Mongolian Herders' Evaluation of Rangeland Ecosystems Services, Values, and Changes over the Past Decade

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Abstract
Mongolia's rangeland is one of the largest remaining contiguous ecosystems encompassing 2.6% of the global grasslands, and almost three-fourths of the country's territory provides essential ecosystem services (ESS) for over 3 million Mongolians and 71 million livestock. The well-being of 171,605 pastoral households directly depends on the rangelands receiving provisional services in the forms of nutrition, material use and energy, regulatory services, and cultural services. This study explored herders' perceptions of these ESS, their evaluation for ESS values, and observations of ESS change for the last decade. The study found that Mongolian herders have more benefits from provisional ESS (on average, 10 out of 18 identified), including nutritional and material use (four out of six and nine respectively), and energy services (two types out of three). An average herder household said to receive eight types of regulatory services out of 10, including environment regulation, storage/sequestration, erosion control, disease, and pest control, flood and wind protection, water cycle, soil formation and climate regulation, and six cultural services out of seven such as experiential and intellectual interactions with nature, historical and cultural heritage, both symbolic and religious-spiritual customs and nomadic identity and pride. The herders most valued the provisioning services, followed by regulatory services, and reported a "declining trend in provisioning ESS for the past decade, while, in their views, non-provisioning services remained "the same." Herders' reported about the exploitation of local ecosystems by external companies without sharing benefits with pastoral communities and contributing to the ESS restoration and maintenance, which was the expression of the common rangeland marginalization narrative. The study recommends necessary policies and actions to ensure equitable benefit distribution derived from rangelands to support adaptive capacity and well-being of pastoral communities, essentially acknowledge the importance of non-provisional ESS across various levels.

Introduction
Rangeland ecosystem occupies 71% of Mongolia's 1,564,112 km2 territory, supporting the livelihood of 285,482 herders and providing forage to 71 million animal in national herds (NSO, 2019). The rangeland ecosystem provides habitat for Mongolia's iconic wildlife, including large herbivores such as the Mongolian gazelle, saiga antelope, wild Bactrian camel, Asiatic wild ass, and birds such as the white-naped crane, bearded vulture and saker falcon, and carnivores like snow leopard, grey wolves, and the Gobi bear. Rangeland vegetation varies across ecological zones, including alpine tundra (3.0% of total area), mountain taiga (4.1%), mountain steppe (25.1%), steppe (26.1%), desert steppe (27.2%), and desert (14.5%) (Hilbig, 1995). These fragile ecosystems also support expanding cultural tourism sector, a volatile cashmere industry, and a rapidly growing mining economy. Livestock herding contributes 89% of the total agricultural production, which constitutes 11% of Mongolia's GDP, 8% of export, and employs 25% of the entire labour (NSO, 2019).

A recent 4.1% decline in rural poverty with increased income and consumption growth (NSO, 2020) might be at the expense of degrading rangeland ecosystems by overgrazing and expanding other land uses. The national statistics showed that between 2007 and 2017, rangeland area has shrunk by 1,247,50 ha (1% decline) being converted to other land uses, notably, urban areas (65%), mining (160%), and roads and infrastructure (29%) (NSO, 2019). The national rangeland health assessment conducted in 2016 found that 42% of rangelands was in a non-degraded state, while 34.6% slightly or moderately degraded, and 23.1% severely or totally degraded (NAMEM, 2018). Briske (2021) contends that a severe consequence of a rangeland marginalization narrative among policies and development programs is the undervaluation of rangeland ecosystem services (ESS), particularly regulatory and cultural services, eventually leading to the expansion of alternative land uses. He further emphasized a need for providing sufficient societal payment for non-provisioning services to balance with overly demanded provisioning services that contribute to a decline in the ecological capacity of rangeland systems (Briske, 2021). In the context of the marginalization narrative,

this study explored how herders whose livelihood and identity depend on rangelands perceive the benefits and values of rangeland ecosystems and how they evaluate changes in the ecosystems' condition for the decade of 2007-2017.

Study Site and Methods

The study sites are located in three ecological zones, including desert steppe, steppe, and mountain forest-steppe in the three districts (Chandmani, Darvi, Zereg) in western Khovd province, Delgerkhaan district of Khentii in the east, and Bayanzurkh district of Khuvsgul in northern Mongolia. We randomly sampled 334 herder households out of 1708 families residing in the five study districts and defined each district's sample size as proportional to the population (Table 1).

