November-December 2019
ISSN: 0193-4120 Page No. 1876- 1882

Landscape and Environmental Analysis and Anthropogenic Disturbance of the Varandey Oil Field

I.O. Binder[1], A.M. Oleynik[2], A.M. Podkovyrova[2], A.S. Piterskikh[1], I.O. Golubev[1]
[1]LLC "GIPRONG – Trust", [2]FSBEI of Higher Education "Tyumen Industrial University"

Article Info
Volume 81
Page Number: 1876- 1882
Publication Issue:
November-December 2019

Article History
Article Received: *5 March 2019*
Revised: *18 May 2019*
Accepted: *24 September 2019*
Publication: *10 December 2019*

Abstract

The analysis of landscape and ecological condition of the Varandey oil field is carried out in the article: the spatial arrangement of groups of landscape complexes, their functions and stability, anthropogenic disturbance is grounded. Landscape and ecological map of the field territory was created.

Keywords*: field, landscape complexes, anthropogenic disturbance, map.*

I. Introduction

Under modern conditions, landscape-ecological investigationis one of the most important methods of obtaining information about the natural and environmental potential of the territory, taking into account its structure and functional features [1, 8, 13].

Landscapes are formed in the all components interaction of the environment. So, landscapes rather than its components are the environment for the location of systems and objects of anthropogenic impact [13].

The morphological structure of each landscape gives it a distinctive appearance. The study allows us to determine the characteristic features of the landscape, the relationship between its components,to identify and also to draw the boundaries of the landscape [9].

The purpose of this study is to analyze the landscape and ecological state of the territory of the Varandey oil field, to create a landscape and ecological map of the territory and establish the relationship between natural and anthropogenic factors affecting the stability of the natural and territorial complex.

II. Object and methods of research.

Administratively, the Varandeyskoye oil field is located in Arkhangelsk Region, Zapolyarny District, Nenets Autonomous District.

Geographically, the field is located on the north-eastern edge of the Russian Plain, in the Bolshezemelskaya Tundra, on the southern shore of the Barents Sea, 300 km north-east of Usinsk - the nearest railway station - and 250 km north-east of Naryan-Mar. The field belongs to the Timan-Pechora oil and gas province.

The following materials were used as sources of information for the creation of the landscape and environmental map and analysis of anthropogenic disturbances in the area:

- Topographic maps of different scales;
- The results of engineering and geodetic, engineering and environmental, and engineering and hydrometeorological surveys;
- Earth remote sensing materials;
- Stock and forest management materials;
- Reference and scientific literature.

Experimental procedure/experimental set up.

1. *The research of spatial differentiation of landscapes*

November-December 2019
ISSN: 0193-4120 Page No. 1876- 1882

The uniformity of the landscape structure, the character of the relief and prevailing soils, a high degree of swamping and lakeiness of the territory, the complex character of the surface hydrographic network predetermine a high degree of vulnerability of the landscape components of the northern hypoarctictundras to anthropogenic impacts, first of all - to the possible accumulation of pollutants in soils, water of low flow reservoirs and their bottom soils, as well as to mechanical disturbances of soils and soils [1, 9].

The relief of the territory is predominantly hollow and hilly. On the sea coast, one can distinguish the coastal sea wall, which reaches a maximum height of 9 m, and the slightly dissected surface of a modern terrace (lid) with heights up to 3 m.

Accumulative terraced plains are composed of sea sandy, sandy loamy, loamy in some places, and alluvial deposits in some places. Among the natural boundaries there are dominating shrubby mossy spotty-pit-and-milky tundras and sedge-and-moss polygonal bogs [5]. In the study area the processes of blowing and thermokarst are developed. Especially large areas are occupied by areas with a landscape of boggy accumulative plains.

Relatively more severe climatic conditions and the wide development of active cryogenic processes, low amounts of matter involved in the biogenic cycle, determine the instability of landscape components of the territory to anthropogenic effects [14].

