Implementation of Green Development Policy Based on Vulnerability Assessment: Khovd *Aimag's* Case Study

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ABSTRACT

In 2014 the Mongolian parliament approved the Green Development Policy. Out of 21 *aimags*, Khovd, Arkhangai, Uvurkhangai, Khentii and Bulgan *aimags* set an objective of prioritizing green development on their local level. This paper is based on the project "*Conducting environmental and social vulnerability research of soums in five aimags leading in green development and developing strategy recommendation*" and it is written using Khovd *aimag* as a case study. Here, in Khovd *aimag*'s 17 *soums*, we evaluated eight variables including drought-*dzud* index, vegetation index, preventable livestock loss, prepared hay and fodder, pasture use index, degree of desertification, land degradation and surface water loss, allowing us to make an integrated assessment of ecological vulnerability. According to our analysis, the Gobi desert steppe region was defined as most vulnerable among environmental zones, and out of a total of 17 *soums* Altai, Uyench, Zereg, Chandmani and Duut *soums* were defined as most vulnerable, followed by Must, Darvi, Munkhhairkhan, Mankhan and Myangad *soums*. There is a need to give top priority to the planning and implementation of green policy in these ecologically more vulnerable soums by increasing their "green" budget. This will allow them to develop their capacity to adapt to climate change, decrease their vulnerability, to conduct optimal management of pasture use and have targeted preparation of hay and fodder.

Keywords: drought-*dzud*, vegetation, livestock loss, pasture use, desertification, land degradation, surface water loss, ecological vulnerability

INTRODUCTION

Climate change and the consequent natural disasters, such as drought and dzud, as well as shortages of natural resources, ecosystem deterioration and desertification are an increasingly negative influence on the economy, society and human development of Mongolia. According to the drought and dzud surveys, in the 70-year period between 1940 and 2010 droughts increased in intensity by 2% per each year across the country, and in the 20-year period between 1990 and 2010 occurrences of drought in summer and *dzud* in the subsequent winter increased by 0.6% per year having negative impact on citizens livelihood and stability of the society (Altanbagana and Davaanyam, 2011).

As over 50% of the gross domestic product of 14 *aimags* out of total 21 consists of agricultural products, making those *aimags* socially and economically dependent on their natural environment and more vulnerable to climate change (Altanbagana, 2013). As for population distribution, 32.8% of total inhabitants of Khovd *aimag* live in rural areas. 74% of rural population in 16 soums of this aimag are located in countryside, while remaining 26% live in *soum* center (NSO, 2015).

Therefore it is necessary, at both the *aimag* and *soum* levels, to protect and efficiently use natural resources, take measures to reduce ecological degradation, increase green employment and develop local areas with green development approaches which strengthen the capacity of adapt to climate change.

In this research we evaluated relevant environmental variables, indexing them and conducting an integrated assessment of the ecological vulnerability of 17 *soums* of Khovd *aimag*. Research results provided an opportunity for the local authorities to plan and implement spatially diverse green development policy for reducing ecological vulnerability in these *soums*.

STUDY AREA

Seventeen *soums* across different ecological zones in Khovd *aimag* were involved in our research: Buyant, Darvi, Durgun, Jargalant, Zereg, Mankhan, Myangad and Chandmani *soums* located in the great mountain chain lowland; Duut, Munkhhairkhan, Must, Tsetseg, Erdeneburen and Khovd *soums* located in the mountain steppe; and Uyench, Altai and Bulgan *soums* located in the Gobi desert region.

STUDY METHODS

Vulnerability as defined by Adger (2006) is “the state of taking stress or damage caused by environmental and social changes beyond the capacity to adapt or the state of being harmed from exposure to stresses associated with environmental and social changes”, and as described in the Mongolian National Human development report (UNDP, 2011) it is “associated to ability to cope with shocks caused by risks of being exposed to social fragility and vulnerability, and by other internal and external factors”.

Based on the results of research conducted on Bayankhongor *aimag’s soums*, Altanbagana (2013) concluded that “*vulnerability of a given system is a ground condition leading to risks, and when the vulnerability eventually increases to reach certain threshold it entails risks*.” In the process of assessing ecological vulnerability in each of Khovd *aimag*’s *soums*, eight variables were considered.

Drought and dzud (black and white) index was estimated using a weather data array from the period between 1995-2013, specifically data from the summer months of May, June and July and winter-spring months of November, December, January and February. Assuming that temperature data alone is not sufficient to characterize winter and summer conditions, we made estimations similar to the normalized temperature and precipitation slope differentiation or Ped’s (1975) index, using Altanbagana’s (2013) approach of adding black *dzud* to drought-*dzud* integrated index using the estimation method of Natsagdorj and Sarantuya (2003).

