

Desertification in Mongolia

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ABSTRACT

In addition to climatic factors there are several specific human activities that have led to serious and widespread desertification in Mongolia. Animal husbandry, especially in the arid and semi-arid regions, is considered as the most essential human induced factor affecting desertification risk in Mongolia. It is an important cause of soil erosion. Grazing pressure is greatest near settlements and water sources. The carrying capacity of pasture land is frequently exceeded in the areas receiving the greatest grazing pressure, resulting in degradation of the composition of plant species and soil denudation. Taking into account the long-term experience of pastoralism, several important conclusions are drawn, including the applicability of the "Clementsian Succession Theory" to Mongolian conditions. The crop cultivation is an important cause of desertification, particularly soil erosion, because spring tilling coincides with the season of intensive wind. Most of the cultivated areas are devoid of trees or other windbreaks. It is estimated that over the past 30 years about 35–50 tons of soil have been lost from each hectare of cultivated land due to wind erosion alone. Half of all cultivated land in Mongolia is considered to be degraded to some degree of erosion. The annual fluctuation and slow increase in per-hectare crop yields observed over the last four decades verify this conclusion.

Another factor is deforestation. Most timber harvesting is carried out by clear-cutting. Generally located on sloped or steep terrain, deforested areas as well as vehicle tracks are particularly subjected to water erosion. It is estimated that nationwide there are four times as many vehicle tracks as are necessary to ensure access.

Mining and inadequate waste management is also serious factors of land degradation. The development of strip mines, as well as the deposition of overburden spoils and tailings all degrade land resources. Domestic and industrial waste is currently deposited on the soil surface in unnecessarily large, designated dumping sites on the outskirts of cities and towns.

Key words: desertification, grazing, Mongolia, soil erosion.

INTRODUCTION

In accordance with the International Convention to Combat Desertification (CCD; United Nations 1994) desertification is defined as land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variation and human activities.

Following this definition, 90% of Mongolian territory can be regarded as vulnerable to desertification. These areas are almost exclusively used as rangelands, supporting about 30 million heads of livestock and numerous populations of wild animals. At present time there is no consensus among scientists on climate variations, particularly on presence or absence of the aridization of Inner Asia and Mongolia. The coastal formations of many lakes in this area and number of other examples are characteristic for lakes with fluctuating water levels. Now there are certain indications of lake level rises (for instance, Ubsu-Nuur, Ureg-Nuur in Great Lakes areas of Mongolia). At the same time it is necessary to note that this fact might have some relation to the increase in glacial river flow due to global warming.

Desertification of a territory is usually reflected first of all by dynamics of sand massifs, which can indicate aridization processes. Sand massifs are the typical landscape elements in the majority of inter mountainous depressions of Inner Asia. The deflation cells and basins among fixed sands are particularly evident in the basin of

Ubsu-Nuur (Largest lake in Mongolia 3423 km²) where eolian processes are becoming active.

There is evidence of increased moisture resources during the last three centuries. The annual precipitation shows steady tendency to growth from the first half of the 19th century (Dagvadorj et al. 1994). In this regard not only mere climatic variation, but also sharp continental climate condition and impact of human activities should be considered as the most important factors of ecosystem vulnerability and desertification risk in Mongolia.

CLIMATIC FACTORS

The climate of Mongolia is characterized by a high moisture deficit (Figure 1), low humidity (Figure 2) and low levels of incident energy. Despite 260 days (more than 3000 hours) of sunshine, total heat units above 10°C rarely exceed 2000 and in some areas are less than 1000. Snow cover is very light so soils are completely frozen in the winter. As a consequence the effective vegetation growing period is short, generally from 80 to 100, days although it can vary from 70 to 130 days depending on altitude and location.

Precipitation is generally low, ranging from less than 50 mm per year in the extreme south (Gobi desert region) to just over 500 mm per year in limited areas in the north (Figure 3). The average countrywide precipitation is about 230 mm which translated into an average of 361.1 km³ of rainwater. Roughly 90% of this amount returns to the atmosphere through evapotranspiration. This is an extremely high evapotranspiration rate compared to other regions of the world. Of the remaining 10%, 63% becomes surface runoff. Most of this surface flow component (95%) flows out of country, while a small portion flows into lakes and basins within the country. About 36% infiltrate into the soil and contribute to subsurface flow. Thus of the total annual precipitation, only about 3% infiltrates into the soil to replenish aquifers and becomes potentially available as a water resource in the form of soil moisture or ground water. This proportion is very low compared to the water balances of other regions in Asia in which not less than 30–40% of precipitation remains available (for example, the Amur and Enisei river basins, Russia).

