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Chapter 12

Human Impact and Land Degradation in Mongolia

Ochirbat Batkhishig

Summary: Climate warming and human actions both have negative impacts on the land cover of Mongolia, and are accelerating land degradation. Anthropogenic factors which intensify the land degradation process include mining, road erosion, overgrazing, agriculture soil erosion, and soil pollution, which all have direct impacts on the environment. In 2009–2010, eroded mining land in Mongolia increased by 3,984.46 ha., with an expansion in surrounding road erosion. By rough estimation, transportation eroded 1.5 million ha. of land. This area is nearly equal to the total amount of agricultural land in Mongolia. Road erosion reduces pastureland capacity and furthermore creates gullies, a very severe result of soil erosion. Overgrazing is one of the main reasons for land degradation in Mongolia. Pastureland in the vicinity of water bodies, settlements, lakes, and along livestock driving roads has severely degraded. Sand movement and free sand cover is becoming one main indicator of overgrazing and desertification. The 145 settlement areas in the Gobi desert steppe region of Mongolia are affected by sand problems. Agricultural soil loss is another big issue. Research results show about 46.9% of total arable land was eroded, and of that 33.7% of the land has experienced moderate to severe erosion. The shallow soil, sparse vegetation cover, and extra-continental climate are additional factors for soil erosion. To determine soil erosion intensity in the Mongolian steppe areas, we used fallout radionuclide techniques—Cs-137. In the study catchment of Baga Boor valley of central Mongolian steppe areas, soil erosion rates varied from 0.93 to 23.83 t $ha.^{-1} yr^{-1}$ and average erosion was 5.613 t $ha.^{-1} yr^{-1}$. The soil sedimentation and accumulation patterns were complicated due to the combination of water and wind erosion. The agricultural soil erosion rates in the case of Selenge aimag Nomgon soum and Central aimag Sumber soum are 32.6 and 49.6 t $ha.^{-1} yr^{-1}$. This is 5.5–8.8 times more than the rate found in the pas-

ture area. The soil erosion in agricultural fields of Mongolia is thus significant. Land conservation policy and adequate land management practice is therefore currently very important in Mongolia.

12.1 Introduction

Climate warming and human actions both have negative impacts on the land cover of Mongolia, accelerating land degradation and desertification. However, it is difficult to distinguish the exact contribution of each of these factors. In Mongolia, where there is a vast territory occupied by pastureland, the climate warming impact on land cover may be very serious. But most researchers argue for the domination of human impacts over climate warming (Qi and Kulmatov,
2008, Dorjgotov et al. 2002), suggesting that anthropogenic factors are the main causes for land degradation in Mongolia.

The economic growth and mining development in Mongolia over the last decades has accelerated land degradation. Loss of productivity in arid regions has created the ma jor environmental constraints for sustainable development. Land degradation due to mining, road erosion, overgrazing, agricultural soil erosion and settlement area pollution are the ma jor environmental problems of the country. Soil degradation is also recognized as a serious and widespread problem (Bridges and Oldeman, 1999). Many peoples' lives are affected by soil degradation; they may suffer directly from a shortage of food and decreased environmental quality. Creating scientifically accurate assessments and precise estimation of soil degradation in Mongolia are challenging issues. The mining land degradation assessment data are comparatively accurate, but side effects of mining are not clear. In addition, overgrazing and desertification assessment data are very uncertain. Researchers have used different methods and approaches for the study of land degradation, but more comprehensive methods and approaches are still needed.

This Chapter attempts to review land degradation data for Mongolia and presents soil erosion case study results using fallout radionuclide methods.

12.2 Land Degradation Land degradation Overview

There are several different sources for statistics about land degradation in Mongolia. One of most reliable data sources are the –Land use inventory reports‖ of the Mongolian Administration of Land Affairs, Geodesy and Cartography. However, some of these data are not very reliable, thus requiring the development of more advanced methods and technologies for accurate estimating. Dregne (2002) noted the uncertainty of world land degradation datasets and the lack of good research data. Table 12.1 presents severe degraded land statistics (Land use inventory report of Mongolia, 2010).

