Artículo de investigación

Assessment of landscape and environmental conditions of Susuman district of Magadan region

Оценка ландшафтно-экологических условий Сусуманского района Магаданской области

Recibido: 29 de julio del 2019 Aceptado: 23 de septiembre del 2019

Written by:
Mariia M. Surzhik[141]
ORCID: 0000-0001-7901-4592
Galina M. Sidorova[142]
ORCID: 0000-0002-0952-8739
Natalya V. Mukhina[143]
ORCID: 0000-0002-2265-8466
Tatyana V. Naumova[144]
ORCID: 0000-0001-5126-1604
Viktor V. Falko[145]
ORCID: 0000-0001-5938-7412

Abstract

In Susuman district of Magadan region, against the background of natural processes, the manifestation of human economic activity is very noticeable, causing a change in the relief. This is due to the industrial development of placer gold deposits, which led to serious violations of the natural complexes of river valleys. The peculiarity of the territory of Susuman district is the imposition of severe climatic conditions and the specifics of human anthropogenic activity, which creates such particularly crisis situations in the environment as thermokarst, soil erosion, waterlogging, flooding of all low landforms, pollution with heavy metals. To assess the violations of the landscape, an analysis of the severity of environmental situations was carried out, which showed that the environmental situation in the area is tense, and in some areas it turns into a critical one. It should be noted that the actual area of disturbed land in Susuman district is much larger than the statistical one. The largest areas of the district are in the gradation of significant and minor anthropogenic loads. The weighted average coefficient shows the average degree of anthropogenic load on this territory, which is still preserved due to a large area of

Аннотация

В Сусуманском районе Магаданской области на фоне природных процессов весьма заметно проявление хозяйственной деятельности человека, которое вызывает изменение рельефа. Это происходит вследствие промышленного освоения россыпных месторождений золота, что уже привело к серьезным нарушениям природных комплексов речных долин. Особенностью территории Сусуманского района является наложение суровых природно-климатических условий и специфики антропогенной деятельности человека, что создает такие особо кризисные ситуации в окружающей среде, как термокарст, эрозия почв, переувлажнение и заболачивание, затопление всех низких форм рельефа, загрязнение тяжелыми металлами. Для оценки произошедших нарушений ландшафта был проведен анализ степени остроты экологических ситуаций, который показал, что экологическая ситуация в районе напряженная, а на отдельных территориях переходящая в критическую. Фактическая площадь нарушенных земель в Сусуманском районе значительно больше статистической.

[141] Ph.D., Associated Professor, Department of the Land Management, Primorye State Agricultural Academy.
[142] Ph.D., Professor, Head of the Department of the Land Management, Primorye State Agricultural Academy.
[143] Ph.D., Associated Professor, Department of the Land Management, Primorye State Agricultural Academy.
[144] Ph.D., Associated Professor, Department of the Land Management, Primorye State Agricultural Academy.
[145] Ph.D., Associated Professor, Dean of the Institute of the Land Management and Agrotechnoligy, Primorye State Agricultural Academy.

forests. However, this does not mean that there is no risk of deterioration of the landscape and environmental situation in Susuman district.
With intensive use of land for mineral exploitation and extraction without compliance with environmental measures, the area of disturbed land will increase by 3-4 thousand hectares every ten years. In addition, some landscapes have irreversible violations. Therefore, it is recommended not to rely on natural restoration of landscapes but to carry out technical and biological land reclamation.

Key Words: Ecology, landscape, Magadan region, rural development, Russian Far East

Наибольшие площади района находятся в градации значительной и незначительной антропогенных нагрузок. Степень антропогенной нагрузки на эту территорию средняя, которая пока еще сохраняется за счет большой площади лесов. Однако это не говорит об отсутствии риска ухудшения ландшафтно-экологической ситуации в Сусуманском районе. При интенсивном использовании земель под разработку и добычу полезных ископаемых без соблюдения природоохранных мероприятий площади нарушенных земель каждые десять лет будут увеличиваться на 3-4 тыс. га. Кроме этого часть ландшафтов имеет необратимые нарушения. Поэтому рекомендуется не полагаться на естественное восстановление ландшафтов, а проводить техническую и биологическую рекультивацию земель.