In general, the following groups of landscape complexes have been identified in the field:

a) flat terrain [2, 3, 4]:

- weakly wavy, pubescent, torulose, relatively drained surfaces of flat and swampy-muniform watersheds, sedge-grass mossy with shrubs on flat hillocks and fluffy-sedge-horse-tailed in the west on soddy-gley soils;

- elevated flat wavy, finely hilly surfaces of watersheds occupied by willow-shrubby-sedge-moss tundra communities on tundra-boggy soils;

- elevated, satisfactorily drained flat and slightly sloping fine-pit-and-mouth surfaces of watersheds, occupied by sedge-moss and shrubby-sedge-variety-sedge-moss tundra communities on boggy peaty-gley soils;

- flat, slightly sloping surfaces of watershed plains, occupied by a network of small thermokarst lakes, covered with shrubby grass-sedge vegetation groups on alluvial silt-marsh gley soils;

- reduced closed overwetted watershed surfaces occupied by sedge-grass moss communities on tundra-bog soils;

-flat, slightly inclined towards the river lowering of flat watershed plains, covered with shrubby grass and moss vegetation on alluvial boggy soils;

b) marshland terrain [15]:

- weakly waterlogged areas with a combination of shrubby-green mossy areas in combination with sedge-shrubby-green mossy tundra and areas of flat-hilly bogs on tundra-boggy soils;

- elevated relatively drained surfaces with polygonal-spotted and hilly-spotted microrelief, occupied by sedge-mossy crustaceans and bogs on boggy upper peaty-gley soils in combination with moss-lichen groups;

- elongated sloping valley-like depressions occupied by shrubby grass-sphagnum plant communities on tundra-boggy soils;

c) flood terrain:

- gentle, undulating trenches of river valleys with fine sandy blowing and spotted-medallion microrelief along the slope edges, occupied by shrubby moss-lichen communities on the named alluvial silt and peat soils, with shrubby, mossy and herbaceous willow and spruce marshy tundra, as well as in combination with sedge and hypnoid bogs on floodplain silt and peat soils;

The landscapes of this group are characterized by erosive and accumulative relief. Most of the river valleys are floodplain, slightly pronounced;

d) anthropogenic terrain:

Anthropogenic landscapes are formed in specific conditions, the characteristic features of which are [6, 12, 14]:

- high technical armament;
- usage of heavy industrial machinery, wheeled and tracked transport;
- concentration of oil production and refining sites;
- polarization and complexity of loads;
- reduction of plant and animal habitats and their number;
- intensive chemical pollution of the territory;
- high rates of transformation of natural complexes.

All of them have a number of features defined by the general purposes of creation:

November-December 2019
ISSN: 0193-4120 Page No. 1876- 1882

- ensuring hydrocarbon exploration;
- development and exploitation of deposits;
- transportation and processing of hydrocarbon raw materials.

The territory's natural landscape complexes have undergone anthropogenic transformation. Anthropogenic factor becomes decisive in the functioning of landscapes. When organizing and functioning of anthropogenic landscapes, a radical reorganization of the natural component is fixed. The analysis of the modern structure of anthropogenic landscapes formed as a result of physical, chemical and biological influences testifies to the preserved connection with the original PTC.

Linear-transport landscapes have a clear linear-band or fractional-band structure. Landscapes of this type perform a system forming function and are formed as a result of construction of infield roads and temporary passage of vehicles. Anthropogenic road areas are represented by separate linear formations: tractor and motor roads, sections of disposable passage of vehicles, as well as sections with numerous (random) movement of machinery. In the study area, there are three types of road tract associated with the formation and use of the roadbed.

The first one is the tractor roads and highways of one track used during the whole year; the second one is the sections of disposable passage of vehicles of one track used in a certain period of the year; the third one is the sections with multiple (random) movement of vehicles in several tracks, which, unlike the first two types of vehicles, form the surface area disturbance.

Since roads cross different landscapes, the degree of disturbance in these areas depends on the type of soil and vegetation, the presence of peat layers, and the frequency of single-track travel. In elevated areas of terrain, rutting disturbance is generally less, where the species composition of plant communities is largely preserved, but the soil layer is significantly compacted. However, the soil and vegetation cover between the ruts remains intact.

