【論文】

Does herder's perception of climate change relate to their strategies choice? Evidence from the pastoral area in the northwest of China

Shuyu HAN*, Katsuhito FUYUKI* and Minakshi KEENI*

Contents

Abstract

The livelihood of pastoralists is highly related to institutional restriction and climate change. The challenge of climate change has been considered an inevitable threat to the sustainable development of herders. However, the impact of the institution is powerful as well. This paper investigates the perception of local pastoralists towards climate change and analyses their perception of grazing strategies selection in northwest China. Case studies were conducted in two pastoral counties of northern China, a region that frequently suffers from drought, low temperature in winter and has experienced numerous institutional changes over recent decades. Based on the exploration of 5 grazing strategies and climate perceptions, the field results show that respondents have a low perception of temperature change and precipitation variation. The policy change targeted the issue of grazing land shortage which led to herders focusing on grazing strategies rather than climate issues The biggest constraint limiting the change of strategy is the shortage of money. Our findings reveal that the local government should provide a training program to herders against the long-term climate change risk. Importantly, the policymaker should pay more attention to individual households' welfare and benefit in the pastoral area.

Keywords: pastureland; grazing management; climate perception; adaptation strategies.

* Graduate School of Agriculture Science, Tohoku University

1. Introduction

Climate change and increasing climate variability have huge impacts on environmental security, as the conflicts over livestock assets often observed in pastoral regions are likely to escalate in the future as a result of changes in environmental conditions (Herrero, Addison, et al. 2016). Pastoralists are highly dependent on environmental resources, and their livelihoods are greatly affected by climate change. Hence, it is crucial to increase their resilience to protect their livelihood in the short term (Herrero, Addison et al. 2016).

China has the world's second-largest area of pastureland. However, human impact and climate change have led to severe grassland degradation in the last few decades (Li, Verburg et al., 2012). The contribution of climate change and human activities to China's grassland degradation is almost at equilibrium (47.9% vs. 46.4%) (Zhou, Yang et al. 2017). These two dominant reasons have been widely discussed in recent years. The damage caused by human factors has been discussed from institutional transformation and over-exploitation activities (Ren, Shen et al. 2007). Institutional transformation and over-exploitation are the main reasons for the damage caused by human factors. Some articles also mentioned that climate factors led to grassland degradation from frequent drought, extreme weather events (Li, Wu et al. 2012, Han, Wang et al. 2018). These external shocks have a great impact on the normal lives of the herders. Hence, herders strive to maintain their livelihood by using various adaptation strategies. The herders' adaptation strategy as a result of decision-making is the main solution against risk and uncertainty. The uncertainty is always a key feature of herders' pastoral production strategies (Scoones 1994, Krätli and Schareika 2010, Scoones 2020). Slovic and Peters (2006) argued that risk is perceived and acted upon in two fundamental ways as feels & analysis and intuitive feelings. Generally, human perception is the premise of feeling, as one person needs to perceive things first and then feel them. In the detention of adaptation to climate change, the main determinant of the motivation to adapt what an actor wants to do, indicated by motives like goals, values, or norms- is the relative risk perception (Grothmann and Patt 2005). Hence, perception is a necessary ability in the herders' community against various shocks. For example, herders perceived surroundings variation such as glaciers movement, grassland condition, climatic change, phenological change to guide them to shift grazing practices (shifting camping site, collection of forage grass for winter feed) (Joshi, Jasra et al. 2013). These variations bring a huge challenge to herders' livelihood and production system.

