Analysis of the critical limits of technogenic territorial resources in the conditions of a modern technopolis

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Abstract. This article discusses the features of accounting for the shortage of land resources and their large-scale reduction in the conditions of modern technopolises, such as Moscow, St. Petersburg, Sochi, Anapa, and so on. These cities are characterized by a large-scale reduction of the environment-restoring territories. Therefore, it becomes important for modern society to preserve agricultural lands, which increase the productivity of landscapes, that is, they have the properties of restoring the city's biosphere.

1. Introduction
In order to ensure the fully effective development of the regions of Russia, it is very important to develop a strategy for overcoming or predetermining the critical features of the technogenic transformation of territorial resources that perform biospheric functions. Agricultural land is one such resource.

2. Materials and methods
The following methods were used as a methodological basis for the study: analytical, system analysis, method of guided classifications, cartographic, zoning methods, methods of spatial GIS analysis, as well as methods of processing geodetic measurements and data obtained using unmanned technologies.

3. Results
Most of the critical limit of the technological transformation of territorial agricultural resources is observed directly in the megalopolises and technopolises of Russia.

First of all, these include the city of Moscow. This region can be called unique in terms of territorial and administrative formation, and it also stands out in terms of the size of the demographic and economic development potential [1]. The distinctive features of this region can also be attributed to its density in terms of saturation with a variety of technogenic objects.

In addition, we note that Moscow and the Moscow region continue to constantly thicken and expand the boundaries of their impact on the environment. According to Rosstat, the population of Moscow is 12 678 079 people, the Moscow region is 7 691 000 people, respectively [2]. That is, the total population in the Moscow metropolitan area at the end of 2020 officially exceeded 20,000,000 people (figure 1).
The population of the Moscow region at the end of 2020, people.

- More than 80% live in cities, while more than 30% of residents live in cities with a population exceeding 100,000 (figure 2).

The process of transformation of territorial resources described above in the conditions of the modern technopolis and metropolis of Moscow entailed large-scale technogenic transformations of the natural environment. This fact jeopardizes the environmental safety of the region, while causing high tension in the development of agriculture.

In accordance with the reports to the government "On the state of the environment in the city of Moscow in 2016-2019", significant climatic changes have recently been observed in Moscow, characteristic of many urbanized territories [4]:

- Sharp climatic changes in the weather;
- Rise in air temperature;
- Gradual exceeding the minimum temperature norm;
- The appearance of a "heat island" (Figure 3);
- Increase in average annual air temperatures near the surface of land;
- Increase in the frequency of thaws;
- Modification of the wind rose, new convection flows;
- The specifics of the receipt and reflection of solar radiation;
- Gradual accumulation of large volumes of smoke, dust and steam;
- Increase in humidity;
An increase in the level of annual precipitation with an increase in the rhythm of drought against the general background of the preservation and decrease of precipitation during the warm period;

- Decrease in precipitation in spring.

As you can see, the list of climatic problems of modern technopolises and megalopolises is great. In addition, it should be emphasized that the share of harmful emissions into the atmosphere from the Moscow region due to industrial enterprises and other stationary sources operating on its territory, which also pollute the environment, is several times higher than the share of emissions from the occupied territory. Thus, more than 80% of all air pollution occurs in road transport [6]. In addition, nearly 900,000 hectares are occupied by solid waste landfills and landfills; there is also a large number of unaccounted, unauthorized dumpsites.

4. Discussion

All of these technogenic factors are detrimental to agriculture. There is a constant decline in productive natural, cultural ecological systems. The assimilation potential of the Moscow region decreases, as well as the potential for self-cleaning of nature from harmful emissions. Landscape and aesthetic values are disappearing everywhere, which could be considered significant for the ethnosocial identification of the population that lives in the territory of a given city and region [7]. Forests are now fragmented, which also reduces the potential for production (reproduction) and oxygen production.

In such current conditions of shortage of land resources for Moscow and the Moscow region, it is simply necessary to draw the attention of specialists, ecologists and the government of the Russian Federation to the fact that agriculture and agricultural land should increase the productivity of landscapes through the use of environment-restoring territories [8]. It is necessary to launch a mechanism for the restoration of the biosphere. It is strategically important to prevent crossing the critical border of the technogenic “capture” of the territory of a megalopolis and a technopolis such as Moscow. This is especially important for lands that perform biospheric functions, including agricultural lands.

5. Conclusion

As the main directions for overcoming the current situation in Moscow and the Moscow region in the medium and long term, a set of measures and directions of the following nature is recommended:

- Currently, on the lands that are used for the production of agricultural products with the use of modern and intensive technologies of growing and cultivating crops, for raising livestock, the process of the so-called "soil alteration" is very noticeable. That is, thanks to this feature,
which was acquired by land resources, one can observe the so-called "azonal phenomena" and, accordingly, it is possible to distinguish them among the lands intended for the main fund of agricultural production. The development potential of these lands and their features is formed only under the influence of favorable natural factors. This fact helps to move away from the qualitative differences in land resources in agriculture. It becomes possible to assess these land resources from the side of the spatial characteristics and features.

- Agriculture is a system in which the plant growing industries are dependent on the state of specific natural conditions in combination with economic prerequisites, and are also supplemented by industries that are engaged in animal husbandry [9]. It is known that lands are used not only for the creation of primary gross production, that is, "the total production obtained under the influence of photosynthesis." From our point of view, it would be much more logical, when characterizing the productivity of an agrosphere suitable for farming, to focus on the indicators of products created. Then, consumer value expressions of created or already created food products can be used as the most significant economic equivalents.

- The use of land in crop production is carried out in accordance with the laws of rotation and combination of different crops. Consequently, the productivity of any site, expressed in the yield of any crop, depends on the organization of the system of using cultivated land as a whole. The value of productivity, both primary and secondary, of any production site is influenced by the level of agriculture and the organization of land use throughout the entire area of the agricultural system.

- Thus, the value of any agricultural system can be associated with the value of the product it creates - "the main external function of the system". It is expressed both in natural and value (conditional) indicators. The relative values of these values, or indicators of the productivity of the agricultural system (total and for individual products), calculated per unit area of the entire system, and not for individual production sites (land), can be considered as criteria for the value of the used land.

The multifactorial ecological and social significance of all suburban lands requires an innovative view of their value. Without new conceptual principles and approaches to organizing the suburban area, the Moscow "thermal island" can get even warmer.

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