On some sections of roads and winter roads, which pass through lowland areas of relief, in ruts 60-70 cm wide, there is waterlogging and excessive moisture. The main types of impact on the environment during the operation of roads are: emissions of exhaust gases and noise pollution; land alienation for temporary and permanent use.

The oil and gas field facilities of the anthropogenic complexes are the sites of exploration wells. Anthropogenic impact locally and tract rarely serve as a source of negative impacts [6]. The risk of pollution increases with technological accidents and fires. Landscapes of this type are characterized by local spills of polluting liquids, the presence of construction debris within the fenced area.

The low-rise type of anthropogenic landscapes at the field is represented by the territories of the outskirts of the village of Varandey, residential and household buildings. Non-asphalted soils are found in some places, but the majority of this type of landscape is located on bulk soils.

Figure 1 shows the location, and Table 1 shows the classification of technogenicly transformed landscapes of the Varandey field.

Figure 1 – Anthropogenic landscapes of the Varandey field

Anthropogenic landscapes			Disturbed soils		
Class	Type	Sort	Type	Sort	Subsort
Industrial	Linear transport	Road	Linear	Turbocharged surfaces	Disposable vehicle passages. Sectionswithmultiple (uncontrolled) movementofvehicles
		Polymagic			Sections occupied by corridors of communication
	Oil and gas field	Operative	Coarse	Technogenic bulk mineral surfaces	Exploration well and well pad areas
Celitabicclass	Low-rise	1-2 storey residential and	The outskirts of settlements, resi-	Turbocharged and technogenic bulk cul-	Sites and buildings in the Varandey area

