Ambient Science, 2020: Vol. 07(1); 19-22
DOI:10.21276/ambi.2020.07.1.aa02

Published by: National Cave Research and Protection Organization, India

ambient SCIENCE
Vol. 7(1): 19-22
Year 2020

AMBIENT APPRAISAL

Main Factors Influencing Changes to Landscapes Under Subsoil Management: a Case Study of Yakutia, Russia

Ivanov V.V.*, Makarov V.S., Mironova S.I.

NIIPES NEFU, Yakutsk, Russian Federation

Study Area: Yakutsk, Russian Federation
Coordinates: 62°02'N 129°44'E

Key words: Ecosystem transformation, Technogenic load, Technogenic ecosystems, Technogenic landscapes.

Abstract

Mining is accompanied by a significant change in the landscape with the formation of transformed complexes, which we consider as natural-technogenic ecosystem complexes. We analyzes here the natural and technological factors of field development, which mainly affect the transformation of the landscape, identifies development stages of natural and technogenic ecosystems. The scale and degree of degradation of the adjacent territory depend on the size of the mining allotment, the production capacity of the enterprise, the technology, and equipment used, the volume of emissions and discharges, the organization of labor, environmental protection measures are taken during the production activity and the volume of nature restoration are measured. Based on an example of the growth dynamics study of residential and industrial landscapes in the area of development of the Neryungrinsky and ChulMakonsky coal deposits in South Yakutia, we concluded that the expansion and overlapping of environmental impact zones can lead to the development of local changes in ecosystems into a wider regional transformation.

Introduction:

Subsoil management with the modern development of technologies and techniques for developing mineral resource deposits is always accompanied by a large-scale transformation. It usually includes almost all the main components of the natural environment, including landscape, atmospheric air, water and land ecosystems. In this case, the relief is mainly subjected to mechanical stress, changes in atmospheric air are associated with the introduction of dust-gas components, products of technogenic emissions into its composition. The aquatic environment undergoes thermal and chemical effects, mechanical, thermal and geochemical loads are applied to the soil and vegetation cover, and the animal world receives the entire anthropogenic press, which, in addition to the above phenomena, also includes physical destruction, noise, and psychological effects.

As a result of the powerful anthropogenic impacts due to mining and related business sectors (energy, transport, including residential, i.e. socio-economic impact) on ecosystems, transformed complexes are formed, which we understand as natural-technogenic ecosystem complexes (PTESK) (Ivanov et al., 2006; Ivanov, 2015).

Methodology:

We have studied the natural and technogenic complexes of Yakutia using the methods of mapping, comparative analysis, as well as the review and systematization of materials for transforming landscapes at different stages of development of mining operations.

The specific nature of the formation of natural-technogenic complexes in mining and industrial landscapes including the directions of their developments are mainly determined by natural and technological factors in the mineral deposits' development. Natural factors that play a significant role in the selection of technological parameters for the development of mineral and hydrocarbon reserves can be divided into natural and climatic conditions of the territory, geological and min-ing characteristics of deposits (Fig.-1). Depending on natural factors, a method of developing a field (open, underground or combined) is justified, which affects the volume of pollutants emissions and discharges, the allocation of land for mining, an industrial site, the placement of dumps and other landscape transformations, *i.e.* on the total impact on

*Corresponding Author: v.v.ivanov@mail.ru

ISSN- 2348 5191 (Print) & 2348 8980 (Electronic)

Ambient Science, 2020: Vol. 07(1); 19-22
DOI:10.21276/ambi.2020.07.1.aa02

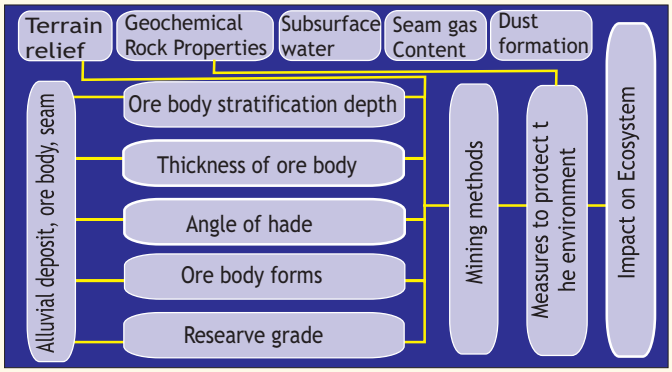

Figure-1: Natural factors in the selection of development systems

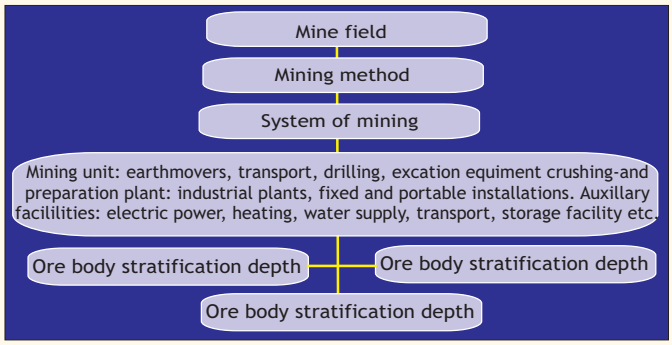

Figure-2: Technological factors of landscape transformation

the environment.

