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Herders' Perceptions about Rangeland Degradation and Herd Management: A Case among Traditional and Non-Traditional Herders in Khentii Province of Mongolia

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Abstract: Herders play essential roles in sustaining Mongolia's economy and rangeland conditions. As about 90% of Mongolia's livestock grazes on natural pasture, how herders manage it largely affects the future sustainability of the livestock industry. Since Mongolia transformed its grazing practices from communal management into loosely regulated household practices in 1990, overgrazing has become a growing concern. Considering this concern, this paper examines the extent to which traditional and non-traditional herders perceive pasture conditions and practice management. We conducted the questionnaire survey among 120 herders in Murun Soum of Khentii Province and asked about rangeland degradation and their coping strategies. To determine correlations between their perceptions/practices and sociodemographic characteristics, we conducted multiple regression analyses. We found that, overall, most herders identified rangeland conditions degrading and grass yield declining with less plant diversity and more soil damage by Brandt's vole. Herders' mobility and herd movement frequency have decreased since 1990, placing more strains on limited pasture areas. In coping with overgrazing, about 20% of the respondents had practiced traditional rangeland management, whereas many others had overlooked pasture conditions and increased goat production as the world's demand for cashmere rose. In response to our question about herders' future contribution of their traditional knowledge to sustainable rangeland management, traditional herders demonstrated their willingness to help local officials manage the pasture. This paper then explores how local administrations and herders may collaborate in the future.

Keywords: herder; rangeland degradation; perception; traditional rangeland management practices; Mongolia



Citation: Ulziibaatar, M.; Matsui, K. Herders' Perceptions about Rangeland Degradation and Herd Management: A Case among Traditional and Non-Traditional Herders in Khentii Province of Mongolia. *Sustainability* **2021**, *13*, 7896. <https://doi.org/10.3390/su13147896>

Academic Editors: Kikuko Shoyama, Rajarshi Dasgupta and Ronald C. Estoque

Received: 2 May 2021

Accepted: 6 July 2021

Published: 15 July 2021

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1. Introduction

Open range livestock grazing practices in the Mongolian Steppes have faced tremendous economic, environmental, and social challenges from overgrazing, desertification, and pasture degradation since the 1990s [1,2]. Rangelands comprise more than 70% of Mongolia's territory, and about 90% of its livestock depends on them [3]. In the last three decades, however, 65% of Mongolia's vast rangelands have been at least partially degraded, and another 7% is completely degraded [4]. A satellite observation of vegetation optical depth (VOD) from 1988 to 2008 confirmed that all areas of the Mongolian steppes, the largest in the world, underwent significant vegetation reduction [2].

Rangelands largely belong to public land in Mongolia. A recent cashmere boom has led to a substantial goat population growth on public land [5]. Contrary to traditional pastoralists, contemporary herders have grazed their livestock in a fixed area with an increasing number of animals. FAO [6] predicted that population growth and changing lifestyle would increase pressure on rangeland in the future; at the same time, the world's meat consumption would increase from 229 million tons in 1999–2001 to 465 million tons

in 2050. Considering these, the sustainability of rangelands in the Mongolian Steppes will face further sustainability challenges [4].

Several studies have identified the importance of herders' perceptions and observations as solution to mitigate these challenges [1,7–10]. Herders' observation of pasture conditions, for example, provides insights into ecological processes and changes [11–15]. Khwarae [9] suggested to incorporate community perceptions and practices into rangeland policies. The participation of traditional pastoralists in implementing these policies can help better sustain rangelands [16,17].

Considering these suggestions, this paper seeks to better understand herders' perceptions and knowledge concerning livestock management, grassland degradation, and other related environmental changes. Here we attempt to demonstrate how herders with various backgrounds perceived vegetation changes and responded to these changes. In addition, we intend to clarify the extent to which traditional knowledge still works for sustainably managing rangelands in Mongolia. Finally, we identify the degree of willingness among herders to participate in rangeland management in collaboration with local authorities.

Review of Livestock Sector and Rangeland Health in Mongolia

Mongolia's livestock industry experienced a turning point in the 1990s [3]. During this decade, Mongolia's livestock industry constituted about 30–40% of its GDP. Since 2000, this share has gradually declined, largely due to growing mining industries and periodic natural disasters that severely damaged grazing practices. As of 2018, the livestock industry produced 4.4 trillion tugrug (MNT) or 10.8% of GDP [18]. It accounts for 9.2%, or USD 642.9 million, of export income and employs 26.7% of the labor force, or 288,700 herders. In 2018, Mongolian herders produced 515,200 tons of meat, 902.4 million liters of milk, 33,000 tons of sheep wool, 10,900 tons of cashmere, 2000 tons of camel wool, and 17.4 million hides and skins. According to the National Statistics Office, the total number of five main livestock species in the country increased from 25 million in 1990 to 66.5 million in 2018, including 3.9 million horses, 4.4 million head of cattle, 459,700 camels, 30.6 million head of sheep, and 27.1 million goats [18].

Pasture degradation, a worldwide problem [10], is particularly serious in Mongolia [19]. In 1970, 90.2%, or 130 million hectares, of Mongolia's rangelands were covered with rich grass [20]. The percentage has dropped to 73.5% in 2018 [18]. Tseelei [21] estimated that Mongolia's rangelands are capable of having 25 million head of livestock, whereas 66.5 million head currently graze. According to the National Agency for Meteorology and Environmental Monitoring (NAMEM), which is responsible for monitoring rangeland health, as of 2015, 65% of the total rangeland was partially degraded and 7% is completely degraded with no possible chance of recovery. A UN study found that rangeland degradation costs Mongolia 368 billion tugriks (USD 135.7 million) per year [19].

In recent years, as we will discuss in the main discussion below, a distance for seasonal herd movement has decreased to the point where, in some areas, little or no traditional seasonal movement is observed. In making several field visits in rangeland, we observed that herders, especially young herders and newcomers, did not appear to know much about how rangelands can be cared for and sustained. Jamsran similarly observed this and argued that the "Tragedy of the Commons" [22] took hold of Mongolia's rangeland [23]. As the rangeland is considered to be the commons, the herders' and the government's responsibilities are somewhat unclear [24,25].

