

# Urban Development Potential of Territories Disturbed by the Mining Industry, Based on the Example of the Moscow Region

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**Abstract.** This article discusses the relevance of technogenic landscapes recultivation near large cities (megapolises) and its metropolitan area as a tool for development of functional city territory reserves. On the basis of world experience, the author reveals aspects that are solved by construction recultivation. The paper overviews the basic methods and solutions of quarries and excavations revitalization. The author outlines the characteristics of the Moscow area disturbed landscape and provide recommendations on restoration of a postindustrial landscape into viable surface of the city. The interrelation of quarry excavation locations in the Moscow region settlement pattern and their further use in urban development is considered. Author proposes a typology in accordance with the main characteristics for further functional filling of quarries. A schematic map of the territories disturbed by the mining activity of the Moscow region is drawn up, on the basis of which the optimal conditions determining the ways of recultivated lands usage are revealed.

## 1. Introduction

With the current pace of construction and urbanization of natural areas, issues of elimination and prevention of negative processes in mining activities are becoming increasingly important. As a result of intensive industrialization, more and more agricultural and forestry lands are going out of stocks, due to developing landscape degradation [1].

Postindustrial (technogenic) landscape, formed as a result of urbanization, with a correct and integrated approach to recultivation of these territories, can be considered as a potential urban development reserve for regions. The purpose of this approach is to create optimally organized and sustainable natural and man-made complexes, as well as to qualitatively improve the planning structure of cities.

## 2. Topicality and scientific value of the issue with a brief literature review.

Restoration and use of technogenic landscapes is one of the most acute problems today. For optimal human life, as well as for functional urban development, environmental stability of a territory is one of the fundamental factors. With all the diversity of the functional use of land, the main purpose of land in urban settlements is the need for megapolises in land resources for the construction, functioning and development of urban economy [5].

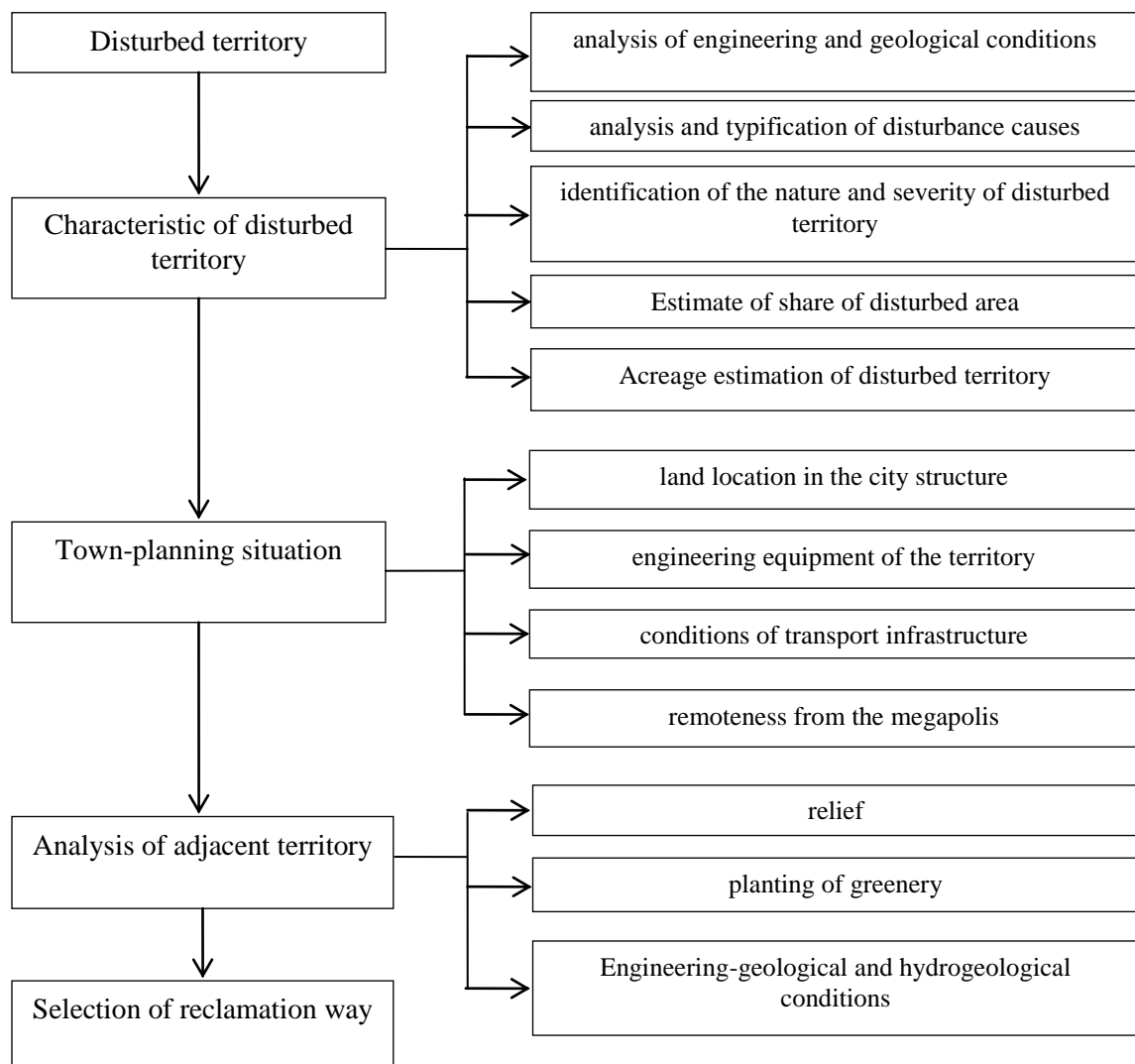
Annually, during construction and in the process of repair and survey works on territories of urban settlements, the surface layer of land is being destroyed. Due to this there is a constant increase in