Table 1 Study sites and sampling of herder households in five soums in three ecozones

	District	Household survey	FG	Ecological zone	Province
1	Darvi	58	2	Desert steppe	Khovd
2	Chandmani	38	2	Desert steppe	Khovd
3	Zereg	51	2	Desert steppe	Khovd
4	Bayanzurkh	132	3	Mountain forest-steppe	Khuvsgul
5	Delgerkhaan	55	2	Steppe	Khentii
	TOTAL	**334**	**11**		

We used two types of survey instruments for data collection, including household surveys and focus groups (FG). The household survey was a quantitative tool guided by the International Forestry Resources and Institutions approach (IFRI, 2013) and included household demography and perceptions of rangeland and natural resource management, ESS, and household livelihood. The survey design for identifying herders' perceptions of ESS was informed by the Millennium Ecosystem Assessment, which laid the conceptual framework and methods for measuring ESS changes (MEA, 2005). FG discussions in each district gathered qualitative information at the community level, such as important resource management stakeholders, location and current status of key natural resources, and perceived well-being categories and livelihood assessment by these classes. For survey data analysis, we used MS Excel and SPSS 23 to compare perceptions on ESS by types. The study team pre-designed an FG outline, organized them using participatory tools, and analysed audio and written records. The main findings from FG were used to complement the quantitative data analysis results.

Results

The study examined ESS types that herders benefit from, their evaluation of service values for household well-being, and perceived ESS changes for the last decade. We describe their responses by ESS categories in following subsections.

Provisioning services

The provisioning services had 18 questions about the herder access to these services that were divided in three subgroups, including nutritional benefits, material use benefits, and energy supply services. Nutrition provision included food benefits from plants, wildlife, and surface and groundwater, while the material provision had uses of wood, plants, and water for household production, livestock forage, medicine, washing, cleaning and drink for livestock, and irrigation. Energy services had three types of plant-based (wood and straws) and animal-based (dung, fat) energy sources and mechanical energy of animal power (horse, camel yak, etc.).

1) Benefits: out of 18 provisioning services identified, herder households accessed, on average, ten services (M=9.8), where the mean for nutrition services was 3.5 out of 6, material benefits, – 4.1 out of 9, and energy services – 2.2 out of 3 energy types (Table 2). The most common services received by the majority of herders included the use of plants as livestock forage to benefit from meat and dairy products (N=329), water for human consumption (N=325), and household water use for washing and cleaning (N=316). 2) Values: among the three provisional services, the most valued benefit was energy provision (M=1.9) compared to nutrition (M=1.6) and material use (M=1.3) that was least valued. 3) Trends: the dominant view of herders was that the provisioning services are "declining" (M=0.98). No one reported increasing trend in ecosystem services in

their areas. The mean for the material uses benefits from ESS was lower than means for nutrition and energy services (*M*=1.03 and 1.39 respectively).

Table 2 Herders' perceptions on ESS benefits, values and trends by types

Ecosystem services	Mean: benefit	*SD*	Mean: value[1]	*SD*	Mean: trend[2]	*SD*
Provisional services (18 types)	9.85	2.62	1.50	.45	.98	.38
Nutritional (6 types)	3.54	.91	1.62	.44	1.03	.38
Material (9 types)	4.10	1.58	1.27	.54	.82	.43
Energy (3 types)	2.23	.79	1.93	.79	1.39	.61
Regulatory services (10 types)	7.70	3.35	1.97	.98	1.48	.73
Cultural services (7 types)	5.62	1.93	2.19	.86	1.72	.67

[1]Values were measured at the following scale: 3=most valued, 2= valued, 1=least valued. [2]Trends were measured at the following scale: 3= increasing, 2= the same, 1=declining.

Regulatory services

The study had ten questions measuring regulatory ESS including environmental regulation, storage/sequestration, erosion control, disease and pest control, flood and wind protection, water cycle, soil formation and climate regulation. 1) Benefits: herders acknowledged their access to eight out of ten regulatory services in their areas (*M*=7.7). 2) Values: the average score for perceived values of regulatory ESS was medium or "valued" (*M*=1.97). 3) Trends: The mean for trends in regulatory services for the last ten years was 1.48, which rounded up to 2 or "the same". This was more positive evaluation than the ones given to trends in provisioning services, which was "declining".

Cultural services

The survey had seven questions related to cultural ecosystem services, which included experiential and intellectual interactions with nature, values related to historic and cultural heritage, entertainment, both symbolic and religious spiritual values and values of nomadic identity and pride.

