Relationship between Ecological Vulnerability and Human development in Mongolia

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Method for ecological vulnerability *(drought, zud, pasture use)* ***assessment***

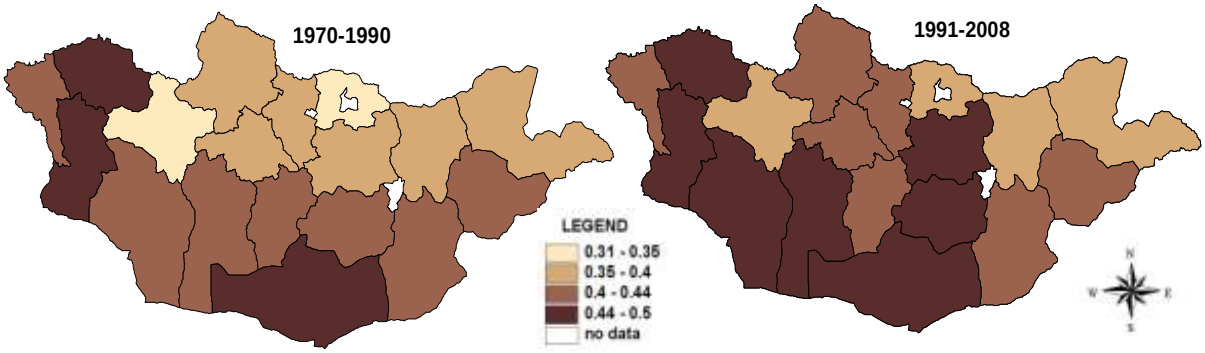
Vulnerability index of pastoral systems to climate and land use changes have been calculated as sum of the *zud* index and rangeland use index. Vulnerability of rangelands is higher when both *zud* and rangeland use intensity are higher.

$V = \Delta N + \Delta S$, ΔN - pasture use index; ΔS - *zud* index, integrated previous summer drought.

Drought assessment

Drought was assessed in temporal and spatial scales at aimag level in Mongolia. Drought had an increasing trend during 68 years between 1940-2008. The highest drought average index was in Omnogov', Hovd, and Uvs aimags during 1970-1990, but the area with the same high index was expanded into central and western parts of Mongolia since 1990. Uvs, Hovd, Gov'-Altai, Bayanhongor, Omnogov', Dundgov', and Tov aimags are on this list. Increased drought frequency and intensity during last 68 years can be explained with global warming. The knowledge of current drought trends and dynamics are very important not only for prevention from future risks, but for development of climate change adaptation policy and implementation of actions (Fig. 1).

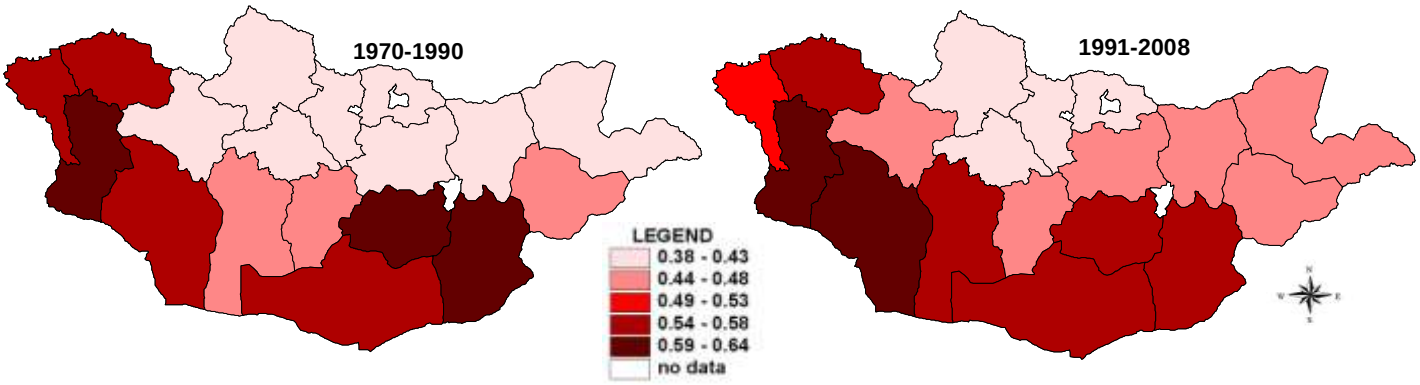
Figure 1. Drought assessment of Mongolia