disturbed areas. One of the most important characteristic features of mining activity is its temporality. However, for such a short period, the geological environment is intensively deformed at a large scale that instantly affects geomorphological, biological and aesthetic aspects of landscapes. Disturbance caused by open development of deposit cover approximately the same area of the adjacent territory as the area of the deposit itself [2]. Therefore, when developing a reclamation project for such objects, not only the territory of the quarry itself should be considered, but also the adjacent area.

Creation of a disturbed territories register and methods suitable for their reclamation could qualitatively improve their further usage, as well as eliminate the ecological tension not only of megacities and their agglomeration, but also of the region as a whole.

However, in the world practice clear rules and norms of postindustrial landscape optimal reclamation are not established. The legal norms currently in force are often contradict social, ecological and economic conditions of a disturbed territory location. One of the principles of an integrated approach for territory reclamation is the complete or partial elimination of unprofitable lands for a particular region. Therefore, when selecting ways of reclamation, it is a necessary to carry out comprehensive analysis of unprofitable lands and separate functional objects there.



**Figure 1.** Block-scheme of an enlarged algorithm for finding optimal functional filling of a disturbed territory

The named problem has existed for a long time, but solutions that offer both unique and general principles for territory restoration has begun to be used only in the XIX century in such countries as Germany, France, England, from the middle of the XX century – in the USA, in the USSR and other countries. Foreign practice of reclamation was mainly used in park creations, due to the picturesqueness of disturbed territory landscape.

In domestic practice, the problematic of disturbed territories was set in the 1960s and for the first time it was overviewed in the dissertation of I.V. Lazareva "Restoration of disturbed territories for urban development", the purpose of which was to develop methodological bases for restoration and usage of disturbed territories for urban development. Technogenic territories were considered as elements used for solving urban planning problems. Due to originality and scientific novelty the proposed methods and techniques for disturbed territories reclamation were included in the "Fundamental principles for restoration of lands disturbed by the development of mineral deposits, geological exploration, construction and other works", SNiP II-60-75 \*\* "Planning and development of cities, villages and rural settlements ", as well as in other methodological materials.

Further there were a series of studies devoted to the recreational usage of the postindustrial landscape by such authors as Bondar Y.A., Pak V.A., Vergunov A.P., Gavrilov G.M., devoted to the planning issues - Zhdakhina N.P., Grimanova I.V., Olenkov V.D., as well as issues related to the economic component - Kabakov S.I., Witt M.B.

### **3. Formulation of the problem.**

One of the tasks of urban development is protection of natural environment from the negative impact caused by technogenic, social and household factors and dangerous geological processes. Technogenic territories qualitatively worsen ecological state of a region, violate visual and spatial aspects and comfort of an urban environment, emphasizing the particular topicality in developing an integrated approach to restore disturbed territories for city-planning use. Inclusion of such territories with different functional content will help to avoid partitioning of megapolises architectural and planning structure, and will also strengthen the ecological framework of the region as a whole.

### **4. Theoretical part.**

Constantly growing shortage of lands suitable for further development and deteriorating ecological situation, have revealed the urgent need to return disturbed territories into viable surface of a city.

