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NATURAL REHABILITATION POTENTIAL IN MINING AREAS

Masters Thesis

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Statutory Declaration

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I hereby affirm in lieu of an oath that I provided the submitted master thesis

NATURAL REHABILITATION POTENTIAL IN MINING AREAS

I did not use any sources other than those stated. In case that the work is additionally submitted on a data medium, I declare that the written and the electronic form are completely identical. The work was not submitted in the same or similar form to any examination authority.

Ulaanbaatar, 2023 - June – 5th

Place, Date

Signature

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1. Introduction

In recent decades, soil erosion in Mongolia has intensified, and the general level of soil fertility has decreased. The effects of global warming, and human activities such as grazing pastureland, mining operation, intensification of agriculture, urbanization, and road damage are the main causes of soil cover degradation. The process and extent of soil erosion and degradation varies depending on the geographical locations. This work will cover the part of climate, soil, and vegetation of the mining area.

It is only environmental factors left tapped and used its resource by mining activity while social and economic factors can receive its accounted valuable amounts. The planning on rehabilitation activity of the mining disturbed land requires 3 main measurements such as mining technical factors, social and environmental factors. The result of taking appropriate measurements of these activities, the biological benefits of the land damaged during mining work will be restored, and the outcome of the residual environment would not be much far of those original form. The social descrimination also capable of characterizing the rehabilitation potentiality in Mongolian South and North area's different ecosystems.

1.1. Problem

During the last couple of decades, a capacity of mining machinery and technologies developed more heavier and stronger than before on extraction. Thus, the scale of human interaction with nature is expanding with other types of interactions such as agriculture and pasureland consumeration.

In addition to antropogenic impact, the side worsening issue of climate change and global warming we receive is the double burdening sign on the environment natural .

Human attention already started focusing on the prevention of environmental adverse impacts, such as loss of soil natural characteristics and water contamination by the mining inappropriate extraction. The existing soil cover of the untapped earth holds its own rich natural ingredients.

Due to the ecosystem characteristics of the geographical location, there is clearly diffferent analysis being identified in pointing the rehabilitation potential of mining areas. So it is necessary to dig in to differentiate the possible rehabilitation characteristics on the most suitable ecosystems. And discrimination of the potentiality by the ecosystem and location makes how to achieve optimized mining rehabilitation results.

On the other hand, Mongolia is one of the natural resource rich countries, where dominating explorations are copper, coal and gold. There are numerous significant coal mining explorations in continuous activity, located in South Gobi of Mongolia, particularly in the Omnogobi province, where Tavan Tolgoi mining, Southgobi sands LLC, Mak LLC etc.

According to the data of the National Statistics committee, most of the national economic resources are rely on the mining income, where for instance in 2021, the total mining sector's income for county were encountered to be 4.1 trillion MNT out of the State budget revenues of 14,2 trillion MNT. Which means that the only mining sector is shaping up one out of 3 of the State revenue, that detailly described as 28.8% of the Total revenue of the State. It also refers to only coal pattern in the mining sector is dominating those revenues, such that forming out 980.8 billion MNT revenue (23.9%) of the mining sector. Similarly, it is outlined as approximately 7% of the Total State revenue (NSC, 2022). The coal mining became the remarkable presenter of the State export dominator, which ensconced staggering 93 percent of the State exports area (NSC, 2022). Thus the importance of mining to the State economy cannot be overstated, as it has been a key driver of economic growth (Interesse, 2023).

However, this large dependance on the mining sector has also made the country vulnerable to swing into economical risk in World production prices, as seen during the recent downturn in the global mining industry (Interesse, 2023).

With all economical burden of the mining exploitation results rapid soil erosion and degardation of both pastureland and watercourses, that has being encountered to result drastically altered its natural complexity.

The policies and law inforcements in relation to the environmental rehabilitation activity has considered dramatically with its follow up implementation through Environmental management plan (EMP) of annual based approvals by the central and local Environmental authorites amongst the bigger scaled minings. Other than that, for both the small-scaled and privately owned artisanal minings estimated over 100.000, who forms nearly 20 percent of Mongolia's rural workforce. The rehabilitation law force doesnt usually applied with each officialized approval documents. Also, the abandoned mining in 80's were also in a state of required to be rehabilitated.

1.2. Aim of the work

The aim of this work is to concentrate on the key terminology of the rehabilitation factors using the concept of pyramide (Figure 8. Rehabilitation pyramide (Knippertz,M. 2005: Analysis of rehabilitation potential for copper mines in Zambia and Mongolia) where the most impacting factors involved to predict the most suitable natural rehabilitaion potential throughout Mongolian natural ecological zones. Therefore, the verification values of the work is overlaying the existing mining site's soil sample results by ArcGIS model-builder method for determining the rehabilitation potential of selected locations of the mining areas.

This thesis is structured as follows: chapter 1 contains the introductory of mining sector briefs on Mongolia, and rehabilitation terminology lines icluded. The methodology is illustrated in Chapter 3, where it is involved the 2 selected ecozones to consider itus contrasting environmental factors for raitng for thesis analysis. The study areas covers amongst both Mongolian Forest-steppe and Desert areas (Chapters 2). That considered brief classification of the climate, soil formation and about vegetation of ecological zones. The results are presented in Chapter 3.6 and then critically discussed in Chapter 4. Finally, a summary is given in Chapter 5.

2. State of the art

The trend of natural rehabilitation in mining areas was gaining recognition as a promising approaches to address the environmental impacts of mining. Researchers were exploring various aspects of natural rehabilitation, ecosystem dynamics, and the development of sustainable mining practices (Zanxu Chen, 2022).

Traditional mineral exploration approaches mainly uses open mining, that they cannot bring the mineral without removing the soils and vegetation that overlay them, and nearly always generate wastes which have to be disposed of on the surface, mining causes major damage to whole ecosystems (Bradshaw.A, 1997).

As mines expand, Accumulating pollution and CO2 emissions in one location also increase dramatically. The habitat is initially reduced by the mines for both people and for flora and fauna and often there is an impairment even after the mine has been closed.The extent and duration of this impairment depend to a large extent on renaturation, recultivation and stabilization of the mine areas. The potential for rehabilitation of the mining area can vary depending on economic, environmental and political considerations (Knippertz, 2005).

Coal mining exploration has started shortly after the victory of the People's Revolution in Mongolia, on December 25, 1922, the new Government decided to nationalize the Nalaikh coal mine, and the foundation for the development of the mining industry in our country was laid from 1976 to 1985, promoted the development of the mining industry. Where there is experience in coal related extraction practices developed over 90 years in Mongolia (MRPAM, n.d.).

However, the consideration on the environmental side has forgotten to take care of its part, that natural resources are the main limited bearer, yet the one main pillar of the 3 complex content (environmental, economic, and social). According to the data of National Standard Center, the national coal export increased to 31176.7 thous.tn in 2020 (NSC, 2022) meanwhile the abandoned mining area counted more than 8000 hectares in

Mongolia (NSC, 2022). In terms of high mining production demand, the rehabilitation activity simplication is much important to modify the revenue into valuable prouction for purpose of easing the vulnarability on mining sector.

Mongolian Government resolution of Mining rehabilitation methodology is based on the regulation of Mining rehabilitation procedure Resolution No A-138 of 2015 by the MNET "Methodology of technical and biological rehabilitation of damaged lands due to mining activities" along with the related MNS standards such as MNS 5914:2008 Environment. Land reclamantion. Terms and definition (MASM TC 07 Environment, 2008).

The fundamental characteristics of the mining rehabilitation strives to conserve the disturbed land into the as possible likely condition of its commencement state.

The terminology regarding what rehabilitation means of, and how it varies (Figure 1) in terms of its action result.

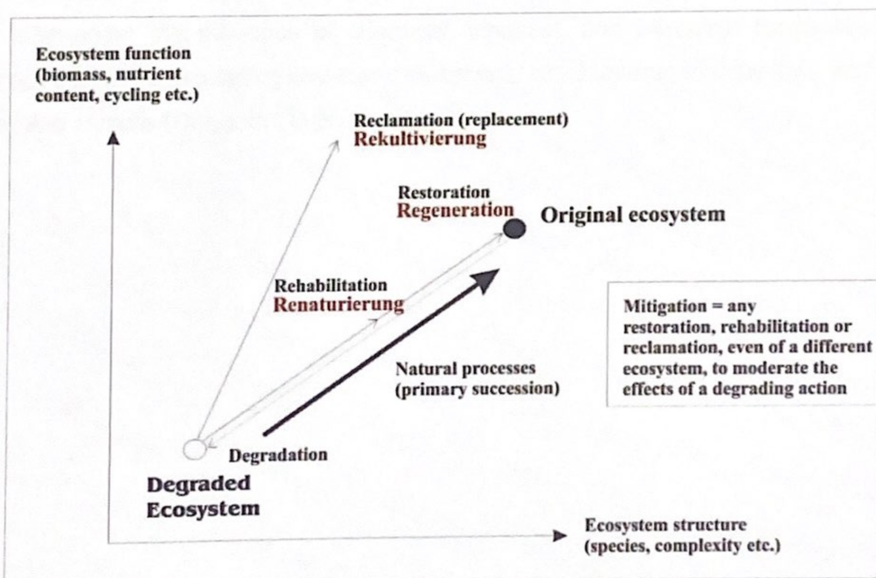

Figure 1. Various terms of rehabilitation ((Bradshaw.A, 1997))

Restoration – returning the land to its previous topography and vegetation cover.

Reclamation – returning land from an abandoned or derelict state to an aesthetically pleasing and a 'safe' condition.

Rehabilitation – returning the land to a different and usually productive use.

Remediation - Remediation is the cleanup of a contaminated area. Remedial actions remove or isolate contaminants from the environment.

Soil

The natural condition of Mongolia has its unique individual system and there are intercontinental environments including local geological history, high mountain belts and specifics of slopes, plain steppe, intermountain depression characteristics. Nonetheless, the distinct significant contrasts of natural factors in different parts of the country define specific soil formation (Sandag, 2021). Soil is one of the parts of the ecosystem that is outlined because of the correspondence of other habitant natural factors. Soils develop over time under the influence of chemical, physical, and biological processes. They developed by the surrounding rocks and sediments which interactions by flora and fauna, water, and climate (Dorjgotov.D B. , 1986).

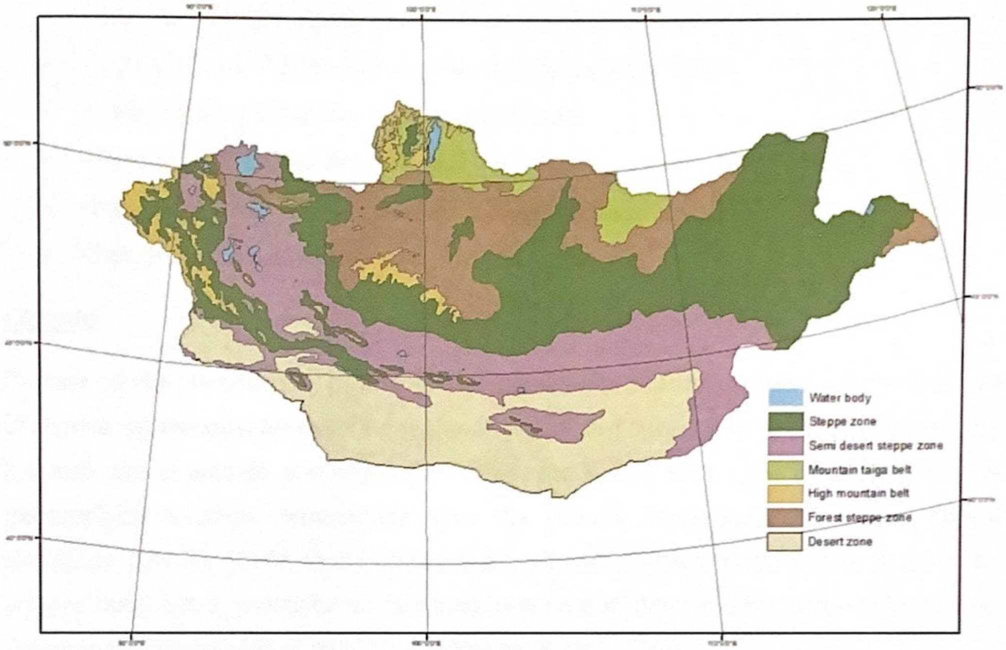

Figure 2. Mongolian ecological zone map – (own representative) (EIC, 2017)

The ecological zone refers by Simon,h: "A zone or area with broad yet relatively homogeneous natural vegetation formations, similar (not necessarily identical) in physiognomy. Boundaries of the EZs approximately coincide with the map of Köppen-Trewartha climatic types, which was based on temperature and rainfall. An exception to this definition are "Mountain systems", classified as one separate EZ in each Domain and characterized by a high variation in both vegetation formations and climatic conditions caused by large altitude and topographic variation (Simons, 2001).

<u>Specific of soil properties of Mongolia </u>(Batkhishig, 2015)

- High elevation of territory and sporadically distribution of permafrost. More than 80% of territory of Mongolia is higher than 1000 m above sea level
- •Domination of soil forming process in the minus temperature, short biological active period, 3-5 month in year

- •Mountain, Forest, Steppe and Desert soils presented
- •Slow process of chemical weathering and clay formation
- •Carbonate accumulation in the steppe soils
- •Gypsum in the Gobi desert soils
- •Stony soil profile and Organic accumulation layer
- •Paleo-cryomorphic features in the soil profile

Climate

Climate can be described as having a harsh continental characterization. Where, this type of climate varies considerably from region to region, not only due to latitudinal differences, but also due to altitude and vegetation cover, etc. It also shows the influencing factors geographical location, remoteness from the oceans, topographical features, global circulation (UNEP, 1996). In the Gobi Desert, annual rainfall is only 40 mm. Small inter-annual variations in precipitation can lead to severe drought events, with some regions not experiencing rainfall at all (Climatic Research Unit, 2020).

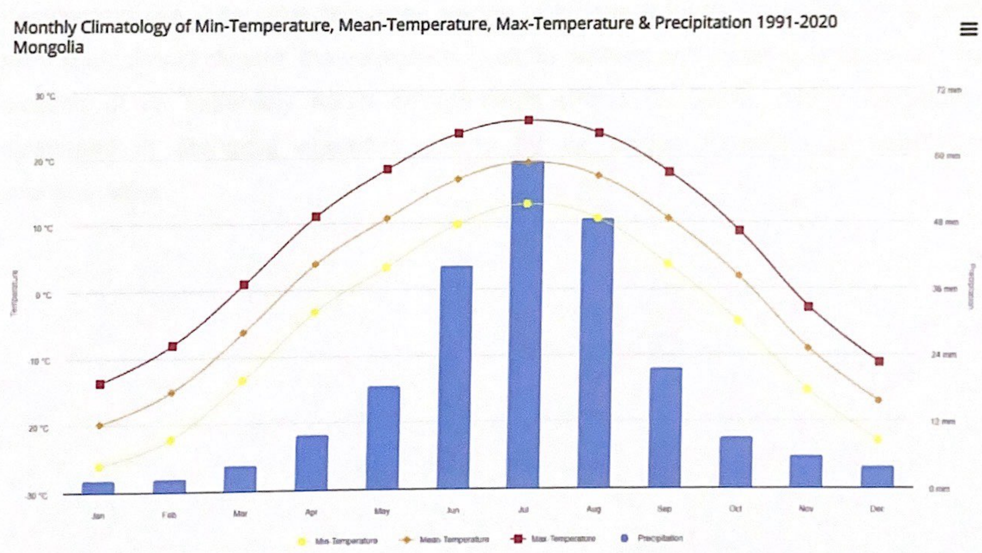

Figure 3. Mongolian climate mean indicators (Climatic Research Unit, 2020)

Mongolia is considered to have the driest climate in the region of the globe, and the ratio of precipitation to evaporation in most areas ranges from 0.05 to 0.65 (aridity index), which makes it a vulnerable country to desertification. The amount of precipitation is many times less than the evaporation of the soil, in other words, there is a lack of moisture in general. The amount of evaporation is less than 500 mm in the high mountain area, 550-700 mm in the forest-steppe area, 650-750 mm in the steppe area, and 800-1,000 mm in the desert area (UNEP, 1996).

There is an aridity index that is widely used to express the wetness and dryness of the climate, i.e., the ratio of annual precipitation and total evaporation of plants and soil (R/E) in the area.

