Urban ecology features of large city disturbed territory
development (case of Volgograd)

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Abstract. The article examines the issues of large city disturbed territory development by
means of town planning at a disturbed area. The territorial characteristics of a disturbed area
with respect to city functional zones are considered. The authors classify the disturbed
territories discovered in Volgograd into four types, calculate the values of the coefficient of
adverse effect caused by disturbed territory on Volgograd urban environment, and estimate the
factors influencing the territory rehabilitation as per the federal standards. The factor analysis
makes it possible to identify morphostructural and urban ecology features of the territory and
make a design decision on its adaptation for further development. The obtained data show
favorable effect of disturbed territory rehabilitation on urban ecology framework. The studies
conducted by the authors revealed favorable residential areas.

1. Introduction
Urban growth and the acceleration of urbanization on the cusp of the 20th and 21st centuries have led
to a tremendous urban development. It aggravated town planning problems related to the effective use
of urban territories, including the ones disturbed in the course of human activities. Disturbed
territories arise because of an incompetent town planning policy based only on the consumption
principles [1-4]. The Town-planning Code of the Russian Federation establishes the concept of
“sustainable territory development” pursuant to which all town-planning policy is to ensure safety and
high standard of living, the control of adverse anthropogenic and other impacts on environment; and
account for the protection and efficient use of natural resources to the benefit of the current and future
generations [5]. One of major problems of Russian territories is a large number of quarries, dumps,
abandoned mines and other obsolete sites; and urban areas having numerous ravines and gullies in the
urban plan structure.

2. Urgency, scholarly importance
The requirement of the efficient use of land in a modern city can improve the urban ecology
indicators. The rational use of disturbed territories will allow expanding urban territories and
contribute to the suspension of soil degradation, erosion process reduction.

   Disturbed territory development is tightly linked with town planning. Both Russian and foreign
experts address this problem [6-15]. The most popular town-planning method for the development of
this type of territory was the transformation of a site with technogenic topography into a recreation
area. It accentuates the landscape individuality and provides the city with unique panoramic views;
add variety to its image. Among a large number of reserve ways of urban environment enhancement and the upgrade of urban landscape aesthetics, the one of particular importance is the landscape rehabilitation of the said to be “wasteland”, barrens, landfills, disturbed landscapes, which are numerous in the existing urban area. Treating nature as a priority again and searching for the means of maximum expressivity have become the main task in creating two botanic gardens in Volgograd, blossoming on the former disturbed territories [6,7,14].

The disturbed territories considered in the research should be divided into several types: exhausted mines, solid waste dumps, ravines and industrial plants situated in Volgograd.

At the stage of territorial planning (the development of the general town-planning scheme) it is necessary to conduct the territory analysis, identify if a chosen land plot should be recultivated, and work out an individualized approach taking into account the topographic peculiarity of the considered site. The main peculiarities of the planning process at a disturbed territory are having permanent structures in place, the nature and degree of disturbance, topographic and landscape features, water content and ground water level [16].

In foreign practice there have been a large number of cases of disturbed territory rehabilitation to make such territories traveler attraction architectural sites, housing sectors, recreation areas and areas used for other purposes. The distinct feature of a design approach worked out for the relief disturbed by technogenic activities is that it is to conserve the natural landscape.

3. Research objective
The disturbed territories considered herein should be divided into several types: exhausted mines, solid waste dumps, ravines and industrial plants situated in Volgograd.

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4. Theoretical foundation
In order to recover disturbed territories specialists have to use land recultivation. Recultivation is a package of works intended to the revegetation of disturbed land and returning its economic value, and the environment improvement beneficial to society.

Currently the issue of rehabilitation and use of disturbed territories is one of the priority ones in Volgograd town-planning activities. In making the classification the method of morphological analysis [17] was used. The method is to consider the characteristics of a territory in question. Based on the obtained findings the choice of the options, which will help to reach the site potential, is made.

In making a decision to recover disturbed land it is required to identify the factors of the disturbed territory assessment, namely morphological characteristics and design peculiarities of the territory. The main morphological characteristics of the disturbed territory include climatic and natural zone, hydrologic and geological conditions of the territory, the disturbed territory size, the degree of dissection (horizontal and vertical) [18], land cultivability. The design properties of the disturbed territory are the location of the urban built-up area against the disturbed territory and its impact on the city infrastructure. The characteristics not included into the main group of factors and applicable to a certain type of the disturbed territory are also taken into consideration. In the case of solid waste dumps, one considers waste storage cluster, disposal methods, technogenic soil zones and hazard class. The additional assessment criteria for the ravine and gully system are man-caused impact sources and recent utilization of the disturbed territory. As for exhausted mines, the additional factors influencing the assessment of an overstrained territory were type and method of mining, the depth of the quarry, formation toxicity and geological conditions emerged in the process of mining. The disturbed territory type which differs significantly from the ones considered above is the built-up
industrial area, which is complicated because of having permanent structures occupying the major part of the site. When said type is considered, the factors taken into account are branch of industry, the value of the industrial site in the city structure and the hazard category. The existing condition of disturbed territories has a great impact on city environment comfort level. Intra-city disturbed areas influence the sanitary condition of air, aeration regime, microclimatic change options. A strong effect is exerted on the land-use environmental compliance, which is directly dependent on the territory condition and human living environment. The consistency of the change of engineering and geological conditions is attributable to creating a comfortable urban environment, land-use environmental compliance [19, 20].