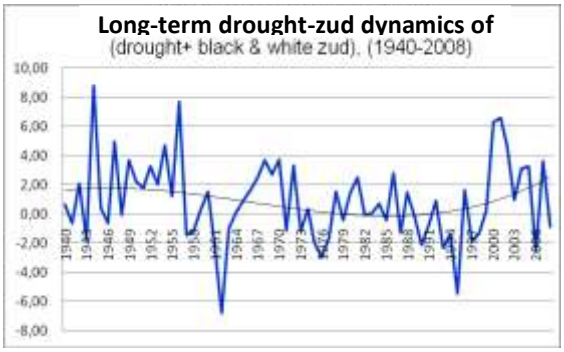
Zud assessment

There are many types of *zud* such as white, black, stormy, cold, iron and glassy according to herders' traditional evaluation (Chogsom 1964). Often results of drought come out during

Figure 2. Integrated drought-zud *(black & white zud)* **assessment of Mongolia**



winter and spring *zud* conditions. Therefore it is better to combine summer drought and following winter in conditions of Mongolia. Natsagdorj and Sarantuya (2003) calculated *zud* index, which incorporated previous summer drought, between 1940-2002, using Ped index. This index accounts only white *zud*. We calculated the *zud* (both white and black) index, which incorporated previous summer drought. Temporal dynamics and spatial distribution of integrated assessment of drought and *zuds* between 1940-2008 have shown in Fig2.

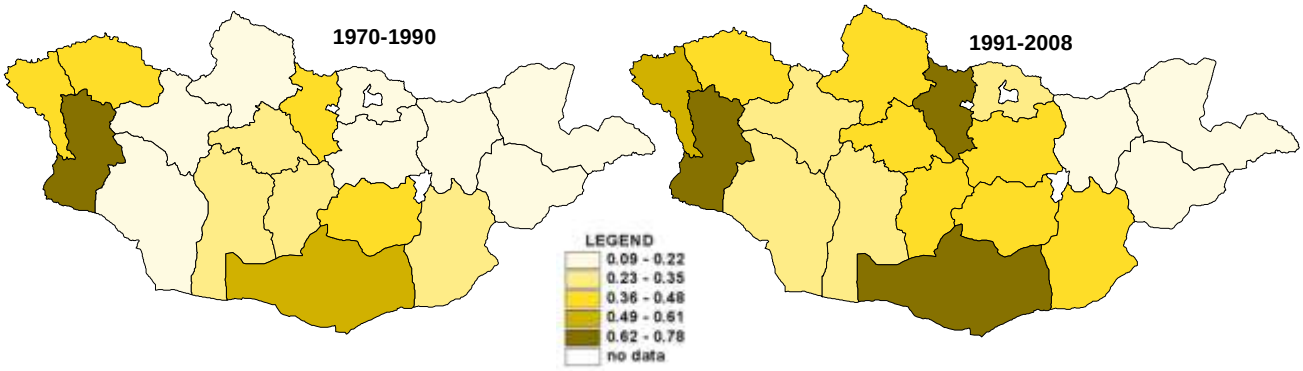


We can generalize 3 different period: high (until 1956), low (1957-1998), and high (since 1999) of integrated *zud* index overall for Mongolia, which doesn't show any spatial characteristics. Comparison of drought and *zud* conditions between 1970-1990 and 1991-2008 periods, Z*ud* with previous summer drought condition was prevailing in Hovd, Dundgov' and Dornogov' aimags between 1970-1990, but it is prevailing in the western and southern parts of Mongolia since 1991. The Gobi aimags Hovd, Gov'-Altai, Dundgov', Dornogov', Omnogov', Uvs and Bayanhongor aimags are the most vulnerable to climate disasters, other aimags locaed between the Govi and Khangai, and steppe region are also vulnerable to climate disasters (Fig. 2).

Pasture use index

In addition to climate change, human factor is critical for land degradation and desertification. Overgrazing tends to be increased in central regions, where human density is increasing due migration from rural to urban areas. Pasture use index defined by livestock density relative to carrying capacity is shown spatially and temporally. Hovd aimag followed by Omnogov', Dornogov', BayaOlgii, Uvs aimags overused their pastoral resources between

Figure 3. Pasture use assessment of Mongolia



1970-1990, whole western and central regions started overgraze since 1990. Hovd, Bulgan and Omnogov' aimags are leading in terms of overgrazing. Pasture use dynamics follow the same pattern of livestock dynamics, being relatively constant during 1970-1990, increasing until 1999, then dropping due to droughts and *zuds*, and increasing again since 2002 (Fig 3).