Natsagdorj and Dulamsuren (2001) reported biannual occurences of black *dzud* in the Gobi desert region of both the Gobi and Western aimags of Mongolia. During a black dzud livestock are usually crowded around wells or patches of water which freeze late in winter, and they often lose their strength and fatness in a short period of time due to rangeland trampling, separation from water supply and being driven to search for water, and this combined negatively influences the stability of the animal husbandry sector. Due to livestock trampling and other environmental factors such as wind, spring vegetation following the black *dzud* lacks essential moisture, which in turn impacts rangeland ecosystem resilience and thus causing more vulnerability (UNDP, 2011).

Vegetation index. Average values for the annual vegetation index were calculated using vegetation data of May to October of each year for the period between 1998-2013, collected at 10 days intervals by SPOT satellite Normalized Difference Vegetation Index (NDVI), with a 1 km-resolution. In calculating the vegetation index, NDVI value of separate soums cannot alone provide sufficient condition to vulnerability assessment. NDVI value can be high in some soums where rangeland production is abundant due to the specifics of the local environment, weather and ecosystem. At the same time NDVI value can be low in Gobi desert soums where vegetation is reduced or rangeland produce is low, while vegetation increase trend may be seen there. Therefore we considered both multiyear average NDVI values, and the angle coefficient of the linear trend equation of NDVI change for the period of 16 years, which expressed trends of decreasing and increasing vegetation in the given soum.

Pasture use index was estimated using livestock number data from 1990-2013, by performing a normalized comparison between livestock number per unit of hectare of the given *soum's* rangeland (unit of sheep/ha) and rangeland capacity. Excess livestock numbers in the given soum over the rangeland capacity can negatively impact rangeland ecosystem causing vulnerability.

Land Degradation and Desertification Index. Based on the "*Desertification Atlas of Mongolia*" (IGE and EIC, 2013) we used desertification, land degradation, damage and degradation assessment maps and results. In each soum we estimated the percentage of the total area ranked as having very strong, strong and fair desertification. Stronger desertification rate in the *soum* is predicted to lead to a loss of ecological stability.

Surface Water Loss Index was estimated using the report of "*National Water Census*" (MEGDT, 2011). Higher rates of loss and a shortage of surface water in the given soum was predicted to increase the ecological vulnerability. This estimation was done by comparing the number of dried up surface water bodies, such as rivers, streams, springs and ponds with the total number of water bodies, transferring the expressed percentage value into an index.

Preventable Livestock Loss was calculated by comparing the number of preventable livestock deaths (sheep unit) of the given year with the total number of livestock (sheep unit) counted at the end of previous year, expressed as a percentage. Livestock is the basic source of soum level population livelihood and the main reason for preventable livestock loss is the impact of drought and *dzud*.

Prepared Hay and Fodder was calculated by comparing total amount of prepared hay and fodder (NSO, 2015) in the given *soum* to total number of livestock (tons/sheep units). Lower rate of prepared hay and fodder per unit of livestock in the given soum makes it ecologically more vulnerable. Basic conditions for sustainable pastoral animal husbandry are favorable summer grazing conditions, rangeland ecosystem productivity and sufficient preparation of hay and fodder for wintering use. In the present time of increasing intensification of drought and dzud cause by climate change (Altanbagana and Davaanyam, 2011) preparation of natural and targeted hay and fodder is one of the factors for reducing vulnerability to these threats. We used the data from hay and fodder preparation in each *soum* in 2010-2013.

Data analysis

The following formula was used to normalize each variable estimated in ecological vulnerability assessment, for the purpose of integrated evaluation, the value was distributed to the same number intervals and transferred into index value.

$$\Delta X_{t,i}^{norm} = \frac{\Delta X_{t,i} - \Delta X_{\min}}{\Delta X_{\max} - \Delta X_{\min}}$$

Here $\Delta X_{t,i}^{norm}$ is the normalized value of the given variable, where *i* is number of *soum* and *t* is time period; $\Delta X_{t,I}$ is the value of the given variable, where *i* is number of *soum* and *t* is time period; ΔX_{min} is the minimum value of the given variable; and ΔX_{max} is the maximum value of the given variable.

