Environmental Safety During the Reclamation of Lands of the Industrial Zones of Cities

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Abstract: In recent years, the increasing rates of land pollution and the formation of man-made waste are not supported by reclamation measures. This problem is especially acute in cities, where contaminated lands can become a source of secondary pollution of contacting environment and have both indirect and direct impact on urban ecosystems and human health. It is necessary to use a systematic approach to organize the full restoration of ecological systems on disturbed lands.

1 INTRODUCTION

Since the end of the 20th century, there has been an intense and diverse anthropogenic impact on natural landscapes, which leads to a large number of environmental problems at present. The environmental consequences of such impacts lead to the formation of disturbed lands that are taken out of circulation. In this regard, it is necessary to form a list of scientifically based measures aimed at protecting nature, its rational use and restoration of disturbed landscapes (Artamonova, 2022, Krasilnikova, 2011).

Contaminated lands are a priority for remediation if they have a negative impact on the people and ecological systems in which they are located. This problem is relevant for industrial lands both in the Russian Federation and abroad. The issues of reclamation of the territories disturbed during the industrial impacts and their introduction into economic circulation are an integral part of environmental problems throughout the world (Brodach, 2022, Remedy, 2022).

This problem is also acute and relevant in Europe (according to observations in 29 European countries), according to the report of the Joint Research Center of the European Commission, it is said that there has been an increase in the volume of disturbed land plots, amounting to about 2.8 million plots subject to reclamation. Of these, about 694,000 sites have been officially registered in national and/or regional registries, and 240,000 are assessed as posing risks to human health and the environment (Pérez, 2018, WHO, 2021).

In the XIX-XX centuries. industrial enterprises were built on the outskirts of the city in the specialized industrial zones, but the gradual development and growth of cities led to the development of industrial zones with residential buildings, as a result of which the enterprises were already within the city. Restoring the ecological and economic value of these sites can solve the problem of the lack of usable urban space for residential and office development, as well as for the organization of recreational areas. Contaminated lands are a priority for restoration if they have or may have a negative impact on nearby human and ecosystem objects. The abandoned and semi-functional industrial sites in cities discussed in this article may pose risks to the population, although it is difficult to prove the direct impacts because of many other sources of pollution (Pérez, 2018, WHO, 2021).

Each of these enterprises occupies a huge area due to the need to establish a sanitary protection zone, but many enterprises spread the negative impact outside the zone by dumping contaminated effluents into rivers, which also pollutes the groundwater with the emissions of harmful substances into the atmosphere. Contaminated soil can become a source of the

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secondary pollution of contacting environment and have both indirect and direct effects on human health. When carrying out reclamation, it is proposed to use an ecosystem approach, which implies a comprehensive restoration of disturbed lands. It includes an increase in the economic, environmental, and ecological value of man-made landscapes that most fully meet the needs of the society. In this regard, information on possible ways to accelerate the return of a sufficient level of fertility or ecosystem functions to disturbed lands is important (Sylvain, 2019).

2 MATERIALS AND METHODS

The objects of study in the framework of this article are partially functioning or abandoned industrial territories. Such reclamation objects are both ecosystem and anthropogenic territorial complexes with many internal connections between its constituent components: the biosphere, atmosphere, rocks that make up the soil thickness. Therefore, the comprehensive information on the state of the reclamated root-inhabited soil layer and the possibility of the formation of biogenicity in it is very important.

The purpose of the study is to identify a set of environmental problems in the reclamation of disturbed lands of industrial zones of cities and to formulate recommendations for their solution. To conduct the study, a systematic approach, methods of analysis, formalization, and synthesis of information were applied.

It is required to conduct in-depth environmental monitoring of such lands, including both the root layer and ecosystem indicators. It is necessary to develop a long-term reclamation program that will allow ranking sites according to their importance, the order of their restoration and maximizing the environmental and economic effect from the return of contaminated lands to economic circulation.

In the context of global urbanization, the attitude that has developed over many decades towards disturbed lands, as economically unprofitable, needs to be changed in all areas. This can begin a number of innovative studies in various areas of disturbed land reclamation, increase investor interest in the restoration and further use of such land, stimulate industrial enterprises to abandon resource-intensive technologies which cause irreparable harm to the environment.

It is also important to note the need to develop a unified substantive-genetic classification of natural and anthropogenic soils, as well as to include them in to the classification scheme of soils of the Russian Federation, which will ensure the creation of a unified register of disturbed soils in all areas, taking into account the geographical and ecological nature of soil neoformation in modern technogenic landscapes (Artamonova, 2022).