Table 12.1 Severe degraded land of Mongolia, 2010

Land degradation activities	Area (ha.)
Mining exploration	16,061.5
Mining investigation	1,904.5
Road construction	1,206.4
Former military activities	25,483.0
Building construction, pipeline establishment work	255.6
Total	44,911.5

Estimation of pastureland degradation, desertification and road erosion is very complicated, and researchers have used different methods and approaches. Since 2000, environment investigation has been operating using remote sensing, ground observation and monitoring. Research data have become more accurate and realistic. The total area affected by severe degradation has been found at about 44,911.5 ha. (Table 12.1). Former military activity degraded a large area of occupied land. Since 1990, army activities have been drastically reduced,

Table 12.2 Mining land degradation by aimags (province)*

Aimag (province)	Area (ha.)
Central	6,645.4
Selenga	3,021.0
Uvurkhangai	2,174.9
Orkhon	2,152.0
Khentii	1,709.0
Umnugobi	1,093.7
Others	1,170.0
Total	17,966.0

*Land use inventory report of Mongolia, 2010 with military-affected land naturally recovering for more than 20 years. Mining eroded land increased after 1995 due to gold fever. In 2008, a campaign for mining eroded land reclamation was initiated, but a large area still needs to recover.

Anthropogenic factors that intensify the land degradation process include human activities such as overgrazing, soil erosion of arable land, deforestation, mining, soil pollution, and road erosion, which all have a direct impact on the environment

12.2.1 Mining Land Degradation

Currently, the mining industry in Mongolia is booming. GDP growth for the country in 2011 was about 17%, largely due to mining. However, the negative environmental impact from mining has become a serious problem, especially resulting from gold mining. Anthropogenic land degradation occurs near mining areas and adjacent road networks for transportation. On-site effects of these features have a significant impact: dusting, pasture degradation, water shortage and pollution.

In total, 38.5 million ha. or 24.6% of the territory of Mongolia is covered by 4,728 mining licenses (Mijiddorj, 2011). According to the ―Land use inventory report of Mongolia 2010‖, 16,061.5 ha. of land was destroyed due to mining explorations and 1,904.5 ha. of land was destroyed due to mining investigation.

Mining and inadequate waste management are also significant factors for land degradation. The development of strip mines, as well as the deposition of overburden spoils and tailings all degrade land resources (Batjargal, 1997). A Ministry of Nature Environment report noted that ―in 2009–2010 mining eroded land increased by 3,984.46 ha.‖.

In 2009, the Mongolian government adopted laws to stop gold mining activities in upstream river and forested areas. These administrative activities resulted in a decrease of mining land degradation. Mining land reclamation started in 2000, and more areas are incorporated every year.

Illegal gold diggers caused land degradation without any reclamation. In 2006, 66,179 illegal gold diggers were counted, while government activities have resulted in a reduction in the number of gold diggers at the present time. 66,179, 53,959 and 35,000 illegal gold diggers were counted in 2007, 2008, and 2009, respectively (Report of Mining department, 2010).

The peak period of mining land degradation occurred from 1995 until 2008. After 2008, government control increased and land reclamation work become better. But off site effects of mining land degradation such as road erosion, dusting, and water resource shortage expanded.

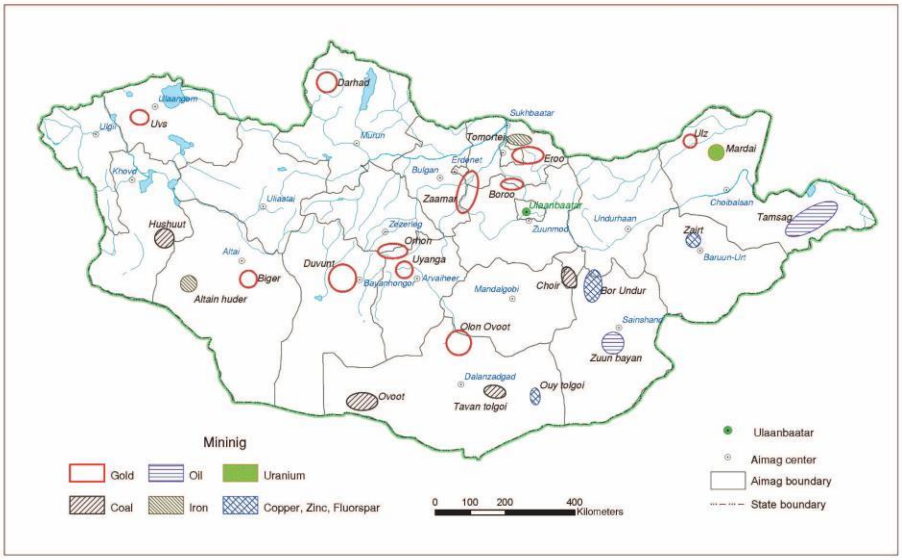

Fig. 12.1 Land degradation surrounding area of mining in Mongolia. All of these mining sites have been developed since 1995.