Ключевые слова: Дальний Восток России, ландшафт, Магаданская область, развитие регионов, экология

Introduction

In the modern era, the relationship between society and nature has reached such a degree of severity that they pose a threat to all life on the planet. Negative consequences of irrational use of natural resources, environmental pollution gradually accumulate and create emergency situations that threaten the possibility of further development of productive forces. This applies to all regions, in particular Magadan region.

The state of land in virtually all regions of the Russian Federation is rapidly deteriorating, including Magadan region. The economy of Magadan region is about 70% dependent on the level of gold and silver production. The industrial development of placer gold deposits has led to serious violations of natural complexes of river valleys. Overburden work and further development of the sites with the help of bulldozers, excavators, washing plants and dredges have led to the fact that after mining landfills there are lifeless dumps, pits, sedimentation tanks and numerous roads. No less harmful are indirect violations: wind and water erosion, changes in the temperature regime of permafrost, changes in the level of groundwater, pollution of the environment with waste oil products.

On the territory of Magadan region, one of the leaders in reserves of minerals such as gold, silver, coal is Susuman district. In connection with the growth of the economy, the volumes of the gold mining industry are also increasing, and this will definitely lead to a further increase in the adverse impact on the environment, accompanied by an increase in disturbed lands. In this case, we can talk about the dynamics of disturbed lands. Currently, the available information on the state and use of land, the development of negative processes in Magadan region is insufficient.

The aim of this work is to analyze the landscape and environmental conditions of Susuman district in Magadan region for the prediction of the environmental situation.

Methods and Materials

Data collection regarding the condition and use of land in Susumansky district of Magadan region were held in the archives of the State Data Fund under the Management of Russian State Register in Magadan region and Chukotka Autonomous district.

Methods of calculation of indicators of ecological stability of a landscape are used in work (Kochurov, 1999). The calculation of this indicator is based on the ratio of the areas occupied by different elements, taking into account their positive and negative impact on the environment.

Assessment of anthropogenic load was carried out by taking into account the scale of degrees (Volkov, 2001). Five degrees on a five-point scale were taken. A high degree of anthropogenic load is related to industrial land, transport (including field roads), livestock farms, populated areas, ravines, landfills and other disturbed land. A significant and medium degree of load is related to agricultural land depending on the intensity of their use. An insignificant and low degree of anthropogenic load is preserved in the territories of limited use or specially protected lands. The anthropogenic load score is calculated as the weighted average score for each land type or land category.

To assess the ecological state and anthropogenic changes in vegetation and animal population, the method of score indicators of B. I. Kochurov (2015) was used. According to this method, the coefficients of absolute and relative ecological tension of the territory are calculated, that is, the ratio of the area of land with high anthropogenic loads to the area of land with the lowest loads. According to the methodology, 6 points of anthropogenic load were allocated. The highest, very high and high degrees characterizing the risk of landscape degradation include industrial land, transport, cities, towns, infrastructure, disturbed land, irrigated and drained land, arable land, areas of intensive logging, pastures and hayfields used irrationally. The average degree of pressure on living communities is observed on perennial plantations and recreational lands. Low and very low degrees are observed on the lands of limited use, which include hayfields, as well as specially protected areas.

Overview of the state of the object of study

Susuman district is located in the North-Western part of Magadan region (figure 1). In the West and North it borders with the Republic of Yakutia, in the South – with Yagodninsky and Tenkinsky districts, in the East – Srednekansky district. The district center is the town of Susuman, which is located 625 kilometers from the city of Magadan on the Federal highway Magadan-Yakutsk. The area of Susuman district is 46.8 thousand square kilometers, which is 10.1 % of the total area of Magadan region.

Magadan region is one of the leading gold-mining regions of the country. The subsoil of Magadan region is rich in reserves of tin, silver, gold, coal and minerals such as building stone, sand and gravel mixture, expanded clay raw materials, peat. The increasing pace of the gold mining industry leads to an increase in disturbed land.

Violations of the quality of land in connection with the extraction and exploitation of minerals contribute to the development of related negative processes (permafrost, waterlogging, flooding, waterlogging, erosion, etc.), which are a source of negative impact on the environment. Therefore, it is possible to distinguish two groups of factors that cause land disturbance: anthropogenic (technogenic) and natural.

