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ECOLOGICAL AND ECONOMIC EVALUATION OF LAND USE IN ZAISAN SLOPE OF THE BOGD KHAN MOUNTAIN

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Abstract – Mount Bogd Khan is the first protected place not only in Mongolia but also in the world. There are 3 protected zones in the reserve, and a few companies are only allowed to operate in a limited zone in the area according to the Law on Special Protected Areas of Mongolia. Nevertheless, many companies are operating in the area and the physical characteristics of the land are being damaged. For this reason, we aimed to identify the main aspects that lead to the ecological degradation of the natural environment. Our research is based on the study of local land use related to soil degradation through soil weakening assessment and ecological and economic evaluation, in order to propose conservation measures.

The objectives are as follows: a) study the granted land, b) determine the soil erosion level of Zaisan slopes) estimate the ecological and economic valuation of soil. This research is used to develop proposals for protective measures through soil ecological assessment. Experimental uses method of soil field research, Tyurin method, methods for determining the volume and weight of soil, mapping for soil erosion and the ecological and economic valuation of the soil is calculated. The total area of Bogd Khan is 41651.0 ha, of which 55.0 percent is forest. The Zaisan slope has an area of 1086.5 ha. Of which 697.43 ha are not eroded. And the forest 482.3 ha, open area is 215.5 ha. Soil erosion has occupied 396 ha square. Of which 97.43 ha is highly eroded, 179.15 ha is medium eroded, and 119.42 ha is low eroded. The built-up area is 10.8 ha square, of which 4.1 ha is built up and 6.7 ha is roads. Zaisan slope is eroded resource of soil roots has reached 139.88 tons, total decrease of soil roots 49200.7 total decrease of soil roots /of revised/ 34626.2 ton. The total ecological and economic valuation of soil cover of Zaisan slope has reached 9.4 billion tugrug.

Keywords – Ecology, Economic, Evaluation, Land Management

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1. INTRODUCTION

Land cover refers to the biophysical characteristics of the earth's surface, including the distribution of vegetation, water, soil, and other physical characteristics of the land. Land use, on the other hand, refers to the way the land is used by humans and their habitat, usually focusing on the functional role of the land for economic activities[1]-[3]. For example, urbanization has converted much of the agricultural and forest land into urban land[4], [5]. Ecological regions, also known as ecoregions, vary in composition and structure around the world. As a base of land resources, each ecoregion is gradually transformed by human use and management, as well as environmental processes. In the twentieth century, climate variability and more intensive land use (LU) have accelerated changes in landscape composition and configuration in the world's ecoregions.

For example, the conversion of 13million hectares of forest land to other land uses (LUTs) worldwide and the loss of associated ecosystem services are major concerns[6].

For sustainable land use planning, the land use planning (LUP) approach nowadays requires more and more data integration, multidisciplinary and complex analysis, and faster or mor accurate information for those involved in land use planning Geographic information systems (GIS), which have high capacity in data integration, analysis,and visualization, are becoming the main tool to support land use planning. The application of GIS in land use planning is well documented[7]-[15].

Soil erosion is one of the eight hazards to soil listed on the Soil Thematic Strategy website of European Commission[16]. In the last decade, the problem of soil erosion has been included in the environmental agenda of European Union (EU) because of its impact on food production, drinking water quality, ecosystem services, mud flooding, eutrophication, biodiversity, and carbon stock reduction[17]. The following aspects are important for soil assessment (a) quantifying the impact of soil loss at such a large scale, (b) assessing the main effects of climate, vegetation, and land use changes on soil erosion rates, and (c) prioritizing effective restoration programs[18].