Because of the continental climate, fluctuations in temperature are extreme, both annually and diurnally. Fluctuations can be as high as 30°C in single day and the difference between average winter low temperature and summer high temperature in excess of 50°C as compared to 25°C range in Europe. Moreover, it is possible even during summer to get sharp falls in temperature and unseasonal frosts can cause harvest losses of between 10 and 30% of crops. In addition, the spring-summer droughts, on the average, occur once in every five years in the Gobi region, and once in every ten years over most other parts of the country (Figure 4).

The danger of sudden local natural calamities should not be ignored as they can also cause long-term disturbances in ecological systems. A significant portion of the land resources in Mongolia is degraded not only due to frequent strong winds but also due to heavy rainfalls. For instance, in 1991, a hurricane with strong winds of velocity of 140–160 km an hour destroyed and carried away fertile soil layer in large areas in the southern part of Mongolia in only a few hours. These soils will probably take

many hundreds of years to re-develop. Thus, in those areas the soil ecosystem will be disturbed for many years.

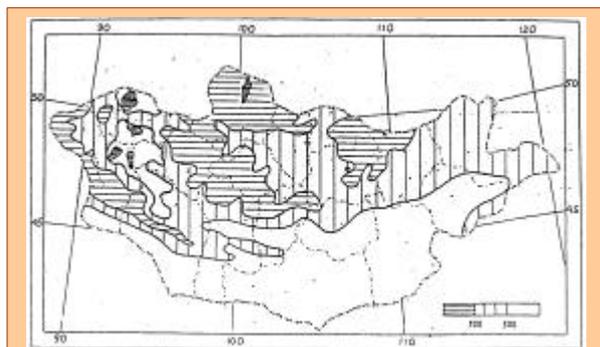


Figure 1. Moistening deficit of crops vegetation period.

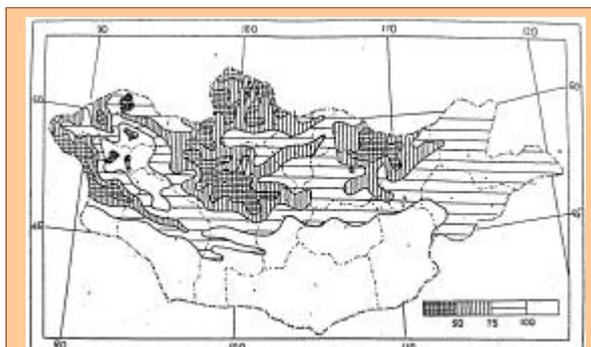


Figure 2. Mean number of day with relative air humidity lower than 30%.

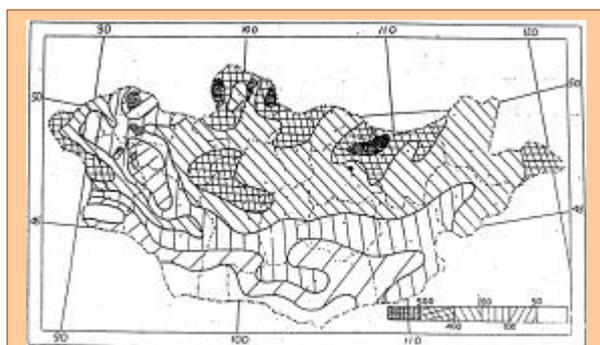


Figure 3. Mean total precipitation amount (mm).

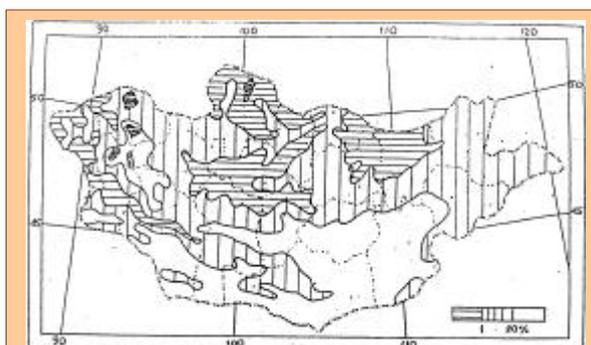


Figure 4. Frequency of spring-summer droughts.

