Mapping of the Volgograd agglomeration territory for its arrangement by the green construction methods

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Abstract. The problems of mapping the territory of the Volgograd agglomeration for the planning of green building works are presented. The estimation of the application efficiency at mapping the geoinformation systems technologies urban landscapes degradation and restoration processes is given. The results of the agglomeration landscapes geoinformation mapping methods development using the large-scale satellite images are presented.

Introduction

Research in the mapping of urban landscapes has difficulties due to the need to study, evaluate and use their geomorphological, ecological and socio-economic characteristics, data on which are presented mainly in the form of quality indicators, as well as insufficient development of methods for conducting a comprehensive assessment of the environmental factors of the arid zone and problematics overlay them on each other in space-time dynamics.

Currently, the ways of overcoming the stated difficulties with the use of geoinformation technologies (GIS – technologies), carried out with the help of modern electronic means of information processing, are being developed. GIS technologies provide an opportunity to integrate cartographic and aerospace monitoring, methods of mathematical modeling and computer mapping into a single process that provides a qualitatively higher level of research results [1].

Their basic discipline is geoinformatics, it studies natural and social-economic geosystems (their structure, connections and dynamics of functioning in space-time) by means of the computer modeling on the basis of the geographical information databases. It includes the technology of collection, storage, transformation, display and distribution of spatially coordinated information, providing the solution of inventory, optimization and management of geosystems. Another area of the research is the development of hardware and software products for the creation of databases and data banks of control systems, standard systems for different purposes and problem orientation [1].

The relationship of cartography and geoinformatics is manifested in the following aspects: a) topographic and thematic maps are the main source of spatial and temporal information; b) the system of zonal rectangular and geographical coordinates, as well as cartographic mapping are the basis for the coordinate reference of all information received and stored in GIS, c) maps - the main means of geographical interpretation and organization of remote sensing data and other information used in GIS; d) cartographic analysis – a universal method of identifying patterns, relationships, dependencies
in the formation of databases included in the GIS; e) mathematical and cartographic computer modeling - a leading tool in the process of decision-making, forecasting the development of geosystems, etc.; f) cartographic image – the most convenient and effective form of information [2].

Developed at the junction of geoinformatics and mapping, geo-information mapping integrates the achievements of remote sensing, space mapping, cartographic method of research and mathematical and cartographic modeling.

The most active results of interrelations between cartography and geoinformatics are used in the field of complex application of geoinformation and automated cartographic technologies and automated (including digital) cartography [3].

One of the main sources of data for GIS is the materials of di-station sensing obtained from space and aircraft-based carriers [4]. At present, along with the aerial photographs traditionally used in meliorative mapping at a scale of 1: 10,000 to 1: 15,000, other types of shooting materials are used more widely - high-resolution television and scanner images taken from artificial satellites. On scanner images of good quality, especially on color synthesized ones, the same objects are clearly distinguished as on photographic ones, but at the same time, the periodic repetition of the survey and the convenience of automated entry into digital databases are provided.

During surveys in landscape melioration, including green building for landscape mapping, black-and-white and multizone surveys performed best in the narrow zones of the visible spectrum of 600-700 Nm with various equipment on different types of films provide the best results [5].

Computer technology mapping, providing a breakthrough in research, design and economic activity, are used mainly in agriculture and forestry and are considered promising in urban planning. But the methods of using geo-information technologies in planning green construction for arranging urban landscapes require some refinement and detailing.

Based on the critical analysis of scientific information on the existing problem, taking into account the experience of using information technologies in aerospace monitoring and reclamation mapping [6], we have developed a methodology for studying and mapping degradation processes in urbanized landscapes.

Methodology

The geomorphological structure of the territories of Volgograd and its environs is quite complex. Its elements are characterized by great diversity, causing a significant difference in the particle size distribution, the presence of soluble salts that are toxic to woody vegetation, the water regime and, consequently, soil fertility, which determines the conditions for the growth and development of greenery. Within the Volgograd agglomeration, valley, slope and watershed landscapes are distinguished.

Most of the Volga valley is represented by a 20–40-meter abrasive accumulative terrace, which passes into the southern part of the city to the Beketov lowland and the low Sarpinskaya plain. At the base of the terrace there are outlets of groundwater.