Anthropogenic factors in the last decade have led to an increase in the area of disturbed land. In terms of the impact on the increase of disturbed lands, they have become comparable to natural factors. In Susuman district of Magadan region, against the background of natural processes, the manifestation of human economic activity is very noticeable, causing a change in the relief. Relief-forming activity manifests itself in a direct impact on the relief especially in the extraction of minerals.

About 60% of alluvial gold is concentrated in Susuman district, where more than 30 enterprises are engaged in gold mining. The mining industry has now become one of the largest sources of disturbance and pollution of the natural environment, it is considered the world's most destructive. The range of influence on the biosphere of destroyed landscapes caused by mining activities is so wide that in some areas it causes unpredictable effects, damaging soil, vegetation, fauna, human health. The main form of anthropogenic relief is quarry, due to the extraction of minerals.

Coal-bearing deposits in Susuman district are developed within the Arkagala coal deposit, which stretches for 60 km along the riverbed of the Arkagala river and is crossed by its numerous tributaries (Shek, 1963). The volume of open-pit coal mining in the total volume of coal production is 65%, and its share is expected to increase over the next decade by another ten percent, which will lead to an increase in the disturbed land areas.

The soil layer on the old dumps is practically absent, which is accompanied by depressed vegetation. Secondary processing of waste dumps of gold mining dredge method leads to the formation of very complex man-made terrain, including uneven piles of overburden, dredging and quarrying, pebble dumps, dredge sinus, a variety of artificial reservoirs. The formed

biocenosis on recultivated dumps at secondary use for gold mining is broken.

In addition to the main form (quarry) of anthropogenic relief, it is necessary to highlight the slight development of linear transport forms, which appeared when repairing bridges, culverts, existing roads including travel for maintenance and repair of power lines, the construction of entrances to places of exploration and mining.

For the period from 2012 to 2018 on the territory of Susuman district it should be noted the absence of new construction of roads and branches of power lines.

In permafrost areas, direct anthropogenic impact is accompanied by frost heaving and cracking of soils, thermokarst, thermogenic deformations that destroy roads, runways of airfields, contribute to buckling of columnar and pile foundations of structures, light bridges, power transmission towers and communication lines.

When mining minerals, there is an anthropogenic impact not only on the land plots allocated for the exploitation of the quarry, but also on the area under access roads and power lines. To bring equipment, trailers for living, etc., it is necessary to build access roads. Their construction provides cutting down of tree and shrub vegetation, removal of a fertile layer of the soil, a construction of drainage ditches, the device of transitions through small watercourses. All of this entails human disturbance areas.

Susuman district is located in the zone of continuous and island distribution of permafrost, the temperature of which at the boundary of the constant temperature layer varies from -1°C to -8°C (Shilo, 1970).

Geographical location, long and cold winters with severe frosts, wet cold summers, atmospheric pressure changes and other natural features have a negative impact on the process of soil formation, in particular, increased hydromorphism. Large relative humidity makes it difficult to evaporate moisture from the surface, and the high horizon of permafrost limits its infiltration into the underlying soil horizons and this causes waterlogging, flooding, waterlogging, flooding of all flat (and even lower) landforms in the region. Of the permafrost phenomena in the area thermokarst, frost cracks and ice are common (Shilo, 1970).

During mining large masses of soil move, the shape of the watercourse on the area included in the land allotment changes, inflows are blocked, tortuosity is disturbed, flow velocity is reduced due to the inability of the deformed cross section to let the water flow resulting in flooding the surrounding areas. The exploitation of placer gold deposits makes significant changes in the regime of rivers. During the development of placers, rock masses are carried away into rivers, long "muddy flows" enriched with silt-clay material are formed downstream. The processes associated with the activity of surface waters were significantly activated: water erosion, surface flooding, waterlogging.

Thus, climatic and anthropogenic factors can overlap, thus creating a particularly critical situation in the environment.

The total area of disturbed lands according to the results of mapping from 1999 to 2018 was increased by 2277 hectares, including the nature of man-made impact, which is identified as the predominant type of impact-subsoil use.