The most commonly used erosion model is the Universal Soil Loss Equation (USLE)[19], and its revised version (RUSLE)[20] which estimates the long-term average annual soil loss due to sheet and rill erosion. Example: In the Netherlands, soil evaluation is based on the Soil Protection Act, which states that current use of soil must not hinder future use. Various functions of soil are recognized, such as: a) soil as a physical basis for structures, dwellings and technical installations, b) soil as a filter and buffer enabling clean groundwater, c) soil as a source of valuable materials, including ores, d) soil as a medium with sufficient fertility enabling agricultural production, and e) soil as a place where ecological functions are fulfilled that are important for the biosphere in general.

Thera are over 600 natural sacred sites in Mongolia. The Bogd Khan Mountain Strictly Protected Area in Mongolia is perhaps the oldest officially and continuously protected area in the world. It was officially declared a sacred mountain reserve in 1778, but evidence of its protected status dates back to the 13th century, almost 100 years older than the establishment of Yellowstone National Park in the US. In 1995, the government declared the mountain Bog Khan a "Strictly Protected Area,'' one of several categories of protection set forth in Mongolian law. This prompted UNESCO to grant the mountain Biosphere Reserve status in 1996.

Mongolia has also added Mount Bogd Khan and two other sacred mountains to the World Heritage List UNESCO as mixed cultural-natural sites. According to the Mongolian Law on special protected areas, the Bogd Khan strictly protected area is divided into pristine zones, protected zones and restricted zones Bogd Khan mountain is part of the southern Khangai-Khentii zone in terms of soil geography region. This region is similar to the Khentii region in terms of soil distribution. Mountain meadow soils, forest taiga soils and steppe soils are common in this region. The predominant soils of the Bogd Khan mountains are: (a) mountain meadow soils above 2000 m, (b) 1700-2000 m high reticulate moss, alir moss cedar, permafrost taiga soils in sqruce forests, (c) mountain taiga soils in larch and birch-larch forests on the ridge and sides of mountains at 1600-1950 m altitude, (d) dark brown forest soils are common at an altitude of 1400-1600 m below the mountain taiga[21].

The newly developed method is related to the increasing conflicts against soil and the decrease of damage in land use of Zaisan slope, which is located in the limited zone of the protected reserve of Bogd Khan mountain. It has never been evaluated land use before and this research has shown that the land is weakened by ecological damage caused by illegal operations in this area.

2. EXPERIMENTAL

2.1 EXPERIMENTAL MATERIAL

Zaisan valley of Bogd Khan mountain:

The Bogd Khan strictly protected place has an area of 416 square km and the highest point ie Tsetsee Gun which is 2256 meters above sea level. The Bogd Khan Mountain has over 220 species of plants, some rare animals like red deer, musk deer, Siberian deer, Siberian ibex, wild boar and many species of birds such as common buzzard, woodpecker, stork, and others. Our uses four sample [see fig1 and table1]. Forest dark brown soil, Meadow soil, Meadow steppa chestnut soil, Mountain steppa chestnut soil.