At the local level (Soum level), the Administration of Land Affairs, Geodesy and Cartography administers the Soum Annual Land Management Planning (SALMP) that regulates rangeland management throughout the country. As it has largely taken top-down approaches, local and traditional herders have had little room to participate in decision making, widening the gap between administrations and practitioners. The SALMP does not appear to have provided clear information for herders, either. Recommendations do not seem to reflect herders' perceptions [4].

2. Materials and Methods

2.1. The Study Area

In undertaking research for this paper, we selected one of the prominent grazing areas of Mongolia: Murun Soum (sub province) in Khentii Province. From our previous experience, we knew that this area largely depended on the livestock industry, and some traditional practitioners were there. This soum is located in eastern Mongolia, 311 km from Ulaanbaatar City and 27 km from Chinggis City, the capital of Khentii Province (Figure 1). The soum administration was established in 1923.

The average annual rainfall in this area is 160 mm. The average temperature ranges from -1 to 2 °C. The high temperature can reach 32.8 °C in June, and the coldest temperatures can be -48.2 °C in December and January. The total territory of Murun Soum is $218,000$ km², and 90% of its territory is used as rangeland. A small portion of the land is used for crop production, including wheat (2500 hectares), potatoes, and other vegetables (90.1 hectares). Gravitational irrigation is practiced here by drawing water from the Murun River [26].

As of 2018, the total population of Murun was 1919, of which 468 were herders (280 herder households) who owned 179,800 livestock or 312,500 Sheep Forage Units (SFUs) (14,000 horses, 11,000 head of cattle, 91,800 head of sheep, and 63,000 goats) [18]. There are 642 head of livestock per household in Murun Soum, whereas the average livestock number per herder household in the nation was 352 in 2017. A total number of livestock increased from 97,000 in 2000 to 179,000 in 2018 (Figure 2). According to the National Statistical Office [27], the carrying capacity of pasture in this soum was 128,862 head of livestock or 233,966.7 Sheep Forage Units (SFUs), including 10,547 horses, 8891 head of cattle, 65,020 head of sheep, 43,963 goats, and 441 camels in 2018. This means that the number had already exceeded the carrying capacity of the soum by 33.6% as sheep equivalents. In particular, the number of goats increased dramatically from 3100 in 1970 to 63,000 in 2018 [28], largely due to the recent cashmere boom. The total human population in Murun Soum decreased from 2440 in 2000 to 1919 in 2018 [28].

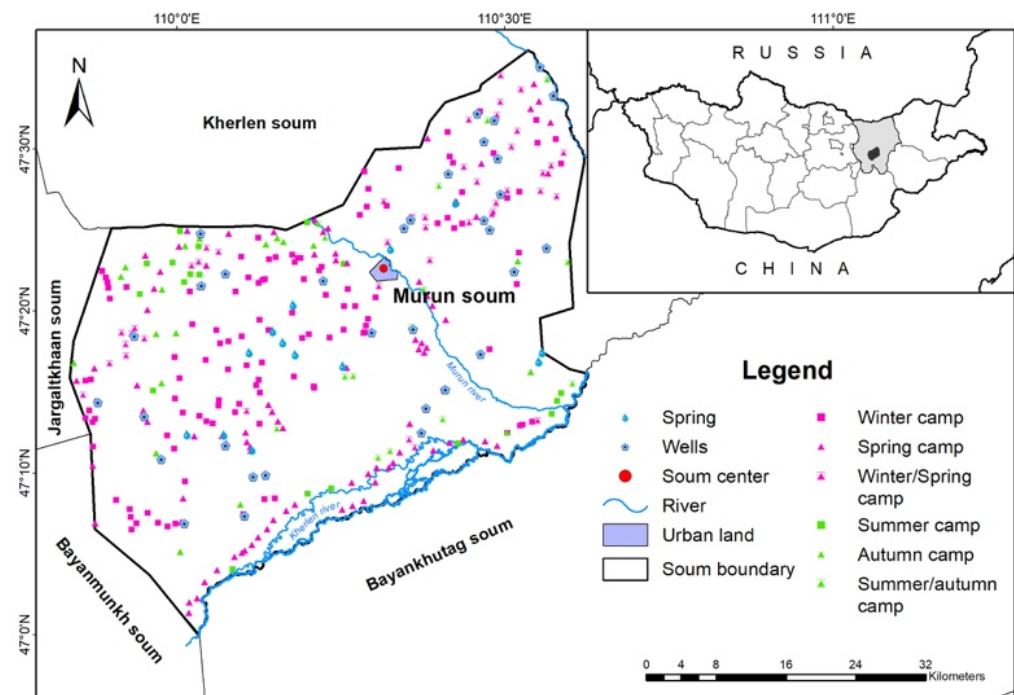


Figure 1. The Study Area Map. Source: Sustainable Livelihood II Project, 2010.