SOIL

The principal soil type is dry-steppe chestnut soil that covers some 40% of Mongolia. Other major soil types are brown desert-steppe and grey brown desert soils. Arable soils are generally dark chestnut and chestnut soils, which are typically light, fine-silty, around 20–30 cm deep with an organic matter content of 3–4% and pH of 6–7.

Due to above mentioned climatic factors the natural ecosystems, including soil, are relatively fragile, highly susceptible to degradation by human activities, and slow to recover. The rates of humus production and vegetative regeneration and growth are very low throughout the country and agricultural productivity is low in comparison to other countries of the same latitude.

VEGETATION

Six vegetation zones can be defined in Mongolia based on different altitude, rainfall distribution and soil type; 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%).

Roughly 124.3 million ha or 79% of land area are covered by grassland and 15 million ha are covered by forest and shrub. Sandy areas are estimated at about 4.4 million

ha (3% of land) and roughly 4.3 million ha are occupied by settlements, plowed farmland and infrastructure. The remainder is covered by water, glaciated and rocky areas.

Total area used for agricultural production is estimated to be 125 million ha or 80% of national land area. The greater part of this area is used for extensive grazing. Not more than 2.5% of the total area is considered to be suitable for arable use (1.7 million ha) and for production of hay (2.0 million ha). Total cropland is put at 1.3 million ha with some 0.8 million ha under crops each year.

About 10% of the land surface of Mongolia, equivalent to some 15 million ha are covered by various types of forest with larch (73.6%), cedar (13%), pine (8%), birch (5%) and other species (fir, aspen etc.) dominating in the northern part of the country and saksaul (*Haloxylon ammodendron*) forests spread in the arid and semi-arid parts of the country, accounting for 28% of the forest cover. Most forests are considered to be critical for watershed protection. Cutting of forest combined with the increasing use of surface water for various economic activities in addition to climatic factors has caused significant reductions in the average flows of many rivers.

THE DEPLETION OF WATER RESOURCES

The impact of human activities and regional droughts on water resources in Mongolia over the past several decades has been profound. Water use for irrigation, mining etc., and human activities in watersheds such as deforestation, have resulted in substantial reductions in river flows and flow regimes, water level reductions or complete drying of many lakes, and lowering of ground water tables. For example, the annual average flow of the Tuul river has been reduced by 32% and roughly half of this reduction may be attributed to the cutting of 270 km² of forest in the watershed of this river 40–50 years ago.

It was reported (Batjargal 1992) that several lakes in the southern part of Mongolia, for example Onggyn Ulaan, Orog, Dzagyn Shal, have been severely depleted or have dried out completely. But since 1993, the situation has changed due to less intensity of drought and most of those lakes have already been recovered. In addition to the obvious ecological disruption caused by lake drying or level reductions, human economic activities on lake-shores, such as the mowing of reed for fodder, have significantly impacted the ecology and wildlife of many lakes.

THE HUMAN INDUCED FACTORS OF LAND DEGRADATION

Land degradation induced by anthropogenic factors is common to all ecological zones of Mongolia. There are several specific human activities that have led to serious and widespread soil erosion and land degradation.

Crop cultivation is an important reason of soil erosion. Spring tilling coincides with the season of intensive wind and most cultivated areas are devoid of trees or other wind breaks. In the Gobi region the average wind speed is 3–4 meters per second or even more which can cause significant soil moisture loss and erosion. It is estimated that over the past 30 years, an average of 35–50 tons of soils have been lost from each hectare of cultivated land due to erosion. Half of all cultivated land in Mongolia is considered to be degraded to some degree of erosion. New land brought under cultiva-

tion is mostly fodder pasture and a significant percentage of this area is marginal and environmentally unsuitable for crop production.

Another factor is vehicle-induced degradation from overland travel in the absence of an established road system. It is estimated that nationwide there are four times as many vehicle tracks as are necessary, causing degradation and denudation of 0.7 million ha of land.

The deforestation due to clearcutting for timber harvest, fire and insect infestations are among the factors contributing to soil erosion. Generally located on sloped or steep terrain, deforested areas as well as vehicle tracks are particularly subject to water erosion.

Mining and inadequate waste management can also make significant contribution to land degradation. An estimated 100,000 ha of land have been degraded by coal and gold mining activities. The development of strip mines and the deposition of overburden, spoils, and tailings all degrade land resources. Only a very minimal amount of the land degraded by mining activities has been restored.