The Mongolian pastoral system was resilient in terms of livestock recovery since 2002, but it is not sustainable from coupled social-ecological point of view. We are degrading the rangelands with overgrazing, exceeding the carrying capacity. In addition, it is possible that we may have major economic drop if similar climate disaster events as 1999-2002 happens.

Ecological vulnerability assessment

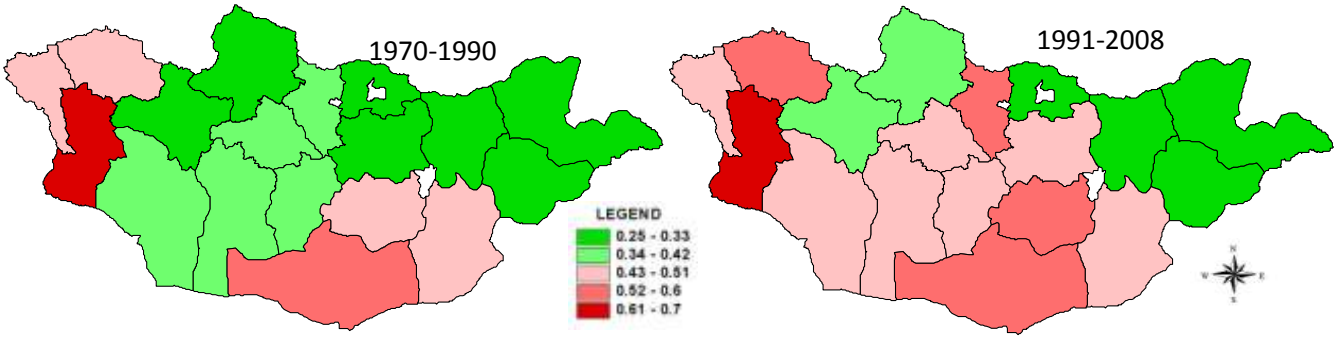
We tried to assess an ecological vulnerability in temporal and spatial dimensions for the first time in Mongolia (Fig. 4). Climate disasters and grazing intensity were two factors we accounted for this assessment. Ecological vulnerability is high when both *zud* risk (with previous summer drought) and overgrazing are high.

Ecological vulnerability was high in western three aimags (Hovd was the most vulnerable) and in the southern three Gov' aimags (Omnogov' was the most vulnerable). However, ecological vulnerability increased enormously since 1991. Ecological vulnerability increased almost everywhere, leaving only northern (except Bulgan) and eastern aimags. Dundgov',

Uvs and Bulgan are added to the list of the most vulnerable aimags. It is likely that ecological vulnerability at country scale jumped to higher level since mid-1990s according to the long-term dynamics, making Mongolia more ecologically vulnerable.

It is not enough nowadays to explain sustainable development as socio-economic growth, conserving nature. We have to take comprehensive measures to prevent, reduce vulnerability, increase adaptation and resilience of socio-economic systems in conditions with increased in

Figure 4. Ecological vulnerability assessment of Mongolia
Biophysical (drought, zud) and human (pasture degradation) impact



frequency and intensity drought and *zud*, reduction of water resources, and desertification due to climate change, especially in aimags, located in the Gov' and central part of Mongolia.

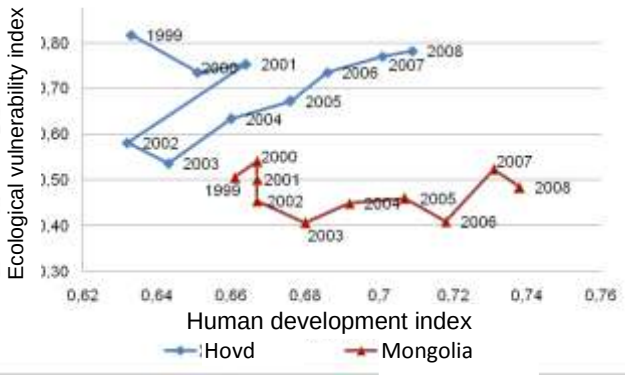
We need to act soon to reduce current ecological vulnerability because we may have to spend more in future if we'll not take actions now. Long-term sustainability can be addressed only when climate change issue is considered because we already know that global warming will continue in this century due to already released greenhouse gases into the atmosphere.

Relationship between human development and ecological vulnerability

Relationship between human development and ecological vulnerability has been studied for the country and Hovd aimag (Figure 5). Hovd was one of the most ecologically vulnerable aimag according our study and also the poorest (UNDP, Poverty map. 2009).