November-December 2019
ISSN: 0193-4120 Page No. 1876- 1882

		industrial buildings	dential and household buildings, garages.	tivated surfaces	

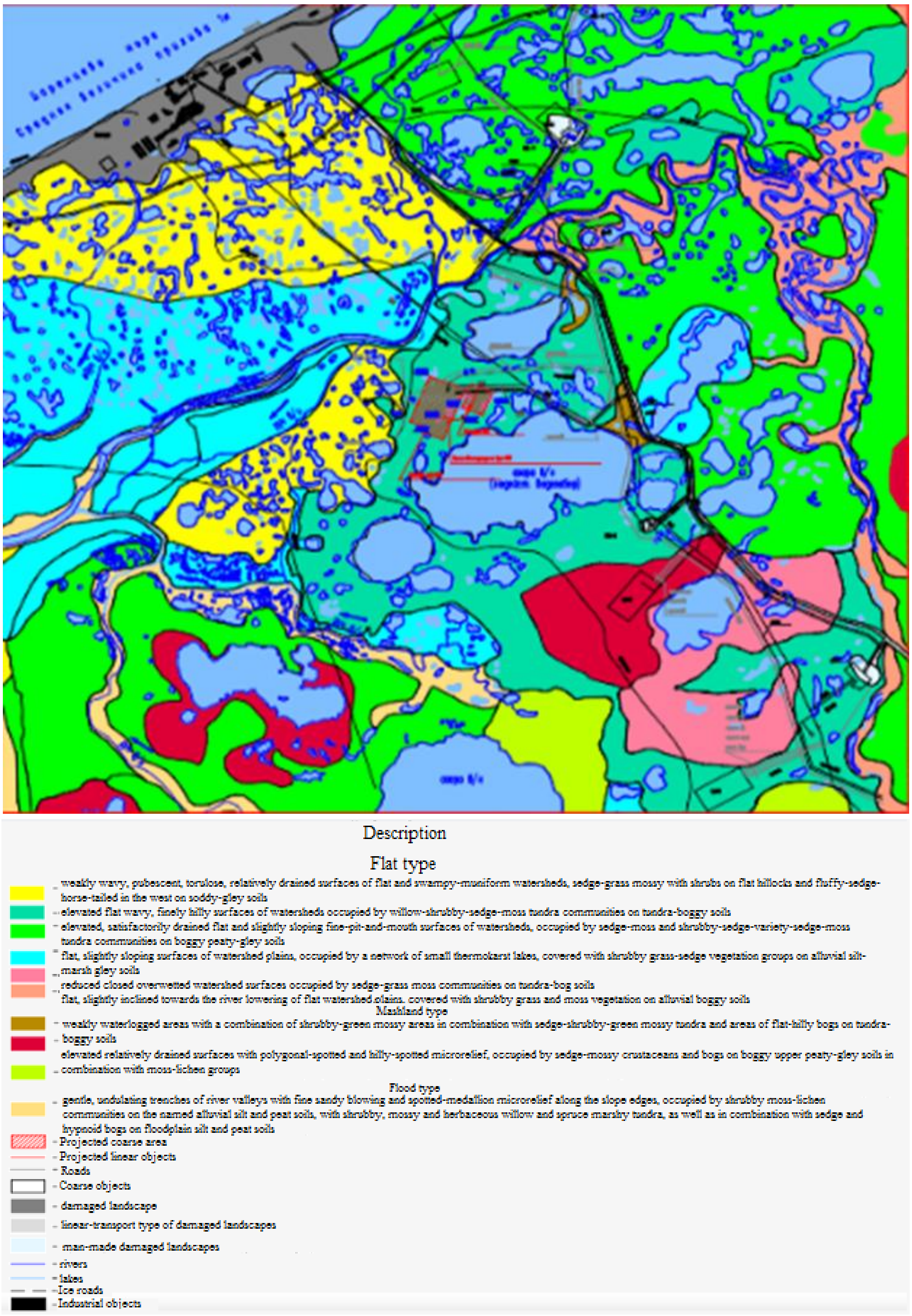

Figure 1 - Landscape and ecological map of the territory of the Varandey field

2 Functions of natural systems

Landscape functions are understood to mean that parts of the natural complex or its components meet the needs of society or the conditions for the sustainable existence of natural systems [13].

The functions of the geosystems can be divided into two groups: *protective*and *resources.*

The *resource functions* are mainly related to oil and gas production activities, as well as hunting, fishing and agricultural activities in particular ecosystems.

Protective functions are related to the regulatory role of certain landscapes and their components, partic-

November-December 2019
ISSN: 0193-4120 Page No. 1876- 1882

ipation in the reproduction of basic physiological and socio-psychological factors of people's lives (atmospheric air composition, water quality), as well as in the reproduction of conditions of certain types and forms of production and non-production activities.

A total of seven main functions have been identified for the study area. Among them, the group of *resource functions* includes: berry and mushroom (BM), hunting and fishing (HF), and wood-resource functions. *Protective functions* determine the role of the system in the preservation of the natural complex of the area. These include: biostatic (BS), water-protection (WP), water-saving (WS) reforestation (RS).

3. Sustainability of natural complexes

Sustainability is seen primarily as an environmental assessment category. It characterizes the ability of ecosystems to maintain their structure and functions differentiated in space and time under the same type of anthropogenic impacts, as well as the degree of their suitability (reliability) for accident-free operation of technical systems and objects.

Biological stability of topoecosystems means the ability of soil and vegetation cover to preserve and restore structural integrity and functional processes under mechanical impact. Mechanical damage to the surface occurs as a result of horizontal and vertical planning of the territory.

Geochemical stability of topoecosystems is understood as their ability to self-clean from technogenesis products, depending on the speed of chemical transformations and intensity of removal of the latter from topoecosystems.

On the basis of the listed factors topological groups of landscapes on levels of biological and geochemical stability to pollution have been allocated (table 2). The level of stability of topoecosystems is determined on the basis of expert assessment and is relative in nature.