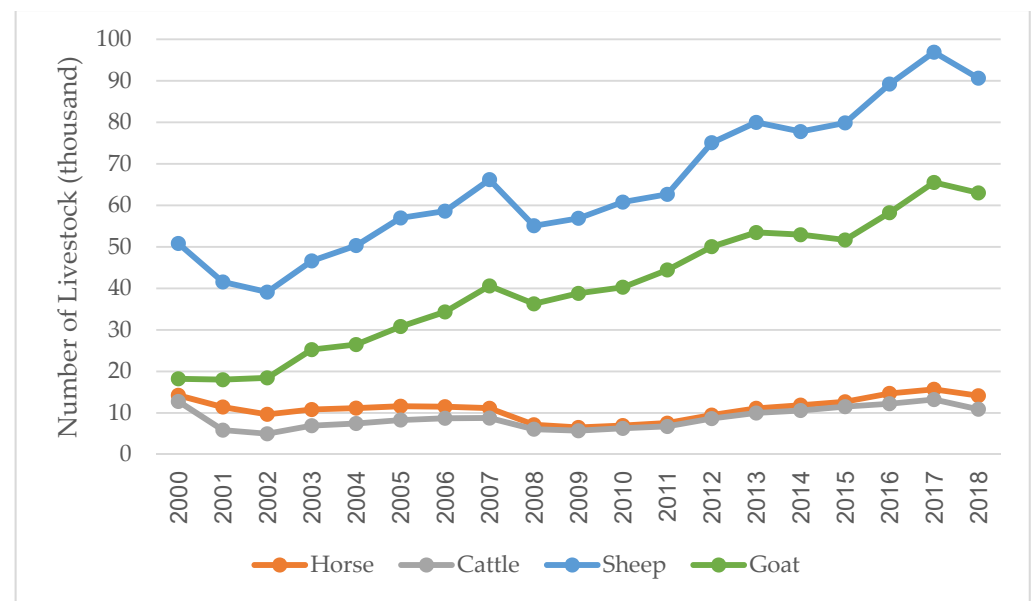


Figure 2. Number of Livestock in Murun Soum (2000–2018); Source: National Statistics Office, 2000–2018.

According to the 2013 Desertification Atlas of Mongolia [29], Murun Soum and its surrounding areas were affected by land degradation and desertification. Some areas were categorized under severe conditions due to intensive grazing near the Kherlen River, where summer camps were located. Gao's [30] remote sensing-based forage model (based on 50% utilization) showed that 91–100% of Murun Soum's rangeland forage was overused, although the National Rangeland Health Report [4] found that this rangeland condition had an 80–90% possibility to recover.

2.2. Data Collection and Analysis

The questionnaire survey was conducted from 15 December 2019 to 18 February 2020, in Mongolian. A simple random sampling method was used to select respondents. There are 468 herders (or 280 herder households) in Murun Soum, and we collected valid responses from 120 of them. As all respondents were actively engaged in herding in different parts of the Soum, it took us about two months to interview them. These herders were often camped in various remote locations and occasionally visited a Soum center where we met them.

This survey had five sections. The first section attempted to identify the sociodemographic characteristics of the respondents, including age, gender, education, household size, herding experience, the number of livestock, and monthly income. The second section consisted of multiple-choice questions, close-ended questions, and open-ended questions that were designed to understand grazing practices and observation about rangeland availability, water availability, and other grazing-related challenges. The third section had Likert-scale questions, multiple choice questions, and close-ended questions that aimed to understand respondents' perceptions about rangeland degradation and ecological changes. The next section consisted of multiple-choice questions, open-ended questions, and close-ended questions. These are to find the extent to which traditional rangeland management practices remained in the study area. The last section had a multiple-choice question, closed-ended questions, and five-point Likert-scale questions to identify respondents' needs and willingness to participate in rangeland management in the study area.

To better understand how the respondents observed the causes of rangeland degradation, we asked them to identify primary factors. We presented choices for the respondents based on past studies. There are several postulations about the causes of rangeland degradation among scholars. They found that rangeland degradation was caused by climate

change and anthropogenic activities (e.g., increased goats) [25,31–36], lenient rangeland regulation or mismanagement [23], the disintegration of traditional practices and movement [31,33,37,38], and mining practices [32]. Bedunah and Angerer [39] argued that identifying the causes of rangeland degradation is rather complex and contentious as all stakeholders and environmental factors are interconnected. Middleton [40] claimed that overgrazing is not the only factor that accelerates rangeland degradation. Desertification and climate change also affected vegetation cover and soil conditions [4,41]. We adopted these factors in our question.

After collecting the data, a multiple regression analysis was conducted to find correlations between respondents' sociodemographic characteristics and their perceptions, including respondents' observations about pasture yield changes and future pasture degradation mitigation. Microsoft Excel was used for analyzing the data.

3. Results and Discussion

3.1. Sociodemographic Characteristics of the Respondents

The first part of our survey attempted to clarify the sociodemographic characteristics of the respondents (Table 1). The result shows that 61% of the respondents were 30 to 49 years old, showing signs of socioeconomic sustainability in herding activities for the next few decades. An additional 25% belonged to the 50–59 age group, including those who had knowledge about before and after 1990, a turning point from commune-based herding. In terms of gender, 79% of them were males. This means that primarily middle-aged males participated in the questionnaire survey. Regarding the household size, 51% had one to four family members, and the rest had more than five persons.

Table 1. Sociodemographic Characteristics of the Respondents.

	Category	Frequency	Percentage
Age	20–29	11	9%
	30–39	33	28%
	40–49	40	33%
	50–59	30	25%
	60 and above	6	5%
Gender	Male	95	79%
	Female	25	21%
Number of Household Livestock	1–500	58	48%
	500–1000	44	37%
	1001 and above	18	15%
Years of Grazing Experience	≤10	22	18%
	11–20	42	35%
	21–30	36	30%
	31–40	18	15%
	≥41	2	2%
Level of Education	No formal	4	3%
	Primary	25	21%
	Lower Secondary	17	14%
	Upper Secondary	53	44%
	Technical	13	11%
	Bachelor	8	7%
Monthly Income of Household USD 1 = 2790 MNT(14 May 2020)	Up to USD 71	47	39%
	USD 72–179	22	18%
	USD 180–358	40	33%
	USD 359 and above	11	10%
Income Source	Dairy products	31	26%
	Cashmere and wool	81	68%
	Meat	110	92%
	Salary (spouse)	12	10%

Even though most of the respondents were middle-aged, the respondents were well-experienced herders. We found that 35% of the respondents had herding experience of 11 to

20 years, 30% of 21 to 30 years, and 15% of 31 to 40 years. Looking at the level of education, the percentage of the respondents who had middle or upper secondary education was 44%. In addition, 21% had only up to primary education. In this study area, parents tend to send their teenage children to herders after completing their primary schooling. About 48% of the respondents had 200–500 head of livestock (categorized as middle wealth or lower-level household), and another 37% had 500–1000 head of livestock (wealthy level household). Those with more than 1000 head of livestock constituted 15%.