RESULTS

The results of evaluation of variables estimated in ecological vulnerability assessment, according to *soums*, are shown in Table 1. Of the 17 *soums* of Khovd *aimag*, the Gobi desert *soums* of Bulgan, Uyench and Altai recorded the highest drought–dzud index, and these *soums* had very high preventable animal loss. Duut, Chandmani, Altai and Durgun *soums* had the lowest index of prepared hay and fodder per unit of livestock. According to the value of the vegetation index, the Gobi desert regions of Uyench and Altai, and the mountain steppe Chandmani *soum* were more vulnerable with regard to vegetation, while in terms of rangeland use, Bulgan, Uyench, Mankhan, and Khovd *soums* showed an excess of livestock number per unit hectare over the rangeland capacity. While Durgun, Darvi and Myangad *soums* are more at risk of desertification, Darvi, Munkhhaan, Tsetseg and Uyench *soums* are more at risk of land degradation and deterioration. Duut *soum* has higher surface water loss record (MNEGDT, 2011).

Table 1. Ecological vulnerability assessment by *soums* of Khovd *aimag.* Note: * 0-0.20 very low, 0.21-0.40 low, 0.41-0.60 medium, 0.61-0.80 high, 0.81-1.0 very high

№	*Variable index component of vulnerability* *	**Soums of Khovd *aimag***																
		Great mountain chain lowland							*Mountain steppe*							*Gobi desert*		
		Buyant	Darvi	Durgun	Jargalant	Zereg	Mankhan	Myangad	Chadnmani	Duut	Munkhhairkhan	Must	Tsetseg	Erdeneburen	Khovd	Uyench	Altai	Bulgan
1	Drought-dzud	0.01	0.64	0.01	0.01	0.64	0.57	0.01	0.73	0.64	0.64	0.64	0.64	0.01	0.01	1.00	0.67	1.00
2	Vegetation	0.50	0.42	0.60	0.50	0.44	0.47	0.35	0.54	0.32	0.44	0.43	0.34	0.24	0.21	0.68	0.56	0.45
3	Pasture use	0.44	0.01	0.21	1.00	0.58	0.61	0.57	0.34	0.11	0.14	0.55	0.47	0.57	0.61	0.70	0.28	1.00
4	Land degradation	0.01	0.88	0.19	0.04	0.43	0.37	0.02	0.43	0.06	0.64	0.41	0.64	0.02	0.01	0.52	1.00	0.22
5	Desertificatio n	0.32	0.70	1.00	0.43	0.37	0.20	0.63	0.29	0.17	0.13	0.05	0.29	0.19	0.01	0.08	0.20	0.16
6	Surface water loss	0.01	0.01	0.01	0.01	0.01	0.01	1.00	0.01	0.56	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
7	Preventable livestock loss	0.23	0.61	0.74	0.07	0.55	0.43	0.40	0.58	0.42	0.53	0.45	0.01	0.51	0.27	0.92	1.00	0.76
8	Prepared hay and fodder	0.52	0.88	0.92	0.84	0.81	0.85	0.75	0.96	1.00	0.77	1.00	0.89	0.84	0.51	0.70	0.91	0.01
	Combined evaluation, by soums	**0.10**	**0.23**	**0.19**	**0.12**	**0.32**	**0.28**	**0.23**	**0.31**	**0.29**	**0.25**	**0.24**	**0.19**	**0.11**	**0.06**	**0.33**	**0.34**	**0.18**

According to our ecological vulnerability assessment most of the *soums* in Khovd *aimag* are in an ecologically vulnerable condition, with the Gobi desert *soums* of Altai, Uyench, Chandmani, Zereg and Duut being the most vulnerable. The ecological vulnerability of Erdeneburen, Buyant, Khovd and *aimag* center Jargalant *soums* are relatively low (Altanbagana et al*.,* 2015).

DISCUSSION

As reported by separate assessment of the total of eight environmental variables and an integrated evaluation of ecological vulnerability, Altai soum was shown to be the most vulnerable due to the highest drought-*dzud* index, preventable livestock loss and land degradation, and the lowest rate of hay and fodder preparation. The basic factor of preventable livestock loss is the intensification and increase in frequency of drought-dzud. It is possible to decrease preventable livestock loss by sufficient preparation of hay

and fodder. As for Uyench *soum* the drought-dzud index, preventable livestock loss and rangeland use is high, but the rate of hay and fodder preparation is low. Also Zereg and Chandmani *soums* had lower rate of hay and fodder preparation, higher rate of drought-*dzud* index and lower rate of vegetation. Most of *soums* had low index of surface water loss, which is associated with abundant rainfall in recent years.