1) Benefits: on average, households received six types of cultural services out of 7 (*M*=5.62). Most frequently benefitted services were spiritual religious services where people worship mountains, ovoos (worship hills), trees (92%), and the ones related to people's identity and pride of their places (95%), and experiential interactions including horse riding, viewing and walking in the nature (85%). 2) Values: on average, herders "valued" cultural services of ecosystem services (*M*=2.19), which was a neutral response. 3) Trends: the average score of 1.72 means that the state for the services was the same as they were ten years ago.

Specifics of ecosystem benefits across ecological zones

Most herders from the desert steppe reported that main ESS benefits come from rangelands and groundwater resources, except Zereg which has wild onion and sea buckthorn plantations. Herders identified overgrazing, increased non-palatable plants, and desertification trends as main threads for maintaining local ecosystem services. Darvi herders criticized air pollution caused by a Chinese coal mining company, contaminating surrounding grazing areas and causing respiratory sickness for livestock. They complained that the corrupt local authorities do not take necessary measures for addressing the pollution or report on the company's contribution to the local economy. Herders from the mountain forest-steppe receive more diverse benefits besides pastures and water, including timber and non-timber products such as wild onion, fuelwood, nuts, berries, and medicinal plants. Here grazing is limited due to large areas of forests and rocks.

The herders reported that locals and outsiders' illegal hunting and fishing considerably reduced wildlife and fish for the past decade. According to herders, an international flyfishing company operates in their area. Still, local communities lack neither information about business income from the local ESS nor the company's contribution to the environment budget. In the steppe zone, the main ESS benefits come from rangeland and water use and hot springs and muds with medicinal attributes. About 15,000 tourists and 5000- 6000 vehicles annually come to the Avarga toson lake resort for medical treatment. Although the collection of fees from the tourism businesses was sufficient, the profit usually goes to the national budget; thus, little or no income remains for the restoration of the surrounding ecosystem and environmental management. Locals reported that the Ministry of Environment and Tourism annually issues hunting permits

for Argali sheep charging a hunting fee of 18 - 20 million MNT, but the district receives a tiny portion. The Focus groups also identified the herder perception of the good life. For most of them, the "good life" concept included the well-being of humans, livestock and nature existing in harmony. Mainly, abundant nature, health, and education of herders and happy livestock were the frequent expressions of the herders' good life.

Discussion

The results confirmed that herders valued most the provisioning services over regulatory and cultural ESS. The provisioning services herders received most included using plants for livestock forage to benefit from meat and dairy products, water use for human consumption, and household water use for washing and cleaning. Herders had more benefits from material use among provisioning services, followed by nutrition benefits and energy use. These results were not surprising as all livestock products, including skin, wool, cashmere, etc. were under the material benefit subtype. However, herders valued more energy benefits of ESS compared to nutritional and material use benefits. This implies that strategies should prioritize supplying herders' energy needs to address the overuse of fuelwoods.

The lack of herders' awareness of regulatory and cultural ESS revealed during the interviews, indicates the need for raising awareness about these ESS types, and links between ecosystem functions, services, and goods with human well-being (Haines-Young & Potschin, 2010). Nevertheless, after explanation, herders' second most valued services were regulatory services, as they seem to understand well the importance of these natural processes. Herders rated the trend in provisioning ESS as "declining", and "the same" - for regulatory and cultural services as compared to the ESS state a decade ago which were in line with other scientific studies measuring long-term changes in rangelands (Jamsranjav et al., 2018). This finding may also imply that rural people continuously receive benefits from natural processes and spiritual and recreational experiences in their areas, although the benefits from products of provisional services are in decline. Overall, the emphasis on provisioning ESS and the lack of herder awareness of regulatory and cultural ESS may reflect the broader government policies and practices that undervalue the significance of non-provisional ESS (Briske, 2021).

On the other hand, as reported by herders, rangeland ESS benefits harvested by external agents such as coal mining, flyfishing and hunting businesses and health resorts do not contribute to the restoration and maintenance of the local ecosystems nor shared with pastoral communities. This fact confirms the narrative of ecological marginalization when more powerful actors overexploit the natural resources exposing local indigenous communities to the risk of losing their livelihood basis (Davies, 2015). Therefore, current policies need to have necessary actions to ensure equitable benefit distribution derived from rangelands to support adaptive capacity and well-being of pastoral communities, essentially acknowledge the importance of non-provisional ESS across various levels.

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