The length of the slope of the Volga Upland in the northern part of the city is on average about 10 km, in the south it decreases to 1.0 - 1.5 km. On the slope there are two floodplain terraces with average relative heights of 10–15 and 50–60 m, above which local structural steps are observed. The surface of the abrasive accumulative terrace is mainly composed of Mechetka deposits. On the Volga side, areas with Hvalynsk chocolate clay adjoin it. In the northern part of the city in the Mechatkin sands, a fifty- to sixty-meter above-flood terrace was developed. To the west of it, there are structural local steps with a height of 80–90 m. To the north of the Kuporosnaya beam there is a 10–15-meter terrace, to the south it manifests itself in the Otradnaya beam and is a wide marshy surface, bounded from the west by a high Yergeni ledge. In the extreme south of Volgograd there is a section of the Volga floodplain with a width of 1.0–1.5 km [7].

Urbolandscapes of the Volgograd agglomeration due to a combination of unfavorable phytogranation conditions are extremely low resistance to man-made and recreational effects. As a result, rapid-
dynamic land degradation processes occurring in its territory, sometimes turning into desertification. Successful implementation of the tasks of arranging urban disturbed lands by carrying out green building measures is possible only with careful analysis of the current situations, which are determined by the peculiarities of the degradation processes of various categories of territories occupied by industrial enterprises, their infrastructure, residential areas and various linear engineering structures [8].

In this regard, in planning for green construction, a landscape-cartographic approach based on aerospace photography and scanning in combination with geo-information technologies is becoming the most important methodological basis, allowing not only to monitor the state of the land and the dynamics of degradation processes, but also to develop a system of integrated land-improvement activities.

To solve the existing problems, the following questions were worked out:

1. Development of the basics of landscape-cartographic approach to the reclamation of degraded urban land.
2. Development of the concept and technology of application of cartographic and aerospace monitoring of degradation and restoration processes in urbanized landscapes, differ in different degrees of landscaping.
3. Development of methods for the qualitative and quantitative assessment of degradation and restoration processes on the basis of remote indicators and biotic criteria for land degradation and restoration.
4. Development of an integrated scale for assessing the degree of degradation of urban soils based on a logistic approach.
5. Clarification of the methods of landscape-typological maps urbanasirakan territories on satellite imagery for the purposes of the green building.

The technology of integrated mapping, proposed by B.V. Vinogradov [9], including field research and Desk analysis of the results of remote survey of territories was used. It is revealed that, as well as forest reclamation combined mapping, the most effective is a five-stage technology of work, consisting of preliminary decoding, field calibration and extrapolation, including field control, final decoding and mapping.

It was found that for achieving a good mapping of urbrandsafe dimensions of the investigated polygons should not go beyond images of scale 1:10000 – 1:15000. In conducting research priority is the visual-instrumental and computer analysis of large-scale space images, as they are reflected not only the physical components of the landscape of its infrastructure and linear structures, but also the landscape as a whole.

An important section of geoinformation mapping is to solve the problems of the theory and practice of landscape interpretation, including in parallel with the topographic areas of special interpretation: geomorphological, soil, geo-ecological, geobotanical, and others. They are based on identifying the relationship between the properties of the object and the features of its image in the pictures. At the same time, the efficiency of decryption largely depends on the completeness of the information of the decoder about the landscapes of the studied territory.

The recognition of objects during interpretation is determined by the peculiarities of the visual perception of their image in the image, including the photographic reproduction of the optical and geometric properties of the elements of the urban landscape [10].

It is revealed that with a sufficiently good quality of shooting and high resolution from a space photograph, it is possible to model both the internal and external structure of the landscape. It is advisable to carry out the decoding of the urban landscape in three stages: preliminary, topographic, and proper landscape.

At the preliminary stage, according to the available information sources, a general scheme of landscape differentiation of the agglomeration territory is outlined and a preliminary classification of its landscapes is drawn up.
As a result of the topographic decoding of the elements of the images, orientation and binding of landscape objects with the determination of the coordinates of their characteristic points is made, their physical and geographical characteristics are given. This reveals the main indicators of the structure of the territory: the morphostructure of the surface, its dismemberment, the degree of drainage and watering, the nature of the building, the presence of green spaces, the location of the carriageways of streets, sidewalks and other types of land tenure.

To clarify the procedure for performing mapping urban landscape landscapes, geoinformational interpretation of several satellite images of suburban areas was carried out, the detailed study of which was of considerable complexity.

Topographic interpretation provided orientation and binding of landscape types to the cartographic basis and made it possible to identify the structural features of their image on satellite images. With proper landscape interpretation, large mapping units were identified and separated: landscapes, and terrain.

Features of the image of various objects of urban areas on satellite images necessitated a detailed study and clarification of the existing methods of their landscape interpretation. Taking into account the fact that space images integrally reflect the morphological structure of the landscape, which is perceived as a combination of localities - dominants, the main emphasis was placed on identifying complex interpretive signs of localities - dominants. Based on the analysis of large-scale satellite images, they were distinguished in all major groups of landscape types.