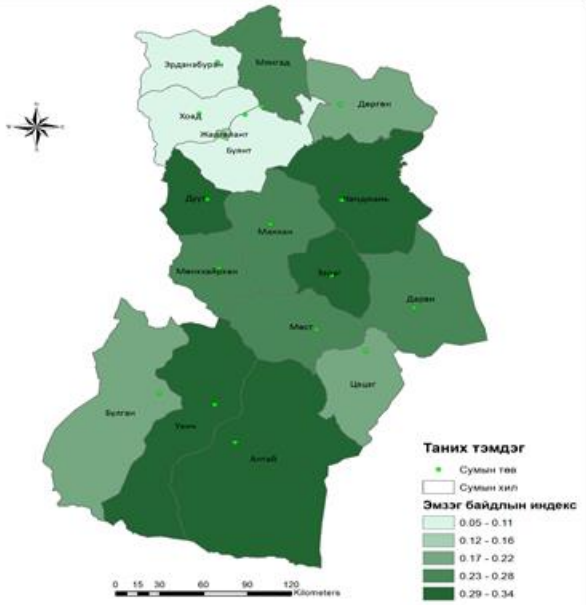

Figure 1. Ecological vulnerability assessment Khovd *aimag*

IMPLICATIONS

These research results provide the opportunity, based on a vulnerability assessment, to implement spatially different green development at the *soum* level. Variables that cause vulnerability differ from in different ecological regions.

Within Khovd *aimag*, Duut, Chandmani, Zereg, Uyench, and Altai are more vulnerable than the others and there is a need to give priority to planning and implementing policies and measures aimed at climate change adaptation capacity building and reducing vulnerability in these *soums*. For the soums with a higher drought-dzud index, there is a need for seasonal rangeland rotation and adjusting the number of grazing livestock to match the rangeland capacity. For *soums* with poor rangeland conditions that limit natural hay preparation, there is a need to give priority to measures of climate change adaptation capacity building by enhancing targeted hay and fodder preparation and increasing the *soum*'s green budget.

In *soums* with high exposure to vegetation decrease, desertification and land degradation, there is a need for technical and traditional measures to reduce land degradation and combat desertification. These can include generating local sustainable land management practices, taking degraded land into localized special protection, and limiting or prohibiting some specific activities in the areas with severe soil degradation and desertification for up to 5 years, according to the relevant legislation.

ACKNOWLEDGEMENTS

We would like to express our gratitudes to the Ministry of Environment, Green Development and Tourism of Mongolia for supporting this policy research project.

REFERENCES

Adger WN. (2006). Vulnerability. *Global Environmental Change,* 16(3), 268-281.

Altanbagana M. (2013). *Ecological and social vulnerability assessment of pastoral systems to climate change.* PhD dissertation, National University of Mongolia, Ulaanbaatar, Mongolia.

Altanbagana M, Chuluun T. (2010). Vulnerability assessment of social and ecological system of Mongolia. *The Proceedings of the 4th International Conference on the Application and Development of Geospatial Technologies in Mongolia*, pp1-12.

Altanbagana M, Davaanyam S. (2011). *Policy research report: Vulnerability and adaptability of socio-ecological system to climate change* (in Mongolian). National Development Institute of Mongolia, Ulaanbaatar, Mongolia.

Altanbagana M et al. (2015). *Policy research report: Ecological and social vulnerability assessment and policy recommendation for 5 aimags (Arkhangai, Bulgan,.Uvurkhangai, Khovd & Khentii) prioritizing green development* (in Mongolian). National Development Institute of Mongolia, Ulaanbaatar, Mongolia.

IGE & EIC. (2013). *Desertification Atlas of Mongolia*. Institute of Geo-ecology & Environmental Information Center.

MEGDT. (2011). *National Water Census 2011*. Ministry of Environment, Green Development and Tourism.

NSO. (2015). *Statistics Book of Khovd Aimag*. National Statistical Office of Mongolia.

Natsagdorj L, Dulamsuren J. (2001). Dzud assessment (in Mongolian). *Journal of Institute of Meteorology and Hydrology,* 23(3), 3-18

Natsagdorj L, Sarantuya G. (2003). Climate change and atmospheric dzud phenomenon for pastoral animal husbandry of Mongolia (in Mongolian). *Ecology & Sustainable Development Series,* 7, 151-180.

Ped LA. (1975). On the new drought and over-moistening index (in Russian). *Transactions of the USSR Hydrometeorological Center,* 156, 19-39.

UNDP, 2011. *From Vulnerability to Sustainability: Environment and Human Development*. Mongolian National Human Development Report, United National Development Program.