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Methodological aspects and creation of a basis of soil and cadastro data

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Abstract

The study aims to investigate methodological aspects and the creation of a basis of soil and cadastro data for the development of a land and information system based on modern information and geoinformation technologies. The results of the research developed a database of soil inventory data, which includes an interactive map and combines the digitized soil contours and parcel boundaries. In

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conclusion, one of the primary tasks for ensuring rational land use and soil protection should be the task of creating a database of soil cadastral data.

Keywords: GPS/ GLONASS, Soil Cadastral, Database, Soil Inventory.

Aspectos metodológicos y creación de una base de datos de suelo y catastro

Resumen

El estudio tiene como objetivo investigar aspectos metodológicos y la creación de una base de datos de suelo y catastro para el desarrollo de un sistema de tierra e información basado en tecnologías modernas de información y geoinformación. Los resultados de la investigación desarrollaron una base de datos de inventario de suelos, que incluye un mapa interactivo y combina los contornos digitalizados del suelo y los límites de las parcelas. En conclusión, una de las tareas principales para garantizar el uso racional de la tierra y la protección del suelo debe ser la tarea de crear una base de datos de datos catastrales del suelo.

Palabras clave: GPS / GLONASS, catastral del suelo, base de datos, inventario de suelos.

1. INTRODUCTION

Land resources represent the basis of integrity and the basis for the development of any state. In Russia, complete and comprehensive knowledge of land resources has always been recognized as extremely important. By the end of the 20th century, first of all, thanks to the enormous efforts of soil scientists, the country received a cartographically secured inventory of soil resources at various scales. On the whole, this information fully met the requirements of the centralized economic mechanism of Russia at the pre-perestroika stage of development. Currently, the situation has changed dramatically. First of all, the country abandoned state land management. The initiative in the use of land is given to the producer and is determined by the market and demand conditions. Under these conditions, the system of information support for land use, created in Soviet times, was unclaimed.

The transformation of soil-spatial data in the direction of their approach to new socio-economic conditions is necessary. The lack of modern information support deprives the state and municipal authorities of the opportunity to formulate real, substantively and regionally differentiated tactics and strategies for the development of economically beneficial, socially acceptable and environmentally acceptable use of the country's soil resources that are adequate for modern economic tasks.

Soils are one of the most important components of the concept of land resources. To a large extent, it is the soils that act as the main indicator of land quality. Inventory of soil resources is traditionally carried out using cartographic methods. Soil mapping is carried out from the very origins of the Dokuchaev doctrine of soils as special independent natural-historical formations formed under the influence of complex interaction of soil formation factors (climate, vegetation and living organisms, the composition and structure of soil-forming rocks, the topography and age of the country).

The compiled soil maps made it possible to understand the relationship of soils with the factors of soil formation and to determine the geographical position of different soils. Therefore, the cartographic form of information on the distribution of different soils is the most effective. Maps allow you to perceive information on the geographical location of soils, compare the composition of the soil cover of different territories, calculate the area occupied by different soils, plan various events on maps, etc.

The accumulation of data about soils and their geography, as well as in connection with the expansion of the number of applications interpretation of soil data, the soil scientists tried to increase the information content of soil maps. However, the increase in the information capacity of the soil maps decreased their degree of readability and perception, which in turn hindered their practical use. The discrepancy between the technical possibilities of traditional paper cartographies and the amount of soil data that are required and can be stock can also be resolved based on modern computer approaches (SAVIN, 2004).

The development of soil science necessitates the development of new approaches to the analysis of the soil resources in Russia. One of the promising approaches is the introduction of geoinformation technologies for the inventory of soil resource data, their storage and applied analysis that determines the relevance of the research topic. At the same time, the rapid introduction of scientific research in the last decade, GIS technologies have created the basis for the development of new methods for an inventory of soil resource of information, its subsequent applied analysis, and database creation of soil inventory data.

– In this regard, there is the question of methodological support of the creation of base soil inventory data.

– The purpose of the research was to develop and test the methodology of creating a database of soil inventory data for the development of land information systems using modern information and GIS technology.

– To achieve this goal it is necessary to solve the following tasks:

– To develop the principles and structure of base soil inventory data for the territory of the Soviet district of the Stavropol territory;

– Is to describe the state of the archival materials of soil surveys and to offer principles of translation of cartographic material in digital form for the compilation of base soil inventory data;

– To develop an interactive map and database of soil inventory data to create a land information system on the territory of the Soviet district of the Stavropol territory based on modern information and GIS technology;

– Create a 3D model of the territory of the district according to the materials of the digital elevation model SRTM DEM (LITVINOV, 2018).