3 RESULTS

Anthropogenic soils are soils that have been influenced, modified or created by human activities. They are found worldwide in urban and other human-affected landscapes. Based on geographical conditions and historical context, four different types of anthropogenic soils can be distinguished: agricultural, archaeological, mining and urban. According to the World Reference Base (WRB), anthropogenic soils found in agricultural and archaeological settings are classified as anthrosols, while soils found in mining and urban settings are classified as technosoils (Loures, 2020).

Due to the differences in natural and economic conditions in different regions of Russia, the problem of reclamation has a different degree of severity. The need for restoration measures is the most acute in the old industrial territories, where huge areas of disturbed lands have accumulated over a long period of economic development of resources. The greatest impact on land resources and the state of the natural environment is exerted by enterprises of the extraction of mineral raw materials, leading to the complete destruction of ecological systems. It is impossible to restore them with the existing soil cover and a wide range of soil-ecological functions. When carrying out reclamation, one should strive to at least partially compensate for the economic damage caused to the soil cover (Zolotykh, 2017).

There are various approaches to the reclamation of disturbed lands depending on the degree of their contamination, which can be divided into physical (for example, installing barriers between contaminated and healthy areas, replacing the soil layer with a clean one) and chemical and biological methods (for example, adding fertilizers, chemical additives, microorganisms to eliminate pollution) (Lobovikov, 2016).

Removing contaminated soil and replacing it with clean soil is not often seen as a sustainable solution to the problem of contaminated land, and technologies that reduce the environmental impact of land restoration are currently favored. There is a significant amount of research that examines the health outcomes of people before and after remediation associated with contaminated sites. Public health surveys on contaminated sites prior to remediation are often not identified by significant impacts on existing populations, possibly due to their exposure to multiple sources of pollution.

3.1 Ecological Features of the Reclamation of the Territories Near Water Objects

Obviously, it is worth considering the processes of reclamation of disturbed lands located near water bodies, including industrial zones. This problem is considered in many articles by foreign authors, etc (Lefeng, 2021, Shuai, 2021, Yusuke, 2018).

In its turn, reclamation, changes the functional purpose of the site and new sources of economic and environmental benefits appear, such as the creation of industrial production, agriculture and marine economy, sea salt production, new sea routes, tourism, and the appearance of land value for sale.

When restoring coastal areas, it is necessary to carefully consider the direction of reclamation and the prospects for further use of the land. Studies show that reclamation of the coastal wetlands along with the economic benefits can lead to the significant environmental problems. The negative impact of reclamation of coastal lands is the loss of biological diversity, water pollution, degradation of wetlands. From 1985 to 2015 75134,3 hectares of coastal land in Hangzhou Bay have been reclaimed. In these areas, the value of a hectare of land in terms of ecosystem services has fallen from 866400 yuan to 285800 yuan, far exceeding the economic benefits received from the reclamation. Urbanized coastal reclaimed areas suddenly reduce the ecological value of lands, in addition, they become highly vulnerable to the natural disasters, which leads to large economic costs for leveling their consequences (Lefeng, 2021).

The value of the ecological services of the natural ecosystem zone is expressed in protection from storms, floods, erosion, waste management, regulation of carbon dioxide, maintenance of habitat for animals and plants, provision of natural materials for industry and food.

3.2 Problems of the Normative Regulation of the Processes of the Reclamation of the Disturbed Lands

To study ways to solve the environmental and economic problems of disturbed land reclamation, it is necessary to apply a systematic approach. It will minimize the environmental damage to the environment and maximize the economic effect from the implementation of environmental measures.

Currently, the issue of standardization of the scope and composition of work on monitoring contaminated territories is being actively discussed. Absence of clear regulations and indicators for assessing the state of land, for example, after reclamation in order to exclude the possibility of the spread of pollution for several years, depending on the type of pollution and the characteristics of the site. In this context, legal regulation of the enforcement processes and implementation of the EU Environmental Liability Directive should be the first step (Remedy for contaminates sites, 2022).

There is a complex of problems in the system of regulatory regulation of reclamation processes, among which are:

– absence of a mechanism for monitoring the implementation of project decisions for land reclamation during the operation of industrial enterprises;

– a low degree of correlation between the projects for the liquidation or conservation of industrial enterprises that have ceased their activities with the projects for the restoration of lands disturbed by their activities;

– there are no mandatory, legislatively fixed, principles for the methodology of risk assessment, i.e. assessment of the occurrence of a significant threat to human health or the environment.