Flora of Mongolia

Mongolia is a vast land-locked country, consists of tectonic forces tilted to the North, that influences extremes of continental climate. Culturally the people are mostly nomadic, having been sustained for centuries by an economy based on domestic livestock pastureland use. The large fenceless steppe of Mongolia forms the plants for grazing. With such utmost climate, the vegetation must be resilient and dynamic to cope with the dictates of its extremely harsh environments (Peter D. Gunin, 1999). Vegetation distributed in Mongolia classifies clearly by its unique formation of vegetation characteristics.

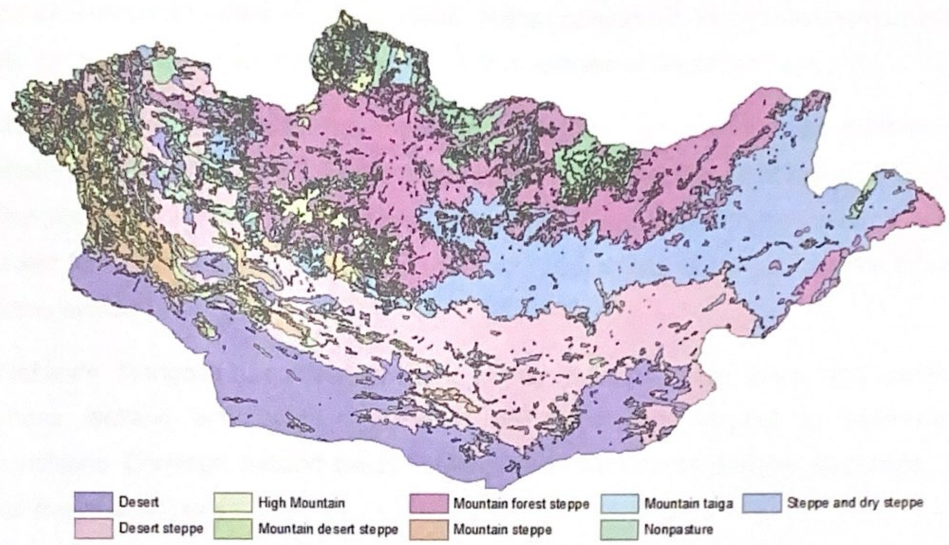

Figure 4. Mongolian vegetation class map ((EIC, 2017))

The vascular plant distribution by individual 16 phytogeographical regions of Mongolia were identified. The highest richness of vascular plant species (1636 species) identified in Mongolian-Altai phytogeographical region, and the lowest species are found in Alashan- Gobi region (272 species). Furthermore, there are 689 species (22.03%) were counted only in one region, however 14 species (0.44%) spread in all phytogeographical regions to the vascular flora of Mongolia (Urgamal.M, 2017).

As a result, Mongolia supports a variety of vegetation types that are adapted to different environmental conditions. Here are some of the major vegetation types found in Mongolia:

Steppe: The steppe is the dominant vegetation type in Mongolia, covering large portions of the country. It consists of vast grasslands with sparse to moderate vegetation, featuring various grass species and herbs. Steppe vegetation is well adapted to the dry and continental climate of Mongolia.

Desert: Mongolia has several desert regions, such as the Gobi Desert and the Taklamakan Desert. Desert vegetation in Mongolia is adapted to arid conditions and includes drought-tolerant shrubs, grasses, and succulents. Some notable desert plants in Mongolia include saxaul, tamarisk, and various species of desert grasses.

Mountain Forests: Mongolia has mountainous regions, particularly in the northern and western parts of the country. These areas support forest vegetation at higher elevations. The mountain forests consist of coniferous trees like Siberian pine, Siberian larch, and fir. Mixed forests of deciduous trees such as birch, aspen, and willow can also be found in some areas.

Wetlands: Mongolia has several wetland areas, including lakes, rivers, and marshes. These wetland ecosystems support unique vegetation adapted to waterlogged conditions. Common wetland plants in Mongolia include reeds, sedges, bulrushes, and various aquatic plants.

Alpine Tundra: In the high-altitude regions of Mongolia's mountains, alpine tundra vegetation is found. These areas have low-growing, hardy plants like mosses, lichens, dwarf shrubs, and grasses that can withstand harsh weather conditions and short growing seasons.

It's important to note that the vegetation types in Mongolia can vary depending on factors such as altitude, climate, soil conditions, and human activities. Additionally, there may be transitional zones or unique plant communities in specific regions.

Hydrogeology

Due it its a landlocked characterization in Central Asia, it exhibits diverse hydrogeological conditions across its territory. Mongolian hydrogeological conditions are:

Aquifer Types: Mongolia features several aquifer types, including shallow and deep aquifers. Shallow aquifers, often found near river valleys and basins, provide relatively accessible groundwater resources. Deep aquifers, located in the central and southern parts of the country, typically require more extensive drilling to access.

Water Availability: The availability of water resources varies across 29 different water basins (Figure 5) of Mongolia. The northern and western parts of the country generally have higher precipitation levels and more abundant water resources compared to the southern and eastern regions, which are characterized by arid and semi-arid conditions.

Water Quality: The quality of groundwater in Mongolia can vary significantly depending on the location. In some areas, natural mineralization and high salinity levels may pose challenges for certain uses, such as drinking water supply or irrigation. Monitoring and management of water quality are essential to ensure sustainable utilization of groundwater resources.

Vulnerability to Climate Change: Mongolia is particularly susceptible to the impacts of climate change, including changes in precipitation patterns and increased variability in water availability. The melting of glaciers and permafrost in mountainous regions can affect groundwater recharge rates and alter the hydrological cycle.

Water Management Challenges: Mongolia faces various water management challenges, including inadequate infrastructure, inefficient water use practices, and limited access to safe drinking water in rural areas. Balancing competing demands for water resources, particularly between mining operations, agriculture, and local communities, is an ongoing challenge.

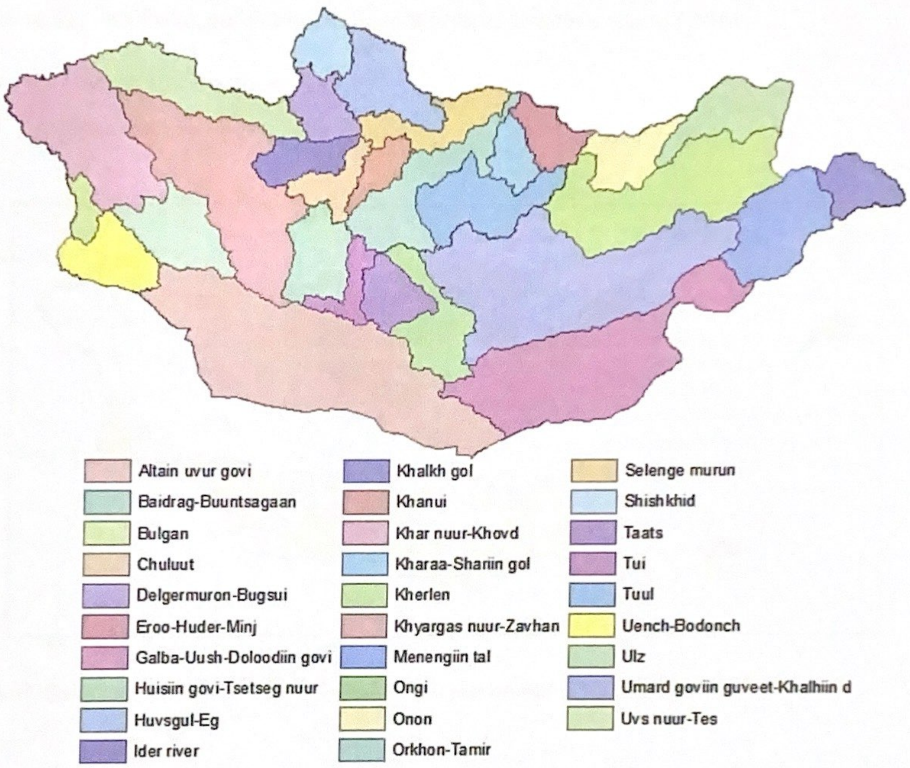

Figure 5. Water basins of Mongolia (EIC, 2017)

<u>*Ecological zoning of Mongolia*</u>

Ecological zonation of Mongolia is divided in 6 complex features, where it differentiates by climate, biodiversity, and territorial combinations and other special uniqueness. For instance, when you imagine if you were in September, somewhere in the desert zone, located far south of Mongolia – you will experience temperature of more than +20^{0}C, particularly see vertebrates, lizards, snakes. Meanwhile, if you were in "Mountain taiga belt" region at the same time, where it is relatively low temperature as minus 0^{0}C, with no trace of vertebrates can be seen. However, the characteristics vary in terms of vegetation species, soil, water, economic and social regime besides climatic and fauna ecosystems.

In this study, we have selected 2 different characterized zones, below:

- III- Forest steppe zone
- VI-Desert zone below (see Figure 6)

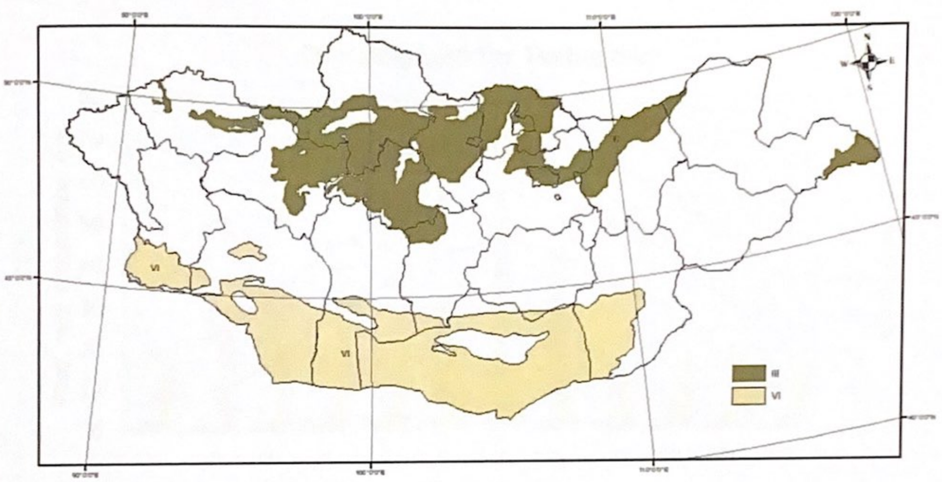

Figure 6. Selected ecological zones – (own representative) (EIC, 2017)

2.1. Ecological zone III - Forest steppe zone

Mongolian sub northern area covers along the parts of 9 provinces of Mongolia, where its soil, vegetation and climatic situation is similar.

<u>Soil formation</u>

Mountain sandy kastanozem soil is Dominating, distributed along the lower body of the mountain gravelly sandy kastanozem soil. It has more fertile components and thicker humus layer than the mountain gravelly sandy kastanozem soil. Profile 2 and 4 depicts the morphological characteristics and amount of fertile components of mountain sandy kastanozem soil (Batkhishig, 2015).

<u>Climate</u>

According to the climatic classification the project area belongs to the mountainous region of Khangai zone. Seasonal climatic period of the year has extreme fluctuation which is depending on ambient weather forming condition of specific characteristics. Four seasonal periods are depicted in Figure 7 (Namkhaijantsan.G, 2002).

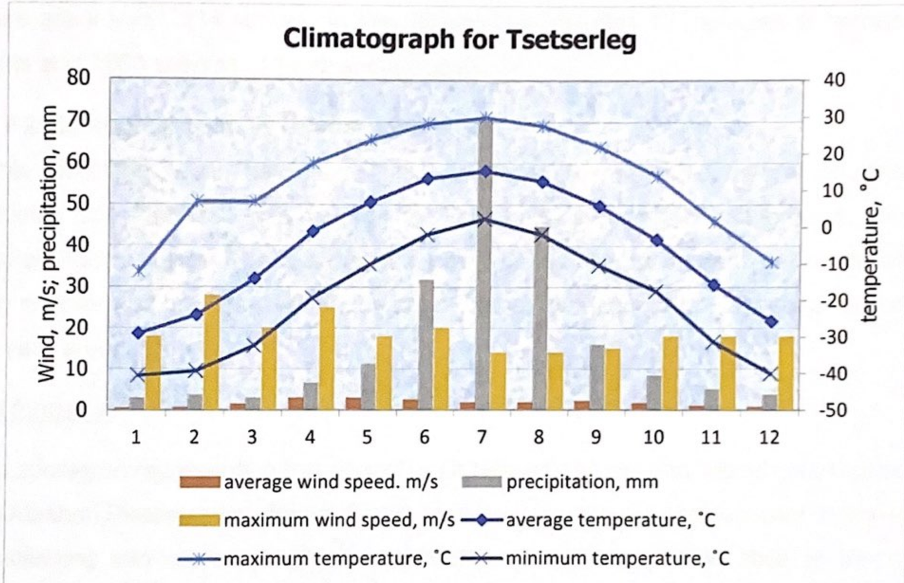

Figure 7. Climatograph of the year

In terms of the global warming within the area, the mean annual temperature in the Hovsgol mountain region has increased by 1.68 °C over the last 40 years, this indication shows greater than the global average (Namkhaijantsan.G, 2002). It also observed that this increase were greater in winter than in summer (Batima.P, 2005).

Vegetation

The area is divided in Khangai mountain-forest-steppe zone, while 16 flora-geographic zones based on the natural environmental and ecological condition.

Flora of this zone are unique, native species that include plants of high mountain of Altai-Soyon and Daguur-Mongolian steppe plants. There are about 20 unique plant species recorded in this zone. These are: Yulden fern, *Yunatov lycopodium*, *Chesneya borissovae* *pavlov*, *Kobresia robusta*, *Carex parva*, *Minuartia rregeliana*, *Schizahne callosa*, *Viola altaica*, *Scrophulariaceae Juss*, *Lathyrus quinquenervius*, *Chelidonium denudatum*, *Alchemilla cyrtopleura*, *Potentilla bifurca*, *L*, *Bettula rotundifolia*, *Diarthron linifolium*.

Khangai mountain-forest-steppe region makes up 17.59% of total territory of Mongolia. There are a total 1214 species in this region. This includes 151 species of herbaceous plants and 1063 species of trees and shrubs.

2.2. Ecological zone VI-Desert zone

In this part of the thesis, the climatic influence on the other factors of natural rehabilitation including soil formation and vegetation. Due to its hot, dry characteristics, the soil specially forms in gravelly and sandy features, and the vegetation become scarce with its both species and biomass. Within the desert zone, the evaporation takes place along all the year around.

Soil formation

This ecoregion represents a transitional zone between Mongolian-Manchurian grassland and Alashan Plateau semi-desert. Shrub semi-desert cover the northern part of the region transitioning into more xerophytic communities on sandy, rubble soils to the south (MacKinnon, 1996). There are dominatng 2 types of soils distributed in the area, where semi desert gleyish soil and brown Gobi soil (Batkhishig, 2015).

In terms of the soil formation process takes place in dry conditions, the wind activates soil air exchange, causing to increase in evaporation and dries out the plant moisture. Therefore only small amount of the roots become fertilized, and the amount of organic residues is very small, hardly exceeding 1%.

Climate

The climate here is similar extremely harsh dry climate and continental characterised by large scale. Summers are warm to hot, depending on elevation, and winters are intensely cold. Winter conditions are harsh due to the rare mountain occurance to shelter the region from cold northerly winds. The mean annual temperature varies from -2 to -6°C, with

January mean temperatures of -20 to -28ºC. Annual precipitation here is extremely scarce about 100 to 150 mm, although total precipitation varies considerably from one year to the next. Most of this precipitation falls during summer (Ulziihutag.N, 1989.)

Vegetation

Vegetation tends to be homogenous across vast areas of the Eastern Gobi Desert Steppe and distinct from the vegetation of grasslands to the east and deserts to the west. It consists of drought-adapted shrubs and thinly distributed low grasses.

Due to the climate and soil characteristics of Gobi, the density of vegetation is low, the sparce vegetation cannot cover the whole soil, it appears to be found in very sparce area, but it is characterized by its unique nutrient quality.

Dominant shrubs include Caragana species (C. bungei and C. leucocephala). This shrubby legume is also dominant over much of the Tibetan Plateau in the transitional area between the cold, moist grasslands of the east and the cold deserts of the western plateau. Other shrubs include gray sparrow's saltwort (Salsola passerina), gray sagebrush (Artemisia xerophytics), Potaninia mongolica, and Nitraria sibirica. Low grasses include needle grass (Stipa gobica and S. glareosa) and bridlegrass (Cleistogenes soongorica).