**Results and Discussion**

It was established that the spatial differentiation of the natural conditions of suburban and sparsely-built urban landscapes is determined, first of all, by the mesorelief. The following types of geosystems were distinguished: a) near-watershed surfaces, b) near-valley and near-sloping slightly eroded slopes, c) floodplain terraces, d) floodplains, e) beams, e) slopes strongly dissected by ravines.

Drawing the boundaries of the types of terrain on the overview map of the contours of erosion-denudation landscapes allowed to proceed to the selection of the boundaries of groups of landscapes. Refinement and specification of the boundaries of landscape types were carried out on the basis of a conjugate analysis of images and topographic maps.

Landscape interpretation of cosmic photographs of natural geosystems of the rank of landscape-terrain in combination with a conjugated analysis of topographic and thematic maps allowed the classification and mapping of the studied landscapes of agglomeration. Then a landscape mapping of geosystems of the Tract-Facies rank was carried out.

The recognizability of the objects under study is strongly influenced by the reflectivity of their surface. The magnitude of the reflection is not the same for different rays of the solar spectrum. Using this fact allows more accurate decoding of urban and suburban areas with a large set of objects to be displayed, since many types of situations that are poorly recorded in the visible spectrum range are contrasted with the invisible infrared range. It is noted that, as well as in suburban areas, geosystems of the rank facies of steppe urbolandscapes of agglomeration are characterized by high brightness and have a maximum spectral line on green areas with tree and shrub vegetation.

A separate study of each facies with large-scale mapping is very laborious due to the wide variety of growing woody vegetation, which is distinguished by biometric and landscape-architectural indicators. Combining facies of similar status and biocenosis into groups and types allowed us to identify areas with similar types of natural conditions.

Each type of landscape corresponds to a certain structure of stows, which is reflected in the pictures by a certain type of pattern and image texture. In the structure of suburban landscapes, the dominant tract forming the general background is usually distinguished. Against this background, a number of minor tracts of small area are often observed. At the same time, a portion of one tone with spots of another tonality is visible in the photographs.
An important step in aerospace mapping is the field calibration of images in key areas laid within the limits of the polygons under study. In taxonomic terms, these are tracts or groups of facies that can be distinguished in photographic images, characterized and extrapolated within polygons.

For the field interpretation of aerial and space photographs of suburban areas, it is advisable to use the method of integrated or landscape profiling. The profile should cover all types of tracts. Profile lines are pre-marked in the pictures, then refined on the ground. Perform a breakdown and leveling of the course, draw the profiles of the territory in the selected direction. On each contour selected in the picture, it is necessary to determine the relief forms, soil and plant conditions, the nature of modern exogenous processes, paying particular attention to the rapid dynamic processes of landscape degradation (excessive recreational load, impact of pollutants, erosion, deflation, etc.).

Within the landscape profile, a description of the components of the landscape is made in each facies or subsurface. Extrapolation includes operations to decipher untested territories according to the established criteria. The field control is performed by sampling the reliability of the interpretation.

The final interpretation and mapping as well as in forest reclamation studies[11] should include all the operations stipulated by generally accepted programs for the desk processing of the material and the mapping of a given scale and subject matter.

Summary
It has been established that for the creation of thematic maps describing the conditions of growth of greenery, the iso-linear method of mapping, the geographical field, is most suitable. In the mathematical sense, the geographic field is the distribution on the earth's surface of a certain quantitative assessment, each point of which is characterized by a specific indicator (scalar)[12]. Scalars display the morphometric parameters of objects, as well as indicators of the intensity of land degradation or restoration processes. If the indicators change from point to point, then they can be characterized by a spatial field, and when changing them over time and space-time, used in the dynamic mapping of the processes of degradation - the restoration of landscapes.

The isoline cartographic materials allow us to represent the processes of changing the state of landscapes in the form of models, which are integral continual images representing scalar fields on which you can perform various mathematical operations. As a result of material processing, a point model of the distribution of process values is created. It is advisable to automate the operation using digitizers, scanners or automatic coordinators.

When combining iso-linear maps of urbanized territories of different content (geomorphological, soil, natural vegetation, etc.), there are great opportunities to study the interrelationship of spatial phenomena using multiple correlation and regression apparatus, factor and component analysis.

Overlaying the maps of the state of the urban landscape (speed, speeding up or slowing down the degradation processes) makes it possible to make predictive maps of the dynamics of recreational and man-made degradation of geosystems, using which, plan activities to end degraded processes and then convert degraded urban landscapes to cultural ones. arrangement of urban areas with green building methods.

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