Climate change has been accepted as a driver of mountain ecosystem change by researchers (Herrero, Addison et al. 2016, Sharif, Rafiq et al. 2019). Previous research mentions the importance of herders' perception of climate change. Few find out the consistency between herders' climate perception and meteorological data (Li, Wang et

al. 2014, Zhang, Cui et al. 2019). These studies have tested the gap between human perception and objective meteorological data and established the correlation. Additionally, some research conducted herder's perception's influence on their production system (Kimaro, Mor et al. 2018). These show that the perception of herders has a great influence on their livestock production. Most articles mention the perception of herders related to adaptation strategies. These papers stated the connection between the perception of local herders and adaptation strategies and mention that the perception of climate change has an important influence on the choice of their livelihood strategies (Butt 2011, Hou, Han et al. 2012, Silvestri, Bryan et al. 2012). As Zhou, Yang et al. (2017) pointed out, human factors almost have the equivalent impact on grassland degradation as climate issues. As herders are highly dependent on grassland resources, it is very important to understand human factors. For example, some research mentioned that some non-climate change issues have significant impacts on locals' livelihood such as conflicts, institutional transformation, economic effects (Salih and Dietz 2001, Wang, Brown et al. 2013, Yu 2016). The above-mentioned research pointed out that government policy regulation, rapid urbanization, and chaos played key roles in shaping livelihood adaptation strategies.

Although the above studies have mentioned herders' socioeconomic responses to climate change from the perspective of human beliefs, it is still difficult to get firsthand meteorology and respondent data from a remote mountainous area. People living in mountainous areas are isolated, making it vital to understand their perception of climate change and how these emotional factors affect their livelihoods. Inadequate knowledge of the impact of climate change on pastoralism and the rangeland ecosystem is a limitation in planning for effective management of rangelands and sustainable development of the livestock industry (Joshi, Jasra et al. 2013). Through the analysis of their perception of climate change, it will be helpful in the policymaking of local governments and improving herders' resilience in facing the shocks.

This study focuses on herders' climate change perception based on a case study conducted in pastoral area counties of northwest China. These regions have a dry climate and are vulnerable to climate change (Fang and Xie 2010). The inclement weather is due to the Qilian Mountain, which blocks atmospheric circulation and has a long distance to oceans (Shi, Shen et al. 2007). Besides, in recent years, these regions also experienced various institutional transformations due to the enactment of the Grassland Law in 2002. The Chinese government developed a series of policies on pastoral land protection and the development of the grazing industries in all pastoral regions (Hua and Squires 2015). These measures were mentioned by some researchers that it could have the key factors to shaping locals' adaptation strategies in China (Wang, Brown et al. 2013, Yu 2016). Therefore, it is also crucial to find out whether the perception of climate change or institutional transformation-related adaptation strategies choice in the study area. Based on the above background, we raise two

questions: (1) do local herders have the right perception of climatic change? (2) local herders' adaptation strategies choice related to climate change perception or institutional transformation? To answer the above questions, we process follow study.

2. Method

Study area

The study (Figure 1) was conducted in two pastoral counties located in northwest China. The Sunan Yugur Autonomous County is located in Gansu Province. It is located in the middle of the Hexi Corridor and the northern foot of the Qilian Mountains. The climate in Sunan County is mostly semiarid with an average temperature of 4 ℃. The second study area is in Qilian County in Qinghai Province which is in the middle of Qilian Mountain. Its climate belongs to a typical plateau continental climate, with a large drop in temperature in humid summers and winters.

In Sunan county, we surveyed three townships (4 villages)-Dahe Township (1 village), Kangle Township (1 village), and Mati Township (2 villages). In Qilian County, we surveyed two townships (4 villages), including Yeniugou Township (3 villages) and Yang long Township (1 Village) (Table 1). Two study areas are highly dependent on livestock farming. Due to the deterioration of the grassland ecological environment caused by climate change and humans, the balance of ecological grass-livestock, and the implementation of the grazing prohibition, herders' breeding patterns in the two counties have been highly affected.

Data collection and Analysis

The research was based on a one-month field trip in the spring season of 2021. A presurvey was held in the first week followed by in-deep interviews. The main data collection methods applied are open-up and semi-structured interviews. The database collected was qualitative. Consent for all respondents was collected before being interviewed. In 2020, the questionnaire was designed to investigate the perception of climate change and adaptation strategies of locals. Besides that, demographic information of the respondents (Table 2) and some livelihood-based questions, such as internet connection, insurance purchasing, loans, cooperation, leaders were also collected. During the household interview, 30 herder's households were interviewed, and 28 valid questionnaires were obtained, which contained 16 in Sunan and 12 in Qilian (Table 1).