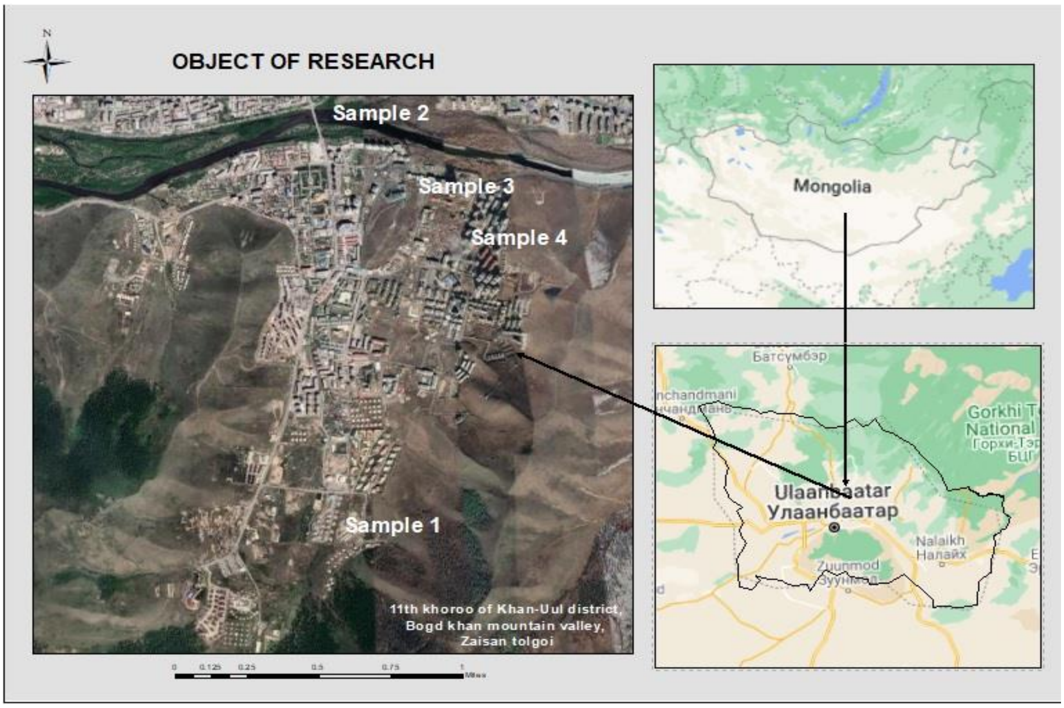

Fig.1 Bogd Khan Mountain valley, Zaisan valley

Table 1. Research Point

Research point	Sample location	Elevation(m)
Sample1 – Forest dark brown soil	N47^{0}51`50.4'' E106$^0$51`50.4''	1426
Sample 2 – Meadow soil	N47^{0}53`20.0'' E106$^0$54`36.4''	1278
Sample 3 – Meadow steppa chestnut soil	N47^{0}53`04.4'' E106$^0$55`03.3''	1309
Sample 4 – Mountain steppa chestnut soil	N47^{0}52`51.6'' E106$^0$55`17.8''	1325

2.1.1. METHOD OF SOIL FIELD RESEARCH

Steps of soil survey method:

a. Planning at field survey using a map of the area and a reconnaissance to determine the boundaries
b. Determining the soils to be sampled considering the different land uses: Agricultural, residential, forest, water, fallow soils, etc.
c. Mapping of the areas
d. Excavation of a standard soil profile pit measuring 50cm x 70m and 60-120cm deep
e. Sampling of the soils using a soil auger in the designated horizons (soil depth rim), e.g., from (0-25cm, 0-20cm, 25-45cm) or more
f. Labeling and characterization of the samples collected on site in pre-labeled sample bags indicating color, type and shape
g. Site description of sampled soils indicating limiting factors of erosion condition, stony or wet (flood conditions) and other information such as vegetation type, parent material, topography, etc.
h. Handling of soil and transport for laboratory analysis
i. Reporting of laboratory results and correlation
j. Extrapolation of results on a soil map describing the study area.

2.1.2. TYURIN METHOD

Laboratory analysis were carried out on the website Soil Laboratory of Soil Science Department of the Institute of Geographic and Geo-ecology of Mongolian Academy of Sciences. Dry the soil sample in dry air and collect large plant debris and roots. Place the sample in a ceramic steamer and crush it with a porcelain spatula (dissect the structure well and remove the soil adhering to the plant roots). Then divide the soil into two equal parts: sieve through a 2 mm sieve. Crush the sieved sample to a fineness of 0.25 mm. Sieve through a 1 mm sieve. Crush the sieved sample to a fineness of 0.25 mm. Organic matter was determined by Turin.I.V. To improve the quality and reliability of the analysis, a sample was repeated three times, and a blank determination (without soil) was made for each 4 samples.

$$A = \frac{(a-b)\times 100\times 0.001362\times K_{H_2O}}{C} \qquad (1)$$

2.1.3. METHODS FOR DETERMINING THE VOLUME AND WEIGHT OF SOIL

The most common method for measuring soil bulk density is take a known volume of soil using a metal ring pressed into the soil (intact core) and determine the weight after drying [22].