An ecological vulnerability of Mongolia reached the

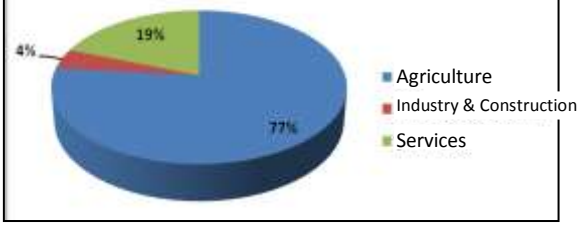
Figure 5. Relationship between human development and ecological vulnerability in Mongolia and Hovd aimag



zenith in 2000 and reduced until 2003, the HDI didn't change during 2000-2002, when we look at relationship between ecological vulnerability and HDI in Mongolia. Since then human development is increasing, but an ecological vulnerability has increasing trend too. There is a threshold for an ecological vulnerability and if our country exceeds it, then not herders will suffer and the HDI of the country might not increase as during 2000-2002 (Fig. 5).

An ecological vulnerability of Hovd aimag reached the zenith in 1999 and reduced until 2003. The HDI even decreased during 2001-2002, since then human development is increasing, but an ecological vulnerability has increasing trend too. There might be a threshold for an ecological vulnerability and if our country exceeds it, then not herders will suffer and the HDI of the Hovd aimag might decrease as during 2001-2002. Share of agriculture in the GDP of Hovd aimag is 77%, which means the GDP of Hovd aimag is dependent on ecological vulnerability: land use and climatic disasters. In 14 aimags (except Suhbaatar, Selenge, Omnogov' and Dornogovi') agriculture's contribution for the GDP is more 50%. Example, we show GDP of Hovd aimag, Mongolia(Fig. 6).

Figure 6. GDP by divisions, Hovd aimag, %



Source: 1999-2006 HDI (MHDR 2007), 2007-2008 HDI and GDP (Staistical Book 2008)

1. **Conclusion**

We studied vulnerability of ecological systems at ecological zone and administrative unit scales. Ecological vulnerability assessment at aimag (province) level showed that the most vulnerable aimags (Hovd, Uvs, Dundgovi and Umnugovi) are located in the Gobi region.

Vulnerability index high is more measure adaptation policy to climate change. Climate change adaptation policy should be different in different ecological and economic zones. Climate change adaptation actions should be integrated with sustainable development programs in order to have better synergy.

Reference

1. Altanbagana, M., T.Chuluun & Dennis Ojima, 2010. "Vulnerability Assessment of the Mongolian Rangeland Ecosystems". Proceedings for Consultative meeting on "Integration of Climate Change Adaptation into Sustainable Development in Mongolia". June 17-18, 2010. Ulaanbaatar, Mongolia.
2. Altanbagana, M., and T.Chuluun. 2010. Vulnerability Assessment of Mongolian Social-Ecological Systems. The Proceeding of 4th International and National workshop "Applications of Geo-informatics for Natural Resource and Environment", Ulaanbaatar, pp.1-11.
3. UNDP. Human Development Report 2009.
4. Natsagdorj, L., D. Jugder and Y. S. Chung, 2003. Analysis of storms observed in Mongolia during 1937-1999. *In* Journal of the Atmospheric Environment, Volume 37, Issue 9-10, Pages 1401-1411, March 2003. Elsevier Science Ltd., Printed in the England.

5. The Ministry of Nature, Environment and Tourism. UNEP and UNDP, 2009. MONGOLIA: Assessment Report on Climate Change 2009, "MARCC 2009", Ulaanbaatar, Mongolia. DDC 551.641 Y-594
6. Natsagdorj, D, Sarantuya, G. 2004, On the assessment and Forecasting of Winter Disaster (Atmospheric Caused Dzud) Over Mongolia- Sixth International Workshop Proceeding on Climate Change in Arid and Semi-Arid Regions of Asia , August 25-26, 2004 Ulaanbaatar, Mongolia, pp. 72-88
7. Chuluun, T., M.Altanbagana and C.Davaanyam. 2008. Policy on adaptation of pastoral systems to climate change, the project brochure, Admon Publishing, Ulaanbaatar, Mongolia, 46pp.
8. S.Tserendash, Methodology of caring capacity of rangeland system. Ulaanbaatar, 2006.

Mongolian National Atlas. 1990. Ulaanbaatar.