Table 12.3 Mining land reclamation (ha.)*

Year	Technical reclamation	Biological reclamation
2008	898.8	807.9
2009	494.84	280.6
2010	688.1	389.75

*Report of Mining department, 2010.

12.2.2 Land Degradation by Road

Road erosion is one of biggest contributors to land degradation in Mongolia. There are not exact data for road erosion. By rough estimation, about 1 million ha. of land have been covered with vehicle tracks (Sarantuya, 2000). Road erosion is directly related to the number of vehicles, which is drastically increasing. In 2011, the number of vehicles in Mongolia increased 6–7 times as compared to the 1990s.

Heavy machineries used for mining are most destructive by way of soil erosion. From Tavan tolgoi coal mining to the Chinese boundary Zagaan Khad, 240 km of road were heavily degraded by tracks and 3000 ha. of soil were eroded.

According to official statistics, the total amount of road in Mongolia is 49,249.9 km, of which only 3,174.8 km is hard covered road, while 3,704.7 km is improved gravel road and 42,370.4 km is soil road (Mongolian Department of Road report, 2010). In reality, however, every single well, spring and –ger‖ (Mongolian traditional nomadic living tent) is connected by roads. It is therefore difficult to measure the total amount of roads in Mongolia.

Road erosion in Mongolia is increasing due to an increase in vehicles and mining activities. By rough estimation, 1.5 million ha. of land have been eroded by transportation. This area is nearly equal to the total amount of agricultural land in Mongolia. Road erosion reduces pastureland capacity and furthermore creates gullies, a very severe form of soil erosion (Fig. 12.2).

Fig. 12.2 Coal transportation in Gobi desert of Mongolia is one of the major causes of soil erosion and dusting. Coal track road in Tavan tolgoi-Zagaan Khad, 2010. (Photo Batkhishig)

12.2.3 Pastureland Degradation and Desertification

Overgrazing is one of main reasons of pastureland degradation (Qi and Kulmatov, 2008). For thousands of years over the history of the Mongolian pasture system, there was some level of equilibrium between the number of livestock and the existing vegetation coverage. A small increase in animal populations or changes in land-use patterns may therefore result in localized degradation. According to the Mongolian Ministry of Nature environmental report, 73.87% (115,525.9 thousand ha.) of the country's territory is suitable for agricultural and pastoral livestock production (Nature environment condition report of Mongolia, 2011). Grassland conversion to cropland and the degradation of grassland are largely due to increasing human population and political reforms of pastoral

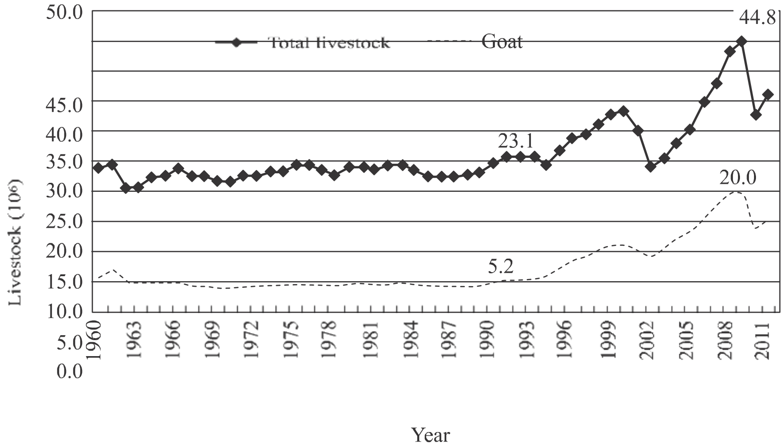

Fig. 12.3 Number of total livestock and goats in Mongolia

systems (Chuluun and Ojima, 2002).