Figure2 - Typology of landscape sustainability

Sustainability category (point)		Leading factors determining the oil spill resistance indicator	Landscape groups
Geochemical	Biological		
6	9	Geochemical barriers are weak (except for sorption barriers at the border of podzolic and illuvial horizons). Oligotrophicity of soils is aggravated by weak intensity of microbiological decomposition. Low intensity of redox processes.	PTCof flat landscapes
1	3	The dominance of the regenerative environment, the presence of a gley lateral barrier, frequent change of organogenic ridges, ogle-like mineral soils and water spaces. Absorption of toxic products and their decomposition products takes place in the areas of sorption organogenic and mineral oxygen barriers.	PTC floodplain landscapes
3	6	Significant diversity of lithological composition, presence of gley, sorption and oxygen barriers, combination of oxidation-reduction conditions, significant self-recovery ability of herbaceous vegetation.	PTC wetland complexes

The total value of the points made it possible to identify the groups of topoecosystems characterized by different degrees, calculated from 0 to 3 points. The highest value of the stability index is taken for 3 points.

As can be seen from Table 2, floodplain and swamp complexes in terms of biological and geochemical stability belong to unstable topoecosystems; plain complexes in terms of geochemical stability - to unstable ecosystems, and in terms of biological stability are characterized as unstable ecosystems.

4. Technogenic disturbance of the territory

The method of contour interpretation of the Earth surface remote sensing data, supported by visual inspection of the territory, is adopted as the leading method of anthropogenic disturbances inventory and mapping. In the process of mapping the current state and disturbance of the territory, two main tasks have

TEST Engineering & Management

November-December 2019
ISSN: 0193-4120 Page No. 1876- 1882

been consistently solved:

- Inventory of existing industrial infrastructure and related secondary disturbances;
- Analysis of forms and scales of anthropogenic environmental disturbances resulting from construction and installation works and operation of industrial infrastructure facilities.

The most typical types of anthropogenic impact on the sites of new construction and reconstruction, as a rule, are:

- Alienation of additional land for the purpose of industrial, transport and related infrastructure facilities;
- Mechanical impact associated with horizontal and vertical land leveling;
- Physical (vibration and noise) impact from moving vehicles and machinery, construction equipment;
- Chemical pollution of the environment by exhaust gases from motor vehicles and internal combustion engines of stationary units and hydrocarbons during their transportation;
- littering of the territory in case of violation of waste storage rules.

The territory of the field under study is equipped with: pipelines, highways, power lines. Among the sites in the study area there are well pads and exploration drilling sites. In connection with the construction of new and expansion of existing industrial and transport facilities, it is planned to alienate undeveloped territories.

The area of the field is subject to the risk:

1. *Physical impact* during drilling and oil production, oil transportation is mainly caused by noise, vibration and thermal impact. Their sources are high-capacity drilling, operating and technological equipment, machines and mechanisms, wheeled and tracked transport. *Vibrating impact* on soils contributes to their loosening, destruction of structural links, as well as compaction under the site facilities and roads, which may lead to an increase in swamping zones on poorly drained and hydromorphic surfaces. *Noise impacts* have a negative impact not only on personnel, causing fatigue and distraction, but also on wildlife, facilitating migration from areas adjacent to the production facility, changing the territories of traditional habitat of animals, their reproduction and forage lands.

2. Chemical pollution of the environment that occurs at all stages of construction and operation of the field. But at different stages the sources and scale of impact differ [6].

During the construction of field and transport facilities, atmospheric air is polluted with exhaust gases from construction machinery, wheeled and tracked vehicles, mobile boilers and power plants, fuel and lubricants storage sites, mortar-concrete units, filling stations, emissions from leaks of process equipment, etc. [10]. Pollution of surface and ground waters is carried out at infiltration into the soil mass of surface runoff from the territories of well pads, flares, industrial sites, residential camps, material storages, industrial and household waste landfills, leakage of hydrocarbons and saline waters (bottom water, formation water) from drilling pits, through leaks of shut-off valves; When applying reagents used on access roads to combat ice (chloride mixtures) and dust in the spring and summer (liquid bitumen and tar, lignosulphates, etc.). The impact on the soil is primarily due to the settled on its surface emissions of fuel combustion products of operating machinery and equipment [11]. Exhaust gases of internal combustion engines contain more than 200 names of harmful substances and compounds, including carcinogenic ones.