Table 1 Data collection in Sunan County and Qilian County in 2021. *Source: Survey in 2021.*

Research sites	Sunan County	Qilian County
Surveyed village	4	4
Semi-structured interviews with local households	18	12

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Table 2 Demographic characteristics of the sampled household.

Indicators	Category type	County name	
		Sunan (%)	Qilian (%)
Gender	Male	68.75%	91.7%
	Female	31.25%	8.3%
Occupation	Full-time herders	87.5%	91.7%
	Part-time herders	12.5%	8.3%
Age (Years)	30-39	-	17%
	40-49	31.25%	58%
	≥ 50	68.75%	25%
Education	Uneducated	12.5%	-
	Elementary school	50%	50%
	Secondary school	31.25%	50%
	High school	12.5%	-
The number of livestock	None	12.5%	16.7%
(By number of cattle)	0-100	68.75%	50%
	101-300	6.25%	8.3%
	≥300	12.5%	25%
The area of household grassland	None	25%	8.3%
tenure （acres）	<1000	50%	58.3%
	1000-2000	12.5%	33.3%
	≥2000	12.5%	-

Note: For counting convenience: 1 Cattle = 4 Sheep (according to average grazing area per animal)
(-) means no responses were given
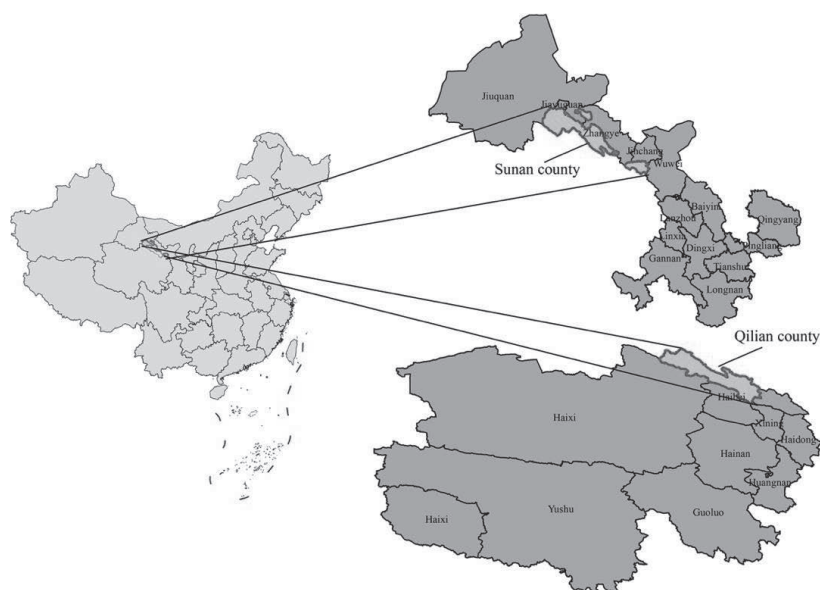***Source:*** *Author's survey, 2021*

Figure 1 Study area.

Meteorological characteristic

Two counties' meteorological data were collected from the local weather station. (Figure 2- Figure 5). Through analyzing the meteoritical data between Sunan County and Qilian County in the past 40 years, we summarized some notable information as followed. Both the counties experienced a continuous average temperature increase in