Method of determining the volume of soil cylinders:

$$V = \pi r^2 * h \quad (2)$$

There.

π – 3.14 constant
r –radius of cylinder, (cm)
h –height of the cylinder, (cm)
v –volume of the soil cylinder, (cm^3)

Determination of soil density:

$$d_V = \frac{P}{V} g/cm^3 \quad (3)$$

There.
P – absolute dry weight of soil, grams
d_V – soil density, g/cm^3

There are many methods for determining the composition of soil particles. In the laboratory, the laser diffraction method, the Kaczynski pipette method, the hydrometer method, and the sieve method are used, while in the field the wet sensing method and the volume are used. The Kaczynski classification and the international classification (USDA) are based on Stokes's law [23].

Stokes' formula $U = \frac{2}{9} r^2 \frac{(D_1 - D_2)}{h}$ (4)

There.

$U -$ particle drop rate, cm/sec
$r^2 -$ particle radius, cm
D_1 –The density of the falling particles
$D_2 -$ The density of the liquid in the particles
$h -$ fluid thickening

Methodology for determination by Kaczynski classification NA the Kaczynski classification divides the composition of soil particles into 9 categories based on the ratio of physical sand (0.01 mm) and physical clay (0.01 mm) [follow Table 2]. This method is based on the relationship between the speed at which a particle falls into water and its site [24]. Kaczynski's classification is a highly accurate method, but it is time consuming and unsuitable for routine analysis [25].

Table 2. Classification of Soil Particle Composition (MNS 5850: 2008)

Types of mechanical components	**Soil texture class**	**Physical clay%. (<0.01 mm)**
Sand	Sand Loamy sand Sandy loam	(<20)
Loam	Sandy silty loam Loam Silty loam Silty	(20-40)
Clay	Clay loam Sandy clay Silty clay Silty clay loam Clay	(>40)

2.2. MAPPING OF SOIL EROSION

The soil of the study area is mapped according to the degree of degradation. A soil disturbance map will show the area of soil with different degrees of disturbance. At least one complete section and one morphological survey will be made on each field, take a sample will be taken from each layer, and determine the volume weight in the upper layers will be determined. Laboratory tests are carried out to determine humus, volume, stone content, carbonate, and to map the data.

- Method of mapping the surveyed area - The boundaries of natural boundaries, rivers, ravines, wells, mountains, and pastures are mapped to distinguish topographic boundaries.
- The measurements taken during the field survey will be digitized and mapped to record the land degradation.
- ArcGIS 10.1 software was used for mapping to record land use and soil degradation in the Zaisan estuary.

2.3. THE ECOLOGICAL AND ECONOMIC VALUATION OF THE SOIL

It is important to accurately determine the organic content, which is a key indicator of soil fertility. The “Guidelines for Desertification Monitoring” adopted by the Minister of Nature, Environment and Tourism in 2010 and 2011, as well as the “Environmental Damage Assessment and Compensation Methodology” for estimating mining-related environmental damage, state that soil degradation should be determined based on humus depletion. The thickness of the soil layer, the humus content and the volume weight are used to determine the humus reserves of the soil.

$$E_s = OR_S * K_P * K_g * K_S * S * H_e \quad (5)$$

There.

E_S – Soil ecological and economic assessment, MNT/ ha
OR_S – Soil humus reserves, kg / ha
K_p – Coefficient of soil properties
K_g – Coefficient of environmental indicators
K_S – Soil type coefficient
S – Soil area, ha
H_e – Valuation of 1.0 kg of compost, MNT / kg

Standard repair factors will be used for soil assessment.

3. RESULTS

According to Mongolian Law on special protected areas, the Bogd Khan mountain Strictly Protected Area is divided into pristine zones, protected zones, and restricted zones. According to the above table, the undamaged area is 697.7 ha, and the damaged area is 396 ha. The most damaged areas are mountain steppe soils with 97.43 ha, moderately disturbed areas are meadow steppe brown soils with 179.15 ha, and least disturbed areas are 119.42 ha [shows fig 2, table 3 and 4].

