions were to identify the underlying factors responsible for the observed changes and use them to help community managers develop an improved adaptive capability in the future.

2. Study area

The Alxa Left Banner of northwestern China covers an area of 80,412 km² in the Alxa League of Inner Mongolia (Fig. 1). This region is very dry, with only 100 mm of annual precipitation and 3000 mm of annual evaporation; the average annual temperature is 7 °C, but mean monthly temperatures range from a minimum of −13 °C in January to a maximum of 27 °C in July (China Meteorology Administration’s National Climate Centre, unpublished data). The arid area includes the Tengger Desert and the Ulan Buh Desert, which cover 42.3% of the area (Alxa League Statistics Bureau, 2008). The eastern edge of the Alxa Left Banner includes the lower slopes of the Helan Mountains, which have higher precipitation and therefore provide important summer pastures. Because of the low precipitation, the main vegetation type is desert grassland composed of drought-tolerant vegetation such as Reaumuria soongorica, Salvia passerina, and Haloxylon ammodendron (Alxa League Chronicles Compilation Committee, 2000), as well as various species in the Chenopodiaceae. Traditionally, local herders were called “the people who live on the backs of camels”, but most of them no longer raise camels and instead herd goats and sheep. Only a few herders who live nearest to the deserts still raise a small number of camels. In 2007, 14,727 herders still engaged in animal husbandry in the Alxa Left Banner (Alxa League Statistics Bureau, 2008).

Unpredictable precipitation changes and frequent drought are the most obvious characteristics of the local climate. Climate statistics obtained from the China Meteorology Administration’s National Climate Centre from 1960 to 2010 (Fig. 2) show high interannual fluctuation in precipitation in the Alxa Left Banner. The maximum annual precipitation was 198.4 mm, and the minimum was only 37.5 mm. The coefficient of variation equaled 39.2%. Drought, which occurs when precipitation decreases below 80 mm, is common, occurring every 4 or 5 years. Overall, precipitation in the eastern part of the banner is greater than that in the western part, and rainfall in the southern part is greater than that in the northern part. In addition, some small wet areas have developed due to a combination of local precipitation and the terrain; the precipitation in these areas is relatively abundant even in a drought year (Liu, 1991).

Before privatization, most herders followed a traditional nomadic lifestyle, in which they moved from lowland areas during the winter to higher-elevation pastures during the summer. All of the land was owned by the government and shared among herders, and there was generally a high degree of cooperation in sharing pastures, both during years with sufficient rainfall and during years with severe drought. In a year with significant drought, herders were often required to travel considerable distances to reach areas of pasture that were capable of sustaining their herds. The privatization of rangeland-use rights in the Alxa Left Banner was carried out in 1996. Under this program, usage rights were distributed at the sumu level (“township” in the Mongolian Language) and the gacha level (“village”). The local government used the total area and total population of each gacha to calculate the per capita area of

---

**Fig. 1.** Location of the Alxa Left Banner in northern China. The Banner covers an area of 80,412 km². Triangles represent the locations of the seven areas where we surveyed 52 households. The sample size at each location is presented in brackets. We conducted two or three detailed interviews at each location.
rangeland. Then, based on the population in each household, they distributed the rights to each family. The area of rangeland per family ranged from 2000 to 4000 ha, depending on family size. To clearly define the new rangeland boundaries, the government built fences. All the herders had to raise livestock in the small and fixed area of rangeland that they received. Wells and bodies of water that had formerly been public property became private resources.

3. Methodologies

3.1. Analytical framework

To answer our first question about herder’s traditional strategies and adaptive capability before the privatization policy, we first described their former adaptive strategies and tried to learn the basic rules of these strategies. To reveal their adaptive capability before 1996, we defined four categories for the capital that comprised the herders’ adaptive capability: natural capital (e.g., environmental resources such as grass and water), economic capital (e.g., household savings), social capital (e.g., the ability to rely on assistance from other herders), and cultural capital (e.g., the collective shared knowledge gained through many centuries of experience). We described these forms of capital by using specific indicators (defined in Section 4.1.2) and obtained detailed qualitative information to reveal the state of the herders’ adaptive capability before 1996.