For many centuries, the amount of livestock in Mongolia was around 20 million, and did not exceed 30 million (Batkhishig, 2000). After the privatizations of the 1990s, the number of livestock rose, and reached 44.8 million in the year 2009 (Fig. 12.3). The number of goats increased due to the high price of cashmere. In 2009, the number of goats was 20.0 million or 44.5% of total livestock. Goats are the animals that are most destructive to pasture and soil, because they eat grass with the roots. As a result of the increase of livestock, pasture pressure rose, which instigated the pasture and soil cover degradation process. According to the reported statistics, 6.8 million ha. of pastureland was degraded (Land use inventory report of Mongolia, 2010). Vegetation species gradually changed due to overgrazing, reducing some native species (Stipa baicalenses, Festuca sibirica etc.), dominated Leymus chinensis, Carex duriuscula and Artemisia adamsii (Bazha et al., 2010). Long-term remote sensing data from NOAA/NDVI indicate 69% pasture degradation due to global warming and overgrazing (Erdenetsetseg and Erdenetuya, 2010).

A case study examining the impact of overgrazing on soil cover in the Eastern Hovsgol lake area indicated that soil humus content decreased by 30%–50% in overgrazed areas. Soil temperature increases and moisture content decreases as a result of overgrazing. Topsoil becomes more dense and compact as a result of animal pressure on the soil surface (Batkhishig, 2006).

Pastureland in the vicinity of water bodies, settlements and lakes, and along livestock driving roads, has severely degraded. Water resources have decreased and rivers and springs are desiccating due to aridity, overgrazing and the centralization of settlements. Areas of degraded vegetation have been formed around population centers and wells. By rough estimation, the size of degraded rangelands around these centers totals 200 thousand ha. In addition, another 400,000 ha. of degraded rangelands are located around numerous desert wells (Kharin et al,1999).

Researchers and scientists have estimated that 90% of Mongolian territory is vulnerable to desertification and 72% of territory is already affected by desertification (National Program Combating Desertification in Mongolia, 2010). Sand movement and free sand cover are becoming one of the main indicators of desertification, with the 145 settlement areas in the Gobi desert steppe region of the country affected by sand problems. A recent Mongolian report estimates that 5% of desertificated area is very severely affected by land degradation and desertification; 18% is severely affected, 26% is moderately affected and 23% is slightly affected (National Program Combating Desertification in Mongolia. 2010).

Desertification in arid areas seems to depend mostly on precipitation and air temperature. Summer 2011 in Mongolia was very rainy, especially in the month of June. Nearly 80% of the territory of Mongolia had very good grass growth for the first time since 2000. Local peoples of the Gobi desert region claimed as a result ―desertification disappeared‖. There still needs to be a more careful and comprehensive assessment of desertification in this region.

Livestock pressure on pastureland and negative impacts on land cover are increasing. There is a need to improve pasture management and land use policies to prevent pastureland degradation.

12.2.4 Soil Erosion of Arable Land

Cultivated land occupies 1.331 thousand ha. of the total land area. Over 57% of total arable land is located in the north-central aimags (provinces) of Tov and Selenge and the northeastern aimag of Dornod in Mongolia.

Since the second half of the 1960s, the agricultural industry has been developed as an individual part of agriculture, and has satisfied all of Mongolia's vegetable needs. The decrease of crop yields, notably affecting the vegetative industry, is primarily related to arable land erosion and degradation. The shallow soil, sparse vegetation cover, and extra-continental climate are additional factors contributing to soil erosion. In its early years, the agricultural industry did not pay any attention to the issue of soil conservation. In 1999, about 60% of total arable land was abandoned (Avaadorj et al, 2000). Research on soil in central and eastern agricultural regions identified that 46.9% of total arable land was eroded, and of this, 33.7% had experienced moderate or severe erosion (Nyamsambuu, 2007).

In topsoil at a depth of 0–20 cm, arable soil humus content loss within 20 years (1970–1990) was about 30.4%; at a depth of 0-10 cm, topsoil had humus loss of 40.3% (Dobrovolskii et al. 2000). Soil erosion of agricultural land was very intensive over the period 1965–1990.

Mongolia implements a short rotation system for use in agriculture named fallow-crop/fallow-crop-crop, and it may be the main cause of soil deterioration. In the past 40 years, due to the conversion from the traditional method, which has been used only for pastoral rangeland, the ecological condition of agricultural land has deteriorated.