Table 3. Bogd Khan Mountain Strictly Protected Area

Name of the state special protection area	Size of the virgin area and the special zone (ha)	Size of the area of the protected and tourist zone (ha)	Size of the restricted area(ha)	Total(ha)
Bogd Khan mountain Strictly Protected Area	7115.3	22291.9	11721.8	41560

Table 4. Soil Degraded Area

Ecosystem type	Soil characteristics	Degree of damage	Damaged area(ha)
forest	Sample 1	non-erosion	697.7
mountain steppe	Sample 2	high	97.43
meadow steppe	Sample 3	middle	179.15
meadow	Sample 4	low	119.42
Total			396

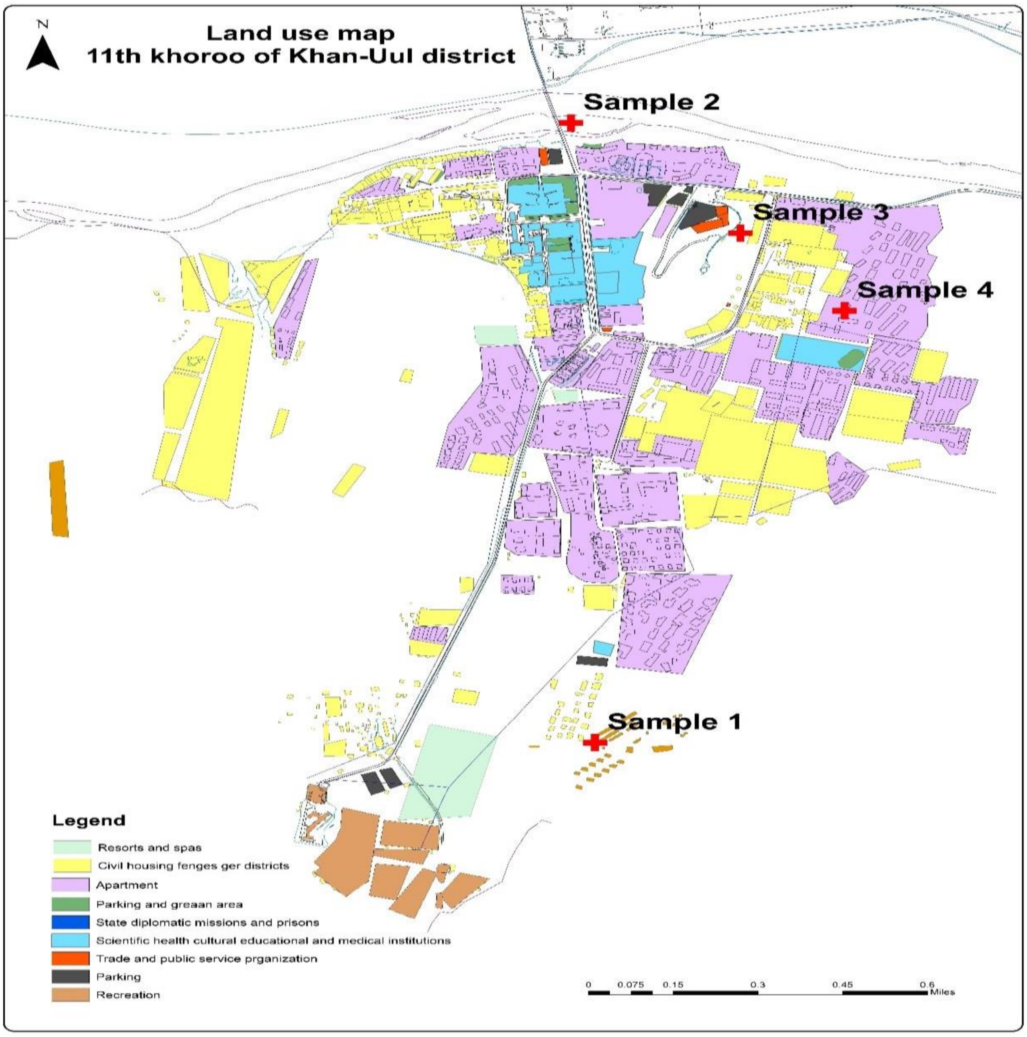

Fig. 2 Land use map /11th khoroo of Khan-Uul district/

Table 5. Humus Reserves of Undamaged Atar Soil

Soil	Soil layer	Thick(cm)	Humus (%)	Volume weight (g/cm^3)	Humus reserves (ton/ha)
Sample 1	A	0-20	8	0.9	72
	B	20-30	4.9	1.1	53.09
	C	30-60	1.3	1.2	46.08
	D	60-	0		
	Total reserves of humus per 1 hectare of soil				172.7
Sample 2	A	0-10	3.4	1.0	34
	B	10-25	3.1	1.1	51.15
	C	25-50	1.4	1.2	42
	D	50-90	0.8	1.3	41.6
	Total reserves of humus per 1 hectare of soil 168.75				
Sample 3	A	0-6	4.6	1.0	27.6
	B	6-20	2.3	1.1	35.42
	C	20-30	0.8	1.2	9.6
	D	30-50	0.1	1.3	2.6
	Total reserves of humus per 1 hectare of soil 75.22				
Sample 4	A	0-10	5.6	1.1	61.6
	B	10-30	3.3	1.1	72.6
	C	30-40	1.8	1.2	21.6
	D	40-60	1.1	1.3	28.6
	Total reserves of humus per 1 hectare of soil 184.4				

According to the results of the study, dark soil incisions were made in the mountain forest grassland, soil samples were taken, the soil morphological characteristics and layers of the soil were determined, and volume samples were collected. Laboratory