Degrading landscapes have a number of specific features: rapidity and intensity of development, period of self-healing or irreversibility of the process. Supercritical changes intrinsic for technogenic reliefs lead to such dangerous geological phenomena as karsts, subsidence of soils, seismic, mudflow, landslide and other phenomena, which excludes further functional use of the territory, without special complex measures of territory engineering protection, including reclamation. Such methods of protection include: change in the hill's relief, regulation of surface water runoff (including lowering), fixation of loose soils and construction of structures aimed for retaining slopes and others [16]. Also as a result of mountain open cuts there is a deterioration of the hydrological and hydrogeological regimes of the surrounding area, pollution of atmosphere, soil, occurs worsening of sanitary and hygienic living conditions for the population [1]. Therefore, return of environmental stability and safety of a territory is a basis part of reclamation work. From the point of view of eliminating ecological damage reasonability of performing reclamation works on disturbed territories is beyond doubt.

Reclamation of territories means a whole complex of various works - mining, melioration, agricultural, forestry, landscaping, engineering, construction and other works - aimed to restore damaged fertility of lands that are abandoned after their targeted use, creation of agricultural lands and plantations in these areas, green recreations, reservoirs for various purposes, using of these areas for construction, etc. [1]. Use of the technogenic landscape in town-planning is possible only with the complex approach, which includes the choice of way and method of landscape reclamation. In world practice the following working methods with rehabilitated landscapes are used:

1) Stability of the technogenic landscape includes:

- determination of the morphotype of the disturbed territory (estimation of engineering and geological conditions) and its resistance to natural and anthropogenic loads (subsidence, erosion, landslides, flooding);
  - evaluation of the compositional significance of the disturbed territory at the scope of planning structure of the city;
  - evaluation of social significance (environmental friendliness, comfort, historical and cultural value, livability, etc.);
- 2) Inclusion of the road, transportation and engineering infrastructures of the quarry, their reconstruction and improvement;
  - 3) Maintenance of ecological safety and stability of the disturbed territory, with the use of an ecological frame, in the form of green plantings system, that constitute spatially-organized infrastructure;
  - 4) Architectural and planning organization of quarry space, adopted in accordance with its reclamation direction;
  - 5) Modeling the relief of the quarry (pruning, strengthening the slopes, etc.) with preservation of its unique appearance;

A complex rehabilitation approach of disturbed territories is based on such fundamental criteria as: place of human activity (economic aspect), conditions of its living environment (social aspect), natural environment (ecological aspect) and organizational (protection of territories and preservation of valuable urban development objects).

The effectiveness of reclamation depends on the choice of the way for further use of the disturbed territory and its functional development. The main reclamation ways are: agricultural, forestry, water management and fishery, recreational, sanitary and hygienic, nature protection, and construction. When creating an architectural and landscape reclamation, the following rehabilitation areas of disturbed territories can be identified:

- 1) quarries which backfilling is technically or economically unjustified, to be used for ponds for various purposes;
- 2) creation of forest plantations for various use or agricultural purposes;
- 3) use of quarry for residential and industrial construction with partial or full backfilling;
- 4) renovation of industrial areas to recreational;
- 5) creation of socially valuable facilities (cultural and educational, entertaining, researching) with the preservation of the uniqueness of the landscape;

In the process of reclamation on the territory of urban settlements, the main task is to preserve the ecological safety and return lands that have lost their value to the urban development resource. That is why, the most popular directions in reclamation of disturbed territories are: recreation, sanitary-hygienic, nature protection and construction.

Moscow agglomeration is an interregional center of socio-economic development, a place of attraction of the central part and whole Russia. Today it remains the largest in Europe with a population of over 20 million people [3]. Therefore, attention to this region is predetermined by its administrative, economic, historical and many other factors.

Moscow region is represented by a wide range of minerals, such as peat, various clays, phosphorites, deposits of limestone rocks, and sand, according to which the Moscow region is one of the leading places in Russia. Consequently, the greatest number of quarries is developed for the construction and operation of linear objects of engineering infrastructure, in the form of roads for various purposes. In total, about 2000 deposits of various types of solid minerals have been discovered in the region. As of 2014 there are about 1795.55 thousand Ha. of disturbed areas on the territory of the Moscow region, where mining activities were previously conducted. The main sources of disturbed areas on the territory of the Moscow region is the construction of federal routes and other linear objects.