Results and discussion

To assess the landscape and ecological state of the lands of Susuman district of Magadan region, the structure of land was analyzed (Table 1).

Table 1. Structure of land by species

Grounds	Area, thousand hectares	Share of total area, %
Agricultural land-total:	14,278	0,31
among them:		
arable	0,647	-
deposit	0,029	-
perennial plantings	-	-
hayfields	3,844	-
pastures	9,758	-
Forest land	3134,566	67,03
Forest lands not included in the forest Fund	8,047	0,17
Land under water bodies	45,270	0,97
Land development	0,623	0,01
Land under roads	2,063	0,04
Swamps	156,705	3,35
Disturbed lands	21,809	0,47
Other lands	1293,203	27,65
all	4676,564	100,00

Analysis of the distribution of land on the grounds of Susuman district showed that this area is dominated by forest land. The infrastructure of the area is not developed. Lands under industrial facilities and exploitation, which are included in the column "other land", occupy a significant area.

The distribution of land by category as of 01.01.2018 is shown in Table 2.

Table 2. Land distribution by category

Land category	Area			
	total, thousand hectares	%	including land disturbed, thousand ha	%
Agricultural land	7,694	0,17	0,039	0,18
The land of the populated points	7,005	0,15	0,052	0,24
Industrial and other special purpose lands	6,490	0,14	0,878	4,02
Lands of specially protected territories and objects	-	-	-	-
The lands of the forest Fund	4594,959	98,25	20,069	92,02
Reserve lands	60,416	1,29	0,771	3,54
Total land	4676,564	100	21,809	100,00

ISSN 2322- 6307

The analysis of land distribution by categories shows that there are disturbed lands among all categories. They are mainly located on forest lands and industrial lands.

It should be noted that the actual area of disturbed land in Susuman district is much larger than the statistical one. Annually statistical reporting includes the land on which reclamation after mining of precious metals is completed to other land.

Land allotments for mining are leased, for the most part, for a period of less than 1 year. As a result, leases of land do not subject to state registration in the Federal service for state registration, cadaster and cartography (ZK, Chapter 5, article 26, clause 2) and the area of these land plots are not reflected in the financial statements of the Department of Russian State Register in Magadan region - Form No. 22-1 and Form No. 22-2.

The ecological sustainability of a landscape is its ability to return to its original state after the cessation of external influences. The property of stability is manifested in all components of the landscape, but it is most inherent in vegetation. When the level of agricultural land development increases, the stability of landscapes decreases. This is especially evident in the intensive use of land-land reclamation and cultural works, development of the territory.

It is known that the environmental sustainability of agricultural landscapes decreases with increasing of arable land cultivation, ploughing and intensive use of land, irrigation and cultural works, building area etc. (Starozhilov Surzhik, 2014). To assess the environmental sustainability of the territory of Susumansky district, the calculation of coefficient of ecological stability was done (Table 3).

Table 3. Determination of the coefficient of environmental stability of the farm territory by the method of S. N. Volkov (2001) (according to statistical reports and updated data as of January 1, 2018)

№	Name of land	Coefficient of ecological stability of the land, C_1	According to statistics		Area updated	
			Area (A), ha	A x C_1	Area (A), ha	A x C_1
1	Arable land (cultivated)	0,14	647	90,58	557	77
2	Deposit	0,62	29	17,98	119	73
3	Perennial plantings (gardens)	0,43	-	-	-	-
4	Hayfields	0,62	3844	2383,28	3844	2383
5	Pastures	0,68	9758	6635	60	40
6	Forest	1	1525028	1525028	1525028	1525028
7	Uncovered forest (meadows, shrubs)	0,62	1609538	997913	1619236	1003926
8	Forest plantations not included in the forest fund	1	8047	8047	8047	8047
9	Under water	0,79	45270	35763	45270	35763
10	Under building	0	623	0	623	0

11	Under roads	0	2063	0	2063	0
12	Swamps	0,79	156705	123796	156705	123796
13	Violated lands	0	21845	0	21845	0
14	Other land (ravines, land after reclamations)	0,4	1293167	517266	1293167	517266
	Subtotal:	-	4676564	3216942	4676564	3216404
	Coefficient of ecological stability	-		0,69		0,69

According to the assessment and the results, we can say that the area is environmentally stable, as the coefficient of environmental stability C en. St. = 0,69. This means that the landscape is capable of restoration.