analyzes determined humus, volume, rock, carbonate, and salinity of the soil. The total humus reserves of 1.0 ha of dark forest soil are 172.7 tons, 168.75 tons of mountain steppe brown soil, 75.22 tons of brown steppe brown soil and 184.4 tons of meadow soil. Due to the land use situation, the humus reserves of meadow steppe brown soil are low [Shows table 5].

Table 6. Resource of Soil Root of Erosion

Soil	Degree of damage	Soil layer	Thick (cm)	Humus (%)	Volume weight (g/cm^3)	Humus reserves (ton/ha)
Mountain steppe brown soil	High	A	0	0	0.9	0
		B	0-10	0	1.1	0
		C	11-21	0.01	1.2	0.12
		D	21	0	1.0	0
Total 0.12						
Meadow steppe brown soil	Low	A	0-5	2.8	1.1	15.4
		B	5-18	1.5	1.2	23.4
		C	18-30	0.9	1.3	14.04
		D	30-50	0	1.0	0
Total 52.84						
Meadow soil	Medium	A	0-4	5.6	1.1	24.64
		B	4-18	2.5	1.2	42
		C	18-30	1.3	1.3	20.28
		D	30.60	0	1.0	0
Total soil humus reserves/ 139.88						**Total 86.92**

Resource of soil root of erosion: It is defined the levels, signs of soil morphology by cutting soil that got into erosion. It is also determined the index: Weight, rocks, carbonate, soil roots and salt. It is a virgin soil which has no signs of erosion compared to the soils with high levels of erosion. The black soil has a constriction at the top of 15 cm, which occurs at medium soil erosion. Total resource soil erosion is humus have reached 139,88ton, it has got in characteristics of soil [Shows table 6].

Soil characteristics: The characteristics of soil erosion soil roots damage the mechanical complication of soil is to show sandy and salty.

Table 7. Resource Decrease of Soil Roots of Erosion.