A significant role in the transformation of landscapes is also played by technological fac-tors (Fig. 2), which include the chosen development method, the system of mining and tunneling, the equipment used, the processing and auxiliary complexes, the scale, and timing of development. When assessing the degree of ecosystem transformation, it is logical to consider the process of environmental change in relation to the source of impact (Ondar *et al.*, 2000), i.e. the mining industry.

In such a system, the most regulated and at the same time acting as a transforming element is production, which in turn can be decomposed into separate components. The transformed part of the system - the natural environment is characterized by complex relationships between its components, abiotic and biotic components, which in natural conditions are in a balanced ecologically balanced state. At the same time, the functioning and development of the new ecological system within the PTESK is determined both by natural conditions and the nature and depth of the production impact on the abiotic and biotic components of the environment. These depend on the intensity of disturbance and pollution of the bowels, soils, water, and air basins; changes in the spatial and species structure and productivity of living organisms, Phyto-, zoo and microbiocenoses that function within this complex.

Results and Discussion:

Analysis and systematization of ecosystem transformation materials during the mineral deposits development in the conditions of Yakutia show that PTESK begins to be formed with some development method in the initial period of field development (exploration, overburden mining, installation of mining and processing equipment, construction of related infrastructure) (Ivanov, 2015). At this stage, the prevalence of the natural component of the transformed ecosystem may be significant, depending on the topography, mining conditions of the area within the mining allotment. The impact on the nearby territories is limited to the very first kilometers from the borders of the land allotment (Table-1).

Table 1: The main stages of the natural and technogenic ecosystems development

Stages of field development	Natural environment changes	
	Within the mining allotment limits	In the adjacent territory
First stage: Construction of roads; sinking of openings; infra-structure construction	The predominance of the natural component; Slight excess of some trace elements in natural environments. The beginning of the land cover degradation.	Changes affect first kilometers
Stage of full development: Increased production and processing volumes; Harnessing the full production capacity of mining equipment	The predominance of the anthropogenic component (mine workings, dumps, engineering networks, shift camps); Complete transformation of the relief, the development of thermoerosive phenomena; Air pollution by emissions from explosive blasting, mining equipment, boiler rooms; Exceeding the MPC by some heavy metals in water, soil cover, plant tissues, small mammals; natural vegetation is observed only in small areas	Changes are observed up to tens of kilometers; Snow cover pollution by emission products; Fires, deforestation, littering with waste, garbage; Changes in the composition of natural waters; Violation of the spawning conditions of valuable fish; Change in biochemical soil and vegetation cover; Changes in living conditions, a decrease in the number of animals, poaching. Possible indirect effects on human settlements.
The final stage: Reduction in mining and processing of rock mass	Increased reclamation volumes; Gradual improvement of the natural waters' composition; Signs of vegetation overgrowing in some areas	Gradual improvement of the composition of natural waters; Land cover restoration

In some cases, some time delay may occur between the first stage and the subsequent development of mining operations, due to organizational, economic, and other costs. During this time, the transformed landscape can utilize the time and grow vegetation, until the appearance

Ambient Science, 2020: Vol. 07(1); 19-22
DOI:10.21276/ambi.2020.07.1.aa02

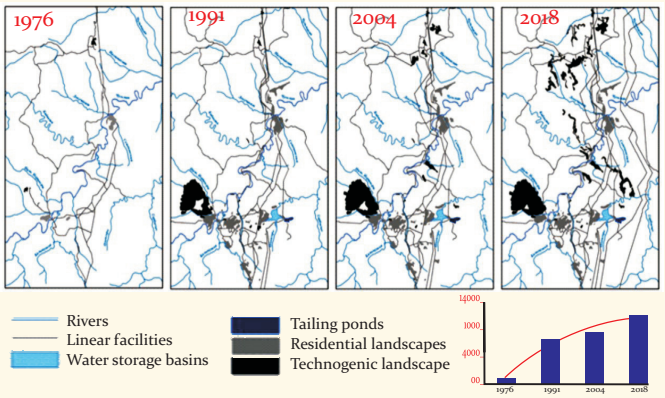

Figure-3: Map of the dynamics of growth of residential and industrial landscapes in the area of the Neryungrinsky and Chulmakonsky coal deposits for the period 1976-2018 according to satellite data decoding Landsat 2, Landsat 5

of thickets of woody species. So, for example, as a result of geological exploration in the 1950s, the landscapes of deposits in the Elkon uranium-ore region still remain altered and are sources of local anthropogenic impact on the adjacent territory.

With the growth of mining, the volume of processed rocks and ore, the increase in the composition of the equipment used, the boundaries of transformable landscapes expand, the degree of the enterprise's impact on the adjacent territory also increases.