3. Methodology

The main concept of the methodology on natural rehablitation potential is based on the rehabilitation pyramide below (Knippertz, 2005). Where it appears that bottom of the pyramide has summed up with 2 main information of the site, the first one is the socio-economical information, the second comes up with the physical geographical features. The reason of choosing the pyramide the main concept., is that both impacts of environmental and anthropoenic impacts being calculated.

3.1. Rehabilitation pyramide

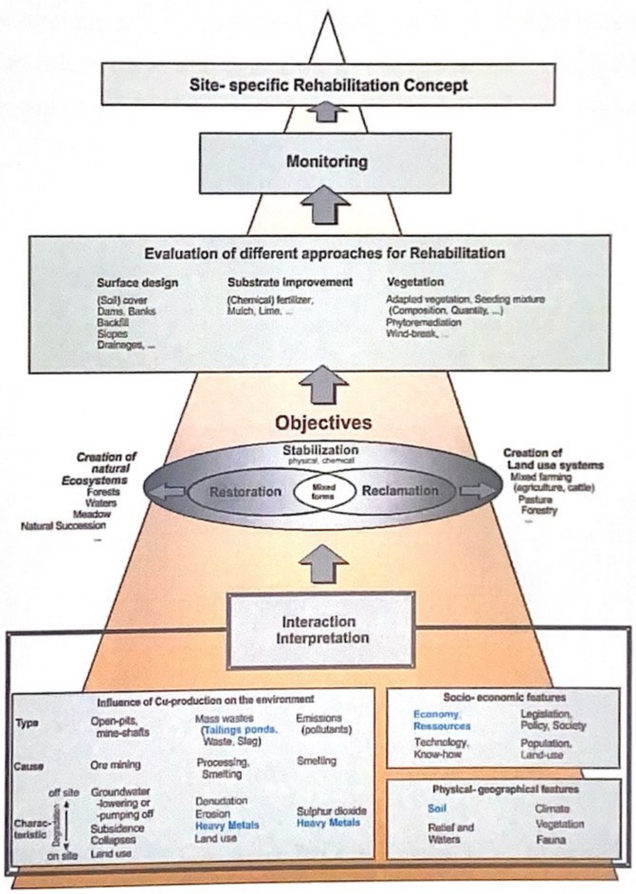

Figure 8. Rehabilitation pyramide (Kniperz,M. 2005: Analysis of rehabilitation potential for copper mines in Zambia and Mongolia)

The studies in relation to the natural rehabilitation potential covers many challenging factors out of the environmental, social and economical factors. In this paper, it focus on the soil, climate and social contributions based on the rehabilitation pyramide's (Knippertz, 2005) main factors, due to its participation percentage of rehabilitation activity.

3.2. Rating of the natural rehabilitation potential

The potentiality of the natural rehabilitation is selected with the most influencing criterias related to the ecosystem determinations. Furthermore, the publictly available Open data is used to determine national ecozone and its specification (EIC, 2017). The ecozones descriminiations relevant to the analysis of the rehabilitation potential is carried out here, that presented in chapter 2.1 and 2.2. Due to the restrictions mentioned, the analysis were tim consuming for all the factors described in the pyramide (Knippertz, 2005).

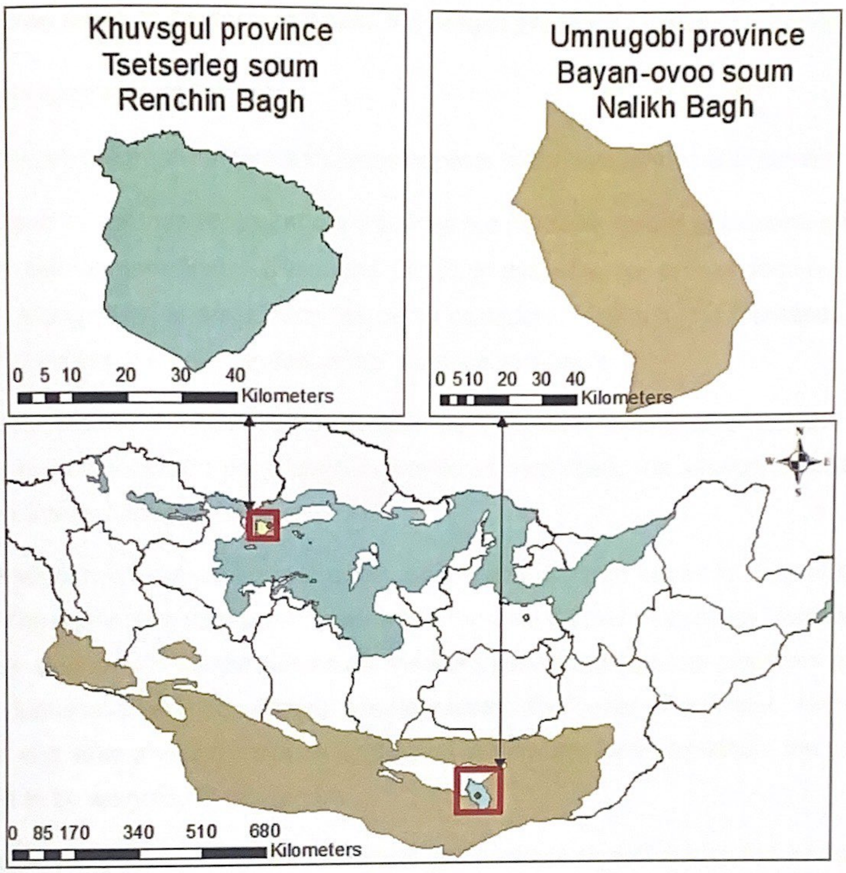

Figure 9. The verification area of the natural zones (USGS, 2020) Own representative)

In the development stage of the natural rehabilitation potential, verification procedures should have taken in consideration to make the methodology meets its intended values of the regions specfications.

For the weighted overlay of the factors presented, the basic data used for the individual indicators and their ratings are presented below. The indicators are reclassified into ten classes, with class 10 being rated as very good and class 1 as poor (Knippertz, 2005).

3.3. Ren Bagh of Tsetserleg soum, Khuvsgul province - Forest steppe zone III

Physical-Geographical Factors

The physical-geographical factor includes aspects of soil, vegetation and climate.

With regard to soil, numerous factors influence the possible spread of contaminants and the potential for rehabilitation (Knippertz, 2005). In this work, soil erosion factors of slope degree, topography, and soil densities being considered – due to the increased risk of erosion, besides the main aspects of soil chemical indicators.

Other relevant pedological structures, such as the redox conditions of the soil or the specific hydrological conditions, are not considered here due to the data situation and the complex interactions among each other.

The vegetation is assessed in this paper, where analysis with regard to their stabilizing effect. The dominating vegetation cover within the area is perennial speppe Artimisia and Meadow steppe with carex duriusculia -needlegrass-various grasses with formation of carex duriusculia and dominating needlegrasses distributed. Prevention from wind erosion and strengthens the slopes by the root system, the less vegetation, the worse a rating is to be weighted in this regard.

With regard to the climate, three influences are particularly decisive for the course of a potential rehabilitation: The interaction of precipitation amount, precipitation intensity and wind speeds influence the risk of erosion to a large extent. In the following it is assumed that events with high rain intensity and thus high rain erosivity occur particularly frequently in regions with a unequal distribution of annual precipitation (Knippertz, 2005). In addition to the amount of precipitation and the wind speed, the seasonality of precipitation is also included in the assessment.

3.3.1. Climate condition

The data (1987-2010) of the Chandagat meteorological station, located 22 km north of the Bagh area (meteo-station, 2012) was used to describe the general climate conditions of the field area. According to the climatic classification the project area belongs to the mountainous region of Khangai zone (Khurgatai khairkhan LLC, 2012).

Temperature

In Tsetserleg soum, average air temperature varies -14.1°C to -29.1°C in November to March, and -3.3°C to +15.4°C in April to October. The warmest month is July and with an average temperature of 15.4°C in this month. The coldest month is January and it reaches -29.1°C. The lowest air temperature reaches up to -40.6°C in January and the highest temperature reaches +30.0°C in July.

Table 1. Climatic characteristics of Bagh area

Month / Parameters	1	2	3	4	5	6	7	8	9	10	11	12
Average temp of month, °C	-29.1	-24.0	-14.1	-1.1	6.9	13.4	15.4	12.6	5.9	-3.3	-15.7	-25.7
Max temp, °C	-12.2	-6.9	7.0	17.5	23.8	28.3	30.0	27.7	22.0	13.9	1.5	-9.5
Min temp, °C	-40.6	-39.3	-32.4	-19.3	10.1	-2.0	2.4	-1.9	-10.4	-17.4	-31.3	-40.0
Wind speed, m/sec	0.6	0.7	1.5	3.0	3.0	2.5	1.8	1.8	2.2	1.7	1.0	0.8
Maximum wind speed m/sec	18	28	20	25	18	20	14	14	15	18	18	18
Total precipitation, mm	3.1	3.8	3.1	6.7	11.4	31.9	70.5	44.8	16.1	8.5	5.1	3.9

Precipitation

According to the Tsetserleg meteorological data, the average annual precipitation is 208.7 mm and most of the precipitation, about 90.9% (189.8 mm) falls during the warmer months and the other 8.1% (18.9 mm) precipitation occurs during winter. There are around 49.2 rainy days and 18.1 days with stable snow cover. Also there is an average of 1.6 stormy days and 2.2 foggy days during the year.

Near the Bagh area snow covers exists usually from November and melts in March (the technical weather documents of Mongolian railway G.Namkhaijantsan, Ulaanbaatar, 2002). During the the summer period, the relative air humidity ranges between 48-71%.

Wind

In Tsetserleg soum the average wind speed reaches 0.6-3.0 m/sec with a maximum wind speed of 28 m/sec. The wind throughout the year is predominantly from the west and the average annual atmospheric air pressure reaches 823.3 hPa.

The maximum wind speed of 18-28 m/sec occurs in winter, 18-25 m/sec in spring, 14-20 m/sec in summer and 15-18 m/sec in autumn. There are about 51.6 dust storm days throughout the year. Table 2 below gives the wind direction frequency of the area.

Table 2. Wind direction frequency Renchin bagh area (%)

month	N	NE	E	SE	S	SW	W	NW
January	6	3.6	1.4	0.9	0.1	3.4	70.8	13.8
April	5.1	7.1	2.5	2.4	1.5	13.3	58.4	9.5
July	6.8	11.8	9.7	6.6	3.6	9.1	44.6	8
October	3.6	5.7	3	2.2	1.3	9.9	69.1	5.1

According to Table 2 and Figure 10, the wind direction is predominantly from the west throughout the year with a frequency of 44.6% to 70%.The wind direction frequency varies and depends on the relief and shape of the land surface of local area.

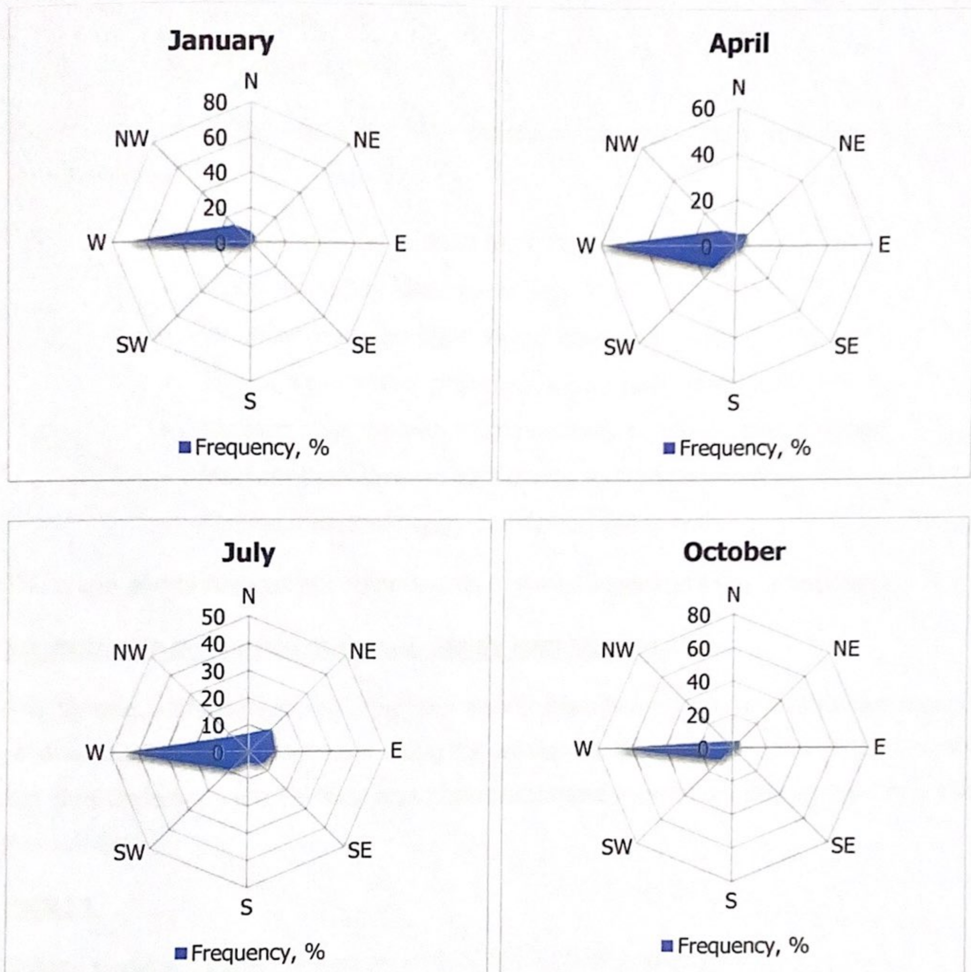

Figure 10. Wind direction frequency of January, April, August and October of the area

3.3.2. Soil

According to the physical and geographical subdivision of Mongolia the Tsetserleg soum belongs to the Khovsgul region. Soil chemical analysis was performed and the following parameters were determined:

1. Soil humus

2. Total nitrogen
3. Soil pH environment

There were Six different types of brown/kastoanozem soil and 1 inter-regional soil type were identified:

- Inadequately developed mountain sandy kastanozem soil
- Mountain sandy kastanozem soil
- Mountain meadow light clayey kastanozem soil
- Thin layered friable gravelly sandy kastanozem soil
- Medium thick layered friable gravelly sandy kastanozem soil
- Medium thick layered light clayey kastanozem soil
- Alluvial meadow-boggy carbonatic saline soil

The origin and fertile content components of the soil types are described below:

Inadequately developed mountain sandy kastanozem soil

The Inadequately developed mountain sandy kastanozem soil is distributed along the relatively stable eluvial sediment along the western area at an elevation of 1861 m above sea level underlying the *Festuca* and *Stipa* dominated vegetation. Soil profile 1 represents this soil type.

Profile 1

Ground surface: Dome of small mountain, flat surfaced, gravelly

Location of Profile 1: Territory of bag-3, Tsetserleg soum of Khovsgul aimag,

X= 49^0 24' 30,9" Y= 97^0 58' 18,9" Elevation=1861,0 m

60-70% of top layer of the 1 m^2 soil is gravel and diameter of gravel is 5-20 cm and very gravelly.

A-0-5 cm: Has dark brown color, damp, plant roots are present, has fragile lumpy structure, light clayey and contrast between the layers is sharp.

Ск-5-8 cm: Has light brown color, damp, plant roots are present, and relatively less gravelly.

Humus layer thickness of poorly developed mountain sandy kastanozem soil is 0-5 cm, and humus content in it is 2,6 %, the amount of mobile phosphorus contained in 100 g of soil is 1,76 mg and exchangeable potassium is 13.6 mg which indicates that the fertility of this soil is below the average in terms of the content of fertile components (Table 4).

Mountain sandy kastanozem soil

Mountain sandy kastanozem soil is distributed along the lower body of the mountain gravelly sandy kastanozem soil. It has more fertile components and thicker humus layer than the mountain gravelly sandy kastanozem soil. Profile 2 and 4 depicts the morphological characteristics and amount of fertile components of mountain sandy kastanozem soil.

Profile 2

Ground surface: Side of a low mountain with a 12° slope elevated 1046,0 m above sea level.