Soil	Degree of damage	Erosion area, ha	Atar soil humus reserves, ha	Humus reserves of erosion soil, ton/ha	Loss of soil humus resources, ton/ha	Loss of total humus resources, ton/ha
Mountain steppe brown soil	High	97.43	172.7	0.12	172.5	16801.5
Meadow steppe brown soil	Medium	179.15	168.7	52.84	115.9	20757.7
Meadow soil	Low	119.42	184.4	86.92	97.5	11641.5
Loss of total humus resources, ton/ha						49200.7

There is in the resource decline of soil roots, and it has occupied /without interval coefficient/ high level eroded area 1680,5 /ha/tn, medium level 20757,5tn, low level area is 11641,5tn total decline of soil roots has reached 49200,7 tn [Shows table 7].

Table 8. Total Decrease of Soil Roots.

Soil	degree of damage	Loss of total humus reserves, ton	Correction factor for soil properties, coefficient	Geographical indicators, coefficient	Repair of soil classification coefficient	Total loss of humus reserves repaired ton
mountain steppe brown soil	High	16801.5	1.5	0.4	0.7	7056.7
Meadow steppe brown soil	Medium	20757.7	1.2	0.8	0.7	13949.1
Meadow soil	low	11641.5	1.3	0.9	1.0	13620.5
Loss of total humus reserves, tons						34626.2

Total decline in soil roots /repaired ton/: Total soil root decline /repaired ton/ on high eroded area is 7056,6ton, on medium eroded area is 13949,1ton, on low eroded area is 13620,5ton total soil root decline of soil roots /repaired ton /is 34626,2ton [Shows table 8].