the past 40 years. Particularly, the average temperatures of the two counties had a considerable increase as compared to the 1980s. As for ten years' average precipitation records, some significant fluctuation existed in specific months between the two areas. In Sunan County, precipitation record shows that summertime rainfall in the last decade was lower than in the 1990s. In Qilian County, the average precipitation in the past ten years from May to July was higher than past 40 years.
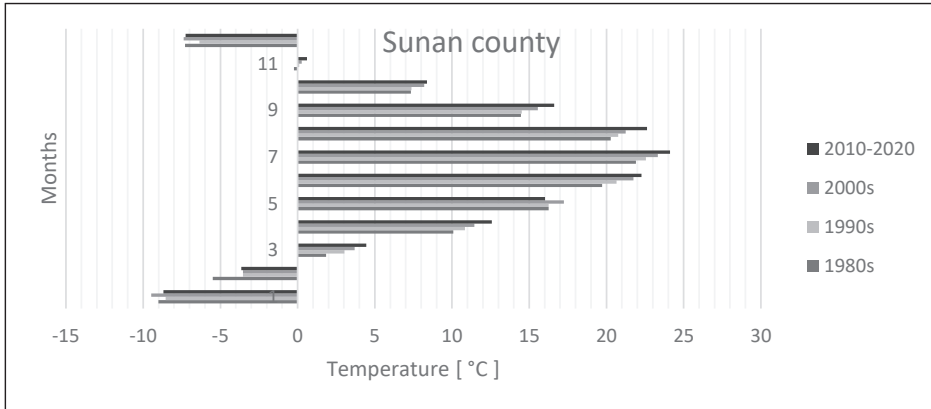

Figure 2 Average annual temperature change trends of Sunan County in the past 40 years.

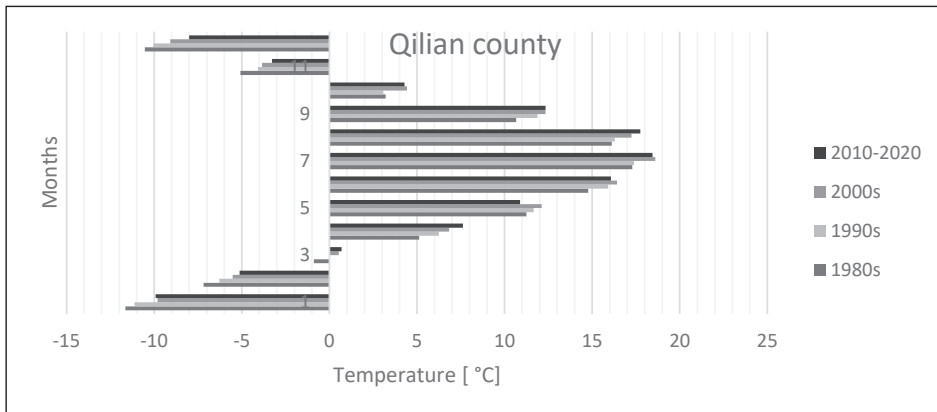*Source: Local meteorological station in 2021*

Figure 3 Average annual temperature change trends of Qilian County in the past 40 years.

Source: Local meteorological station in 2021

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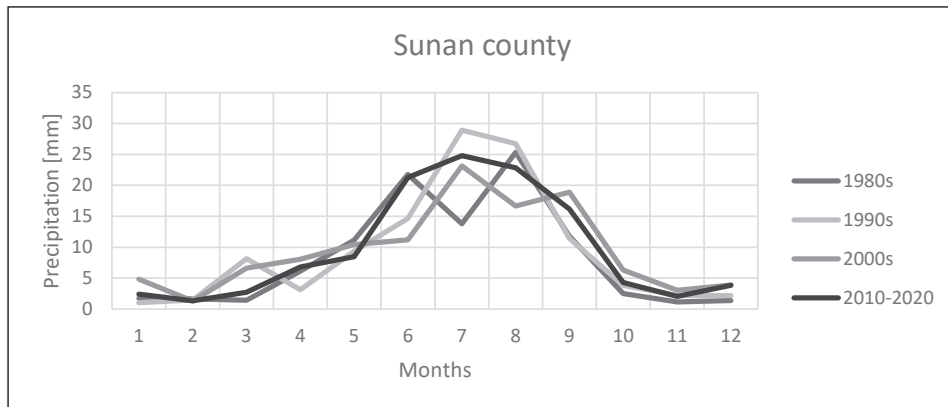