Domestic, industrial, construction, and other forms of waste are currently deposited on the soil surface in unnecessarily large dumping sites on the outskirts of cities and towns.

ANIMAL HUSBANDRY IS AN ESSENTIAL FACTOR OF DESERTIFICATION RISK IN MONGOLIA

The most prevalent human activity in Mongolia that can potentially induce anthropogenic land degradation augmenting desertification risk is animal husbandry, characterized by livestock grazing. This is most pronounced at locations where climatic, topographic, and human influences create a "convergence" of factors that lead to accelerated degradation. Grazing pressure is greatest near settlements and water sources. The carrying capacity of pasture land is frequently exceeded in the areas receiving the greatest grazing pressure, resulting in degradation of the composition of plant species and soil denudation.

Animal husbandry continues to be the dominant economic sector in Mongolia, with daily impacts on virtually all the population. The semi-nomadic livestock herders were estimated as 183.6 thousand households or 410.0 thousand herdsmen with total 31.3 million livestock in 1997 (Mongolian Statistical Yearbook 1998).

During the last 10 years, between 1987 and 1997, the number of livestock in Mongolia increased by 38%. An increase in total livestock numbers is of concern because the country has lost the original traditional livestock herding system due to modernization of the socio-economic system, including grazing control practices, and at the same time has not yet established mechanisms to ensure the sustainable use of rangelands through livestock control and monitoring. In order to decrease the desertification risk, it is necessary to develop animal husbandry management strategy based on both the best traditional livestock herding practices and modern scientific methods. It should be taken into account that nomadic pastoralists, particularly in the Mongolian territory, have grazed different ecosystems for thousand of years in a sustainable manner.

SOME ASPECTS OF THE ANIMAL HUSBANDRY PROBLEM IN MONGOLIA RELATED TO THE DESERTIFICATION RISK ISSUES

The experience of pastoralism in Mongolia suggests that even the most degraded areas, with some exceptions, appear to be ecologically capable of responding to proper livestock management strategies.

In this regard, it was necessary to consider the applicability of so called “Clementian Succession Theory” to the Mongolian condition. This theory is well known and found good application in North America, Africa and Australia. The reasons, why this is less applicable in case of Mongolia, are (NPACD 1994):

- The long history of pastoral livestock grazing precludes the recognition of climax plant communities in most regional ecosystems.
- The long history of pastoral grazing indicates evolution of plant species and plant communities either adapted physiologically to being heavily grazed seasonally or having evolved characteristics that enable the plants to resist grazing by herbivores (spines, toxins, etc.).
- Most forage plants comprising Mongolian pasture communities are highly grazing tolerant or grazing resistant.
- Evidence that at least the majority of regional ecosystems are characterized by multiple steady state equilibrium rather than a single steady state equilibrium, i.e., that if the factor causing ecological degradation is sufficiently severe to destroy plant community composition and structure, the soil erosion will be such that a new steady state equilibrium of plants and soil will be achieved rather than secondary succession to the original climax community on removal of the factor causing degradation.
- The management of livestock by adjusting stocking rate or excluding grazing herbivores entirely to achieve higher stages near the ecological climax becomes a costly and probably impossible management goal, especially as it applies to the Mongolian pastoral livestock production system.

CONCLUSION

- Desertification is evident in Mongolia and the most important factors of it are the vulnerability of the ecosystem to human activities, especially animal husbandry.
- The management of livestock should focus on maintaining the current steady state equilibrium rather than trying to change plant community species composition and structure towards the higher ecological condition of a possible hypothetical climax of plant community.
- The plant communities and land resources should be rated according to their susceptibility (indicators of physical and chemical properties of the soil, including the amount of moisture) to factors causing a shift to a less productive steady state.
- If the multiple steady state hypothesis is accepted, the focus of livestock management should be on preventing movement of pastoral grazing resources to a new state that is of less benefit to the grazing animal in terms of biomass production and animal preference for plant species comprising the biomass.

- Livestock grazing can induce loss of soils to the degree that the natural plant community is no longer capable of maintaining itself. Only on these sites, where natural plant communities will be replaced, intervention programs are applicable.
- National Plan of Action to combat Desertification should be converted into a continued functioning mechanism of interaction among agriculture, animal husbandry, forestry, water resources management, and industry; bringing into focus the most desertification prone areas.

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