To explore how privatization has affected the herders’ strategies and adaptive capability, we divided this question into three parts. First, we tried to figure out whether their adaptive capability changed after privatization. To do so, it was necessary to define assessment indicators and corresponding criteria. We defined the purpose of adaptation as the need to reduce losses of animals and of their production during drought years. For a given severity of drought, greater losses indicate weaker adaptive capability. To reflect these losses, we chose the livestock production cost and number of livestock as indicators. We then compared the changes in these two indicators in drought years before and after privatization to assess the change in adaptive capability. Second, based on the results of this assessment, we tried to identify what changes in the traditional strategies explained these results, because adaptive strategies directly influence the livestock production in dry years. Third, we analyzed the changes in the indicators that represented the herders’ various forms of capital to find the root reasons for the changes in adaptive capability and strategies.

3.2. Data collection

From 2008 to 2011, we conducted four surveys in the Alxa Left Banner. To cover the full study area, we randomly selected two sumu in the south, two sumu in the middle, and three sumu in the north (Fig. 1) and randomly interviewed a total of 52 households, including 33 households from 2008 to 2010 and 19 households in 2011. All of the interviewees were herders, and 20 of them were women. By conducting structured interviews, we obtained basic information such as the size of each family, the number of workers, and the income from and costs of animal husbandry. We also conducted open-ended interviews to learn the animal husbandry processes they used. Our interviews from 2008 to 2010 revealed no significant differences among households within a given sumu in their production and lifestyle. Therefore, to obtain more detailed information on their adaptation to drought before and after privatization, we conducted detailed interviews with 19 households from the 7 sumu in 2011. These detailed data included information about changes in traditional adaptive strategies, in access to resources, and in social relationships. In addition, local government officials were interviewed to collect information on the implementation of this policy and historical data on livestock production. We also collected secondary supporting data from the Alxa League Statistics Bureau (1992, 1993, 2002–2008), the Alxa League Chronicles Compilation Committee (2000), and related documents to assist our analysis.

4. Results

4.1. Traditional adaptations before 1996

4.1.1. Traditional adaptive strategies

For many centuries before the privatization policy, local herders integrated their accumulated knowledge based on a profound understanding of their environment into every aspect of their animal husbandry and their life. The use of two traditional grazing strategies and the raising of diverse livestock were their main adaptive strategies.

The first grazing strategy involved moving to new grazing areas two or more times per year. These moves were typically performed twice in normal years, between relatively fixed areas of summer and winter rangeland, with the livestock moved between them in the spring and autumn. However, livestock could be moved several times when necessary, such as during relatively severe droughts. The second traditional management strategy is called “taking otor” in the Mongolian Language. During severe droughts, which affect large areas, herders would move temporarily over long distances to unaffected or less severely affected areas, perhaps even outside of the Alxa Left Banner. When local conditions improved, they returned to their original land.

These two strategies reflect herders’ full use of locally available resources in different times and locations. The strategy of moving two or more times was based on the local ecological and climatic characteristics. Because of the area’s range of terrain types and rainfall, the banner can be divided into six different kinds of grassland (Table 1). The distribution of these grasslands is related to the Helan Mountains in the east, because the ranges of altitudes and precipitation levels create different grassland distributions. The areas with the most precipitation are at high altitudes in the Helan Mountains, whose altitude reaches more than 3000 m. At lower altitudes, both precipitation and grassland coverage decrease.

Based on a full understanding of this grassland distribution, herders usually chose to move two or more times to take advantage of these resources. Fig. 3 illustrates some typical patterns. During the winter, herders often grazed their livestock in lowland meadows near floodplains, seasonal rivers, and desert lakes, which have relatively abundant grass in winter. During the spring, as the temperature increases, they moved their livestock out of these areas and toward the Helan Mountains, where precipitation is

Fig. 2. Annual precipitation in the Alxa Left Banner from 1960 to 2010. Source: China Meteorology Administration’s National Climate Centre (1960–2010).