Anthropogenic load characterizes the degree of landscape change by man (Table 4).

Table 4. Assessment of land by the degree of anthropogenic load according to S. N. Volkov (2001)

Degree of anthropogenic loads	Score, S	The title of the land	Area (A), ha	AxS
High	5	Land of industry, transport, settlements, roads, broken lands	124495	622475
Significant	4	Arable land, perennial plants, vegetable gardens, land after reclamations	1293879	5175516
Average	3	Cultural grasslands: a well-deserved beams, pastures, hayfields	13602	40806
Minor	2	Forest belts, bushes, forests, swamps, under water	3344588	6689176
Low	1	Special Protection National Territory	-	-
Subtotal:			4676564	12527973
Coefficient of anthropogenic load			2,68	

The largest areas of the district are in the gradation of significant and minor anthropogenic loads. The weighted average coefficient shows the average degree of anthropogenic load on this territory, which is still preserved due to a large area of forests. However, this does not mean that there is no risk of deterioration of the landscape and environmental situation in Susuman district (Table 5).

Table 5. Assessment of land by the degree of anthropogenic load according to B. I. Kochurov (1999)

Degree of anthropogenic loads	Score, S	The title of the land	Area A, ha	AxS
Highest	6	Land of industry, transport, cities, towns, infrastructure, disturbed lands	124495	746970
Very high	5	Irrigated and drained lands	322	1610
High	4	Arable land, areas of intensive cuttings, pastures and hayfields used irrationally	1307159	5228636
Average	3	Perennial plantings, recreational land	-	-
Low	2	Hayfields, forests of limited use	3334588	6669176
Very low	1	Environmental and unused lands	-	-
Subtotal:			4676564	12646392
Coefficient of anthropogenic load (K_a)			2,70	

According to the method of B. I. Kochurov (1999), the anthropogenic load is slightly higher than according to the method of S. N. Volkov (2001) considered above. Both of these methods confirm the presence of an average degree of anthropogenic load on the territory of Susuman district.

The Ka coefficient shows the ratio of the area of land disturbed by mining, industry and transport to the area of the territories poorly modified or unchanged by economic activity. The higher this ratio, the less favorable conditions for human life and activity, which leads to the need for restoration of landscapes and activities for their rational use. The state of the study area is taken into account when calculating the $K_{\circ}$. The reduction of ecological tension reduces the value of this indicator, and if it is equal or close to 1.0, we can talk about a relative equilibrium between the value of anthropogenic load and the potential of landscape stability (Volkov, 2001).

The danger of increasing anthropogenic load in the study area is that the natural conditions of the Northern territories are more vulnerable than with a similar load in the temperate or southern latitudes. The fragility of the habitats of the Northern latitudes is due to a narrower range of life resources, which can be much easier to break and much more difficult to recover. In this direction, research is being conducted in the field of geoecology, covering a wider range of issues of sustainability and restoration of ecosystems.

The concept of "ecological (geoecological) situation" is widely used in the ecological and geographical literature, but so far it has no generally accepted interpretation. Summarizing the existing ideas (Starozhilov & Surzhik, 2014), we define the ecological (geoecological) situation as a spatio-temporal combination of environmental natural and anthropogenic conditions and environmental problems that

significantly affect the life and activities of the population, as well as the general state of the environment. The term "acute environmental situation" is often used, which is usually associated with environmental problems or threats to human health and life.

The formation of environmental situations is due to the action of several groups of factors – natural, economic, social, demographic, political. The main cause of their occurrence is the anthropogenic factor-a significant violation of the natural resource and environmental potentials of landscapes (deforestation, exceeding the annual growth of wood; soil washout of more than 5 t / ha per year; intake of pollutants in concentrations exceeding the maximum permissible concentration, etc.).