Emerging a disturbed territory reduces the possibility to form a landscape framework of the city, being a combination of the following factors:

- location made by the combination of the daylight surface and upper layers of soil;
- the correction of natural relief taken by artificial means (hydraulic deposition of soil, surface planning, ground excavation and etc.);
- the creation of technogenic relief through artificial replanning, namely by means of adding artificial units to topographic peculiarities, for example, urban infrastructure, artificial hard surfaces for roads and pedestrian areas.

The landscape framework of the city cannot be built up without territory urbanization, and the disturbed territories being available and expanded add to the problem. The disturbed territory assessment factors will allow making the choice of the disturbed territory function and give the idea of the town-planning potential of the considered sites. According to where the disturbed territory is located one can calculate its adverse effect coefficient. The disturbed territory adverse effect coefficient is defined as the total area occupied by the items of the disturbed territory being relative to the total city area.

In order to define the adverse effect coefficient it is required to measure the area of the impact of the disturbed territory on the city territory. The research is conducted by making a chart of city districts using a grid having $\Delta$ with the step of 200 m and based on the data on the disturbed territory areas. In each considered grid square the disturbed territory impact on the urban environmental quality is defined, besides the population being inside the area of influence is also identified.

The adverse effect coefficient $K_{ae}$ shows the number of people at each hectare of the city district territory being under the influence of the disturbed territory. The adverse effect coefficient for urban territories is determined as per the formula (1) [4]:

$$K_{ae} = \frac{N}{S} \times \frac{Sdt_c}{S},$$

(1)

$K_{ae}$ - disturbed territory adverse effect coefficient, person / ha;

$N$ – city population, persons;

$Sdt_c$ – district disturbed territory area, ha;

$S$ – total district area, ha.

The choice of the best possible use is one of the most relevant processes in the disturbed territory development. The process of choosing the best function of the disturbed territory should be divided into several stages: primary acquisition, obtained data analysis, the choice of the function for the territory (the construction of buildings and facilities, green building, creating water reservoirs), working out an action plan on rehabilitation, choosing the most effective direction of the disturbed territory development, economical comparison of the chosen options.
5. Practical relevance, suggestions and implementation results, experimental findings

As per the research held within engineering and environmental survey, in Volgograd there have been discovered 29 disturbed territories which can be classified under 4 types:

- type 1 – territory of exhausted mines;
- type 2 – territory of solid waste dumps;
- type 3 – territory of ravines and gullies;
- type 4 – territory of industrial plants, mostly non-performing ones.

The disturbed territory is divided by the geographic and functional characteristics. The territorial characteristics include the location of a disturbed territory within the city limits – city territories, and the location outside the city limits – out-of-town territories. Thus, based on the disturbed territory location 4 patterns are defined (Figure 1-4).

The results of defining the adverse effect coefficient exerted on the Volgograd city environment by the disturbed territory are demonstrated in Table 1.
Table 1. The adverse effect coefficients for the districts of Volgograd.

| District of Volgograd | Adverse effect coefficient for the districts of Volgograd \( K_{ae} \), persons per hectare |
|-----------------------|------------------------------------------------------------------|
| Traktorny             | 2.74                                                             |
| Krasnooktyabrsky      | 7.85                                                             |
| Dzerzhinsky           | 1.27                                                             |
| Tsentralny            | 2.79                                                             |
| Voroshilovsky         | 1.04                                                             |
| Sovetsky              | 0.26                                                             |
| Kirovsky              | 0.21                                                             |
| Krasnoarmeyskky       | 2.50                                                             |

Obtained rates characterize the degree of negative effect of the disturbed territory on the city district residents. In Krasnooktyabrsky district of Volgograd the living conditions for the population are impaired because of disturbed territories (\( K_{ae} = 7.85 \) persons per hectare). The coefficient of adverse effect from all types of disturbed territories on the city of Volgograd is 1.01 persons per hectare.

To eliminate adverse effects and improve the performance of a disturbed territory it is necessary to find the best possible site function, which will make for opening the site potential.

Aimed at identifying the type and way of the disturbed territory use, having regard to functional zones, the assessment of the factors influencing the process of site restoration in compliance with GOST 17.5.3.04 – 83 [16].

6. Conclusion

The most efficient functions for disturbed territories have been identified. They are industrial and civil engineering, creating water reservoirs and green building (on the territory of exhausted mines and solid waste dumps). The obtained data show favorable effect of disturbed territory rehabilitation on urban ecology framework. As a result of the conducted research favorable residential areas have been revealed.

In town-planning the technique of choosing the function for a disturbed territory on the basis of urban ecology features with due regard to disturbed territory assessment factors (morphological characteristics and design peculiarities of the territory) has been made.

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