As for the monthly income, 39% of the respondents said that they earned less than 200,000 MNT (equivalent to USD 71.8 with the exchange rate on 26 April 2020), and 17% earned 200,001–500,000 MNT (USD 71.8–179.5). These income levels fell below Mongolia's per capita GDP in 2019 (USD 4295.28), according to the World Bank data [42]. The rest had relatively livable incomes with 34% of the respondents having earned 500,001–1,000,000 MNT (USD 179.5–359) and 10% having more than 1,000,000 MNT per month. According to the National Statistics Office in 2019, the average monthly income per household in Mongolia was 1,343,428 MNT (USD 482.3). Selling meat was the most profitable source of income for them (92%), followed by cashmere and wool (68%). About 26% of the respondents were engaged in dairy product sales. The rest worked in administrative services at public offices.

3.2. Herders' Perceptions about Rangeland Conditions

To understand how herders observed current rangeland conditions, we first asked the respondents whether or not their rangeland area was sufficient for their livelihood. A half of them (50%) answered positively. Another half said that an excessive number of livestock had made it difficult to maintain the health of their rangeland. Next, we asked if the respondents found water availability sufficient in their grazing area. In response, 74% of the respondents said that it was adequate.

We then asked the respondents to choose listed challenges in livestock grazing (Figure 3). About 74% of the respondents chose rangeland degradation as the main challenge. Another 62% found a growing number of Brandt's vole problematic. Other challenges identified were drought (35%), decreasing plant species (34%), severe winter weather or so-called *dzud*, which killed a large number of livestock from starvation and cold (26%), and pasture dispute (16%). This result suggests that Murun herders faced two main problems: rangeland degradation and increasing Brandt's vole populations. Regarding the pasture dispute, we were told that some herders accidentally grazed someone else's pasture reserves for winter and spring without permission.

Brandt's vole, a rodent species, is considered the main threat to rangeland health and livestock breeding. It not only eats plants but also damages the roots by digging extended channels in the soil. A study found a connection between rangeland degradation and the growing number of Brandt's vole in recent years in the study area [43]. Another study found that high density of Brandt's vole's population caused vegetation loss [44]. However, this point appears to be contested among some scholars.

3.3. Herders' Perceptions about Rangeland Degradation and Ecological Changes

In this section, we asked the respondents about their observation of rangeland conditions. First, we asked them to evaluate the scale of changes (from "Severely degraded" to "Totally improved") in rangeland. The notable aspect of the result was that 42% of the respondents found pasture yield degrading and 30% found it moderately degrading. Another 12% found it severely degraded. On the other hand, those who found their pasture conditions somewhat improved consisted of only 5%. This result shows that about 95% of the respondents found their pasture more or less degrading.

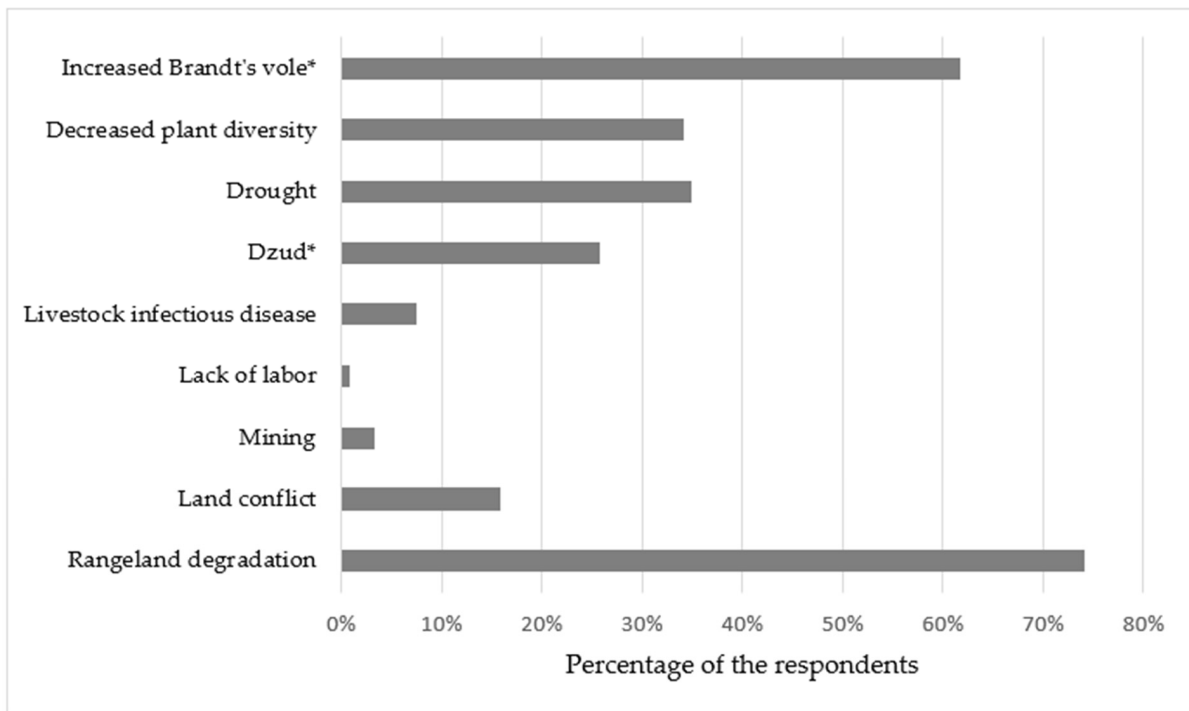


Figure 3. Murun Soum Herders’ Perceived Challenges in Livestock Grazing. * *Dzud*, severe winter weather, killed a large number of livestock from starvation and cold.

To know more specifically about what aspects of rangeland conditions the respondents found their rangeland degraded, we administered ten indicators. Six of these focused on grass conditions: “Plants are less diverse”; “Yield has decreased”; “Poisonous plants were increased”; “Disappearing nutritious plant species”; “Plants are widely scattered”; and “Plants are getting shorter.” In addition, two indicators focused on soil conditions: “Soil is getting drier” and “Soil is getting salinized.” The other two were “Desertification has expanded” and “Brandt’s vole increased” (Figure 4).