Location of Profile 2: Territory of Bag 3 of Tsetserleg soum of Khuwsgul aimag,

X= 49^0 23' 52.04" У= 97^0 57' 18,9" Elevation =1795,0 m

Morphological description of profile 2:

А-0-11 cm: Dark brown color, sparse plant roots present, damp and loose dusty, color contrast is bright when transitions to next layer.

Вк-11-22 cm: Light yellowish color, not sparse but dense and damp. Few vegetation roots and light sandy crumbled gravels present. Color contrast is clear through layer transitions.

ВСк-22-55 cm: Yellowish color, plant roots absent and sandy. Color contrast blurred when transitions to next layer.

Photo 1. *Vegetation in 1m square area*

Photo 2. *Ground surface*

According to chemical analysis results of Profile 2, the humus layer thickness is 11-15 cm, the maximum amount of humus content is 3.36-3.91 %, total nitrogen percentage is 0.16-0.19%, and soil pH environment is 8.20-8.25 or weak basic, mobile phosphorus amount contained in 100 g of soil is 2.05-2.34 mg and exchangeable potassium amount is 12.0-16.0 mg. This is sufficient amount of fertile components for planted and natural vegetation to grow.

Mountain meadow light clayey kastanozem soil

Mountain meadow light clayey kastanozem soil is distributed along inter mountain narrow valleys over the deluvial carbonated sediment where damp meadow vegetation dominates. Morphological characteristics and content of nutrient components of Profile 16 and 5 are described below.

Profile 16

Ground surface: Narrow valley in between small mountain, 8^0 slope.

Location of Profile 16: Territory of Bag 3 of Tsetserleg soum of Khuwsgul aimag.

X= 414668 Y= 5464186 Elevation =1893,0 m

Morphological description of profile 16:

A-0-25 cm: Dark color and damp, sparse vegetation roots present and dense but fragile granular structured

Вк-25-40 cm: Light grey colored, no plant roots present, has granular structure and light clayey, light sandy and contains crumbled stones, color contrast is sharp when transitions to next horizon.

ВСк-40-50 cm: Light color, damp and no plant roots are present, sandy and contains stones. Transition line between the soil layers is blurred.

Photo 7.6 Soil profile

Photo 7.7 Vegetation in 1m square area

<u>Profile 5</u>

Ground surface: Intermountain narrow valley, slope 7°, 3 % of surface layer of the soil is covered with stones.

Location of Profile 5: Territory of Bag 3 of Tsetserleg soum Khuwsgul aimag,

X= 423005 У= 5463963 Elevation =1783,0 m

Morphological description of Profile 5:

A-0-21 cm: Dark color, damp and sparse plant roots present, loose granular structure and light clayey, contrast of transition color is gradual between layers.

ABк-21-32 cm: Light grey color, no plant roots present, granular structure and light clayey, light sandy and contains crumbled stones. Color contrast is sharp when transitions to next layer.

BCк-32-43 cm: Grey color and damp, no plant roots present, sandy and contains crumbled stones. Color contrast is sharp when transitions to next layer.

Cк-43-70 cm: Light yellowish color unstructured sand.

The thickness of the humus layer of the mountain meadow light clayey kastanozem soil is 21-25 cm and humus contained in its upper layer is 2,25-4,04 % and pH environment of the soil is weak basic, the amount of mobile phosphorus per 100 g of soil is 1,89-3,24 mg while exchangeable potassium amount is 20,0-21,1 mg (Table 5)

Photo 3. *Soil profile*

Photo 4. *Vegetation in 1m square area*

Thin layered friable gravelly sandy kastanozem soil

The thin layered friable gravelly sandy kastanozem soil is distributed along inter mountain open valleys and also along lower foothills of mountains at an average elevation of 1700-1900 m over the deluvial carbonated sediment (Profile 9 and 12).

Profile 9

Ground surface: Inter mountain wide and narrow valleys, slope 6°, 10%of the surface of the soil is covered with stones.

Location of Profile 9: Territory of Bag 3 of Tsetserleg soum, Khuwsgul aimag.

X= 416910 У= 5469721 Elevation =1870,0 m

Morphological description of profile 9:

A-0-16 cm: Dark brown color, damp and sparse plant roots present. Fragile granular structure and light clay. Color contrast is sharp when transitions to next layer.

Bк-16-34 cm: Light yellowish color with few plant roots. Granular structure and light clay, contains crumbled stones and color contrast is sharp when transitions to next layer.

BCк-32-43 cm: Grey color, damp, no plant roots present and sandy. Contains crumbled stones and transition color is gradual between soil layers.

Cк-34-55 cm: Yellowish color, damp, thin plant roots present, sandy and transition contrast to next layer of soil is gradual.

Photo 5. Soil profile

Photo 6. Ground surface

Profile 12

Ground surface: Inter mountain open valleys with 7° slope, 10 % of the surface of the soil is covered with stones..

Location of Profile 9: Territory of Bag 3 of Tsetserleg soum, Khuwsgul aimag.

X= 416910 У= 5469721 Elevation =1870,0 m

Morphological description of Profile 12:

A-0-20 cm: Dark color, damp, loose granular structure, sandy and color contrast is sharp when transitions to next layer.

Вк-20-44 cm: Light white color, damp, no plant roots present, loose granular structure, sandy and contains crumbled stones. Color contrast is sharp when transitions to next layer.

ВСк-44-63 cm: Light grey color, sandy and contains crumbled stones. Transitions between layers is gradual.

Thickness of humus layer is 16-20 cm and humus content in its upper layer is 2,23-2,44 %, pH environment is pH-8,29-8,38, amount of mobile phosphorus contained in 100 g of soil is 1,68-2,06 mg and exchangeable potassium is 10,0-19,0 mg.

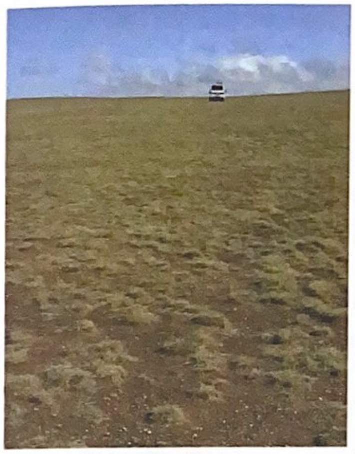

Photo 7. **Profile**

Photo 8. **Vegetation in 1m² area**

Medium thick layered friable gravelly sandy kastanozem soil

Kastanozem soil is divided according to the thickness of the humus layer (Dorjgotov.D, 2003) as below:

Table 3. Kastanozem soil classification

Kastanozem soil	**Thickness**
Thin layered kastanozem	0-20 cm thick humus layer
Medium thick layered kastanozem	20-30 cm thick humus layer
Thick layered kastanozem	more than 30 cm thick humus layer

As result of soil survey, the thin and Medium thick layered two sub-types of kastanozem were identified.

Medium thick layered sandy kastanozem soil is distributed in the Mogoin gol river bank and in crop land. During the 80's, a decent amount of crop has been produced in the Mogoin gol valley. Currently the land is fallow and gradually becoming pasture land. Profiles 19 and 23 are representative of these soil types and are described below.

Location of Profile 19: Territory of Bag 3 of Tsetserleg soum of Khuwsgul aimag.

X= 417014 У= 5466013 Elevation =1820,0 m

Ground surface: Inter Mountain open valleys with 5°slope, 5% surface of the top soil is covered with stones.

A-0-23 cm. Dark brown color, sparse plant roots present, loose granular structure and sandy. Transition color contrast to next soil layer is sharp.

Вк-23-68 cm. Yellowish color, very sparse plant roots present, fragile granular structure, sandy and color transition between soil layer is gradual.

ВСк-68-75 cm. Light white color, no plant roots, sandy and this layer extends to great depth.

Photo 9. Soil profile

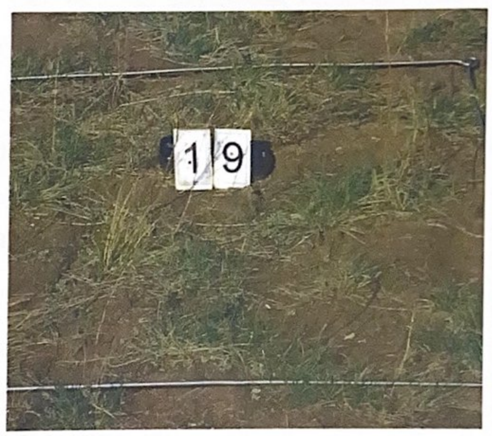

Photo 10. Vegetation in 1m square area

According to the field survey description of these two profiles, the thickness of the humus layer varies between 23-27 cm. However, the average humus content in the upper layer is (A) 4,33-3,65 %, total nitrogen is 0,21-0,18 %, pH environment is pH-8,02-8,23 or weak basic, mobile phosphorus contained in 100 g of soil is 1,98-2,98 g and exchangeable potassium is 12,3-19,0 mg. In terms of mechanical composition, it is sandy.

<u>Medium thick layered light clayey kastanozem soil</u>

This type of soil is distributed along inter mountain narrow valleys and passages.

Profile 10

Location of Profile 10: Territory of Bag 3, Tsetserleg soum, Khuwsgul aimag.

X= 419780 У= 5471692 Elevation =1836,0 m

Ground surface: Narrow valley between mountains with 5° slope. No gravel on top of soil surface.

A-0-25 cm: Dark brown color, damp, sparse plant roots present and fragile granular structure. Light clayey and soil layer transition is sharp.

Вк-25-33 cm: Light color, damp, plant roots very sparse, fragile granular structure and sandy. Soil layer transition is gradual.

ВСк-33-57 cm: Brown grey color, plant roots absent and sandy. This layer extends to great depth.

The thickness of the humus layer of the light clayey brown soil is 25 cm and the humus contained in its upper layer is 2,05%, this increases to 2,79 % at a depth of 10-20 cm. This is due to the mechanical composition of soil.

Photo 11. Soil profile

Photo 12. Vegetation in 1m square area

The pH environment of the soil is 8,38 or weak basic and the amount of mobile phosphorus accumulated in 100 g of soil is 1,95 mg while the amount of exchangeable potassium was 9,0 mg. In terms of the mechanical composition of this soil, it is light clayey.

Alluvial meadow-boggy carbonatic saline soil

This soil originates in the lowest points of the inter-mountain valleys in meadow area, well water fed and wet areas. This type of soil is distributed over the alluvial granular gravels and sand sediments along Mogoin gol river in territory of Bag 3 of Tsetserleg soum.

Profiles of 15 were taken as representative of this type of soil and a description are detailed below.

Profile 15

Location of Profile 15: Territory of Bag 3, Tsetserleg soum of Khuwsgul aimag.

X= 421798 У= 5467019 Elevation =1770,0 m

Ground surface: Narrow inter-mountain valleys with 2° slope. Soil surface is covered with crumbled stones.

A-0-10 cm: Black, dark grey color, damp, large granular structure, light clayey and gleyed. Color transition to next soil layer is sharp.

BCк-10-17cm: Red color, damp sand, color transition to next layer is sharp.

C-17-26 cm: Light grey color, damp and wet and gleyed.

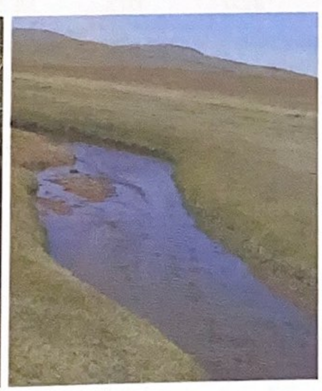

Photo 13. Profile in 1m² area *Photo 14. Ground surface* *Photo 15. Vegetation*

Table 4. Chemical characteristic of soil

Profile №	Depth cm	pH	$CaCO_3$ %	Humus %	EC_{25} Ds/m	Element of nutrition, mg/100gr	
						P_2O_5	K_2O
Poorly developed mountain sandy kastanozem soil (1)							
1	0-5	8,0	0	2,6	0,126	1,76	13,6
Mountain sandy kastanozem soil (2)							
2	0-10	8,20	2,30	3,26	0,127	2,05	12,0
	15-20	8,14	17,81	3,13	0,215	1,98	11,0
	30-40	8,49	14,18	8,82	0,081	0,98	9,0
4	0-5	8,25	-	3,91	0,065	2,34	16,0
	5-15	8,08	-	4,09	0,040	2,16	21,0
Mountain meadow light clayey kastanozem soil (3)							
16	0-10	7,97	-	2,25	0,625	1,89	21,0
	10-20	8,37	-	1,95	1,294	1,24	20,0
	30-40	8,49	14,54	1,17	5,490	1,09	19,0
	40-50	8,70	14,30	0,61	6,530	0,45	10,0
5	0-10	8,56	2,79	4,04	0,179	3,24	20,0
	20-30	8,38	7,51	1,87	0,090	1,24	11,0
	35-40	8,34	4,73	0,77	0,804	0,87	9,0
	50-60	8,61	3,03	0,28	0,409	0,64	8,0
Thin layered friable gravelly sandy kastanozem soil (4)							
9	0-10	8,38	-	2,44	0,189	1,68	10,0
	20-30	8,59	15,99	2,46	0,340	1,94	12,0
	40-50	8,80	16,12	0,69	0,837	0,87	10,0
12	0-10	8,29	-	2,23	0,417	2,06	19,0
	10-20	8,20	0,24	2,39	2,145	1,45	18,0
	30-40	8,84	6,91	0,90	2,760	0,67	8,0
	50-60	8,79	12,12	0,21	2,388	0,16	7,0

Profile №	Depth cm	pH	$CaCO_3$ %	Humus %	EC_{25} Ds/m	Element of nutrition, mg/100gr	
						P_2O_5	K_2O
Medium thick layered friable gravelly sandy kastanozem soil (5)							
19	0-10	8,23	-	3,65	0,125	1,98	12,3
	10-20	8,11	-	2,15	0,456	1,26	15,2
	30-40	8,56	6,34	0,81	0,099	0,87	14,0
23	0-10	8,02	-	4,33	0,370	2,98	19,0
	15-25	8,17	-	2,65	0,119	1,34	16,0
	30-40	9,73	12,24	0,97	0,939	0,67	8,0
Medium thick layered light clayey kastanozem soil (6)							
10	0-10	8,38	-	2,05	0,985	1,95	9,0
	10-20	8,43	1,94	2,79	6,040	1,78	11,0
	20-30	8,52	11,75	1,53	6,470	1,06	8,0
	40-50	8,37	2,42	1,27	4,760	0,94	8,0
Alluvial meadow-boggy carbonatic saline soil (7)							
15	0-10	8,38	4,12	8,37	0,118	2,48	24,0
	11-16	8,40	6,06	4,12	0,855	2,16	26,0

Table 5. Mechanical composition of soil

Profile №	Depth cm	Stone >mm %	Mechanical composition % , (size, mm)			Name of mechanical composition
			Sand (2-0,05 mm)	Dust (0,05-0,002 mm)	Clay (<0.002 mm)	
Poorly developed mountain sandy kastanozem soil (1)						
1	0-5 см	20	60	17	23	Sandy
Mountain sandy kastanozem soil (2)						
2	0-10	10,0	51,3	38,0	10,6	Sandy
	15-20	15,0	60,1	30,7	9,2	Sandy
	30-40	20,0	54,2	36,6	9,2	Sandy

Profile №	Depth cm	Stone >mm %	Mechanical composition % , (size, mm)			Name of mechanical composition
			Sand (2-0,05 mm)	Dust (0,05-0,002 mm)	Clay (<0.002 mm)	
4	5,0	5,0	51,3	35,1	13,6	Sandy
	5-15	35,0	58,6	30,7	10,6	Sandy
Mountain meadow light clayey kastanozem soil (3)						
5	0-10	10,0	55,7	35,1	9,2	Light clayey
	20-30	8,0	51,3	36,6	12,1	Light clayey
	35-40	30,0	64,5	24,9	10,6	Sandy
	50-60	40,0	67,4	23,4	9,2	Sandy
16	0-10	5,0	58,6	30,7	10,6	Light clayey
	10-20	15,0	48,4	38,0	13,6	Light clayey
	30-40	10,0	48,4	35,1	16,5	Light clayey
	40-50	20,0	44,0	38,0	18,0	Sandy
Thin layered friable gravelly sandy kastanozem soil (4)						
9	0-10	10,0	46,9	38,0	15,0	Sandy
	20-30	20,0	63,0	26,3	10,6	Sandy
	40-50	30,0	44,0	41,0	15,0	Sandy
12	0-10	8,0	45,5	41,0	13,6	Sandy
	10-20	30,0	54,2	35,1	10,6	Sandy
	30-40	15,0	49,9	35,1	15,0	Sandy
	50-60	20,0	48,4	35,1	16,5	Sandy
Medium thick layered friable gravelly sandy kastanozem soil (5)						
23	0-10	15,0	54,2	36,6	9,2	Sandy
	15-25	30,0	61,6	29,3	9,2	Sandy
	30-40	20,0	51,7	38,0	10,6	Sandy
Medium thick layered light clayey kastanozem soil (6)						
10	0-10	20,0	42,5	41,0	16,5	Light clayey
	10-20	10,0	60,1	30,7	9,2	Sandy
	20-30	10,0	51,3	38,0	10,6	Sandy

Profile №	Depth cm	Stone >mm %	Mechanical composition % , (size, mm)			Name of mechanical composition
			Sand (2-0,05 mm)	Dust (0,05-0,002 mm)	Clay (<0.002 mm)	
	30-40	10,0	54,2	36,6	9,2	Sandy
Alluvial meadow-boggy carbonatic saline soil (7)						
15	0-10	3,0	57,2	32,2	10,6	Sandy
	11-16	30,0	65,9	24,9	9,2	Sandy

Overvew of the soil type

Seven types of soil were identified and classified within the selected Bagh in Tsetserleg soum of Khuvsgul province (Khurgatai khairkhan LLC, 2012).