Fig. 3. Some typical traditional grazing areas and migration routes.
higher, leading to more productive grasslands. Because the summer temperatures are mild in the Helan Mountains and there is enough grass, herders usually stayed in the mountains for about 2 or 3 months. When the autumn came and temperatures dropped, herders moved their livestock back down to the foot of the mountains, returning to the winter rangelands that have rich water and grass resources. These moves allowed them to take maximum advantage of the available vegetation and water and revealed a profound understanding of the local environment and climate characteristics. Especially when it is dry in the plains, this strategy provides access to grass in areas with higher precipitation, thereby mitigating the effects of drought.

In contrast, taking otor is an important adaptive strategy to survive severe drought. When drought occurred, herders often contacted their relatives to learn of areas where there was no drought, and then moved their livestock to these unaffected areas. Herders sometimes moved to other banners or even to surrounding areas such as Erdos and even as far as Gansu Province. During these times, all herders from the same gacha or the same kinship relationships often planned their moving routes and moved together.

Taking otor also reflected their deep understanding of the local environment. Some studies have shown that despite the highly variable environment in terms of precipitation quantity and distribution, certain areas have relatively stable grass production; these stable resources become key resources when severe drought occurs (Scoones, 1995; Illius and O’Connor, 1999). Livestock mobility on a large scale was a useful and effective way to give herders access to these key resources. These movements also reflected the herders’ ability to effectively track resource availability over large areas (Illius et al., 1998). In addition, herders traditionally formed long-term, mutually beneficial relationships and networks that were important for mitigating the effects of drought. Herders who were taking otor could leave a few of their livestock to express their thanks to local herders, though this was not required because the system was based on the potential for reciprocity. All herders knew that drought could strike them some day, and that their kindness during the current drought would be repaid during some future drought.

In addition, to these two grazing strategies, herders usually chose the livestock species most appropriate for the local environment and raised diverse livestock species to reduce their losses in drought years. As we noted previously, herders of our study area were once called “the people who live on the backs of camels”. Camels, which can live in a very dry environment, were traditional “vehicles”, and also provided wool, skins, and milk. In addition to camels, herders traditionally raised four other kinds of livestock: goats, sheep, horses, and cattle. Goats eat less forage than other livestock and require less labor. Sheep are the main source of a livelihood and of the necessities of life, but eat more grass than other animals and require more care. Herders like to eat their meat, and their wool can be used to make carpets and clothing. When herders move their livestock, horses and cattle can be used to transport the family’s possessions and supplies. Cattle provide a source of meat and milk, but consume large amounts of grass. This diversity can prevent losses of all animals when one kind of livestock dies during a drought. And each livestock species has its own preference for different vegetation species, so raising diverse livestock can improve the efficiency of rangeland utilization. Therefore, in the local culture, simultaneously owning these five kinds of livestock symbolizes wealth.

In summary, this analysis reveals how local people developed traditional knowledge about the heterogeneity of the available resources and the key resources based on a profound understanding of the local environmental and climatic characteristics. By combining this knowledge with kinship and reciprocal social relationships, herders moved livestock two or more times to take full advantage of available grasses and gain access to a stable supply of grass. They could also take otor to reach more distant resources in areas unaffected by drought to decrease losses during a severe drought. In addition, knowledge of specific characteristics of each livestock species let herders use the diversity of livestock to adapt to droughts.

### 4.1.2. Herders’ adaptive capability before 1996

Knowledge of resources and the reciprocal social relationships that help herders to perform their traditional adaptive strategies were important forms of capital that herders possessed. These forms of capital were also the most important determinants of their adaptive capability. In this section, we will analyze these forms of capital before 1996 to reveal the adaptive capability of the herders before the privatization policy.