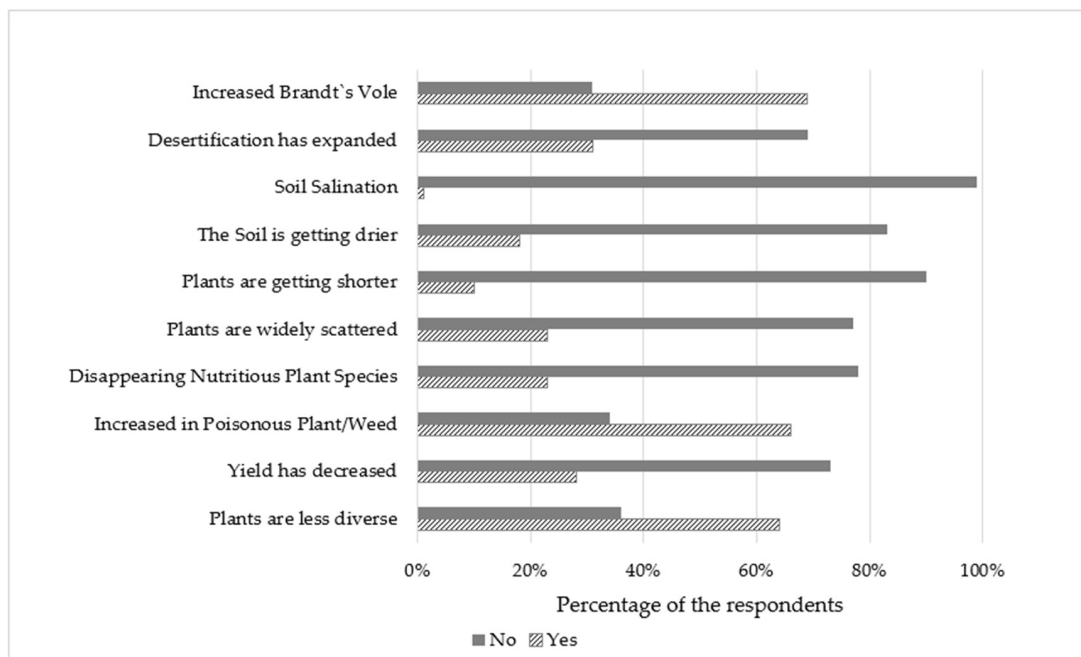


Figure 4. Identified Rangeland Degradation Indicators (Vegetation and Soil).

The result shows that more than 60% of the respondents identified the following three indicators: “Plants are less diverse,” “Poisonous plants were increased,” and “Brandt’s vole increased.” Regarding soil conditions, 17% of the respondents found it was getting drier, and only 1% found the soil salinized (1%). These results imply that the respondents mainly checked vegetation changes to assess pasture conditions.

Regarding the causes of degradation, the respondents found it mainly attributable to overgrazing (91%). They also identified reduced mobility in herding (92%), climate change (reduced amount of rain) (94%), increased Brandt’s vole population (51%), increased livestock population (47%), pasture destruction by roads and vehicles (43%), weak pasture use regulation (36%), and an increase in goat numbers (18%) (Figure 5).

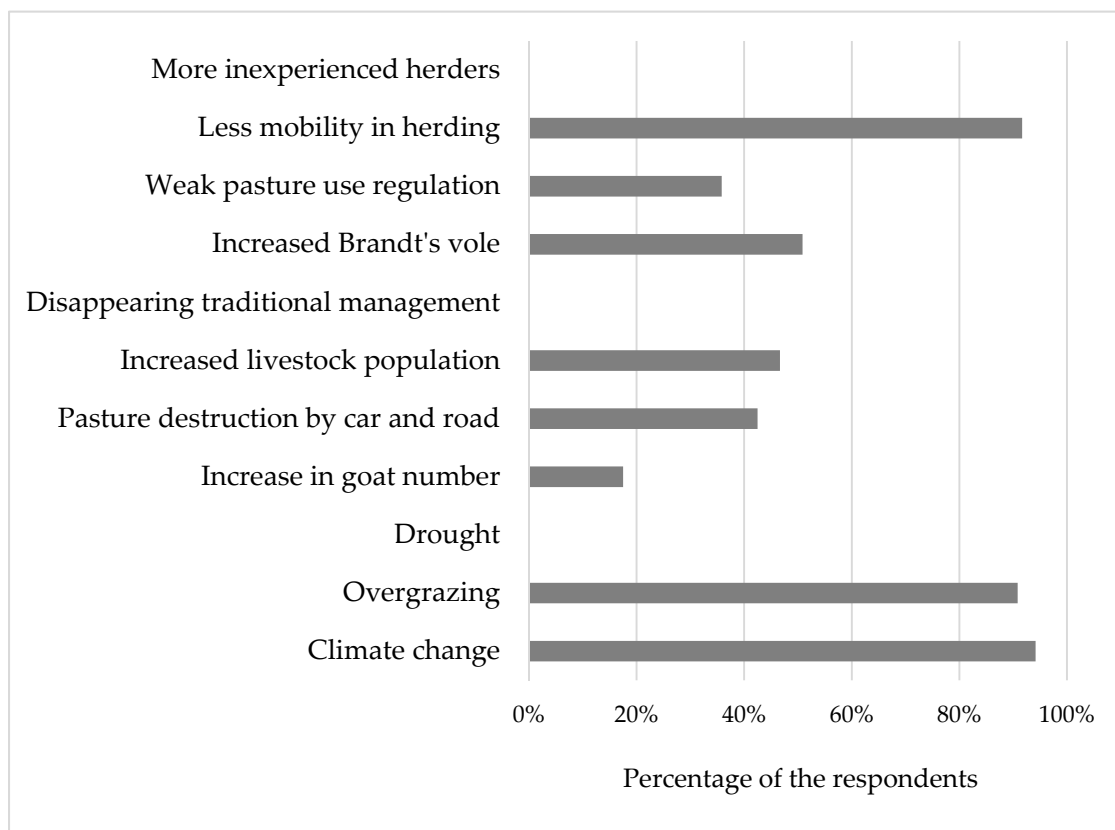


Figure 5. Observed Causes of Rangeland Degradation.