In the 1990s, Mongolia's agricultural sector was drastically reduced due to the country's transition to a market economy (Fig. 12.4). Over the last 20 years, most agricultural soil was in the process of naturally recovering its organic resources and fertility. However, most of the 200,000 ha. of fertile agricultural land were utilized intensively, without any fertilizers. Between 1999 and 2008, a period of hot, dry climate dominated Mongolia, and the agricultural sector declined. The Mongolian government launched the agriculture-expanding program –Atar-3‖ in 2008; agriculture is now increasing, and wet, rainy years have followed the dry period. However, not many soil conservation measures have been practiced. Soil erosion, nutrient depletion, and loss of productivity are threatening agricultural land.

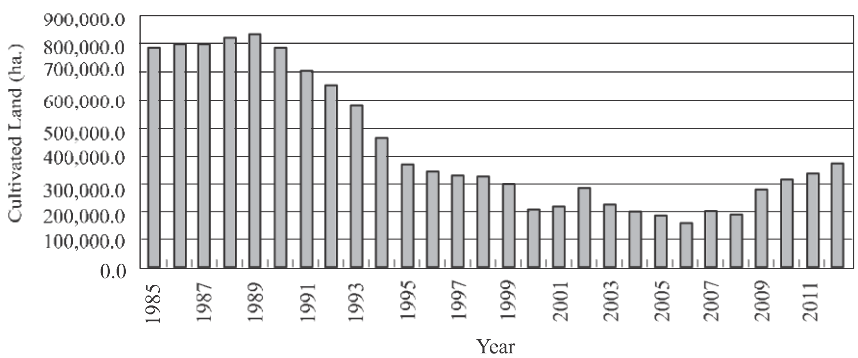

Fig. 12.4 Cultivated land of Mongolia.

12.2.5 Deforestation

In Mongolia, 12,917.5 thousand ha. of land are covered by forest; this represents 8.26% of the country's total territory (Nature environment report of Mongolia, 2011). Mongolia is one of the most poor forest resource countries in the world. The forest area includes 140 species of trees and bushes, and is mainly dominated by coniferous and deciduous trees. Due to climate warming and negative human impact, the frequency and probability of occurrence of forest fires is increasing. In the last 30 years, forest area has decreased by 210.3 thousand ha., and 757.4 thousand ha. of forestland has been damaged by forest fires and cutting (Dorjsuren, 2009).

Most timber harvesting is carried out by clear-cutting. Deforested areas, as well as vehicle tracks, which are generally located on sloped or steep terrain, are particularly subject to water erosion. Forests are cut for commercial and household purposes, and saxaul (desert tree-Haloxylon ammodendron) and bushes are cut for household purposes as well.

In the period of 1990–2005, human impact on forestland increased. Forest conservation policies have improved in the last few years. Forest cutting and forest fires are decreasing.

12.2.6 Soil Pollution

Soil and water pollution in big cities, especially in Ulaanbaatar, the capital city of Mongolia, is a major environmental problem. Urban and settlement areas occupy 620.6 thousand ha. or 0.39% of the total territory. The population of urban areas is continuously increasing; currently about 63.3% of the population is living in cities (Statistical yearbook of Mongolia, 2010).

Domestic and industrial waste is currently deposited on the soil surface in unnecessarily large and designated dumping sites on the outskirts of cities and towns. Each year, 780–800 thousand tons of solid waste are disposed in 321 open waste dumps in rural areas and at 11 open waste points in Ulaanbaatar city, causing severe health problems and environmental pollution (Nature environment report of Mongolia, 2011).

Ulaanbaatar (UB) city's environmental conditions have been drastically declining for the last few years, threatening the normal living conditions of the local population. According to results from 2011 research, a nearby leather-processing factory contaminated soil with up to 637–555 ppm of chromium, exceeding the standard level by 3–4 times. Due to an increase in transportation and the use of unleaded gasoline, soil was contaminated by lead (Pb). The average lead content in UB city soil is 47.3 ppm, twice as high as the 1995 level (Batkhishig et al., 2011). The soil, air and water pollution situation in Ulaanbaatar city is currently very serious, and city governors are trying to address these problems.