Natural capital usually refers to the natural resources and environmental services delivered by nature. Previous research has provided some evidence that full ownership of resources is not necessary to achieve a sustainable outcome, but that rights of access to resources are important (Coleman, 2009; Coleman and Steed, 2009). Access to natural grasses is one of the most important
forms of natural capital for herders because the highly changeable climate of arid areas results in a spatially and temporally heterogeneous distribution of this resource. Before 1996, herders had access to natural grasses across a large area of rangelands and could freely move their livestock within their community territory or take other longer distances to make full use of the heterogeneous resources in drought years. Access to water is a second, crucial form of natural capital. All the herders we interviewed reported that before 1996, there were several wells in each gacha, and that they usually grazed their livestock around these wells to obtain convenient access to water. These wells were a public resource, and were therefore freely available to everyone.

Economic capital refers to economic resources that herders can invest to build their capability. These resources can help them obtain more forage and mitigate their losses when drought occurs. Household savings are the main economic capital that herders own, and are usually saved for use in an emergency. However, most herders have no habit of saving cash, and livestock are their only important form of household savings. Before 1996, a typical household usually had a stable number of livestock (about 100–200 animals) even in dry years, and the number of livestock rarely decreased sharply.

Social capital refers to the relationships and networks among people and organizations. For a community, there are two main kinds of social capital: “bonding” and “bridging” social capital. Bonding capital refers to the multiple and redundant ties that build and stabilize community cohesion; bridging capital involves looser ties that create bridges among more distant organizations and communities (Narayan, 1990). Relationships between herders within the same gacha are one kind of bonding social capital that reflects the connectivity within the gacha. Before 1996, herders chose adaptive strategies based on these mutually beneficial relationships. Especially in dry years, these connections helped them find more grass to let their herds survive the drought. Relationships between herders and their gacha leader are another kind of bonding social capital and have traditionally been very important in the process of coping with drought. Gacha leaders were traditionally the heart of the gacha because they brought herders together to find ways to adapt to drought, such as cooperating to dig new wells. They were also responsible for routine matters such as resolving disputes among herders. Because of their importance, the relationship between herders and their gacha leader was very tight before 1996. Relationships among gachas reflect herders’ capability to seek resources from other communities, and are an important bridging capital. Historically, the traditional mobility was rooted in the connection among communities. Moving long distances to reach stable resources during a drought helped people from different areas to establish further close connections with other communities. Relationships between the gacha and the government are another bridging capital, and can reflect a community’s ability to gain access to resources from outside the community, such as governmental financial and technical support. Before 1996, the government provided timely disaster warnings and forage to herders and helped them to organize moving routes. Tight partnerships were established between herders and the government. Thus, centuries of livestock production in the difficult environment of the Alxa Left Banner formed a strong and flexible social network based on reciprocity within and outside communities that helped herders adapt to drought.

Cultural capital reflects people’s knowledge of their environment and how they act within it, as well as their traditions and language (Emery and Flora, 2006). In arid areas, centuries of experience with these adaptations have formed a mutual social memory among herders, and this social memory has been handed down across the generations by the culture of these people. Knowledge of the value of livestock shows herders’ adaptive capability by choosing the most appropriate livestock species for their local environment. Herders in the Alxa Left Banner traditionally were very familiar with the characteristics of each livestock species and used this diversity by choosing livestock adapted to environmental conditions. Knowledge of grazing patterns reflects herders’ understanding of their local environment. Based on profound knowledge of the heterogeneity of grass resources and other key resources, herders used the available grazing patterns efficiently before 1996.

In summary, before privatization, herders had access to heterogeneous grass and water resources across a wide area, owned a stable number of livestock that served as household savings in drought years, and had strong social connections within and outside their local community. In addition, they mastered knowledge of the value of livestock and of grazing strategies. By judiciously using these forms of capital, they were able to develop their own adaptive strategies and sustain their adaptive capability before 1996.