- According to the survey result, the content of soil nutrients is on average level. This is sufficient to supply moderate amounts of nutrition to natural and planted vegetation. The soil pH level is above 8 or almost neutral. There is plenty of phosphorus and potassium.
- Since the soil distributed in the area, has a moderate supply of nutrients and is classified moderate in terms of agrochemical characteristics, 40 kg of acidic mineral nutrient compost (in terms of physiological characteristics) with ration of N40:P60:K60 per 1 ha area would required to be added when conducting soil restoration. Also local plants need to be used when re-vegetating.
- The average depth of the fertile layer topsoil layer is 20 cm.
- The soil is not currently subject to heavy human/technical induced degradation but is heavily degraded by the Brandt's vole population.
- Some wastes were found in some areas. The soil is light and consequently prone to wind erosion. Therefore, vehicle and equipments must follow defined path and dust should be suppressed with water once the coal mining activity commences.
- For restoration of the mine, it is best to collect and use seeds of local plants.

3.3.3. Flora formations

Following characteristics of flora Familyes have been distributed in the Bagh area:

- Larch forest
- Stipa L – festuca – mountain steppe with various grasses 2a. Festuca – mountain steppe with various grasses
- Needlegrass – steppe with various grasses
- needlegrass – steppe with artemisia
- Needlegrass artemisia- mountain steppe with thermopsis R.Br
- steppe with artemisia
- Saussurea DC – Heteropappus steppe
- Stipa L – steppe with Stipa L
- Dry steppe with needlegrass
- Needlegrass – meadow steppe with various grasses

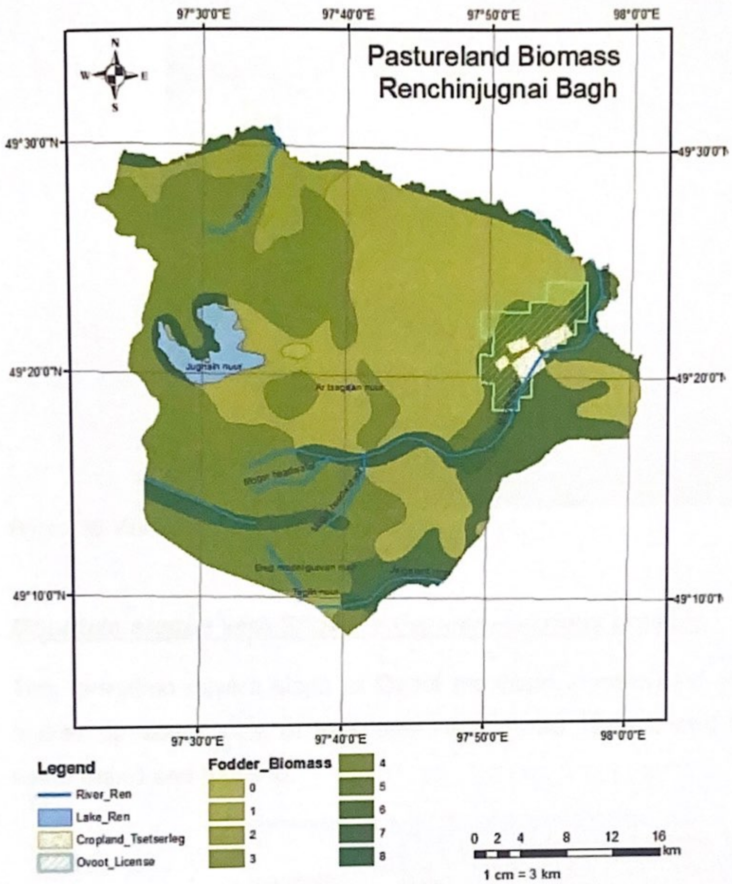

Figure 11. Fodder biomass distribution on the verification area (own representative)

Distribution of the flora formations and each formations are desribed below:

Mountain slope with larch forest

This characteristic is common in northwest of the area. Besides larch trees, Artemisia L. grows in this area. This formation make up about 3% of the total Bagh area.

Photo 16. *Formation of larch forest*

<u>Mountain steppe with Stipa L – Festuca – various grasses</u>

This formation covers slope of Ovoot mountain in northwest of the project area and makes up about 10% of total area.Here grows Stipa L and Festuca and used as pastureland and hayfield.

Photo 17. *Steppe with Stipa L-Festuca-varios grasses*

Steppe with needlegrass and various grasses

This fromation is stretched from west to north of the area and makes up about 11 % of the total area. This flora formation is mainly occurs in landscape of meadows between the mountains. The area is currently used as pastureland and hayfield.

Photo 18. Steppe with needlegrass and various grasses

Steppe between mountains with needlegrass and artemisia

This formation of flora grows mainly in north of the area and makes up less than 5% of the total area. Though mainly needlegrass Artemisia, it is also common for lichen of *Parmelia vagtans* type to grow overwhelmingly.

Photo 19. *Steppe with Artemisia - needlegrass*

Meadow steppe with carex duriusculia -needlegrass-various grasses

Formation of carex duriusculia and various needlegrasses distributed in river valley meadow and occurs in eastern and southern part of the project area.It makes up less than 1% of total area.

Photo 20. *Meadowy steppe with various needlegrasses*

Mountain steppe with needlegrass artemisia-Thermopsis R.Br

Mountain steppe formation with needlegrass artemisia-Thermopsis R.Br is situated in a little area in the centre of the total project area. It makes up 1% of the total area. This formation is part of flora formation between the mountains and it is vegetation cover nearby project settlement place.

Photo 21. Mountain steppe with needlegrass Artemisia- Thermopsis R.Br

Dry steppe with artemisia

Fromation of dry steppe with Artemisia covers most of the project area and mainly situated in the centre of the project area. It makes up about 30% of the total area. Artemisia dominates in the formation and includes Poaceae, Leontopodium, Festuca, Saussurea sporadically.

Photo 22. Dry steppe with artemisia

Steppe with Sausurea DC – Heteropappus

Formation of Sausurea DC and Heteropappus is situated in the centre of the project area. However, occurrence of this flora is very rare and it makes up 5% of the project area. This Formation occurs in mass flowering which creates association and created pink spotted covering.

Photo 23. Dry steppe with Sausurea DC- Heteropappus

Steppe with Stipa L and Artemisia

Formation of Stipa L and Artemisia is situated in the eastern part of the project area and makes up about 3% of the total area. This Formation inclues *Parmelia vagtans* and much land lichen covering.

Photo 24. Mountain steppe with various grasses and artemisia

Dry steppe with needlegrass

Dry steppe with needlegrass is one of widespread flora formations of the project area and it is mainly situated in central part of the project area and little bit in south of the area.This makes up 11% of the total area. This formation includes Sausurea DC.

Photo 25. *Dry steppe with needlegrass*

Steppe with Carex duriusculia – Needlegrass – various grasses

Formation of carex duriusculia is distributed from in the south to the east of the area along river valley meadows.This makes up about 10% of the total project area.

Photo 26. *Meadowy steppe with carex duriusculia -needlegrass-various grasses*

Overview of the flora

Determining vegetation harvest allows amount of harvest of each natural landscape.

Table 6. Vegetation harvest survey findings

No. of points	Location	Vegetation pattern and landscape	Moist weight (g/4 m^2)	Dry weight (г/4 м^2)	Difference
1	415692 5468964	Type of needlegrass artemisia	1325	363	962
2	416634 5466596	Steppe landscape	1560	615	945
3	416614 5466622	Old wheatfield with artemisia	1155	580	575
4	424286 5470536	Tes river bank, meadow, vegetation covering	2575	770	1805
5	417913 5472216	Mountain steppe with Stipa L	580	344	236
6	416280 5471863	On edge of forest	2145	780	1365
7	415822 5471633	Mountaintops	525	198	327
8	719432 5464459	Meadow of Mogoit river bank	2478	888	1590

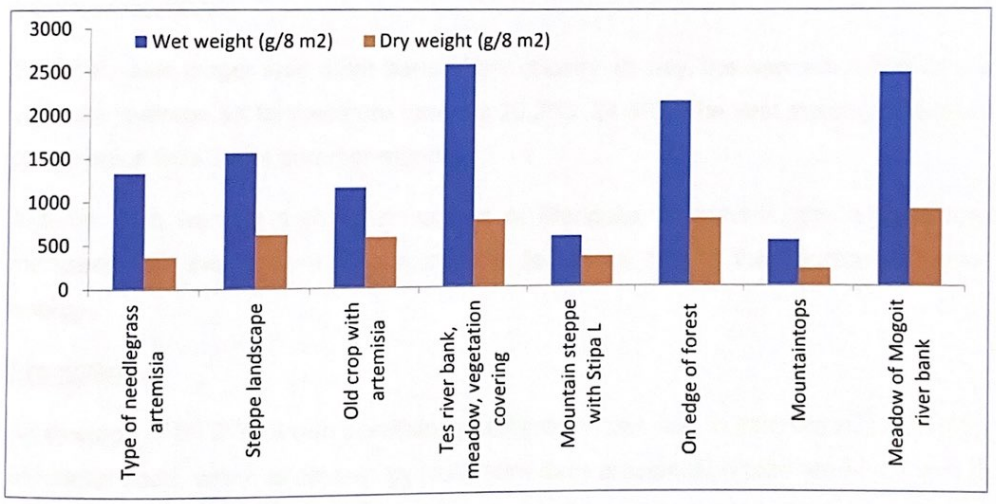

Figure 12. Difference of dry and wet weight of plants

According to the figure above, difference of wet and dry meadow and forest vegetations were relatively higher than dry steppe vegetations. This demonstrates that meadow landscape contains relatively higher moisture content and mountain steppe and steppe vegetation grows in condition with less moisture.

Meadow vegetation mainly includes needlegrass, Artemisia, carex and various grasses. Carex species and needlegrass representatives mainly occur in moist land and pasturelands and these are good feeds for livestock animals. Steppe vegetation mainly includes stipa L, Festuca and Artemisia.

3.4. Nalikh Bagh of Bayan-Ovo soum, Umnugobi province - Desert ecozone VI

3.4.1. Climate

Data from the Bayan-Ovoo Soum weather station for the last 20 years were used to determine climate conditions. The Bayan-Ovoo weather station (106.07 ZU, 42.58 N, 1190 m above sea level) observes 3 times a day.

Spring: air temperature fluctuations increase, high wind speed values are observed, humidity decreases and the air becomes drier. Also, the weather changes rapidly and becomes unstable.

Summer: lasts longer than other parts of our country. In July, the warmest month of the year, the average air temperature reaches 20.2ºC -24.0ºC. The vast majority of annual precipitation falls in the summer months.

Autumn: It is warmer than other regions of Mongolia. In autumn, the air pressure increases, but the amount of precipitation decreases due to the decrease in solar energy.

Precipitation

An average of 63.2-70.9 mm precipitation falls down per year in this region. Probability of natural flood, which is caused by maximum daily precipitation reaches 50-60 mm in a day happens once in 50 years. Great amount of precipitation in a day causes heavy snowfall in winter, enhances erosion by run off that causes soil fertility decline and flood risk, one of the natural disasters that make livestock and transportation activities difficulty in summer times. Flash flood usually occurs after intense and heavy rain, and it erodes soil. Snow cover is usually 1-5 cm in depth in winter and it has 5-8 mm water content in it.

Temperature

The thermal regime is greatly influenced by the characteristics of the area, such as soil, vegetation, barriers, etc. The average annual temperature is 6.3°C. The average temperature of July, the warmest month of the year, is 24.3°C, and the average temperature of January, the coldest month, is -12.9°C.

Wind

According to a study conducted in the Gobi region of Mongolia, it is believed that soil deflation takes place actively when there is a wind speed of 7-9 m/s at a height of 10 m/s. Then, according to the research conducted on the hourly observation of wind speed, it is reasonable to take that soil erosion can be active for about 1500 hours. However, if we consider the wind speed of 4 m/s to move a small piece of soil, it means that the soil can be eroded for 4200-4600 hours a year.

3.4.2. Soil

The area belongs to the "semi desert brown soil" type according to the soil geography of Mongolia, and the " subtype of semi desert brown" soil is mainly distributed.

The depth of seasonal soil freezing reaches 1.6-2.5 m in winter. During the cold winter, the temperature of -10 °C penetrates the soil up to 40 cm deep.

Characteristics of the soil in this region, the soil temperature up to a depth of 40 cm is higher than the air temperature above the soil throughout the year. (Umarov.K.I., 1978) This is especially evident in winter, for example, according to the measurements made in December, the soil temperature at a depth of 20 cm is 5-7 °C higher than the atmosphere temperature, and the temperature at a depth of 40 cm is 8-11 °C higher than the atmosphere temperature. In summer, the soil heats up strongly, the temperature on the surface of the soil reaches +60°C to +67 °C, and the temperature of +15 °C penetrates into the soil 2-2.5 m deep. Even though the sand-silt stone cover on the surface of the Gobi brown soil is not thick (0.5-2 cm), it has the characteristic of protecting the surface of the soil from overheating by affecting the thermal regime of the soil to a certain extent (Umarov.K.I., 1978). Due to the hot and dry climate in summer, the surface and upper layers of the soil heat up strongly, and the process of mineralization of plant residues is intense. This causes the accumulation of organic matter in the Gobi brown soil, forming a unique characteristic of the soil. The layer of humus accumulation is not as obvious as that of the field soil, but some signs of the desert soil source (hard surface layer and its lower layer) are visible.

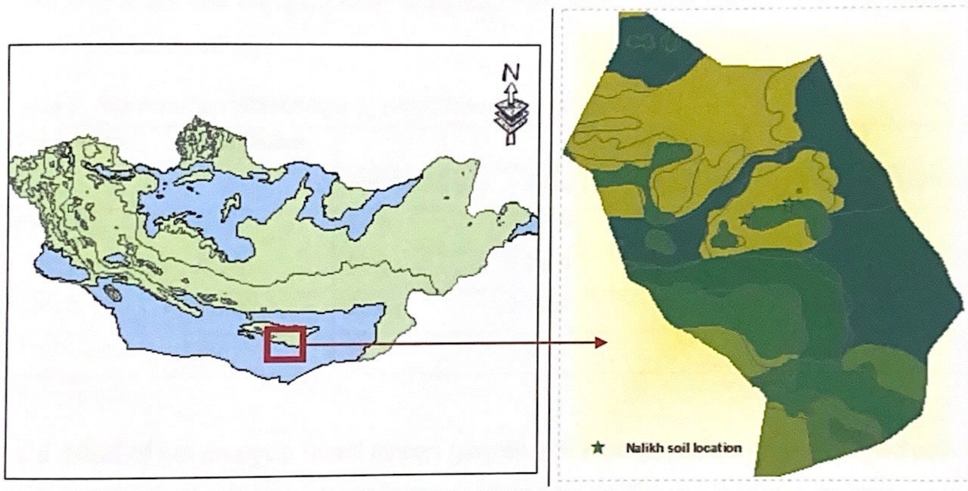

Figure 13. Sample location of Nalikh Bagh

Table 7. Nalikh bag soil sample pH

№	CO_3^{2-}	Цахилгаан дамжуулах чанар, µS/cm	pH
5	<7.5	83.50	7.74
11	<7.5	73.20	7.76
12	<7.5	82.10	7.83

8	<7.5	78.40	7.84
6	<7.5	83.20	7.91
10	<7.5	78.30	7.81
2	<7.5	98.10	7.82
1	<7.5	85.90	7.74

Soil analysis

There are 2 dominating types of soils distributed (semi desert gleyish soil and brown Gobi soil) and three samples were analysied from semi desert gleyish soil analyzsed on May 11, (LitLab, 2014)

Table 8. Mechanical composition of semi desert gleyish soil

Profile No	**Depth,cm**	**Active mg/100g**		
		Sand (2-0.05)	Dust (0.05-0.002mm)	Clay(<0.002mm)
Profile-1	0-3	64.5	26.0	9.5
	5-20	67.4	24.9	7.7
	25-30	67.4	24.6	8.0
	40-50	60.1	31.5	8.4

As a result of lab analysis, semi desert gleyish soil was consisted of sandy mechanical composition depth of topsoil layer of the semi desert gleyish soil is 20 cm, humus content is 1.15%, Potassium content 10.73 mg/100 g, Phosphorous content 1.06 mg/100g, Calcium carbonate content ($CaCO_3$) 2.24, dissolved oxygen (pH) 8.11 or alkali and dissolved salt amount is 0.095 ds/m (Ecotrust LLC, 2014). It explains that this type of soil fertility is medium; easily soluble salt content can be seen on Table 8 and Table 9 below.