The creation of the targeted programs of both federal and local significance is necessary for a qualitative increase in the effectiveness of reclamation measures and the legislative consolidation of a single, but taking into account the characteristics of each region, technological sequence, which includes (Emelyanova, 2021):

– a set of works on technical inventory, certification of disturbed lands;

– creation of a register of especially polluted sites;

– creation of a register of valuable agricultural lands;

– schemes of the planned use of restored lands.

Conducting a comprehensive inventory of disturbed lands is necessary to improve efficiency and select the sequence of restoration of contaminated sites. The results of the inventory are the basis for the development of a set of measures for land restoration (Emelyanova, 2021).

The concept of payment for a negative impact on the environment is enshrined in the legislation of the Russian Federation by Article 16 of the Federal Law of January 10, 2002 N 7-FZ (as amended on July 14, 2022) "On Environmental Protection". Payment is made for the following types of pollution in accordance with the Federal Law:

– emissions of pollutants into the atmospheric air by stationary sources;

– discharges of pollutants into water bodies;

– storage, disposal of production and consumption waste, including storage of by-products of production.

The main function of the payment described above is to improve the nature management mechanism. Payments are accepted for each polluting element separately or type of negative impact. This encourages enterprises to use resource-saving technologies in production (On Environmental Protection, 2002).

According to the Federal Law, the payment for the negative impact is the subject to transfer to the budgets of the regions of the Russian Federation in which the enterprise is located. Such payments in accordance with Article 16.6 of the Federal Law No. 7 should be used for early detection and assessment of accumulated environmental damage, organization of work to eliminate existing pollution or other measures to prevent and (or) reduce the negative impact of economic and other activities on the environment, preserve and restoration of the natural environment, rational use and reproduction of natural resources, ensuring environmental safety (On Environmental Protection, 2002).

3.3 Application of the Environmental Design in the Reclamation of the Disturbed Lands

In the Russian Federation, most of the agricultural land and industrial zones have problems that do not allow them to be fully used to obtain an environmental, economic, social effect. The establishment in Federal Law No. 7 "On Environmental Protection" of a payment for negative impact is an important but insufficient mechanism for rationalizing nature management and returning polluted lands to circulation. It is necessary to improve the regulatory and legal framework as part of the development of a mechanism for managing the rational use of natural resources and land protection with the development of a phased plan for financing work to restore disturbed lands.

At the pre-project stage, it is necessary to carry out a complex of engineering surveys (geodesic, geological, environmental, hydrometeorological) to determine the qualitative and quantitative characteristics of the reclamated area. Qualitative characteristics are understood as relief, type and physical properties of the root layer, type, degree of contamination hazard, etc. Quantitative characteristics are understood as the area of the site, the amount of developed soil (determined by calculating the balance of earthworks), the amount of pollutants in the root layer, and so on.

Conducting a complex of engineering surveys can be complicated by various factors, such as difficult terrain, the presence of water, forest facilities, severe pollution, which can affect workers conducting surveys. Of the many ways to determine the coordinates of the turning points of the site, an analytical method based on the use of GPS receivers is used. In his article Rogov N.S. shows the advantages of using conventional GPS receivers when carrying out geodetic work over the use of expensive tacheometric survey of the area. Based on the results of the research, the author concludes that the accuracy of the data obtained using GPS receivers is sufficient for remediation work in oil-contaminated areas, in addition, this will reduce the cost and timing of field work (Rogova, 2017).

At this stage, an assessment of the environmental risks of the site to be reclamated is also carried out, which will make it possible to calculate the cost and degree of the negative impact of the disturbed site on humans and the environment (Stebekov, 2021).

This stage is very important, as it determines the data included in the reclamation project and, as a result, the cost of restoration work. Taking into account the obtained data of engineering surveys, the identified pollutants, the location of the site, its topography, the environmental, economic and social feasibility of restoration, the direction of reclamation is selected.

Also, an important factor is the most rational use of the disturbed area after restoration.

According to GOST R 57446-2017 the main areas of disturbed land reclamation are:

– agricultural;
– forestry;
– fishery;
– environmental protection;
– recreational;
– water management;
– construction.