4.2. Effects of the privatization policy on adaptation

4.2.1. Assessing the change of adaptive capability

We used animal production losses during a drought to assess the change of adaptive capability and used the livestock production cost and number of livestock as indicators to compare the changes in animal husbandry losses during periods of drought before and after the 1996 privatization. Fig. 4 shows large changes in the ratio of livestock production cost to income for the region’s herders. Because the government did not collect statistical data on livestock production costs and herder income between 1993 and 2000, we have no data for this period. After 2000, the livestock production cost amounted to more than 45% of livestock production income. At the beginning of the 1990s, this proportion was only around 40%. However, the precipitation after 2001 was higher than that in 1991 and 1992. Thus, even though the degree of drought decreased after the privatization in 1996, the livestock production cost as a proportion of income increased. Drought occurred in 1991, 1992, and 2001, with total annual precipitation of only 76.0, 60.5, and 67.1 mm, respectively, in these years. The corresponding proportions of income accounted for by costs (e.g., purchasing supplemental fodder and water), in these years were 40.0, 41.9, and 62.0%, respectively (Fig. 4). Therefore, the privatization policy increased livestock production costs for a given income level.

During our survey, herders told us that the increased livestock production cost resulted from increased demand for fodder due
to a lack of natural grass during a drought. Before privatization, they were free to move their animals to better pastures during a drought and therefore rarely had to purchase fodder. Other livestock production costs such as epidemic prevention by means of vaccines and medicine were relatively fixed. Some herders told us that before 1996, when drought struck, they only needed supplemental fodder to feed their livestock during the winter or lambing season. Subsequently, they needed to begin feeding their livestock in the autumn, and some even had to feed their livestock during the summer. The proportion of animal husbandry income (for a total of 52 households) that each household spent to purchase fodder ranged from 21 to 76% in 2011, and averaged 43%. Even from 2008 to 2011, when precipitation was higher than average (Fig. 2), 15% of herders spent more than 60% of their income to purchase fodder. Thus, when drought occurred, their fodder costs increased.

In addition, the livestock number of each household in dry years has changed. Before privatization, a typical household owned between 100 and 200 livestock in dry years. After 1996, livestock numbers decreased to between 0 and 50 per household in dry years. The livestock number that herders owned in dry years changed after privatization as a result of increased livestock sales and livestock losses.

All herders we interviewed reported that after 1996, they had to sell many animals during a drought; 6 of the 52 households (11.5%) sold all of their livestock at least once. They also explained why this was necessary: When droughts occurred, animals lost weight because they lacked food. Because the price of meat was usually relatively stable, they earned less money from selling the same number of livestock as usual because of the decreased weight of each animal. In order to meet their basic living expenses, they therefore had to sell more animals. In addition, when they could not supply enough natural forage or purchased fodder to raise their livestock, all 19 households had to sell their animals prematurely to decrease their fodder purchase costs. After 1996, these problems became more severe and more common.

After 1996, losses of animals during a drought also increased. All 19 households in our 2011 survey reported that some livestock were poisoned by eating poisonous drought-tolerant weeds when grass was unavailable, and that this problem became more frequent after 1996. In 2004, a year with above-average precipitation (Fig. 2), 68,415 livestock from four sumu in the Alxa Left Banner were poisoned, and 3180 (4.6%) died. In 2005, a year with average precipitation, 580 households in several sumu reported that 99,400 of their livestock were poisoned and that 1778 (1.8%) died (Xu et al., 2008). All 19 households confirmed that livestock were poisoned at least once, and that this usually happened more often in dry years. Two households reported that more than half of their livestock died because of eating poisonous weeds. Five households reported greatly decreased wool production by poisoned goats, and that production of offspring was severely reduced.

Before 1996, herders never sold more livestock than usual during a drought, and few animals were lost. After the privatization, drought forced them to sell all of their animals or all except the youngest animals, or to sell their animals earlier than usual. In particular, a lack of palatable grasses often forced the animals to consume toxic drought-resistant vegetation that killed some animals and caused decreased production of wool and offspring. Therefore, the 1996 privatization policy greatly increased livestock sales and losses in dry years, and resulted in greatly decreased livestock numbers. 13 of 19 households reported retaining only a few dozen livestock in dry years and the other 6 households retained no animals. Although the livestock number decreased before 1996 in dry years, herders were usually still able to maintain more than 100 livestock.