Figure 4 Average annual precipitation changes trends of Sunan County in the past 40 years.
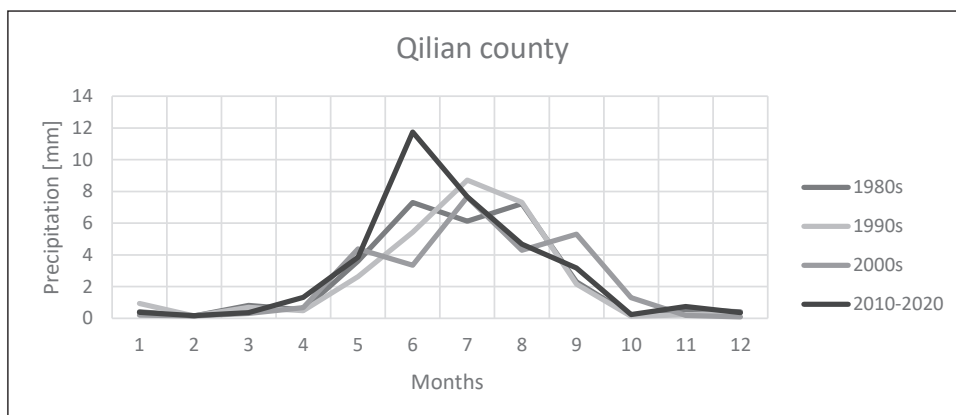
Source: Local meteorological station in 2021

Figure 5 Average annual precipitation changes trends of Qilian County in the past 40 years.

Source: Local meteorological station in 2021

3. Result & Discussions

Perception of climate change and adaptation has been closely linked in the field of agriculture-related research (Below, Schmid et al. 2014, Abid, Scheffran et al. 2015, Hou, Huang et al. 2015, Zhang, Cui et al. 2019).

Herders' perception of climate change

Climate change perception is the ability to perceive climate change which requires sufficient labor experience and the surrounding social environment and keen insight. Herders' perception of climate change was detected by three questions related to pasture degradation, income, and climate change awareness. Firstly, more than half of respondents in the two counties believe that grassland degradation is related to climate change, with Sunan County accounting for 62.5% and Qilian County 58% respectively.

Herders show that drought and less rain significantly impact grassland degradation, which exacerbates land degradation. Secondly, nearly half of herders (44% in Suman) and (42% in Qilian) in the two counties believe that climate change does not cause many impacts on their income. Respondents argue that forage cost, facilities investment, renting grazing land is much higher than the loss from climate-dominated animals' death and grassland degradation. Finally, 67% in Sunan and 50% in Qilian County had never heard of climate change This could be attributed to the fact that the older respondents received elementary education. They spend their whole lives in one place and rarely receive new information, leading to weak knowledge of climate change. In general, surveyed herders did not have a strong understanding and awareness of climate change.
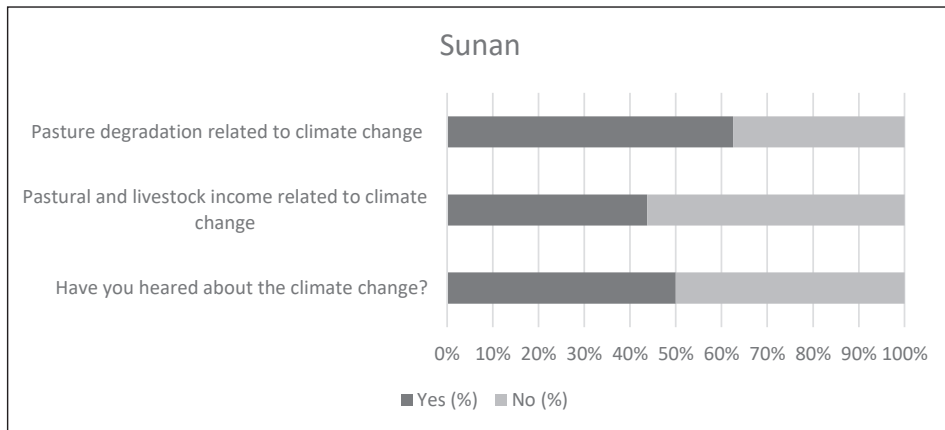

Figure 6 The climate change cognition of respondents in Sunan County.