Ecological (geoecological) situations always have a spatio-temporal character. According to the spatial scales of occurrence, they can be divided into local, regional, global. It follows that the analysis of environmental situations should be carried out within certain territorial structures - geo - and ecosystems of different hierarchical levels. Areas of their manifestation have complex boundaries formed by a combination of boundaries of natural and anthropogenic landscapes, river basins, administrative areas, types of land use. Short-, medium - and long-term environmental situations can be distinguished on a temporary basis. Since the occurrence of acute environmental situations often worsens the conditions of human life and activity, it is necessary to assess the degree of their danger. The greatest practical interest is the assessment of severity (criticality, tension) of situations, i.e. identification of degree of danger of consequences of economic activity of the person from positions of the person.

Based on these positions, it was proposed to determine the severity of environmental situations on the basis of indicators characterizing: a) the quality of life of the population (i.e. the degree of compliance of environmental characteristics with the needs of human activity); b) the degree of preservation of natural resource potential of landscapes; c) the intensity of violations of the structure and properties of landscapes.

Taking into consideration these signs, the following situations can be more or less clearly characterized now: satisfactory, tense (conflict), critical, crisis, catastrophic.

A satisfactory situation is characterized by areas relatively little affected by human activities (protected areas, areas with well-preserved structure of the economy of the population). Anthropogenic changes capture individual components of nature. Changes are easily reversible when loads are reduced or stopped. Pollution most often does not exceed the maximum permissible concentration (MPC) and practically does not affect the health of the population.

The tense (conflict) situation is manifested in the developed areas with stable functioning socio-economic structures. Some components of geo - and ecosystems change negatively, which leads to some deterioration of living conditions and activities of the population. Improvement of the situation is achieved through stabilization of economic activity and improvement of production technology.

In a critical situation, anthropogenic loads, as a rule, exceed the established normative values and environmental requirements. There are significant changes in geo-and ecosystems, increasing the threat of depletion of natural resources, deteriorating living conditions of the population. The reduction and elimination of anthropogenic pressures may lead to the normalization of the environmental stop and partial recovery of geo - and ecosystems.

The crisis situation is observed in cases where human economic activity leads to disruption of the structure of geo - and ecosystems, depletion of natural resources, significant pollution of the biosphere components. In this regard, negative changes in the environment are becoming sustainable; it threatens the health of the population, the state of natural ecosystems, the genetic fund of plants and animals.

In catastrophic situations, anthropogenic loads (including environmental pollution) repeatedly exceed the permissible limits. The structure of natural complexes and, accordingly, the existing system of nature management is being destroyed. As a result, there are deep, often irreversible changes in the natural environment, which entail a significant deterioration of public health, violation of the ecological balance, degradation of flora and fauna.

Let us consider the assessment of the severity of the environmental situation in the South-Eastern part of Susuman district (Table 6).

Table 6. Assessment of the severity of the environmental situation in the South-Eastern part of Susuman district

Disturbed land, % of area	Degree of disturbance of landscapes	Health status of the population	Category of environmental situation
2,33	Changing component properties	Deterioration of health of certain population groups	The environmental situation is tense on the separate areas, turning into critical

According to the calculations of assessing the severity of the environmental situation of the populated South-Eastern part of Susuman district, we can draw the following conclusion: as in this part of the district the main mining of gold is held, respectively, changes of the component properties of landscape disturbance have taken place and, consequently, deterioration of the health of specific population groups (diseases of the respiratory system)is observed which corresponds to the tense ecological situation on separate territories turning into critical.

In recent decades, there has been an increase in disturbed lands, so it is necessary to make a forecast of the development of disturbed lands and, consequently, degassing processes.

Forecasting has two interrelated and interdependent directions:

a) Prediction of the possible rate of development of disturbed lands
b) Prediction of the possible state of the complex properties of soils (primarily physical), subjected to degradation processes.

The solution of these problems, with all the differences in methodological approaches, should be based on the one hand on the basis of a deep analysis of the accumulated material of observations of the dynamics of land disturbance in a multi - year cycle, on the other hand-on the knowledge of the causes and mechanisms of soil degradation processes.

With a detailed analysis of the stock materials and collected data on hydrogeology, climate, geomorphology, etc., it can be predicted that with intensive use of land for the development and extraction of minerals, without compliance with environmental measures, the area of disturbed land will increase by 3-4 thousand hectares every ten years.