We then tried to understand respondents’ willingness to limit the number of their goats in the future. The result shows that 51% did not intend to increase the goats. They may have considered the goat as the leading cause of overgrazing and pasture degradation. On the other hand, 15% of the respondents mentioned that they preferred to increase the number of their goats in coming years. Traditionally, herders managed the composition of the livestock. The proportion of goats was maintained within 18–20% of the total number of livestock to avoid pasture degradation and mitigate disaster impacts [23]. However, in Murun Soum, the number of goats rose sharply from 18,000 in 2000 to 63,000 in 2018 (35% of the total livestock) largely, due to growing international cashmere demand [45].

3.4. Effects of Herders’ Socioeconomic Characteristics on Their Perception

We conducted a multiple regression analysis to better understand respondents’ perceptions about observed changes in pasture yield. We paired respondents’ perceptions with age, education, household size, grazing experience, number of household livestock, and monthly income. We found that education (p -value = 0.010) and gender (p -value = 0.008)

were significantly correlated (Table 2). About 23% of the respondents were educated up to the tertiary level.

Table 2. Factors Determining Respondents' Observations about Pasture Yield Changes (from "Severely degraded" to "Totally improved").

Variable	Coefficients	Standard Error	Critical Value	<i>p</i> -Value	Lower 95%	Upper 95%
Intercept	2.704	0.706	3.829	0.000	1.305	4.103
Age	−0.008	0.017	−0.496	0.621	−0.041	0.025
Gender	−0.091	0.283	−0.320	0.008 *	−0.652	0.471
Education	−0.019	0.035	−0.541	0.010 *	−0.087	0.050
Household Size	0.042	0.073	0.574	0.567	−0.102	0.185
Grazing Experience (years)	0.027	0.017	1.642	0.103	−0.006	0.060
Household Livestock (number)	0.000	0.000	0.232	0.817	0.000	0.001
Number of People Engaged in Herding	0.064	0.112	0.573	0.568	−0.157	0.286
Monthly Income of Household	−0.161	0.087	−1.853	0.067	−0.332	0.011

* *p*-value < 0.05.

The respondents were asked about whether or not rangeland degradation would occur in the future. The result shows that 40% of the respondents said that the rangeland degradation would not happen in the future. On the other hand, 24% of the respondents thought it would worsen in the future. Herders with large herds tended to be confident that pasture degradation would be alleviated. Herders with small herds believed that large-scale grazing was to be blamed for pasture degradation.

Perceptions regarding the future mitigation of pasture degradation widely varied among the respondents. To understand why the respondents thought differently, we correlated their perceptions with such sociodemographic features as age, education, household size, grazing experience, the number of household livestock, and monthly income. We found that education (*p*-value = 0.004) and monthly income (*p*-value = 0.011) had significant correlations with their perceptions about future pasture degradation mitigation (Table 3). This implies that the respondents with higher education and income levels tended to be more optimistic about future mitigation

Table 3. Determinants of Respondents' Perception about Future Pasture Degradation Mitigation (From strongly agree to strongly disagree).

Variables	Coefficients	Standard Error	Critical Value	<i>p</i> -Value	Lower 95%	Upper 95%
Intercept	3.522	0.579	6.078	0.000	2.374	4.670
Age	0.007	0.014	0.543	0.588	−0.020	0.035
Gender	−0.249	0.232	−1.073	0.286	−0.710	0.211
Education	0.031	0.028	−1.099	0.004 *	−0.088	0.025
Household Size	0.016	0.060	0.275	0.784	−0.102	0.134
Grazing Experience (years)	−0.008	0.014	−0.609	0.544	−0.035	0.019
Household Livestock (number)	0.000	0.000	−0.349	0.728	−0.001	0.000
Number of People Engaged in Herding	−0.023	0.092	−0.252	0.802	−0.205	0.159
Monthly Income of Household	0.183	0.071	−2.575	0.011 *	−0.324	−0.042

* *p*-value < 0.05.

3.5. Herders' Perceptions of Traditional Rangeland Management Practices

In the next section, we attempted to understand how herders decide to move their livestock to new pasture areas. More than 80% of the respondents considered both grass and water availability (Figure 6). In addition, 66% of the respondents would move their herds to rest the pasture. Other reasons included avoiding severe weather (12%) and to match livestock numbers to the specific carrying capacity of a specific pasture (13%). The rain/water availability (5%) and disease (4%) had low responses.