Table 9. General chemical analysis of semi desert gleyish soil

Profile No	**Depth,cm**	**pH H_2O**	**$CaCo_3$**	**Humus**	**EC2.5**	**Active mg/100g**

		(1:5)		%	dS/m	P_2O_5	K_2O
Profile-1	0-3	8.27	0.00	1.236	0.081	1.24	12.5
	5-20	8.01	2.18	1.267	0.102	1.09	11.4
	25-30	8.07	4.54	0.946	0.103	0.86	8.3
	40-50	0.15	4.00	0.750	0.114	0.42	7.6
Average criteria for topmost 3 layers		8.117	2.240	1.150	0.095	1.063	10.733

Overvew of the soil type

Seven types of soil were identified and classified within the selected Bagh in Tsetserleg soum of Khuvsgul province (Khurgatai khairkhan LLC, 2012).

- According to the survey result, the content of soil nutrients is on average level. This is sufficient to supply moderate amounts of nutrition to natural and planted vegetation. The soil pH level is above 8 or almost neutral. There is plenty of phosphorus and potassium.
- Since the soil distributed in the area, has a moderate supply of nutrients and is classified moderate in terms of agrochemical characteristics, 40 kg of acidic mineral nutrient compost (in terms of physiological characteristics) with ration of N40:P60:K60 per 1 ha area would required to be added when conducting soil restoration. Also local plants need to be used when re-vegetating.
- The average depth of the fertile layer topsoil layer is 20 cm.
- The soil is not currently subject to heavy human/technical induced degradation but is heavily degraded by the Brandt's vole population.
- Some wastes were found in some areas. The soil is light and consequently prone to wind erosion.Therefore, vehicle and equipments must follow defined path and dust should be suppressed with water once the coal mining activity commences.
- For restoration of the mine, it is best to collect and use seeds of local plants.

3.4.3. Vegetation

The desert brown soil of the area is dominated by desert and steppe vegetation, mainly Alium- Cleistogenes - Caragana ,Gobi stipa, Gobi bridle grass, wild leek, wild onion, common yarrow, and wild fade.

It will cover 12.9% of the country's entire area, including hills, plains, large depressions between mountains, and will cover an area equal to 12.9% of the country's territory. Since the vegetation cover is sparse (from 8-10% to 20-25%), there is a lot of bare land (Гордеева, 1974).

3.5. Legal terms on the rehabilitation of Mongolia

There is a quiet a detailed standards and preocedures in place, that the different types of minings should plan and implement of. While the specifics of existing soil of thosedifffernt types of minings, doesnt really considered. For instance the rehabilitation standards were applied on the general requirements of the minings, such as MNS 5916:2008 - Environment. Requirements for fertile soil removing and its temporary storage during the earth excavation. MNS 5918:2008 - Environment. Re-vegetation of destroyed land. General technical requirements, MNS 5850:2008 - Soil quality. Maximum acceptable concentration of soil pollutants elements and substance. Rehabilitation cost estimate guidelines - Decree № 07-114 issued by Minister, Ministry of Environment and Tourism.

<u>Law on soil conservation:</u>

The purpose of the law is to regulate relations concerning protection of soil from degradation, restoration, and desertification prevention. This law also regulates the soil protection measures during the agricultural land use period, which is stated in Law on Land and Law on Agriculture, and implementation of integrated measures and actions for combat desertification and soil protection. The law outlines the soil erosion, soil degradation, soil pollution, and desertification classification, and desertification assessment, monitoring, measures for soil protection and combat desertification, participation of state organizations, citizens, economic entities, and their rights and duties, and consideration of disputes ensuing from soil protection and combat desertification measures, termination of illegal decisions, and liability for violations.

3.6. Rating of the selected verification area

The rating of the study is also considered the main characteristics of degradation source of the mining, that is generally impacts in dot point. The degradation source of the mining is actually not impacting like moving along lines or distributing among fast moving over an area, such as the livestock pastureland deterioration or climate change impact on the land. Needless to say, that the part of mining area takes 0.1 percent of total Mongolian territory, whilst livestock pastureland is dominating 89 percent. The largest area of mining sites that land degradation in area-wise is illustrated in Table 10.

Table 10. Mongolian biggest mining site, area

Mongolian biggest mining areas	Area Approximate estimation (ha)
Erdenet mining open pit area	1600
Oyu Tolgoi mining open pit, waste handling area	2500
Tavan Tolgoi area	4600
Nariin sukhait mining	115
Baganuur mining	1900
Boroo gold mining	450

Only it influences on accumulation of the point source pollution on the same location. Needless to say, rating is considered on dot point characteristics of mining rehabilitation potential.

When weighting the assessment, 100% of the maximum value will be given to the soil with the highest ph value with highest humus content and the highest plant growth within the favourable climate condition area. Whilst the 0% rating is prescribed of the minimum valued soil with the lowest qualified humus content with lowest degree of growth.

The selected small unit of ecological zones of Mongolian Northern – forest steppe zone III and Southern – desert zone VI are described in the previous chapter 3.3 and 3.4. Where the most important yet chosen factors of rehabilitation potentials are being analyzed. The rating of the selected verification areas shown below. These factors are chosen due to the data availability.

The verification area of the northern area, is chosen to the smallest administration unit of study area, which is 3rd Bagh called Renchinjugnai located at Tsetserleg soum of Khuvsgul province Figure 14.

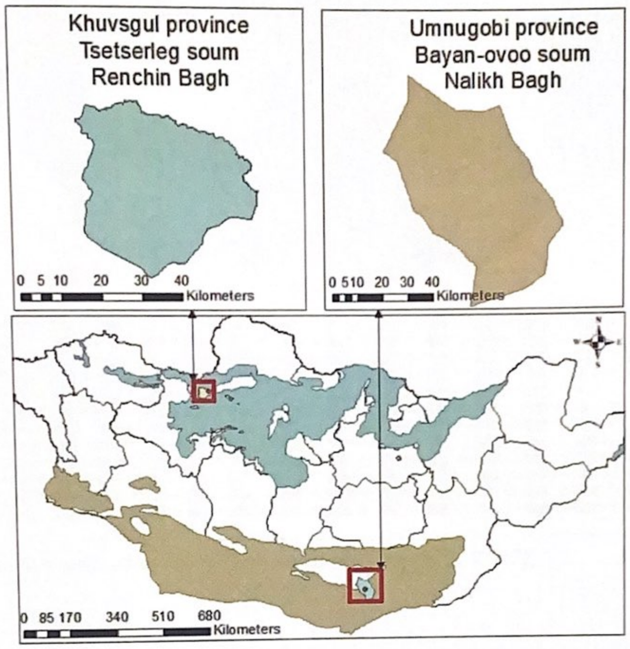

Figure 14. Renchin Bagh of Forest steppe zone III and Nalikh Bagh of Desert zone, Location map (own representative)

3.6.1. Soil identification

It is refferred that 219 types of soil was recorded among Mongolian territory.

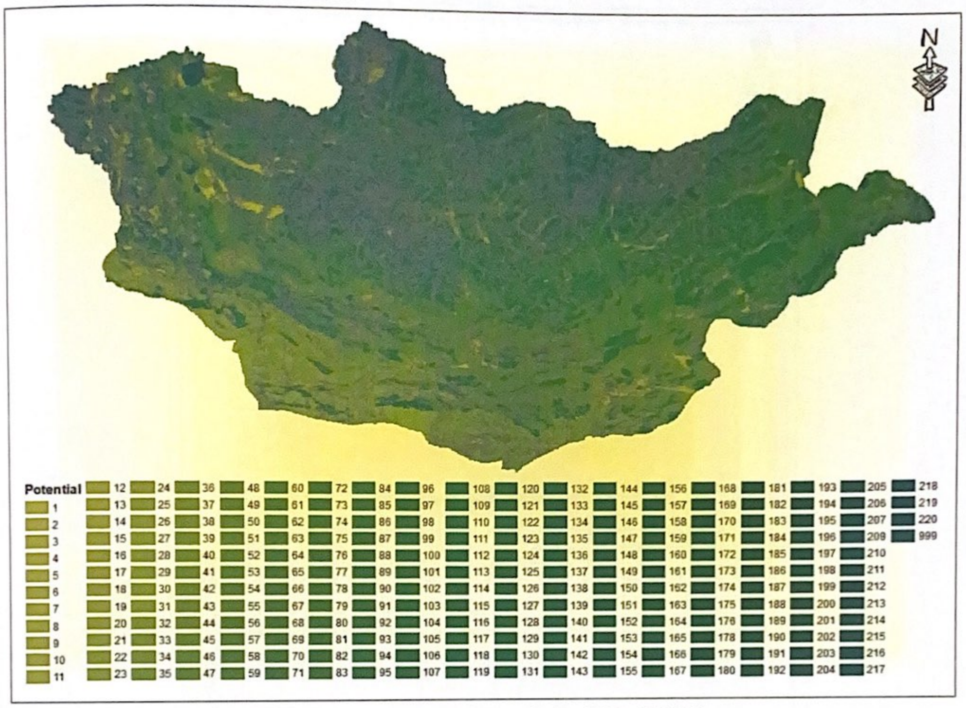

Figure 15. Mongolian soil types (own represetative from (EIC, 2017))

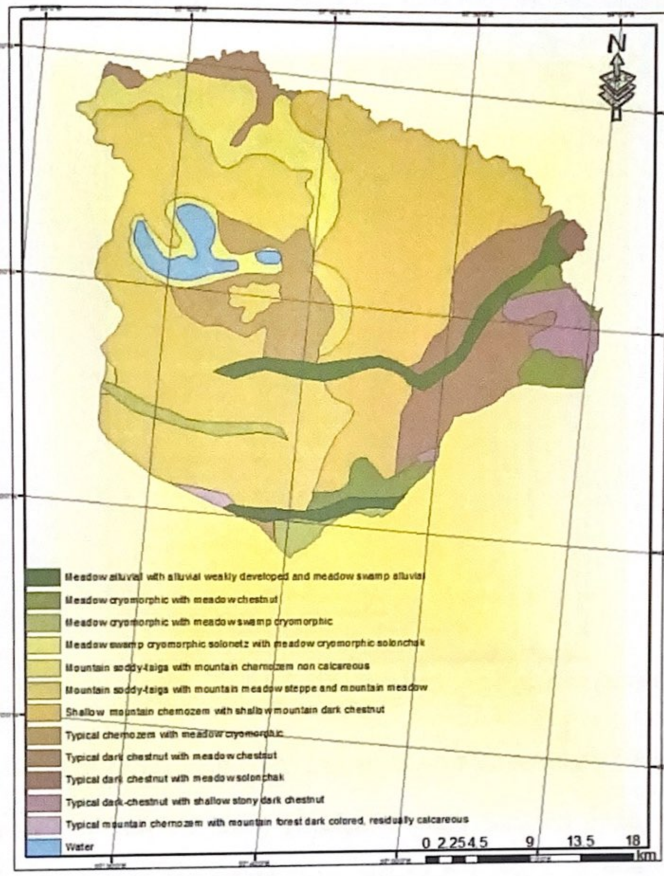

Figure 16. Soil identification map - Rechin Bagh Khuvsgul provice (own representative)

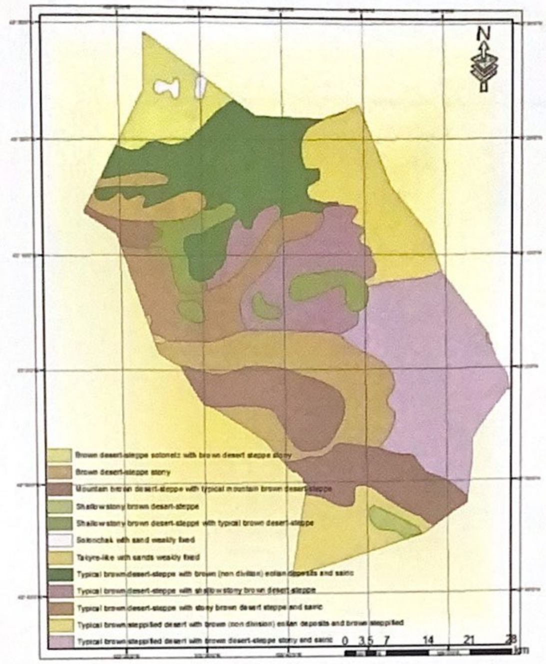

Figure 17. Soil identification map - Nalikh Bagh Umnugobi provice (own representative)

The total recorded soil types were both12 types of soils covered on both study areas.

The soil capability is clarified using Landsat 8, with Satallite imagery comparison. (USGS, 2020) The image combination conists of a band 7, 6 and 4 taken 2020 September 18th: Landsat Collection 2 Level2 – Landsat 8-9 OLI/TIRS C2 L2

The overaying soil and vegetation into rating of Mongolian all soil types (Figure 1)

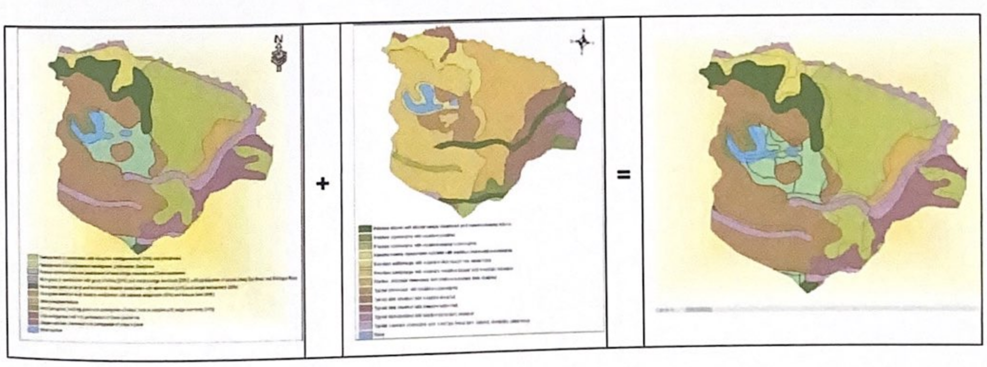

Figure 18. Overaying soil and vegetation into rating of Mongolian all soil types (EIC, 2017)