These results show increasing animal husbandry losses (increased livestock production costs and decreased livestock number) in dry years after 1996. Based on our assessment criteria, this represents decreased adaptive capability after the privatization policy.

4.2.2. Changes in adaptive strategies

The increased livestock production costs and decreased livestock numbers in dry years may have been directly caused by the changes in the herders’ adaptive strategies. All of the 19 households we interviewed in 2011 used the two abovementioned grazing strategies (seasonal migration and taking otor) before privatization. However, these households reported that they could no longer move their livestock after privatization. They were prevented from taking otor during severe droughts, and even their traditional seasonal mobility was prevented because of the clear and fixed boundaries established by the government. Instead, they were forced to graze their livestock in the fixed area of rangeland they received.

After 1996, herders abandoned the strategy of using diverse livestock to adapt to their environment. Camels usually need a large area of rangeland, but the fences constrained movement of the camels, leading to many disputes among herders. As a result, they had to sell or kill many of their camels. Government data suggest that the number of camels in the Alxa Left Banner decreased from 250,000 in 1990 to 20,000 in 2005. Shortages of natural grass during a drought prevented herders from retaining big animals such as horses and cattle, so they were forced to sell them cheaply and only retain small livestock such as sheep and goats, which can survive with less grass and can reproduce rapidly. An old gacha leader who was responsible for a local livestock census told us that the livestock number in his gacha changed dramatically after 1996. The number of camels decreased from about 3500 to 200, and few herders still raised them. From an original population of 100 horses, none remained, and the number of cattle decreased from around 90 to around 10, while the number of sheep and goats doubled to roughly 20,000. We observed a similar trend for the 52 households we interviewed. In 2011, the number of animals per household ranged from 0 to 10 for camels (<1% of the total), from 80 to 600 for goats (70–90% of the total), and from 20 to 70 for sheep (10–30% of the total). Few people still raise camels, and goats accounted for more than 80% of the animals raised by these households. This reflects a widespread lack of access to stable sources of grass, since goats were traditionally only raised when there was insufficient grass.

Thus, after privatization, herders’ traditional adaptive strategies (seasonal migration, taking otor, and maintaining diverse livestock) have been severely constrained by the fixed boundaries. Instead, herders have had to adopt high-cost strategies, such as buying more forage and selling more livestock (as discussed in Section 4.2.1).

4.2.3. Reasons for decreasing adaptive capability

Based on the above analysis, herders of the Alxa Left Banner had higher adaptive capability before 1996 based on the use of their traditional strategies. After the privatization policy, animal husbandry losses increased and herders’ adaptive capability decreased. To analyze how this institution weakened their adaptive capability and constrained their strategies, we have summarized the changes in the various forms of capital available to herders in Table 2.

Natural capital, which refers to herders’ access to natural grass and water, has decreased since 1996. All the herders we interviewed reported that their access to grasses and water has been severely constrained by privatization because of the clear and fixed boundaries established by the government. When the government...
distributed rangelands in 1996, they created an additional problem by failing to consider the location of the wells. Of the 19 households interviewed in 2011, 18 had rangeland with no well. Because of the long distances to wells and the presence of fences that blocked their access to the wells, herders were usually required to use vehicles to obtain water and spend considerable money on gasoline and diesel. One family that had a well on their rangeland even charged fees to obtain water and spent considerable money on gasoline and diesel.

An especially damaging change is the loss of the tracking strategy: moving two or more times per year within and outside their region so they could move over long distances when necessary to reach stable sources of grass. Since privatization, herders no longer have access to the wells, herders were usually required to use vehicles to obtain water and spent considerable money on gasoline and diesel. One family that had a well on their rangeland even charged fees to obtain water and spent considerable money on gasoline and diesel.