One of the main methods of the reclamation in urban conditions is the redevelopment of the territory with a change in the existing type of land use to obtain the maximum environmental and economic effect from the use of the restored site. On the restored sites, depending on the needs of each territory, it is possible to place residential and office buildings, as well as to organize recreational areas (Sevryugina, 2020).

In accordance with the chosen direction, a reclamation project is drawn up, the scope of work is calculated at both stages (technical and biological), the amount and types of mineral and organic fertilizers applied are calculated, and the types of grasses planted to restore the vegetation cover are determined.

The project and regulations for reclamation should be developed in accordance with the requirements of the current regulatory documentation:

– Decree of the Government of the Russian Federation of July 10, 2018 N 800 "On the Implementation of Land Reclamation and Conservation";

– GOST R 59057-2020 Environmental Protection. Earth. General Requirements for the Reclamation of Disturbed Lands;

– GOST R 59060-2020 Environmental protection. Earth. Classification of Disturbed Lands for the Purpose of Reclamation;

– GOST R 57446-2017 Best Available Technologies. Reclamation of Disturbed Lands and Land Plots. Restoration of Biological Diversity;

– GOST R 57447-2017 Best Available Technologies. Reclamation of Lands and Land Contaminated with Oil and Oil Products.

Reclamation projects include a large component related to environmental aspects. For the first time, environmental design in the relation to the reclamation appeared in the 70s of the XX century both in the USSR and in Europe. At the same time, the first regulatory documents regulating the design and implementation of the reclamation appear. The reclamation of disturbed lands should be carried out taking into account the above measures, which will reduce economic costs and increase the environmental effect.

The reclamation project must necessarily be developed with the inclusion of the solutions related to increasing the economic, environmental, aesthetic value of the restored lands and the rationality of nature management. The design should be carried out in compliance with the following features:

– the development of a set of measures for environmental protection at all stages of work and during the operation of the restored site;

– the development of measures to limit negative nature management during the operation of the restored site;

– the consistency and complexity of the proposed solutions;

– the development of measures for the operational management of the infrastructure of the restored site.

In the environmental design, both regulatory and methodological bases are used, including regulatory (GOST, SP, TU, etc.) and legal documents (Codes, Federal Laws, Government Decrees, etc.).

The environmental design is regulated by design rules, building codes and regulations (SNiPs), departmental standards and instructions for the environmental justification of the economic activity of a certain design object, and also sanitary standards and design rules for various industrial environmental and other objects (SanPiN) (Bychkova, 2020).

The project for the reclamation of disturbed lands must undergo an environmental review. In the countries of Europe, since the middle of the 20th century, ecological expertise of nature management projects began to develop. The main purpose of it is to predict the negative impact of economic activity on the components of the environment. Also, it becomes possible to assess the sufficiency of measures included in the project to rationalize the use of resources, to protect the environment. Ecological expertise is a kind of control and monitoring of environmental activities.

Carrying out measures to reduce possible environmental pollution at the design stage costs about 5-10 times cheaper than the elimination of pollution after the work (Bychkova, 2020).

In Russia, environmental expertise of projects began to develop in the 90s of the XX century. At that time, the Main State Ecological Expertise was created, which, on behalf of the USSR State Committee for Nature Protection, began the development of a regulatory framework. Currently, the environmental review of projects is regulated by the Federal Law "On Environmental Review" dated November 23, 1995 N 174-FZ.

There are two types of the expertise: state and public. Complementing each other, they allow minimizing the risks of the negative impact on the environment, considering the problem both from the point of view of state authorities and from the side of citizens living directly in the territory of the planned economic activity.

4 CONCLUSION

Anthropogenic impact on natural landscapes leads to the formation of a large number of disturbed land plots and the intensification of environmental problems throughout the world.

It is necessary to carry out in-depth monitoring of such lands in order to develop a long-term reclamation program that will allow ranking sites according to their importance, the order of their restoration, to carry out a set of works on technical inventory, certification of disturbed lands.

As part of improving the regulatory system, it is necessary to develop a mechanism for monitoring the implementation of design decisions for land reclamation both during the operation of industrial enterprises and during their liquidation or conservation.

In order to minimize economic costs during restoration work and maximize the environmental effect, it is necessary to carry out a set of studies and activities to assess environmental risks even at the pre-project stage.

When carrying out reclamation, it is proposed to use an ecosystem approach, which implies a comprehensive restoration of disturbed lands. It includes the increase in the economic, environmental, and ecological value of man-made landscapes that most fully meet the needs of society.

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