It should be pointed out that the processes of soil degradation are unidirectional (irreversible). Once started, they continue and lead to subtype and type changes in soils. The importance of the processes is evidenced by the fact that the soil experiencing negative processes, the activation of which is caused by man-made impacts, loses the original genetic affiliation and quality.

For the actual reflection of the processes of land violation and the creation of regional and federal programs to prevent and eliminate the causes of the increase in acreage of disturbed lands, soil degradation there should be regular studies of land, the complex of measures preventing the increase of disturbed lands in areas with particularly well-developed mining.

Conclusions

The use of natural resources of Susuman district with a bias towards the preferential use of the territory for the extraction of minerals (primarily precious metals) is the main source of disturbance and destruction of the components of nature: vegetation and soil cover, groundwater, local hydrographic network (streams, small rivers, lakes, etc.), changes in relief. Anthropogenic activities, including the use of natural resources, lead to disruption of the geological and biological cycles of matter in nature.

It is economically inexpedient to rely on natural restoration of natural quality of lands because of long terms that is connected with big losses from their non-use in economic turnover. Therefore, it is necessary to combine technical and biological methods of recultivation of such lands until their natural quality is fully restored and put into

economic circulation. However it demands additional financial costs, which will pay off only in 5 - 10 years.

All disturbed lands are subject to reclamation regardless of the stages, methods or technologies of development of placer deposits.

The main criteria for assessing the degree of land disturbance are: the degree of violation of soil and vegetation cover, changes in relief, pollution and littering of the natural landscape, the development of adverse effects on the surrounding area, the manifestation of negative processes.

The increase in the area of disturbed land indicates a progressive process of land violations. All of the above says about the urgent need to apply a system of measures to reduce the area of disturbed land. The basis of the system should be the reclamation of land after its use for mining. To reduce the negative impact on nature, various environmental actions should be carried out aimed at preserving, improving and restoring the lost original state of natural components.

Bibliographic references

Archive documents:

Forms of the statistical reporting № 22-1 and № 22-2 on Susuman area of Magadan region "Data on availability and distribution of lands by categories and grounds" for 01.01.2018 (2018).
The scheme of borders of Susumansky district, Magadan region, scale 1:500000. (1983). Magadan. Dalgiprozem.
Technical report on soil-geobotanical survey of the farm "Energetik". (1987). Magadan. Dalgiprozem.
Materials of allotment of land plots on the territory of Susuman district of Magadan region for the mineral exploitation. (2010-2018).
Instructions for the reclamation of land disturbed during the development of placer gold deposits (2006). Magadan: JSC Research Institute-1.

Printed article:

Kochurov, B.I., Zotova, L.I., Tumel, N.V. (2015) Ecodiagnostics of dangerous geoecological situations during the economic development of permafrost zones (Ekodiagnostika opasnyh geoekologicheskih situacij pri hozyajstvennom osvoenii kriolitozony). Problems of Regional Ecology (4), 157-164.

Book with author:

Starozhilov, V. T. Surzhik, M. M. (2014). General landscape studies and use of the landscape approach in ecological monitoring. (Obshchee landshaftovedenie i ispol'zovanie landshaftnogo podhoda v ekologicheskom monitoring). Ussuriisk: Primorye State Agricultural academy.
Volkov, S. N. (2001). Land use planning. On-farm land management. (Zemleustroitel'noe proektirovanie. Vnutrihozyajstvennoe zemleustrojstvo). Moscow: Kolos.
Kochurov, B. I. (1999). Geoecology: ecodiagnostics and ecological and economic balance of the territory. (Geoekologiya: ekodiagnostika i ekologo- hozyajstvennyj balans territorii). Smolensk: Smolensk Humanities University.

Book with editor:

Shek, N.D. (Ed.). (1963). Surface water resources of the USSR. Hydrological knowledge. (Resursy poverhnostnyh vod SSSR. Gidrologicheskaya izuchennost') Leningrad: Gidrometeoizdat.
Shilo, N.A. (Ed.). (1970). North of the Far East. Natural conditions and natural resources of the USSR. (Sever Dal'nego Vostoka. Prirodnye usloviya i estestvennye resursy SSSR). Moskow: Nauka.