12.3 Use of Fallout Radionuclide Methods for Soil Erosion Study

Soil erosion in Mongolia is becoming a very serious problem. It is therefore necessary to obtain accurate estimations of the soil erosion and sedimentation rates.

In the 1990s, N. Norov of the Nuclear Center of the National University of Mongolia measured cesium-137 isotopes in the soils of Mongolia, but this was not significantly connected with soil erosion rates (Norov et al, 1998). In 2000, Japanese researchers studied soil erosion in the areas of Kherlen Bayaan Ulaan and Baganuur, using Cs-137 (Kato et al, 2006). They concluded that the –long-term soil erosion is very significant, and deposition areas were detected at the down slope of the catchment‖. Since 2007, we have been involved in the IAEA pro ject –Implementation of the Fallout Radionuclide Technique for Erosion Measurement, MON/ 5015‖. Some results of our investigation are presented here.

Ob jective of the study. To establish a soil erosion sedimentation rate in the steppe region of Mongolia, using fallout radionuclides methodology Cs-137 (Fig. 12.5).

– Identification of local reference value.
– Soil erosion rate in pasture and abandoned crop field area in steppe region of Mongolia in the case of Argalant.

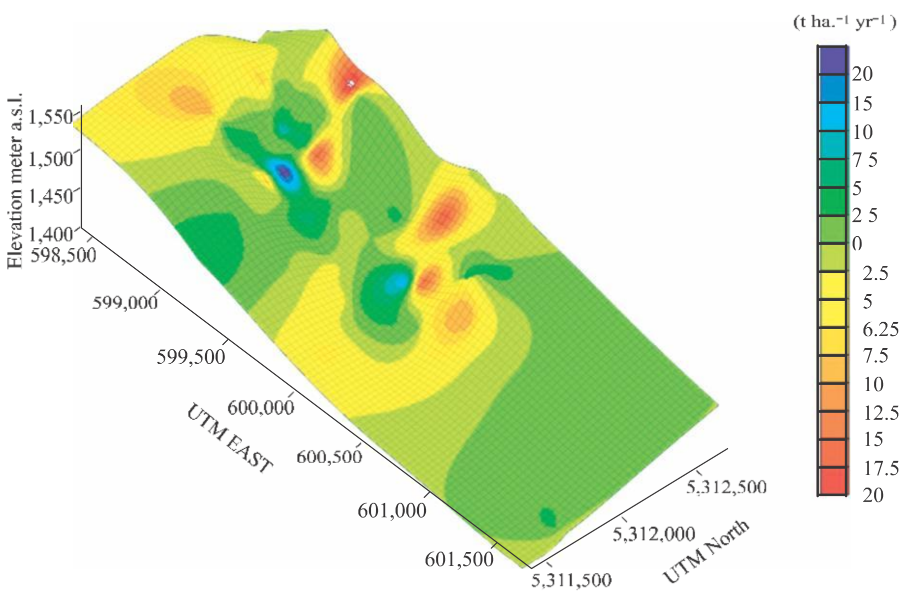

Fig. 12.5 The spatial distribution of Cs-137 inventories in the Baga Boor valley of Central Mongolia, steppe pasture conditions

Specifics of Mongolian conditions. In the Mongolian steppe areas, soil erosion is caused by both water and wind. It is difficult to distinguish the dominant erosion factors. Fallout radionuclide techniques for wind soil erosion are not sufficiently developed. The use of Cs-137 in wind erosion studies is less common (Pennock and Appleby, 2002). Therefore, there were some difficulties in sampling methods, especially when choosing reference sites in wind and water erosion conditions.

Study area. Typical steppe of central Mongolia, with hillocks, small mountains, and valleys. The soil erosion and deposition rates were studied in small valleys and hillock fields in steppe area.

Administratively, this land belongs to Argalant Soum of Central Aimag, central Mongolia. Average elevation ranges from 1,400–1,600 m above sea level. This land is used for grazing purposes, while in the northern plains, abandoned agricultural fields are distributed. Our study field is the small valley of Baga Boor, which is oriented towards the southeast with 3 km long and 2 km wide. The highest point in the valley is the upstream mountaintop, which reaches an elevation of 1,563 m above sea level. The southern mountaintop of Doloon Undur reaches an elevation of 1,545.1 m above sea level. The lowest point in the valley is 1,420 m above sea level. The area has a relative height of about 140–150 m, with an average slope inclination of 6°–10°. The area of the valley is about 250 ha.