The most technogenic districts of the Moscow Region are Solnechnogorskiy, Ruzskiy, Noginskiy and Orekhovo-Zuevskiy districts. The disturbed area of each exceeds 100 thousand Ha. The leader is

Solnechnogorskiy district, the total area of which is 681.05 Ha. This is due to the construction of federal highways, such as the A107 "Moscow Small Ring", M11 "Moscow - St. Petersburg" and other linear facilities.

In the construction of the Moscow Ring Road, according to the projects of the "Soyuzdorproekt", soil quarries (reservoir quarries) were developed in the construction of highways Moscow Ring Road-Kashira, Serpukhov-Tula, Sverdlovsk-Tyumen, at Kupavinskiy asphalt plant of Mosavtodor and other quarries along highways. So there is a different set of gravel, gravel-sand and sand quarries-reservoirs in Ikshanskiy, Lyuberetskiy and other districts of the Moscow region [4].

The problem of the above-described soil quarries occurs in the wrong approach at the stage of designing the quarry development - they are considered separately. There is no linkage with existing culverts and other structures, the design documentation does not show the borders of catchments, the direction of surface water runoff, the slopes of the terrain are not developed and the evaluation of the hydrological and environmental consequences during quarrying also are not carried out.

As these disturbed territories already represent an artificially created natural object, the rational reclamation of this landscape will be recreational functional filling with the maximum preservation of its unique landscape and biological return to the natural environment complex.

In addition to recreational use, the practice of using "leftover" territories for the construction of mass gathering objects for people is widespread in the world experience. Further functional filling is selected depending on the typology of the object, the location of the area in the megapolis / agglomeration / region structure and the geometric parameters of the quarry.

As such an example on the territory of the Moscow agglomeration, can serve Europe's largest sports and rifle complex "Fox Hole", located 60 km from the capital by Dmitrovskij highway. The club building is located in the crater of a sand quarry, and the quarry itself forms an artificial landscape.

## **5. Practical significance, proposals and results of implementation.**

After analyzing the construction reclamation in the world practice, it was revealed that the functional filling of the quarries determines a number of factors, but the common parameters for optimal reclamation are: small depth, mined minerals, location relating to the populated area. Detailed characteristics and examples of architectural and landscape reclamation are given in Table 1.

The results of the research will allow to develop a geoinformation system with the main characteristics of the disturbed territories and subsequent recommendations on their functional use in the urban aspect.

## **6. The conclusion.**

The proposed methodology of technogenic territories functional filling allows to choose the most optimal way for further development of the territory. The performed analysis of anthropogenic territories reclamation has shown a great potential for further urban development of megapolises. Proposed complex approach will help to identify the most rational use of degraded lands. In urban planning, architectural and economic aspects, reclamation of technogenic landscapes solves a number of tasks, such as:

- ✓ prevention / liquidation of geological hazard processes
- ✓ additional land resource in case of inadmissibility of agricultural lands alienation
- ✓ creation of unique objects on the basis of real and potential disturbance of urbanized territories
- ✓ attraction of tourists to agglomeration
- ✓ reduction of society stratification at the periphery
- ✓ dynamics of the region's land fund

**Table. 1.** Typological classification of architectural and landscape reclamation, formed on anthropogenic relief

Group of disturbed territory	Technical indicators of the disturbed territory				Position of the area in structure	Assumed function
	Characteristic of disturbed territory by the form of relief	Predominant relief element	Area	Mined natural resources		
Excavation pit	Medium-deep; Basin-shaped, Medium-deep Plateau-shaped, close to natural surfaces	Bottom, Ledges, scarps Plateau	More than 10000 sq m	Building materials	In the city; near the megapolis	Entertainment, culture, physical and sports, recreation area
External elements	Plateau terraced Crest-shaped Plateau-shaped medium-high Plateau-shaped Terraced medium-high	Plateau, terraces on working board Crest system Plateau, scarp Plateau, Terraces in scarps				
Excavation pit	Basin-shaped, skin-deep	Bottom, scarps	5000-70000 sq m	Building materials	In the central part of city, relatively remotely from the city	Spectacular
Excavation pit	Basin-shaped, skin-deep	Bottom, scarps	Depending on the intended object	Sandstone, limestone, granite, coal, oil shale and other	Periphery of the megapolis, as part of the agglomeration	Cultural and educational
Excavation pit	Basin-shaped, skin-deep	Bottom, scarps	Depending on the intended object	Kaolin, Granit, Construction materials and other	Outside of megapolis, of agglomeration	research

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