5. Discussion and conclusions

In 1996, rangeland-use rights were privatized in the Alxa Left Banner. Before this policy, local people learned and preserved centuries of knowledge of the heterogeneity of resources and of key resources in their region based on a profound understanding of their region for many centuries.

Cultural Capital, which refers to herders’ knowledge of the value of livestock and of traditional grazing patterns, has also decreased since 1996. Herders have gradually abandoned their traditional use of livestock diversity to adapt, and much of their traditional knowledge of the value of these animals has gradually disappeared. An especially damaging change is the loss of the tracking strategy that allowed herders to monitor climate conditions throughout the region so they could move over long distances when necessary to reach stable sources of grass. Since privatization, herders no longer use this strategy, and there is considerable doubt whether their traditional knowledge of the local environment and the resulting adaptive strategies will be handed down to new generations. This valuable local knowledge is not passed along by the modern education system and may disappear. This would be a great loss, because this precious knowledge preserves the common social memory of local people who have adapted to environmental change in their region for many centuries.

Social Capital, which specifically refers to relationships within and outside communities, has decreased since 1996. Privatization has weakened the relationships among herders and created new, but weaker, connections within the gacha. The previous example of a rangeland owner charging fees for access to water that was formerly free to everyone illustrates this point. The privatization policy has not only strengthened herders’ consciousness of and sensitivity to rangeland boundaries, but has also changed their way of thinking. Now, they place less weight on mutually beneficial relationships and more weight on their own interests and profits. Some herders seriously claimed that “The livestock of others can’t enter my rangelands, otherwise I will catch them and charge a fee”.

Our surveys showed an increased number of disputes among herders. Some (13 of 19 households) reported that these disputes resulted from an unfair distribution of grassland of different quality, and some (5 of 19 households) no longer allowed another herder’s livestock to graze freely on their land. Relationships between herders and their gacha leader have also weakened. After 1996, herders became responsible only for their own production. They no longer needed to collectively organize moving routes to adapt to droughts, and this loss of cooperation weakened the bonds. Of the 19 households, 11 reported fewer and more widely spaced visits from leaders and 4 felt that their leaders were too new and no longer recognized them. Relationships between gachas were also worse than before the privatization policy. Herders’ movements in dry years have been severely constrained by fences and by an increasing sense of self-interest since the privatization. All of the 19 households reported that they no longer moved their livestock to another gacha, and 7 households reported increased disputes between communities, such as capturing livestock from another gacha that strayed onto their land. In addition, 13 of the 19 households complained about the government’s unfair distribution of rangeland, which had not accounted for resource heterogeneity. This sense of unfairness has damaged their relationship with the government, and the resulting decrease in communication decreases opportunities for the government to seek resources for them. Thus, after the privatization, these key components of herders’ social security have been seriously weakened.
livestock. After privatization, the local government built fences to clarify the boundaries of the rangelands assigned to each household. These fences and the resulting social changes largely eliminated access to the traditional strategies. In addition, key forms of capital that provided high adaptive capability have been weakened: herders face severely constrained access to natural grass and water, decreasing household savings, severely undermined reciprocal relationships among herders and among gachas, increased distrust of gacha leaders and the local government, and loss of knowledge of the value of diverse livestock and traditional grazing strategies. These changes have dramatically decreased herders’ adaptive capability, leading to greater losses of livestock and of their production in drought years.

The privatization policy has therefore had severe negative effects on the traditional strategies and on herders’ adaptive capability. As has been noticed by many scholars (Humphrey and Sneath, 1999; Ho, 2001; Williams, 2002; Li et al., 2007), this reform of rangeland property rights is inseparable from the decreased quality of the herders’ livelihoods. Xie and Li (2008) argued that especially in years with an environmental disaster, herders have been unable to sustain a stable standard of living after implementation of the policy. These negative effects on herders’ livelihoods were also found in our study. Li and Huntsinger (2011) found that the policy has weakened herders’ ability to benefit from rangelands by weakening or eliminating their ability to cope with nonequilibrium conditions. The policy has therefore not only increased herders’ exposure to risk, but has also changed their formerly low-cost coping strategies, thereby increasing their vulnerability to droughts (Zhang, 2011). These negative effects were confirmed by our studies of the herders’ adaptation to droughts.