Methods. In the study catchment area of Baga Boor, sampling points were selected according to relief elements. In total, 120 soil samples were analyzed to determine Cs-137 activities in 2007. Core sampling methods with depth of 15 cm were used, with a depth of 20 cm for the valley bottom area. Transformation of measured Cs-137 inventories of soil movement used Profile distribution model, and for agricultural soil used Mass balance model-2 (Walling et al. 2002).

Reference inventory. The tops of small hillocks were selected as the local reference inventory site. The soil samples taken along the northwest to southeast wind directions oriented transects of Zagaan hutul. In 2007, scraper plate methods were used at the reference sites for soil sampling, at 2 cm intervals. In the next year, 2008, 2 mm intervals were incorporated for scraper plate method soil sampling.

Results. At the top of the hillocks, the Cs-137 reference inventory range was 1,558–1,778 Bq m^{-2}, with an average of 1,668 Bq m^{-2}. We used this value for our calculations. In the mid slopes, soil Cs-137 activities ranged from 561–1,349 Bq m^{-2}, lower than the reference value, while in the southeast-facing lower shaded slopes, a higher value of 1,980 Bq m^{-2} was found. Lower slopes showed significant soil accumulation, especially notable in the lower shaded slopes. Accumulation of sediments was caused mostly by water erosion, while wind blowing concentrated materials at the lower slopes. Plant coverage was thicker and denser in shaded lower slopes than on wind-facing lower slopes. Upper slopes indicated a more significant loss of sediments. In the study catchment area of Baga Boor, soil erosion rates varied from 0.93 to 23.83 t $ha.^{-1}$yr, and average erosion was 5.613 t $ha.^{-1}$ yr, or 0.37 mm of soil loss per year. Deposition rates varied from 0.01 to 32.187 t $ha.^{-1}$yr, and average deposition was 4.43 t $ha.^{-1}$ yr, or 0.47 mm of soil accumulation per year. The soil sedimentation and accumulation patterns were complicated due to the combination of water and wind erosion. Water erosion dominated mountainous hillocky areas, with soil loss at steeper slopes and deposition of sediments at the lower slopes. The northwest- and southeast-facing slopes were more affected by wind erosion.

Soil erosion and soil organic content were significantly correlated (Correlation coefficient = 0.559, n = 124). Eroded soil had less organic content and less fertility than non-eroded soils (Fig. 12.6).

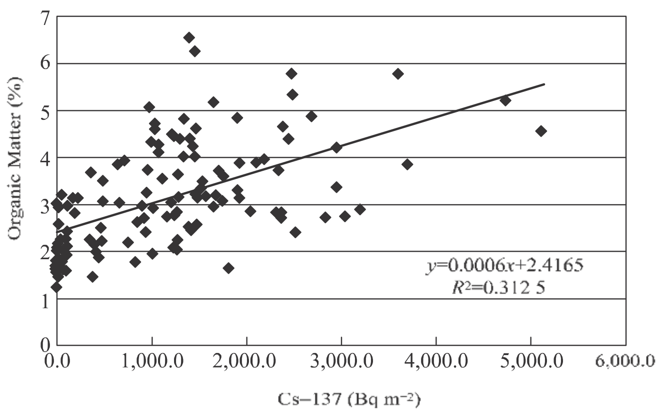

Fig. 12.6 Soil organic content and erosion

South-facing slopes were more affected by erosion than north-facing slopes. North-facing slopes were less dry and had more vegetation cover. Due to less erosion activity, north-facing slopes were usually steeper than south-facing slopes.

In the lower plains of Baga Boor area, there are abandoned agricultural fields. The agriculture mostly consists of wheat produced from 1970 until 1990. In the last 20 years, this area was used as grazing land. A total of five core points were sampled at a depth of 30 cm. Mass balance model-2 was used to determine soil erosion. Agricultural soil erosion rate is 3.403 t ha.$^{-1}$yr^{-1}; if compared with nearby grazing land soil erosion rates, the agriculture soil erosion rate increased to 5.178 t ha.$^{-1}$yr^{-1}. Soil organic content decreased by 34.9% compared to non-agricultural fields.