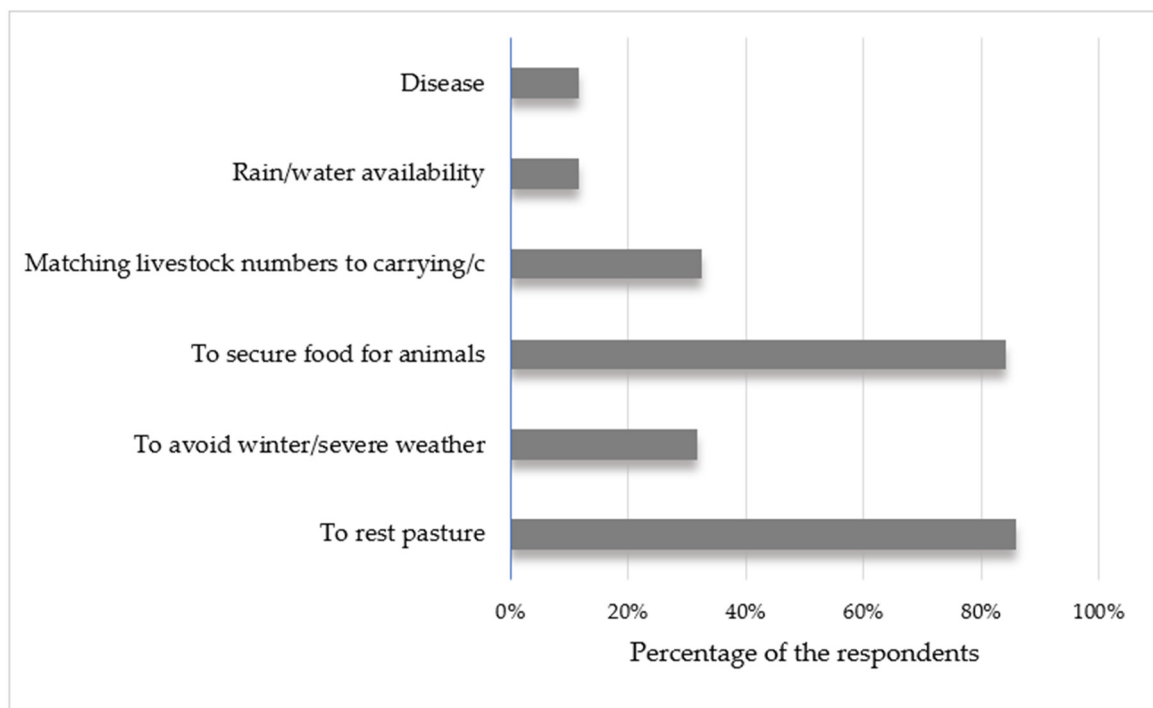


Figure 6. Murun Soum Herders' Reason to Move Their Livestock.

Past studies attributed the causes of pasture degradation and lowered livestock quality to the declining trend of herding movement and the frequency of changing pastures in Mongolia and Inner Asia in general [1,23]. Therefore, we first asked the respondents about the frequency of changing their pasture per year. In response, 3% of the respondents said to do so once or twice, 37% three to five times, 36% six to eight times, and 24% eleven times or more. Tumurjav [8] showed that traditional herders in steppes typically changed pastures seven to eight times a year. Considering this to be applicable to the study area, about 60% of the respondents still practiced traditional movement.

However, frequency is only one aspect of traditional herd movement. We attempted to know respondents' moving distance between camps. More than 74% of the respondents moved within 10 km each time during Spring–Summer and Summer–Autumn grazing seasons. In colder months, this distance became longer. Only 6% of the responding herders moved more than 30 km in spring and summer. Traditional herders in steppes typically moved 30 to 40 km [8]. Considering this, we found that more than 60% of the respondents moved their herds up to six times per year, but they tended to have fixed locations, and their moving distances were shorter than traditional practices.

Along with these movement questions, we attempted to identify rangeland management strategies and practices among the respondents in the past and the present. Here what we mean by the past is the so-called collective period or *negdel*, in which Marxist-based herding communes governed grazing activities within designated territories under the leadership of the General Committee and chiefs [46]. After 1991, communal governance was individualized with the introduction of the market economy.

Thus, we asked the respondents to select the practices they used to do during the collective period and then about current practices with multiple choices (Figure 7). The results show that before 1990, the respondents typically engaged in frequent seasonal movements (22%), *otor* (long-distance movement of herds) (20%), and reserving winter and spring pasture in summer (17%), matching livestock to the forage budget of the season (14%), herd splitting (13%), and rotational grazing management (10%). Fencing for hay in a certain pasture was widely practiced in other areas, but only 4% of the respondents did so in the study area.

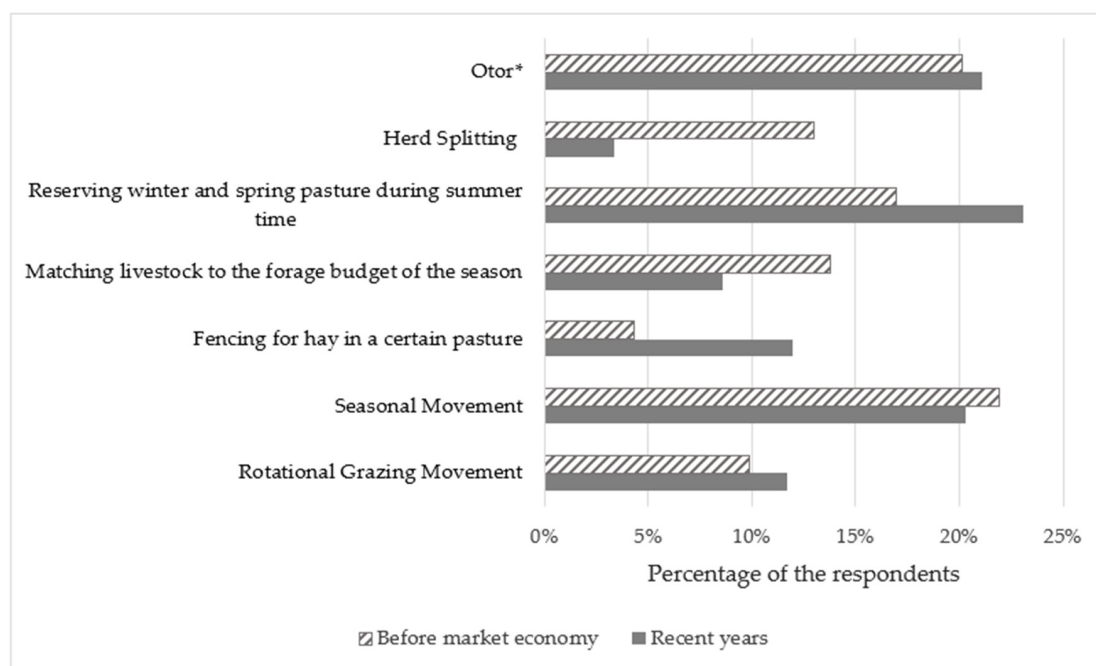


Figure 7. Comparison Between pre-1990 and Contemporary Traditional Rangeland Management Practices. * *Otor* means a long-distance movement of herds.

Concerning their current practices, the respondents, especially in the younger age groups, relied more on summer pasture reserves (23%), while *otor* (21%) and seasonal movement (20%) remained important among traditional herders. Practices of herd splitting (3%) and matching livestock to the forage budget of the season (9%) had become almost obsolete in the study area largely due to the collapse of communal governance [11].

Regarding *otor*, as it is related to movement distance, we added one more question to see if the respondents still practiced it. In response, 48% of the respondents said that they practiced it and moved their herds into neighboring soums, including Bayanmunkh, Bayan-Ovoo, Bayankhutag, and Umnudelger. By doing so, traditional herders aimed to fatten their animals.