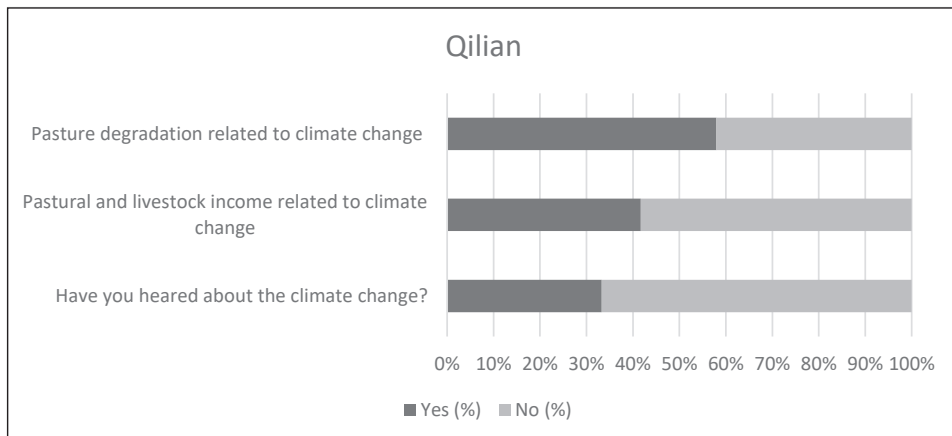*Source: Survey in 2021*

Figure 7 The climate change cognition of respondents in Qilian County.

Source: Survey in 2021

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According to the temperature data, there is a consistently increasing trend in annual mean surface temperature in the study area. To obtain interviewees' detailed perceptions, they were further asked specific questions about temperature change, precipitation change. We raised two questions as follows (1) what do you think of the average temperature change in the past ten years? (2) what do you think of the temperature change in summer and winter? The first question's answer can be divided into three groups: only 37.5% (Sunan) and 16.7% (Qilian) of respondents pointed out that annual average temperature was increasing; 35.7% (Sunan) and 25% (Qilian) considers that average temperature became lower; 25% (Sunan) and 58.3% (Qilian) thinks that there was no change. The perception of summer temperature changes in the two places is slightly different. 50% of respondents in Sunan County consider the temperature in summer increasing. While only 25% of herders have the same opinion as in Qilian County. Herders observed apparent deviations in winter temperature change trends. In Sunan, only 6.5% of herders believe that the average winter temperature has increased in the past ten years. The herders who indicated that the temperature has decreased and remained unchanged accounted for 81.25% and 12.5%, respectively. In Qilian County, no herders believed that the average temperature in winter has risen. On the contrary, 83.3% believed that the temperature in winter had decreased and 16.7% believed that the temperature had not changed in winter. Herdsmen generally believe that: "The winter in recent two years become colder compared to previous years." The perception difference that existed in the two counties may be caused by the difference in climate and environment between the two sites. Qilian County's climate belongs to a typical plateau continental climate, with a large drop in temperature in humid summers and winters. Herdsmen's inaccurate perception of the temperature change trend in winter may be influenced by recent cold and dry weather trends.

According to precipitation data in two counties, the average precipitation in Sunan County during 2010-2020 was significantly lower than in the 1990s. In Qilian County, the 2010-2020 average precipitation was slightly higher than the previous 30 years. The annual average rainfall from May to the end of June has significantly increased compared to the past 30 years. The herders were asked what they felt about the precipitation change in the past ten years. The results show that respondents have significant differences to precipitation fluctuation perception in the two counties. In Sunan County, the majority of the respondents (87.5%) believe that average precipitation in the past ten years has decreased. In Qilian County, approximately 41.7% of herders believe that precipitation decreased, 58.3% of respondents believe that there is no change, and none think precipitation increased. Average precipitation in Qilian County has increased slightly, but none of the respondents have been able to perceive it correctly. The long-term frequent drought and slight rainfall may hinder herders' cognition of recent weather changes.