However, we must stress that not all livestock losses can be attributed to this policy. Natural disasters, defective infrastructure, and careless management could also cause these losses. In addition, the privatization policy has brought some benefits to herders, although these benefits may not help herders to improve their adaptation to droughts. First, this policy has improved herders’ enthusiasm for production and reduced free-rider problems by clarifying the rights to specific resources. Although privatization clarified rangeland boundaries, it has constrained access to grasses across a large spatial scale, especially in dry years. Second, since the rangeland-use rights have been allocated to individual households, poor herders who have few livestock can receive money by renting their rangeland to herders with larger livestock numbers, thereby providing income that can support their daily life. Unfortunately, their rangeland is no better than other rangeland in dry years, so no one wants to rent their land in these years, and their rental income is not stable. Third, the distribution of rangeland gave some herders income opportunities that were not available to others by providing water from wells on their rangeland. This income is also not stable in dry years. Thus, although the privatization policy has brought some positive effects to herders, there is no obvious evidence that these positive effects have improved the herders’ adaptive capability.

In this paper, we used changes in the number of livestock as an indicator to assess the changes in the adaptive capability. This approach is imperfect because it does not account for the ability of herders to sell parts of their herd to buy fewer but more drought-resistant livestock species. However, this phenomenon is rare in the Alxa Left Banner. The Alxa Left Banner is a very dry environment, and the native livestock raised by local people are very drought-resistant and highly adapted to the local environment. Most of the herders we interviewed told us that they often sold several livestock in dry years, but none of them reported buying other livestock that they had not previously raised because they believed this would increase their risk. Traditionally herders have always tried to keep their number of livestock stable, since livestock represent their wealth. Thus, before 1996, they rarely sold many livestock even in dry years. Livestock sales were used only as a last resort. Thus, based on the goal of livestock production and the characteristics of our study area, animal losses appear to represent a viable indicator of the herders’ adaptive capability.

Although the privatization policy was intended to improve animal husbandry, it failed to account for the high variation in rangeland quality and the unpredictable impacts of climate on the local people. To solve these problems, managers in some pastoral areas of arid China are trying to rebuild the traditional mechanisms of cooperation to allow greater livestock mobility. This cooperation will give herders access to more natural resources, as in the period before 1996. However, other forms of capital such as social capital remain weak, so the herders’ adaptive capability may remain weak even after these changes. This weakness results from tradeoffs among the ability of each capital component to modify the effectiveness of other components (Coleman, 2011). For example, a lack of accurate and timely knowledge of regional resource availability in the absence of the social capital required to permit collective action (i.e., to let herders exploit that knowledge) may prevent a satisfactory response to problems such as drought (Adger, 2003). The adaptive capability of any system is limited by the weakest of its components (Yohe and Tol, 2002). Therefore, herders of the Alxa Left Banner, who are already facing an unpredictable climate, may face even more severe challenges in the future as a result of climate change. This means that it is urgently necessary to reconsider the privatization policy in such a way as to preserve and eventually increase the natural, economic, social, and cultural capital these people have developed over centuries of traditional pastoralism. Because of the damage that has resulted from the privatization policy, it may take a long time to restore these essential forms of capital.

**Acknowledgments**

This research was supported by the National Natural Science Foundation of China (41171428) and a Ford Foundation grant. We thank three anonymous reviewers for their valuable comments and advice and Geoff Hart for providing considerable language help. Special thanks go to all the hospitable herders, who were always patient with our numerous questions. We are also grateful for the help of our students, especially Yanbo Li, who helped greatly in our fieldwork.

**References**