Beryllium-7 methods were used for short-term erosion events. Zagaan hutul hillocks were selected as the study area, the same as the Cs-137 reference site. The main scope of the study was concerned with soil wind erosion specifics. The sampling was made on July 2, 2008 using the scraper plate method with 2 mm depth intervals from the top 2 cm of soil. A total of 10 sites were selected along the northwest to southeast directions transect, following the dominant wind direction.

The Beryliium-7 activity was only found in the top 2 mm; below this, depths were not counted or had a zero value. Also, the top 2 mm of some soil profiles had a zero value. Wind-facing upper slopes, and wind-shaded lower slopes had no value, or more erosion. Accumulation marked lower wind-facing slopes, upper shaded slopes, and plain sections. According to Davaat station (100 km north-west from study site), the weather before the sampling period was rainy; May–June of 2007 experienced 121.7 mm rain, with especially high precipitation at the end of June.

Using the profile distribution model in the steppe pasture catchment of Baga Boor study area, the average soil erosion rate was found to be 5.613 t $ha.^{-1}yr$, the net erosion rate was 0.8 t $ha.^{-1}yr^{-1}$, and the sediment delivery ration was 31%.

A study of short-term soil erosion events in steppe area using Beryllium-7 methods shows that there is more soil erosion on the wind-facing upper slopes, with accumulation on the upper part of wind shaded slopes and the lower part of wind-facing slopes. This indicated the influence of both water and wind erosion on soil.

A study on agricultural soil erosion was conducted in the northern Mongolian Nomgon soum of Selenge aimag and Sumber soum of Central aimag. In the study area, dark Kastanozem soils with loess-like silt texture are distributed. Agriculture practices beginning in the 1970s have involved planting mostly wheat. For soil erosion calculation, we used Mass balance model-2 (MBM2). The results of the study show significant loss of topsoil, mostly by wind erosion.

Agricultural soil erosion rates in the case of Selenge aimag Nomgon soum and Central aimag Sumber soum using MBM2 were found to be 32.6 and 49.6 t $h.^{-1}yr^{-1}$. This is 5.5–8.8 times more than pasture area. The soil erosion in agriculture fields in Mongolia is therefore significant. In Mongolian agriculture, soil conservation practices are rarely used.

Conclusion

Anthropogenic land degradation in Mongolia is increasing. Mining land degradation, road erosion, overgrazing, agriculture soil erosion and settlement area pollution are currently major environmental issues in Mongolia. There are different statistics about the land degradation of Mongolia. The estimation of Pastureland degradation, desertification and road erosion is very complicated and researchers used different methods and approaches. Since 2000, environmental investigation has been accomplished using remote sensing, ground observation and monitoring. The peak period of mining land degradation continued from 1995 until 2008. After 2008, government control increased, and land reclamation work improved. However, there were off-site effects of mining land degradation expanding, such as road erosion, dusting and water resource shortage. Road erosion increased in Mongolia due to an increase in vehicles and mining activities. By rough estimation, 1.5 million ha. of land was eroded by transportation. Overgrazing and desertification are two of the biggest environmental issues in Mongolia. Desertification in arid areas seems to mostly depend on precipitation. Summer of 2011 in Mongolia was very rainy, especially in the month of June. Nearly 80% of the territory of Mongolia had a very high level of grass growth for the first time in the last ten years since 2000. Locals of the Gobi desert region claimed that ―desertification disappeared‖. More careful and comprehensive assessment of desertification is necessary. Since 2008, agriculture in Mongolia has expanded. However, soil conservation measures are rarely practiced. Soil erosion, nutrient depletion, and loss of productivity are threatening food security in the country. We used fallout radionuclide methods for soil erosion rate estimation. The average soil erosion rate for one year in the steppe pasture catchment of the Baga Boor study area of central Mongolia is 5.613 ò/ha. In the cases of Selenge aimag Nomgon soum and Central aimag Sumber soum, agricultural soil erosion rates were 32.6 and 49.6 t $ha.^{-1} yr^{-1}$, respectively. This is 5.5–8.8 times more than pasture area. Arable land soil organic content decreased by 34.9%, compared to non-agricultural fields. Therefore, soil erosion in agricultural fields in Mongolia was found to be significant. It is thus necessary to improve pasture management and land use policies in order to reduce land degradation.

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