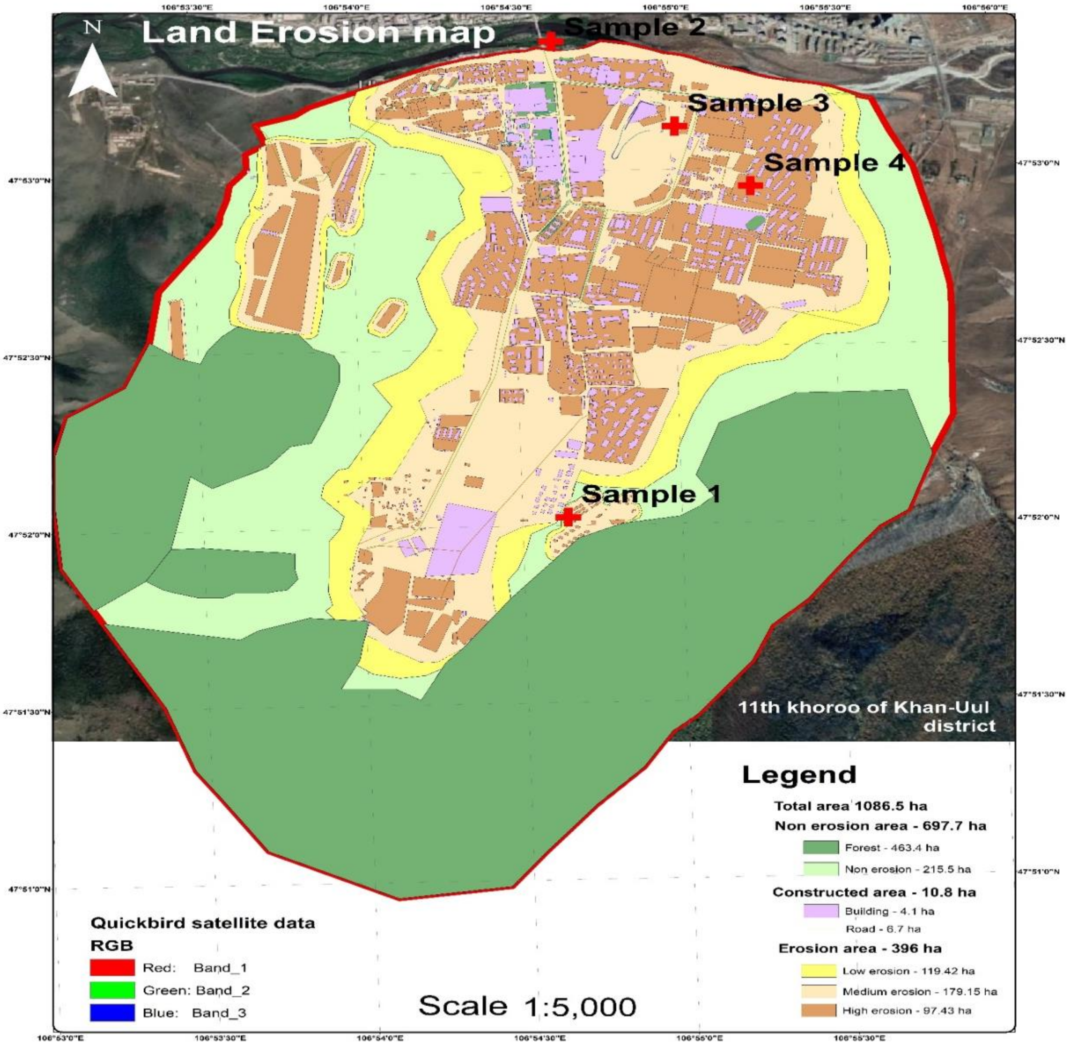

Fig. 3 Land Erosion Map

Table 9. Ecological and Economic Evaluation of Soil

Ecosystem	**Soil**	**Degree of damage**	**Degraded area, ha**	**Loss of humus resources, ton**	**Valuation billion, MNT**	**Valuation of 1 hectare of soil is, MNT**
mountain steppe	mountain steppe brown soil	high level eroded area	97.43	7056.6	1.9	276
meadow steppe	meadow steppe brown soil	medium level	179.15	13949.1	3.8	276
meadow	Meadow soil	low level area	119.42	13620	3.7	276
Total			**396**		**9.4 billion tugrug**	

Ecological and economic evaluation of the land cover that will be eroded in the future: The Zaisan slope has an area of 1086,5 hectares. Of these 697 hectares are not eroded. And the forest 482,3hectares, free soil is 215,5 hectares. Soil erosion has taken 396hectares of area. Of which 97,43 hectares are high grade erosion 179,15 hectares are medium grade erosion, and 119,42hectares are low grade erosion. The buildup area is 10,8hectares of which 4,1hectares are build up and the road 6,7 hectares. Zaisan slope is eroded resource of soil roots has reached 139,88ton, total decrease of soil roots 49200,7 total decrease of soil roots /by revised/ 34626,2ton. The total ecological and economic evaluation has reached 9,4 billion tugrug [Shows Fig 3].

4. CONCLUSION

a. 119,9hectares of square land has been granted illegally in the limited zone of the protected territory of Bogd Khan mountain and this situation becomes the decline of the ecosystem of the natural environment and comes into conflict with the natural environment law and other regulations.
b. In our study, the soil erosion on the whole area of Zaisan slope was determined and the extent of damage was found to be 119,42hectares area, 179,15hectares average, 97,43-hectare high, compared with the total area of 1086,5hectare.
c. The losses due to soil erosion have reached 9,4 billion tugrug which have already damaged areas above the mentioned and accept that there is no person who get the responsibility for the payments of the loss. In this case, the country districts department of mast write the conclusion immediately about the quality of soil and restoration of resources of soil improvement and deal with person who is using land and getting decline the soil.
d. There are various estimates made by researchers about soil erosion in Mongolia. The Government of Mongolia has developed a methodology for determining the degree of soil degradation based on the popularity of soil humus and this method is being used on a new basis. According to previous researchers, soil fertility in the Bogd Khan mountain Strictly Protected Area has declined in the area where it has been exploited, while there has been no change in the area where it has not been exploited or disturbed. Because of urbanization, the number of plant animal species may have decreased.

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