3.6. Herders' Willingness to Participate in Rangeland Management

In the last section of our survey, we tried to understand how herders and government officials may cooperate for rangeland management in the present or the future. The respondents were first asked whether or not the soum government had helped them making herding decisions for better rangeland management. In response, 75% of the respondents said they made decisions without help. Only 8% of the respondents said that the soum government helped them manage. These results show an overall lack of cooperation between herders and the soum government in managing pastures. In the future, however, 47% of the respondents showed their willingness to support soum in managing pastures by using their knowledge and experience.

In addition, we attempted to understand respondents' willingness to improve their knowledge by either participating in training or receiving information. The result shows that 90% had not participated in training and workshop on rangeland management. However, 74% wanted to receive information about the carrying capacity of pasture for livestock and rangeland restoration. Some others wanted to stabilize sand dune expansion and land degradation by Brandt's voles.

To better understand the current state of collective pasture management, we asked the respondents about their involvement in a pasture user group, which has promoted local pasture management in the last ten years or so under the auspices of international organizations. We found that 59% of the respondents were not. Only 11% of the respondents

were involved. The rest of the respondents were not sure about their involvement. This result possibly suggests that a communal organization, somewhat similar to *negdel* in the collective period, may not be able to exert influence over herding practices in the future.

We asked if the respondents were willing to limit the number of their livestock. About 65% of the respondents answered positively, but 18% found it impossible.

We attempted to understand the extent to which the local government enforces regulations to sustain the health of pastures. More than 65% of the respondents supported the pre-designed statement that the soum government should strictly observe regulations. Almost one-quarter of the respondents agreed that grazing fees should be introduced to herders for sustainable rangeland management. Those herders with relatively small numbers of livestock tended to believe that large-scale herders should pay higher grazing fees. Regarding the way rangeland should be managed sustainably in the future, 84% of the respondents agreed that herders should manage rangeland themselves. Jamsran [23] pointed out that herders had a certain level of distrust of local governments due to the past rangeland mismanagement.

After identifying respondents' willingness to work with the local government, we attempted to identify factors that influenced their willingness (Table 4). In doing so, we correlated their perceptions with some sociodemographic characteristics, such as age, education, household size, grazing experience, the number of household livestock, and monthly household income. The result shows that age (p -value = 0.015) and experience (p -value = 0.008) were particularly significant factors. This implies that those with more years of grazing experience expressed their willingness.

Table 4. Factors Influencing Respondents' Willingness to Help Soum Authorities Manage Rangeland.

Variable	Coefficients	Standard Error	Critical Value	p -Value	Lower 95%	Upper 95%
Intercept	1.731	0.484	3.580	0.001	0.773	2.689
Age	0.007	0.011	0.654	0.015 *	−0.015	0.030
Gender	0.145	0.194	0.748	0.456	−0.239	0.530
Education	0.043	0.024	1.799	0.075	−0.004	0.090
Household Size	−0.038	0.050	−0.773	0.441	−0.137	0.060
Grazing Experience (years)	0.003	0.011	−0.269	0.008 *	−0.025	0.019
Household Livestock (number)	0.000	0.000	0.194	0.847	0.000	0.000
Number of People Engaged in Herding	−0.143	0.077	−1.865	0.065	−0.294	0.009
Monthly Income of Household	0.098	0.059	1.656	0.100	−0.019	0.216

* p -value < 0.05.

4. Conclusions

This paper has examined Murun Soum herders' perspectives and knowledge about past and present livestock management, grassland degradation, and other related environmental changes. Our respondents, mainly middle-aged and elderly males, were veteran herders with almost 50% having more than 20 years of experience. Some had more than 40 years of experience. We also had the relatively young respondents and newcomers to this industry, especially those involved in cashmere production.

The results of our survey demonstrated that rangeland degradation and a growing number of Brandt's voles had posed the main threats to rangeland health in Murun Soum. About 95% of the respondents found that rangeland yields had somewhat declined. Their observation focused primarily on vegetation changes rather than soil conditions, although they did find damages to the rangeland soil by Brandt's voles.

Our study also found that the respondents moved their herds seasonally, reserved winter and spring pasture, and practiced *otor* for fattening their livestock. Comparing pre-1990 practices with contemporary ones, we found some remaining traditional practices, but these were declining. About a half of the respondents customarily practiced *otor* by crossing into neighboring soums, though the movement distance generally had become shorter in recent years.

Regarding the future participation in sustainable rangeland management in the study area, traditional herders showed their willingness to cooperate with soum authorities and other outsiders. Although more than 91% of the respondents depended on livestock outputs for livelihood, 65% showed their willingness to curb livestock numbers. Traditional small-scale herders, especially elderly ones among our respondents, were keenly aware of the importance of keeping vegetation diversity. They also expressed a need to maintaining the number of goats under the 18–20% range. Finally, we found that the post-1990 herding privatization has made an indelible mark on current herding practices, in which 84% of the respondents showed their interests in individual rangeland management rather than communal one.

Overall, it is possible to protect and improve rangeland health by adopting or enhancing traditional practices in Murun Soum if local and central governments, including researchers at public institutions, make a locally visible commitment to inviting traditional herders to participate in rangeland management. Thus, we argue that it is important to better understand traditional Mongolian herding methods in a given locality with regional socioeconomic situations.

Author Contributions: Conceptualization, K.M. and M.U.; methodology, K.M. and M.U.; software, M.U.; validation, M.U.; formal analysis, M.U. and K.M.; investigation, M.U.; resources, M.U.; data curation, M.U.; writing—original draft preparation, M.U.; writing—review and editing, K.M.; visualization, M.U.; supervision, K.M.; project administration, K.M.; funding acquisition, K.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research was partially funded by the Project for Human Resource Development (JDS) Fellowship of the Japan International Cooperation Agency from 2018 to 2020.

Data Availability Statement: Not applicable.

Acknowledgments: We appreciate herders who shared their opinions and valuable comments with us in Murun Soum of Khentii Province, Mongolia.

Conflicts of Interest: The authors declare no conflict of interest.

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