Essential contribution to environmental pollution is made by operating gas flare units. Gas contamination and smoke pollution of the atmosphere around the flare causes impoverishment of the species composition and structure of the vegetation cover, leading, in turn, to a decrease in soil fertility.

3. Land reclamation related to unauthorized landfills of household and construction waste, which often contain hazardous chemicals. In case of violation of the rules of storage and transportation, loose and dusty substances (construction and drilling mixtures) pollute soils, as well as water bodies when flushing with rain and snowmelt waters [7].

III. Conclusion

The type of terrain of the Varandey field has been identified as relatively homogeneous in terms of natural conditions, with its characteristic combination of natural landscapes. Their common features are conditioned by the location and composition of landscaping processes. The basis for the identification of terrain types was the character of the relief in combination with lithological and social complexes and the degree of drainability of the territory.

TEST Engineering & Management

November-December 2019
ISSN: 0193-4120 Page No. 1876- 1882

It can be noted that the entire investigated territory of the Varandey field is located within landscapes with low stability, where any man-made disturbances lead to the disturbance of the natural and territorial complex and its destruction.

Anthropogenic impact associated with the development of the field and new construction of field facilities significantly affects the environment.

References

[1] Beruchashvili, N.L. Methods of complex physical-geographical research [Text] / N.L. Beruchashvili, V.K. Zhuchkova. - MOSCOW: MG, 1997. - 320 p.

[2] Dobrovolsky, G.V. Soil geography: textbook [Text] / G.V. Dobrovolsky, I.S. Urusevskaya (2nd ed., reworking and additional). - Moscow: Moscow State University, 2004. - 460 p.

[3] Egorov, V.V. Classification and diagnostics of soils of the USSR [Text] / V.V. Egorov. - M.: "Kolos", 1977 - 221 p.

[4] Ivanova, E.N. Soil classification of the USSR [Text] / E.N. Ivanova. - M.: Science, 1976. - 227 p.

[5] Ilyina, I.S. Vegetable cover of West Siberian plain [Text] / I.S. Ilyina, E.I. Lapshina, N.N. Lavrenko. - Novosibirsk: Nauka, 1985. - 251 p.

[6] Methodology of ecological monitoring for pollution control in the zones of influence of oil pipelines (oil product pipelines), oil loading stations and substations [Text]: RD-13.020.00-KTN-384-09 // SPS "Consultant plus".

[7] Methodical recommendations on revealing degraded and polluted lands [Text]: Roskomzem 28 December 1994, Ministry of Agriculture and Food of the Russian Federation 26.01.1995, Ministry of Natural Resources of the Russian Federation 15.02.1995 - Moscow, 1995.

[8] Methods of complex physical-geographical researches: textbook for students. V.K. Zhuchkova, E.M. Rakovskaya. - M.: "Academy", 2004. - 368 p.

[9] Milkov, F.N. Landscape sphere of the Earth [Text] / F.N. Milkov. - M.: Thought, 1960. - 258 p.

[10] About the protection of the atmospheric air [Text]: federal law of 04.05.1999 № 96-FZ // SPS "Consultant Plus".About environment protection [Text]: federal law dd. 10.01.2002 № 7-FZ // SPS "Consultant Plus".

[11] Regulation on the assessment of the impact of planned economic and other activities on the environment in the Russian Federation [Text]: Order of the State Committee for Environmental Protection of the Russian Federation of 16.05.2000, № 372.- Moscow, 2000.

[12] Preobrazhensky, B.C. Fundamentals of landscape analysis [Text] / V.S. Preobrazhensky, T.D. Aleksandrova, T.P. Kupriyanova. - Moscow: Nauka, 1988. - 192 p.

[13] Nature use in the north-west of Siberia: experience of problem solving" [Text] / Under the editorship of Prof. Kozina V. V., Osipova V.A. - Tyumen: TyumGU, 1996.

[14] Shishov, L.L. Classification and diagnostics of soils in Russia [Text] / L. L. Shishov et al. - Smolensk: Oikumensk, 2004. -342 p.