In general, we found that respondents' answers are contrary to temperature and

precipitation records. Most herders' perceptions of climate change are affected by short-term effects and long-term consciousness. Herders generally believe that winter temperature has dropped in the past ten years because they feel that the winter of 2020-2021 was extremely cold. This result is consistent with the facts, as some research reflects that the global cold-drying trend is spreading globally due to the impact of the COVID-19 pandemic (Mecenas, Bastos et al. 2020). As for long-term consciousness, pastoralists have a deep impression of the long-term drought in the northwest of China. In Qilian County, even though average precipitation has increased slightly in the past ten years, nearly half of the herders still believe that the precipitation has decreased. In addition, affected by the long-term drought, herders generally agree that the drought frequency has not changed. More than half of Sunan and Qilian counties believe that the temperature has dropped and remained unchanged in terms of the annual average temperature. Indoor breeders account for a more significant proportion.

Meanwhile, most respondents believe that the grassland degradation was led by climate change rather than human intervention. This contradicts the view of most researchers and reflects the lack of understanding of grassland degradation in the herders' community. Although the herders show that climate issues have huge damage to grassland degradation, they believe that their income fluctuation is not related to weather issues. Generally, they consider that grassland limitation and market-fluctuation are two crucial factors to decide income.

The influence factors related to strategies selection

Information on climatic risks is essential for actions to face climate change (Wilby, Troni et al. 2009). Individuals and groups' perception of the harm caused by climate change strongly affects how they face the adverse effects of climate (Adger, Huq et al. 2003, Patt and Schroter 2007). Understanding climate change perception is critical to herder communities' grazing strategies and the decision makers' judgment (Li, Wang et al. 2014, Zhang, Cui et al. 2019). In the study area, we summarized five grazing strategies adopted by local herders. (1) Breeding community; (2) Rent land grazing; (3) Grassland transfer; (4) Land stock cooperatives; (5) Artificial grass planting. These were new grazing strategies adopted in the local community of the study area.

Perception

According to the survey results, climate change perception does not play a decisive role in the choice of adaptation strategies selection. We did not find that local herdsmen's choice of adaptation strategy is due to climate change. Life maintenance and grazing land are two important motivations in the local herders' community. Most herders are forced to choose new grazing strategies because of the grazing prohibition implemented by the local government. They argue that grassland area is not enough for grazing.

Other factors

The ethnic group is a crucial factor related to strategies selection. There are four main ethnicities in the study area, including Han, Hui, Yugur, and Tibetan. The Han and Hui are without grassland management rights in the study area who migrated from nearby provinces. In Qilian County, 10/12 of the interviewees are Tibetans and the other two Hui were migrants. We found that the *Breeding Community* was chosen by the migrant population (Han, Hui), as since the 1980's these migrants move to study areas without pastureland management rights. They have to choose the in-door breeding method to maintain their livelihood. Most interviewees in our study had low education of primary and junior high school degrees. There is no evidence showing the effect of different strategic choices due to educational differences. On the other hand, in terms of strategies' diversification, younger groups herder tends to select more than two strategies. Most of them have higher education levels and smartphones with an internet connection, which guarantee them to receive and exchange information. Information sources guarantee they are more likely to adopt new strategies. Finally, the most important two factors we found that relate to strategies selection are livestock and the size of grassland tenure. The pastoralists who own a large number of animals with limited grassland size select the strategy of *rent land grazing and artificial grass planting*. These people are expanding the size of grassland by renting and increasing grass production to relieve the pressure of land use limitations. Herders mostly adopt the *grassland transfer* with no livestock or few livestock and surplus grassland tenure. They earn income by transferring or renting the right to people whose pasture is not enough to guarantee the unused land resources to be utilized. The *land stock cooperative* is generally adopted by herders who have small-sized operations with a low ability to enter the market and a weak ability to resist risks. The participation of cooperatives helps these small-scale managers to share risks and increase connection with the market. In addition, the involvement in cooperatives allows these small households to spare more time to do part-time work because there are special people to take care of cattle and sheep in *land stock cooperatives*.