Figure 19. Soil potentiality map of Nalikh Bagh, Umnugobi aimag

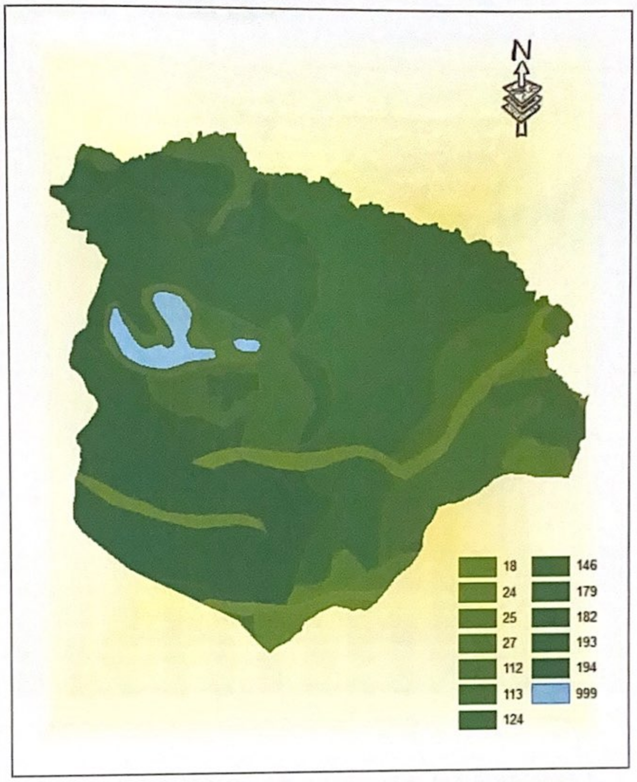

Figure 20. Soil potentiality map of Renchin Bagh, Khuvsgul aimag

3.6.2. Vegetation identification

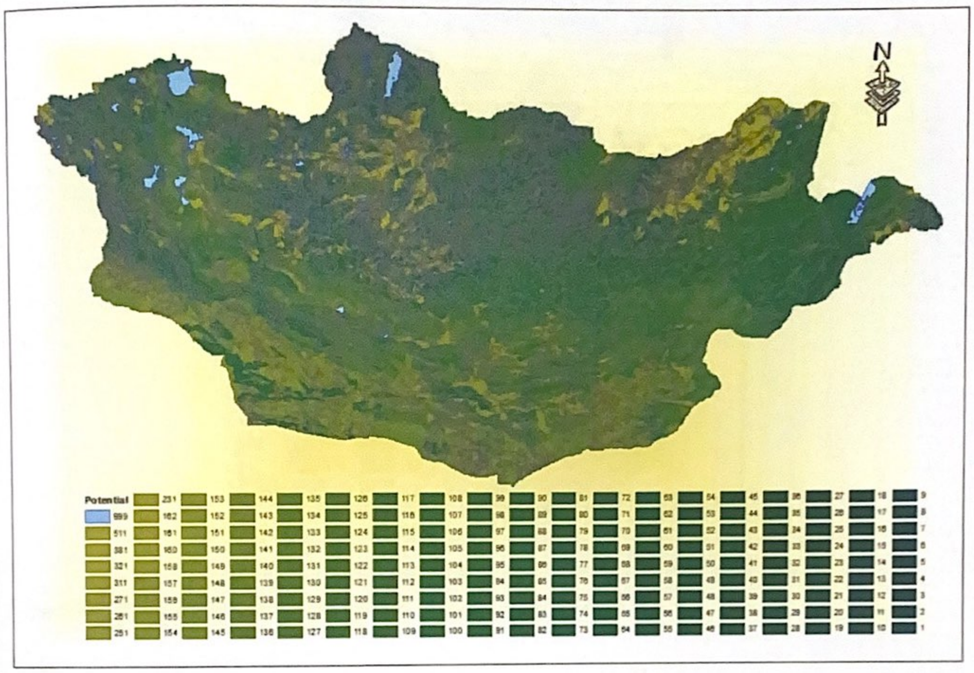

Figure 21. Mongolian vegetation types ((EIC, 2017) own representative)

It interprets that Mongolian vegetation types are much evenly distriuted with its own respective unique climatology besides the natural location differences.

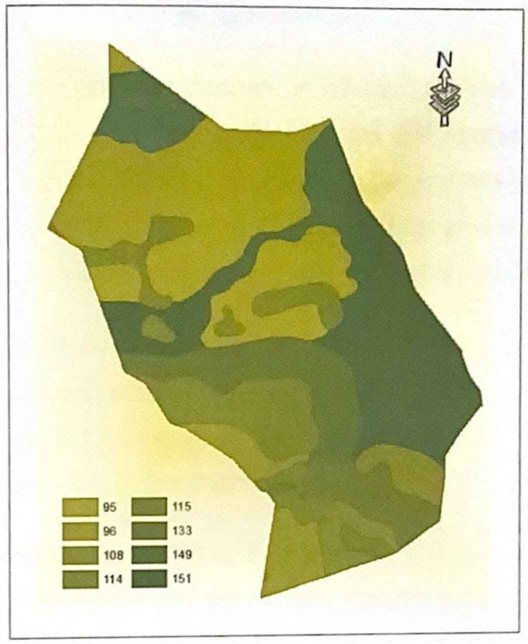

Figure 22. Vegetation potential of Nalikh Bagh Umnugobi province

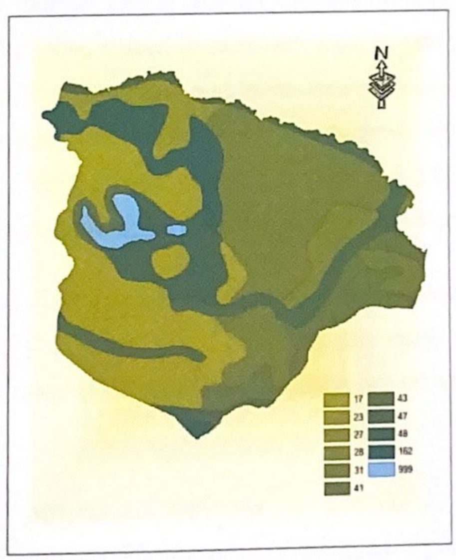

Figure 23. Vegetation potential of Rechin Bagh Khuvsgul province

4. Discussion

The factors from different ecozones located in different climatic environment that can influence the rehabilitation potential were selected and reclassified. The weighted intersection of the individual factors aim to develop a general analysis with the possibility of adapting the model to mining locations. The basis of the analysis is the consideration of three factors. The first factors includes climate, vegetation and soil.

To present the results, these three factors were assessed across Mongolian northern ecozone and southern desert ecozone. Mining and exploration activities taking place on both these 2 ecozones, but mostly the biggest deposts are lies in southern ecozone, such as Oyu tolgoi, Tavantolgoi, Southgobi sands etc.

Rating - climate conditions, the wind, temperature, precipitation conditions are the main impact of the soil formation and yet erosion, that considered in comparison to the other ecosystems within Mongolian territory. In terms of given geographical harsh climatology condition in relation to the chapter Climate condition2.1 Ecological zone III - Forest steppe zone, the wind speed in northern area is just a little bit lower than the southern area due to the high mountain and landscapes. However, the climate of Forest steppe zone rating was appointed 60 out of the reference 80 point due to its annual average precipitation and wind speed. Whilst, south zone 2.2 Ecological zone VI-Desert zone precipitation rate is appointed 50 in terms of intensified hot, dry characteristics.

Rating - soil conditions. The considered factors of soil were only soil types here. And the main type of Ecological zone III - Forest steppe zone soil is meadow steppe Kastanozem soil, which rated 60. In contrast, a typical brown desert-steppe soil gets 40 point.

Vegetation rating, the vegetation biomass or scarcity is considered other than vegetation species. For example, 70 percent in Ecological zone III - Forest steppe zone appointed by its intensity of average cover of 70 percent of cubic meter. On the other hand, the intensity of Ecological zone VI-Desert zone is covered hardly reaching to 30 percent of the average indication, as mentioned in chapter 2.2.

The summary of natural rehabilitation potential ratings among the Ecological zone of the minings are summarized respectively as below:

Table 11. Ecological zone rating (Knippertz, 2005)

Weighting factors	**Forest steppe zone III**	**Desert ecological zone VI**	**reference**
Climate	40-50	40-50	80
soils	60-70	30-40	70
Vegetation	40-50	30-40	80
Rehabilitation potential	155	115	230

It can be illustrated that, mining site specialization by their ecological zone can describe its natural rehabilitation potential for example:

- The Mogoin gol mining – 155
- Oyu Tolgoi, Tavan Tolgoi - referred to as 115

After the natural rehabilitation rating on the ecological zoning, the verification of the specialized zone information is applied by unit-based databases and sample analyzes of soil, climate, and vegetation information of the small site.

4.1. Verification areas

The verification area of the northern area, is chosen to the smallest administration unit of study area, which is 3rd Bagh called Renchinjugnai located at Tsetserleg soum of Khuvsgul province Figure 14.

And the other contrasting area was chosen to be the Nalikh Bagh of Bayan-Ovo soum, Umnugobi province - Desert ecozone VI, where the soil sample was taken to analyze its contents illustrated in Attachment 1. Soil sample result – Nalikh bag.

Both areas are being rated in terms of climate, soil, and vegetation insights to compare the provided ratings of Ecological zone, illustrated in Table 11.

Table 12. Verification area of the study area

Weighting factors	**Forest steppe zone III**	**Desert ecological zone VI**	**Verfication Renchin Bagh**	**Verification Nalikh Bagh**	**Reference**
Climate	40-50	40-50	55	50	80
soils	60-70	30-40	70	40	70
Vegetation	40-50	30-40	55	30	80
Rehabilitation potential	155	115	180	120	230

Verifying with the critical ratings utilizing identical factors as climate conditions (the wind, temperature, precipitation), soil (pH, humus, Carbonate ion (CO_3^{2-})), and vegetation (scarcity, biomass) respectivly have provided.

Climate rating on verification area

It is rated as 55 points appointed out of the same reference of 80 point due to much cold in Renchin Bagh climatology (Chapter 3.3.1), where there are average 49.2 rainy and foggy days and 18.1 days with stable snow covered. Whilst, there is an average of 1.6 stormy days and 2.2 foggy days during the year.

On contrast, climate in Chapter 3.4.1 of Nalikh Bagh is rated as 50 due to the hot and dry conditions. As the lowest precipitation occurrence of average 63.2-70.9 mm precipitation falls down per year in this region.

Soil rating of verification area

Considered factors of soil average pH in Ren Bagh of Tsetserleg soum, Khuvsgul province - Forest steppe zone III was 8.36 referring to Table 4. Chemical characteristic of soil. Meanwhile, the pH level average stands 7.8 regarding Table 7. The ratings 70 and 40 respectively.

Vegetation rating, the vegetation biomass or scarcity is considered other than vegetation species. For example, 55 percent was appointed referring to Chapter 3.3.3. whilst 30 percent was appointed referring to Chapter 3.4.3.

On the other side of the verification and analysis, both information being collected utilizing intersection part of Georeferencing tool of ArcGIS below:

Table 13. Renchin Bagh soil type poential and overlayed vegetation potential

Soil code	Soil potential	Average vegetation overlay
Typical dark chestnut with meadow chestnut	113	51
Typical dark chestnut with meadow solonchak	112	38
Typical chernozem with meadow cryomorphic	124	76
Typical dark-chestnut with shallow stony dark chestnut	146	40
Typical mountain chernozem with mountain forest dark colored, residually calcareous	182	17
Shallow mountain chernozem with shallow mountain dark chestnut	179	50
Mountain soddy-taiga with mountain chernozem non calcareous	194	56
Mountain soddy-taiga with mountain meadow steppe and mountain meadow	193	52
Meadow swamp cryomorphic solonetz with meadow cryomorphic solonchak	27	36
Meadow cryomorphic with meadow chestnut	25	119
Meadow cryomorphic with meadow swamp cryomorphic	24	63
Meadow alluvial with alluvial weakly developed and meadow swamp alluvial	18	34
Average amount	**111**	**52**

Figure 24. Soil potential

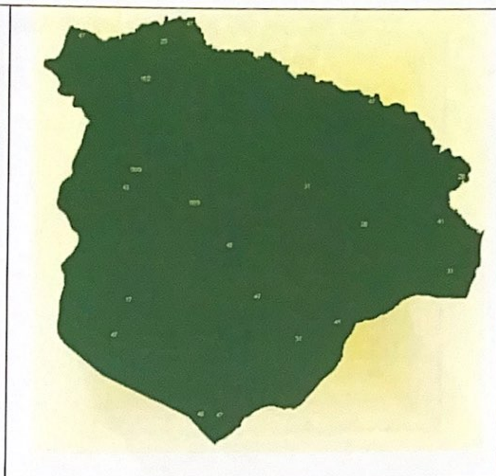

Figure 25. Vegetation potential

Figure 26. Soil and Vegetation potential amount, result of intersection

Soil potentiality intersection with vegetaion overlayed process on Nalikh Bagh

Figure 27. Soil potential

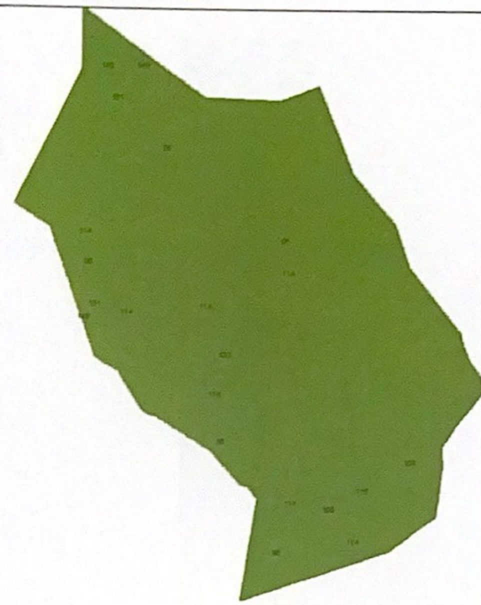

Figure 28. Vegetation potential

72	95
72	114
72	133
72	149
72	151
70	95
70	114
70	151
68	95
68	96
68	114
68	115
68	133
68	151
66	95
66	149
66	151
64	95
64	108
64	114

64	115
64	133
64	151
62	95
62	96
62	108
62	114
62	115
62	151
137	95
137	114
137	133
137	151
135	95
135	114
135	151
131	108
131	114
131	151
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160	96
160	108
160	114
160	115
160	133
9	149
9	151
7	133
7	149
7	151

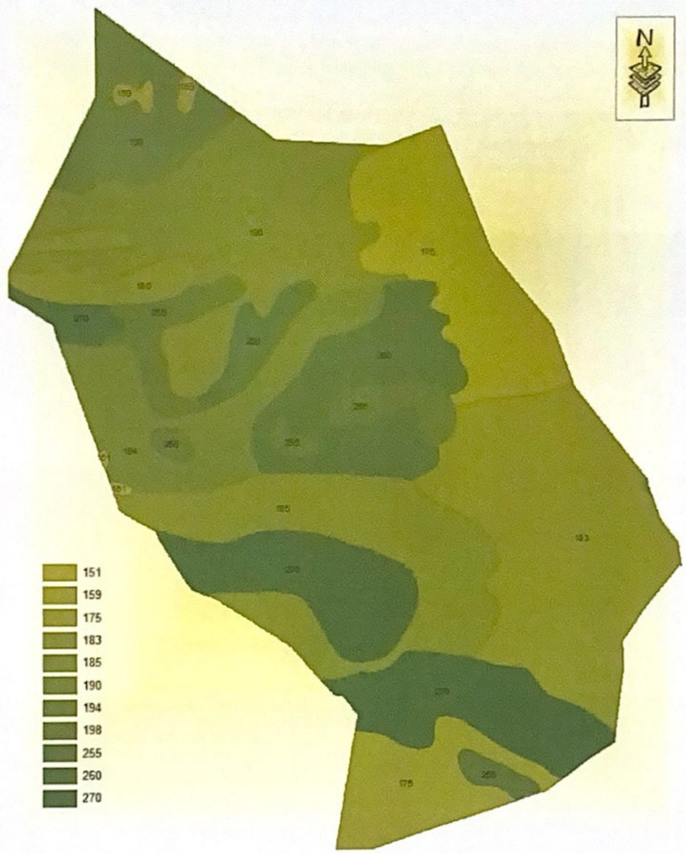

Figure 29. Soil and Vegetation potential amount, result of intersection

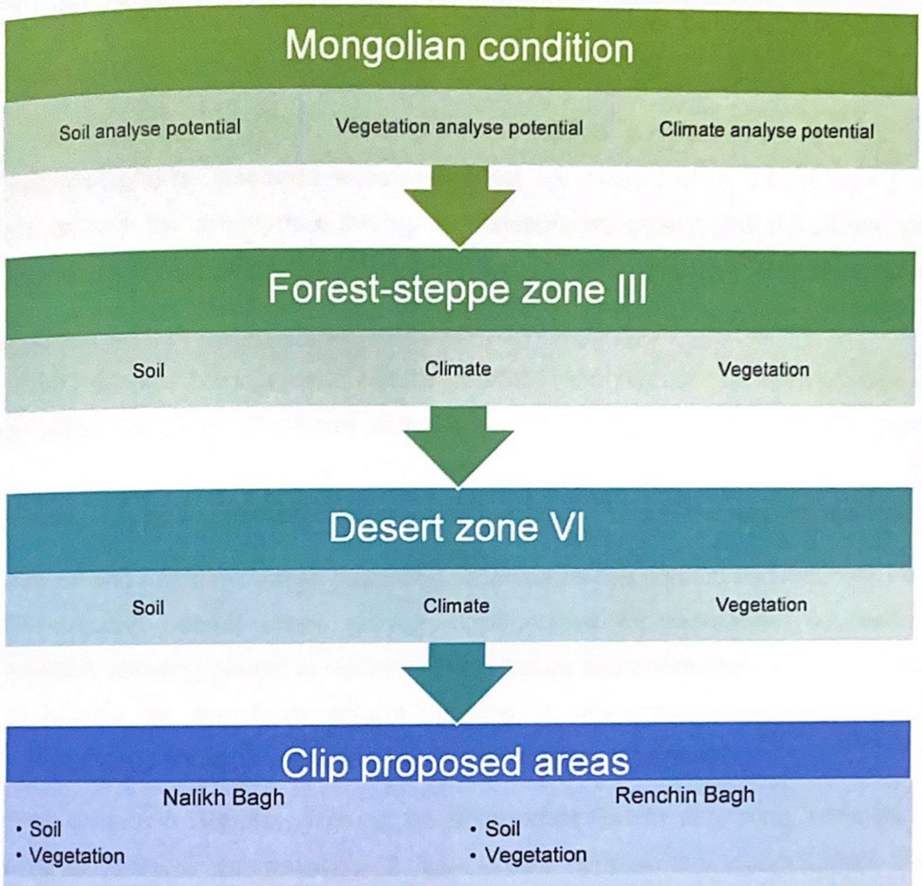

Figure 30. Study area – process scheme

4.2. Benefits of the Natural rehabilitation potential

It also known as ecological restoration or ecosystem restoration, offers several advantages. Here are some key benefits of natural potential rehabilitation:

Soil Stabilization and Erosion Control: Rehabilitating ecosystems helps stabilize soil and control erosion. The restoration of vegetation cover and root systems aids in preventing soil erosion and loss, particularly in areas prone to land degradation, such as degraded forests, deforested lands, or areas affected by mining or agriculture. This helps to retain soil fertility, prevent sedimentation in water bodies, and mitigate the impacts of erosion on surrounding ecosystems.

Climate Change Mitigation: Ecological restoration contributes to climate change mitigation efforts. Restored ecosystems act as carbon sinks, sequestering carbon dioxide from the atmosphere through enhanced plant growth and soil carbon storage. This helps to reduce greenhouse gas emissions and mitigate the impacts of climate change.

Water Resource Management: Natural potential rehabilitation can have positive effects on water resources. Restored ecosystems contribute to improved water quality by filtering pollutants, reducing sedimentation, and regulating water flow. Restored wetlands, for example, help in water retention, flood control, and groundwater recharge.

Cultural and Aesthetic Value: Restoring ecosystems has cultural and aesthetic benefits. Rehabilitated natural areas provide opportunities for recreation, education, and research, allowing people to reconnect with nature and appreciate its beauty. Restored landscapes can also have cultural significance, preserving traditional practices and enhancing the sense of place and identity for local communities.

Socio-economic Benefits: Natural potential rehabilitation can bring socio-economic benefits to local communities. It can create employment opportunities through restoration projects, eco-tourism, and the sustainable use of restored ecosystems. Restored habitats can also support sustainable agriculture, forestry, and other livelihood activities.

Overall, natural potential rehabilitation offers a holistic approach to environmental conservation and sustainable development, promoting the recovery and resilience of ecosystems while providing numerous ecological, social, and economic benefits.

5. Conclusion

Ecozone of the Northern area dominates forest-steppe soil , where climate and population density occurs much colder and higher than the south area.

It is economically and sustainable beneficial to utilize natural rehabilitation method instead of forcing mining rehabilitation by scattering seed, irrigating. By the ecosystem functionality, the Natural potential rehabilitation aims to restore the natural functions and processes of ecosystems. By restoring degraded areas to their original state or improving their ecological condition, it enhances the overall functionality of ecosystems. This includes restoring nutrient cycling, water filtration, pollination, and habitat provision, leading to improved ecosystem services.

On the other hand, by the biodiversity conservation side, ecological restoration plays a crucial role in preserving and promoting biodiversity. By creating or restoring suitable habitats, it supports the recovery of native plant and animal species, including endangered or threatened species. Restored ecosystems can provide critical corridors for wildlife movement and contribute to the conservation of regional biodiversity.

In my perspective, global warming impacts particularly on the land degradation, making matters worse there is icreasing livestock foot. However mining dot point degradation takes considerably low amount of overall land degardation. Therefore, this mining rehabilitation methods really should use this existing natural rehabilitation potentiality.

<u>The Northern ecozone</u>

The study area is situated in a forest steppe region of Mongolia, rich with various species. A total 174 species have been identified in the area. This is a relatively high number compared to other steppe and desert, steppe regions.

Although the project area does not have rare or very rare flora, according literature (Grubov, Guidebook on vascular plants of Mongolia. 2007; IUCN, Reference on common plants of Mongolia, 2000; Forage plants. 2007) Seven species of rare (*Allium lineare, Iris Potaninii, Polygonum viviparum, Stellaria media, Sedium aizoon, Plantaga Komarovii, Achillea asiatica*) and one species of very rare plant (*Rhodiola rosea*) might occur in this area. Although these were not encountered personally during the survey, since their habitat is same, it might be present in the area. Also *Parmelia vagans* – lichen vegetatation grows abundantly in the area. This lichen is a herb used for traditional healing.

These 174 species do not occur in Red book list of Mongolia and in list of Appendixes of *Convention on International Trade in Endangered Species* of Wild Fauna and Flora/CITES/.

Growth of young trees on edge of green zone of the project area demonstrates that rehabilitiation of the forest is good. During the survey, we observed, cluster of young trees on edge of the forest.

In terms of vegetation of the area, local residents use it as pastureland and hayfield. As of now, there is no other impact than this.

<u>Southern ecological zone</u>

As a result of lab analysis, semi desert gleyish soil was consisted of sandy mechanical composition depth of topsoil layer of the semi desert gleyish soil is 20 cm, humus content is 1.15%, Potassium content 10.73 mg/100 g, Phosphorous content 1.06 mg/100g, Calcium carbonate content (CaCO3) 2.24, dissolved oxygen (pH) 8.11 or alkali and dissolved salt amount is 0.095 ds/m. It explains that this type of soil fertility is medium; easily soluble salt content can be seen on Table 8 and Table 9 below.

According to a study in the Gobi region of Mongolia, it is believed that soil deflation takes place actively when there is a wind speed of 7-9 m/s at a height of 10 m/s. Then, according to the research conducted on the hourly observation of wind speed, it is reasonable to take that soil erosion can be active for about 1500 hours. However, if we consider the wind speed of 4 m/s to move a small piece of soil, it means that the soil can be eroded for 4200-4600 hours a year.

The area is part to the "semi desert brown soil" type according to the soil geography of Mongolia, and the " subtype of semi desert brown" soil is mainly distributed.

The depth of seasonal soil freezing reaches 1.6-2.5 m in winter. During the cold winter, the temperature of -10 ºC penetrates the soil up to 40 cm deep.

Characteristics of the soil in this region, the soil temperature up to a depth of 40 cm is higher than the air temperature above the soil throughout the year. (Umarov.K.I., 1978) This is especially evident in winter, for example, according to the measurements made in December, the soil temperature at a depth of 20 cm is 5-7 ºC higher than the atmosphere temperature, and the temperature at a depth of 40 cm is 8-11 ºC higher than the atmosphere temperature. In summer, the soil heats up strongly, the temperature on the surface of the soil reaches +60ºC to +67 ºC, and the temperature of +15 ºC penetrates into the soil 2-2.5 m deep. Even though the sand-silt stone cover on the surface of the Gobi brown soil is not thick (0.5-2 cm), it has the characteristic of protecting the surface of the soil from overheating by affecting the thermal regime of the soil to a certain extent

Acknowledgement

A train without a head would never turn its right way for a great long-lasting journey, train without a tail would never end with its targeted goal.

I would like to express my great thanks to Professor Knippertz for his support, and the paper would not be able to write this far without Professor Gantuya.

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Appendices

Attachment 1. Soil sample result – Nalikh bag

Маяг ХФ-01

ГТЛ-ийн Захирлын 2017 оны 249 тоот тушаалын 1-р хавсралт

ГЕОЛОГИЙН ТӨВ ЛАБОРАТОРИ

CENTRAL GEOLOGICAL LABORATORY

ilac-MRA

MNAS

ШИНЖИЛГЭЭНИЙ ДҮН

Захиалгын дугаар: ХФ 2018/2183 **Захиалагчийн нэр: Монх Ноён Суврага ХХК**

№	Лаб №	Дээж №	Дээжийн тодорхойлолт	Элемент, мг/кг		pH
				CO_3^{2-}	Цахилгаан дамжуулах чанар, µS/cm	
1	31993	5	-	<7.5	83.50	7.74
2	31994	11	-	<7.5	73.20	7.76
3	31995	12	-	<7.5	82.10	7.83
4	31996	8	-	<7.5	78.40	7.84
5	31997	6	-	<7.5	83.20	7.91
6	31998	10	-	<7.5	78.30	7.81
7	31999	2	-	<7.5	98.10	7.82
8	32000	1	-	<7.5	85.90	7.74

Чанарын хяналт

1	31995	12	Шифр-7047	<7.5	82.40	7.81
Шинжилгээний аргын код				Титр-93	УсШ-104	УсШ-102

Энэхүү шинжилгээний дүн нь захиалагчаас ирүүлсэн тухайн дээжинд хамаарах бөгөөд зөвхөн эх хувь нь хүчинтэй.

Гүйцэтгэсэн инженер: А.Ундармаа
(нэр)

Хэвлэсэн огноо: 2018.10.04

Хуудас (2/2)

Attachment 2. Soil sample result – Renchin bagh

“НАРТ ШУҮН КОНСАЛТИНГ” ХХК
ХӨРСНИЙ ИТГЭМЖЛЭГДСЭН ЛАБОРАТОРИ

Монгол улс. Улаанбаатар хот. Сонгино Хайрхан
дүүрэг. 19-р хороо. УЭГ. 3К 17024 Ш/х 10
Утас: (976)-99176123. 99231836
E-mail: nartconsulting@gmail.com

№ 19/ 06-18

ИТГЭМЖЛЭГДСЭН ЛАБОРАТОРИ TL 145

Захиалагч: **“Эхмонголын байгаль” ХХК**
Дээж авсан цэг: **Хөвсгөл аймаг Цэцэрлэг**
Сорьц авсан огноо: **2019 оны 06 сар 11 өдөр**
Шинжилгээ хийсэн огноо: **2019 сарын 06.18**
Харилцах утас:

ХӨРСНИЙ ХИМИЙН ҮНДСЭН ҮЗҮҮЛЭЛТҮҮД — ХҮСНЭГТ I

Дээж авсан гүн. см	pH	Давс. %	ЦДЧ. ds/m	Ялзмаг. %	$CaCO_3$. %	NO_3. мг/100г	Солилцох сууриуд. мг-экв/100 г		Шим тэжээлийн элементүүд. мг/100г	
							Ca^{+2}	Mg^{+2}	P_2O_5	K_2O
Зүсэлт I										
0-10	6.5	0.051	0.041	10.65	-	1.54	26	10	1.7	20
10-23	6.6	0.024	0.057	8.61	-	0.97	27	6	1.6	12
23-42	7.2	0.025	0.052	4.64	-	0.23	20	7	0.6	12
42-60	7.3	0.052	0.043	1.79	-	0.09	18	2	0.5	10
Зүсэлт 2										
0-8	6.8	0.045	0.188	3.62	-	0.19	12	7	1.8	27
8-19	8.4	0.685	2.143	1.01	1.12	35.62	8	6	1.3	6
19-50	8.7	0.715	2.236	0.92	0.98	36.15	20	12	0.9	9
Зүсэлт 3										
0-6	8.4	0.033	0.106	4.33	-	0.12	25	3	2.3	15
6-27	8.6	0.045	0.152	2.54	0.78	0.36	15	4	0.8	6
Зүсэлт 4										
0-9	8.7	0.065	0.217	1.47	-	2.65	12	5	1.3	7
9-30	8.7	0.065	0.217	1.67	-	0.73	13	4	1.7	14
Зүсэлт 5										
0-20	7.5	0.015	0.046	5.17	-	0.27	15	5	1.7	23
20-40	7.8	0.010	0.050	1.77	-	0.56	12	6	1.2	15
Зүсэлт 6										
0-10	8.2	0.015	0.114	4.72	0.96	1.12	20	5	1.6	22
10-27	8.7	0.035	0.125	2.61	1.22	0.38	11	7	1.4	17
27-40	8.4	0.405	1.267	3.08	0.84	8.17	28	12	1.3	9

ХӨРСНИЙ МЕХАНИК БҮРЭЛДЭХҮҮН — ХҮСНЭГТ 2

Дээж авсан гүн, см	Механик ширхэгүүд, % ширхэгийн хэмжээ, мм						
	1-0.25	0.25-0.05	0.05-0.01	0.01-0.005	0.005-0.001	<0.001	<0.01
Зүсэлт 1							
0-10	6.9	58.84	20.1	2.02	4.72	7.39	14.14
10-23	8.5	52.44	23.07	2.46	5.65	6.86	14.98
23-42	17.9	45.76	19.47	5.12	3.63	8.08	16.83
42-60	6.29	54.36	14.38	3.63	5.81	15.51	24.96
Зүсэлт 2							
0-8	4.41	64.47	16.72	3.03	2.30	9.04	14.38
8-19	2.91	61.41	14.62	1.13	14.01	5.89	21.04
19-50	7.06	34.18	23.25	3.67	11.39	20.42	35.49
Зүсэлт 3							
0-6	16.72	56.41	15.78	2.20	1.77	6.10	11.08
6-27	24.31	49.42	15.67	1.53	1.61	7.43	10.58
Зүсэлт 4							
0-9	14.68	56.56	18.03	1.89	3.35	5.454	10.70
9-30	15.28	56.49	18.80	2.22	1.41	5.77	9.41
Зүсэлт 5							
0-20	13.73	51.96	17.57	2.98	5.97	7.75	16.72
20-40	19.46	67.52	2.62	1.85	0.72	7.79	10.38
Зүсэлт 6							
0-10	17.92	59.17	12.28	1.09	4.12	5.41	10.62
10-27	17.54	55.01	14.82	1.21	4.76	6.62	12.60
27-40	21.62	47.5	16.92	3.59	5.13	5.21	13.93

ХӨРСНИЙ ХҮНД МЕТАЛЛИЙН ҮЗҮҮЛЭЛТҮҮД — ХҮСНЭГТ 3

Дээж авсан газар. Газар зүйн байршил	Дээж авсан гүн.см	Cr мг/кг	Pb мг/кг	Cd мг/кг	Zn мг/кг	Cu мг/кг	Ni мг/кг
Зүсэлт 3	0-10	-	12.4	<0.01	79.2	32.4	2.5
Зүсэлт 6	0-10	-	1.8	<0.01	58.9	25.3	-
Зөвшөөрөгдөх дээд хэмжээ. MNS 5850:2008		**150**	**100**	**3**	**300**	**100**	**150**

** Жич: Энэхүү шинжилгээний хариу нь тухайн ирсэн дээжинд хамаарна.*

ЗАДЛАН ШИНЖИЛГЭЭНИЙ АРГЫН СТАНДАРТУУД : (MNS3310:1991. MNS2143:2000. MNS 5850:2008. *Хүнд металлуудыг -хаан дарсанд атом шингээлтийн спектрометрээр*)

ЗАДЛАН ШИНЖИЛГЭЭГ ГҮЙЦЭТГЭСЭН: Х.ЖАРГАЛМАА.
Л.БАДМААРАГ

ХЯНАСАН ЛАБОРАТОРИЙН ЭРХЛЭГЧ : Г.СОЛОНГО Ph.D *ttachment 3. Mongolian biggest area, mining sites (Google Maps,NVIDIA Corporation 00027.00020.00100.09664), 2022)*