On the territory of the mining allotment, the land cover is almost completely destroyed, significant areas are occupied by rock dumps, tailings, mine workings, various transport, engineering networks, power lines, repair bases, gas stations, and shift camps. At that stage, the features of permafrost are maximally manifested: thermokarst phenomena, frost heaving of rocks, ice formation, thermoerosion, solifluction, etc. Dust and gas emissions during drilling and blasting operations, during the mining equipment operation, processing, crushing and screening devices, boiler houses, and dust removal from exposed areas and waste dumps affect the biogeochemical composition of the soil and vegetation cover and natural waters.

The scale and degree of the adjacent territory degradation depend on the size of the mining allotment, the production capacity of the enterprise, the applied technology and equipment, the emissions and discharge volume, the labor organization, the environmental protection measures implemented during the production activities, and the volume of nature-restoration measures. At the stage of reducing production volumes, the load on the natural environment decreases, the first signs of vegetation overgrowing begin to appear in the developed areas of the field, the hydrochemical and microelement composition of the waterways is gradually improving.

However, the technogenic load on the natural environment does not stop even after a complete stop of mining operations and the liquidation of production. For example, in the Aldan region, the Lebedinsky ZF tailing dump remains a potential source of environmental impact. Geochemical tests of the tailing dumpsite, carried out 4-5 years after the factory shutdown, revealed a fairly wide range of trace elements and chemical compounds hazardous to the natural environment, including traces of sodium cyanide (Artamonova *et al.*, 2005).

The duration of secondary pollution of natural environments depends on the self-healing ability of this landscape and the funds invested in remediation measures, the completeness and quality of their implementation.

Currently, intensive coal mining is concentrated in South Yakutia, where since 1975 the Neryungrinskoye large coal deposit has been open-pit mined, the Mechel group is implementing a project to build the Elga coal complex within the North-West section of the Elga coal deposit, UK Management Company "Colmar" is building 2 large mining and processing complexes of ore-processing mills Denisovskoye and Inaglinskoye. The total annual coal production in 2023 of the Denisovsky and Inaglinsky plants should be 30 million tons (Ivanov, 2015).

Figure-3 shows the dynamics of landscape transformation during coal mining in the area of Neryungricity and settle Chulman, where there is a gradual increase in areas of disturbed landscapes associated with increasing volumes of coal mining by the Neryungrinsky quarry, the construction of Neryungricity, the laying of the railway, the ESPO pipeline and the Power of Siberia gas pipeline.

The indirect influence of the Neryungri industrial complex during atmospheric air pollution can be traced up to 80-100 km in the southeast direction (Ivanov, 2015) and the total area of the territory changed with background indicators is 1200-1500 km2. These results were confirmed by a mathematical model developed by employees of the Joint Institute of Geology, Geophysics, and Mineralogy (Artamonova et al., 2005) based on joint research with us on dust emissions from mining operations in the Neryungrinsky open pit.

As production increases by Denisovsky and Inaglinskyore-processing mills, significant expansion and imposition of impact zones on the natural environment can occur, which can lead to the development of local ecosystem changes in a larger regional transformation.

Conclusively, due to the natural conditions of the Yakutialocation, intensive development of deposits can have significant environmental consequences. Therefore, the issues of solving environmental problems in the mineral deposits development in the region are currently gaining deeper content, in both of the scientific and applied fields.

Acknowledgments:
The author would like to express gratitude to the management

and staff of the studied area for their unreserved cooperation.

References:

Alaev, E.B. (1983): **Social'no-ekonomicheskayageografiya: ponyatijno-terminologicheskijslovar'**. [Socio-economic geography: a conceptual and terminological dictionary]. Pub. by: Mysl' the University of Michigan. 350 p.

Artamonova, C. Yu., Kolmogorov, Yu. P., Raputa, V.F. & Yaroslavtseva, T.V. (2005): Effect of Atmospheric Pollution on the Ecosystems of the Neryungri Fuel and Energy Complex (Yakutia). *Chem. Sustain. Develop*., 13:491–500.

Gumilev L.N. (1990): **Ethnogenesis and the Biosphere of Earth**. Pub. by: Gidrometeoizdat. 526 p.

Ivanov, V.V., Mironova, S.I. & Shumilov, Yu.V. (2006): [**Prirodnye i tekhnogennye ekosistemy YUzhnoj YAkutii**]. **Natural and technogenic ecosystems of South Yakutia.** Pub. by: Moscow, Nedra-Dusiness Center. 187 p.

Ivanov V.V. (2015): **Transformation of natural complexes during subsoil use in Yakutia.** Pub. by: Novosibirsk: Nauka. 248 p.

Ondar S.O., Putintsev N.I. & Ashak-ool A.V. (2000): [**Problemy ustojchivosti ekosi-stem i ocenka ih sovremennogo sostoyaniya**]. **Problems of sustainability of ecosystems and assessment of their current state**.Pub. by: V.V. Bugrovsky - Kyzyl: TuVI-KORP SB RAS. 182 p.

Snakin V.V. (2000): [**Ekologiya i ohrana prirody**]. **Ecology and nature conservation.** Ed. by: A.L. Yang Shina. - M .Pub. by: Dictionary Akademia. 384 p.