Obstacles to herders' adoption of adaptation strategies

The research also explores several main obstacles when herders apply adaptation strategies (Table 3). 76.9% of respondents show that shortage of money is the biggest obstacle when they adopt the strategy. They think that the current strategies increase extra costs compared with traditional nomadic grazing, such as building the fence, renting land for grazing, transport cost, purchasing forage, etc. The second obstacle is a labor shortage including 54.7% of respondents. The interviewees mentioned that most of the young and high educated people tend to migrate to urban areas. Both the young labor shortage and the aging problem would become the potential threat to long-term sustainable development. As for lacking technology, shortage of knowledge, poor infrastructure, and lacking credit are occupied 48.9%, 45.6%, 45.8%, 47.4%

respectively. Lacking information is the least mentioned constraint (16.5%) when herders apply the adaptation strategies. The smartphone, 4G, 5G spread widely, so almost everyone owns a smartphone with an internet connection. The herders create a WeChat group by themselves and exchange useful information.

Table 3 The constraints of herder's strategies. Source: Survey in 2021

Obstacles	Percentage
Lack of technology	48.9%
Shortage of money	76.9%
Shortage of knowledge	45.6%
Labor shortage	54.7%
Lack of information	16.5%
Poor infrastructure	45.8%
Lack of credit	47.4%

4. Conclusion

The pastoralists living in the Qilian Mountains face increased exposure to climate risks and cope with stricter land restrictions by policies. In addition, they must deal with the cross-effects of these multiple changes to maintain their livelihoods. To figure out how local pastoralist households mitigate the negative impacts of climate change, we investigated the two pastoral areas in the northwest of China.

The results show that most respondents never heard about climate change and have a weak perception of annual average temperature. Herders' perception of winter temperature change is weaker than summer temperature perception due to the influence of short-term effects and long-term consciousness. Herders' long-term drought cognition influenced the weak perceptions of annual precipitation in both counties. As the two survey sites are in the northwest of China with less rainfall and frequent drought, the residents had suffered for a long time. The low educational level limits cognition and acceptance level. This raises the importance of having a training group or agency in the study area. We also find 5 types of strategies adopted by the two pastoral areas. These strategies could help maintain their livelihood and increase their adaptability to uncertainties. While demographic factors had an effect on the choice of strategy, the aging problem could also affect strategy diversification. The younger group herders with higher education and access to a smartphone with internet connections could obtain more information with technical help. In addition, respondents with younger age and higher education could accept new ideas faster than older herders. The ethnic difference could also influence the strategy's choice—the Han and Hui mainly selected *breeding communities*. However, most local pastoralists (Yugur and Tibetan) choose pastoral related strategies. In fact, herders' strategies selection is not highly related to climate change perception in our study area. On the contrary, their choices are much related to their adaptation to grassland policy changes. Hence, the number of livestock and the grassland size are the most important two factors related to strategy choice. The herder owning a large number of animals with limited grassland size selects strategies

that can relieve the pressure from grazing bans and restrictions such as *rent land grazing, grassland transfer.* Conversely, herders owning surplus pastures and a suitable number of livestock rent pasture to others or other strategies to increase the extra income. Some small houses would select the *land stock cooperatives* to enhance market access and decrease the damage by sharing risks. As for the adaptation strategies' constraints, there are 7 constraints related to herders' adaptability of those strategies. The shortage of money and labor shortage is being the two main obstacles. This is because the current strategies require higher costs than traditional breeding methods, such as fence, water resource facility, forage, and transport. The labor shortage is another constraint as the majority of young laborers immigrate outside the pastoral area. The aging problem is a potential threat to sustainable development in pastoral regions.

The findings of this study provide some policy implications for the pastoral area in China. Firstly, climate change-related training programs should be provided in the herders' community. Although most of our respondents are at a low education level, they highly depend on natural resources in their livelihood. Without relevant knowledge, the local herders will have a low level of resilience against shocks. Climate change could bring severe damage to them in the long-term future. Secondly, policy formulation should consider individual households' welfare and give them more assistance to deal with grassland shortage and adopt new grazing strategies.

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