2. METHODOLOGY

Recent decades have been marked by the rapid development of information technologies, which largely determine the progress of science and the development prospects of each of its areas. One of the points of growth in modern soil science is soil cartography, which is currently undergoing a transition to the so-called digital methods, that is, methods of compiling soil maps based on computer analysis of spatial data. Rethinking and improving on their basis the basic approaches to traditional cartography of soils contain great innovative potential. Opportunities are opening up for solutions at a new level of scientific and practical problems - an inventory of soil and land resources, soil and environmental monitoring, modeling and prediction of soil processes, which is necessary to optimize nature management, reproduce fertility and prevent soil degradation (KOMOV & CHESHEV, 2016).

In the transition to digital soil cartography, cooperation and the exchange of information between soil scientists-cartographers with extensive experience in traditional soil research and specialists who own modern technologies is of great importance (ALEX & MCBRATNEY, 2003).

At present, the issue of rational use of the country's soil resources and at the same time increasing the intensity of agricultural production is extremely urgent. These tasks should be solved by the implementation of balanced management decisions and the use of modern agricultural and information technologies. The latter is essential for the characterization and accounting of soil resources, as well as the creation of a soil-geographical base of soils (FEUERHERDT & ROBINSON, 2007).

Information technologies are already used in several regions of the Russian Federation for agroecological monitoring tasks, and the need has ripened for digitizing soil data. The data of soil surveys are mostly stored on paper or in scanned form, not intended for digital processing. Essays on soil surveys, becoming a kind of database of soils, contained a wide range of indicators that were not directly reflected on the map. It is impossible to structure large volumes of heterogeneous information without computer analysis (LYAMKIN, 2003). This implies the need for an inventory of soil-geographical data. Since a wide range of soil information is involved in the tasks of a comprehensive inventory of agricultural land, the digitization and vectorization of soil and geographic data, as well as the structuring of agrochemical data, presented in digital but disordered form, are necessary (ERMOLAEV, 2017).

The use of GIS technologies to solve the problems of systematization and data processing makes it possible to efficiently and efficiently use, organize organized information flows. They combine the achievements of machine graphics and databases, providing the assessment and visualization of spatially distributed data. Research in this direction has been successfully carried out in many regions (PAVLOVA, 2016).

At the initial stage of development of the soil geographic information system, much work needs to be done to create a database in which cartographic, analytical, textual information about the object of study is integrated. The main purpose of the database as the main link of the GIS is to serve the information needs of the user and is also designed to ensure the integrity of soil data and serve as a single information platform of the district (VOLKOV, KOMOV & KHLYSTUN, 2015).

The source material for the vectorization of the soil cover is the soil map of the Soviet district of the Stavropol Territory, scale 1: 100 000 (SAPOZHNIKOV & STOLBOVOY, 2012). Effective use of archival materials is possible only in the case of structuring the semantic component of maps and creating digital cartographic materials on their basis. The first and crucial stage of vectorization is an inventory of available soil information. Paper-based soil surveys are scanned and stored as images. Thanks to modern computer technologies, the received files are processed by a graphic editor to combine the scanned map sheets into a single image.

Figure 1: Soil map of the Sovetsky district of the Stavropol Territory on paper

Soil maps, in addition to information about the soil cover, contain additional information about the soil survey (date of the survey, the scale of the survey), data on the topographic survey of the farm, data on related farms, etc. (KOSHELEV, 2018).

After compiling the classifier in Mapinfo Professional GIS, vectorization is performed, which is the selection of spatial data by creating a vector layer from polygons (soil contours and land plots of farms) and points (soil sections) on the layers of raster images of the soil map and satellite image. Mapinfo Professional has a function for controlling the transparency of raster image layers, which makes it possible to correct the vectorization of the soil map based on the actual satellite image data (Figure 2).

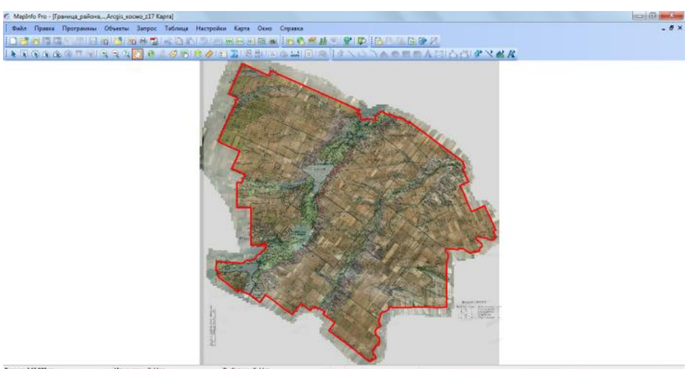

Figure 2: A raster soil map superimposed on a space image and a transparency function

At the final stage of vectorization, data is imported and soil map visualized. One of the main advantages of vector soil maps is the possibility of representing them in the form of thematic layers with attribute data entered according to the compiled classifier. In a GIS environment, a digital vector soil map is rendered according to any of the attributes introduced or their combination using different color schemes. When specifying a geographical object on an interactive map, you can get additional information about it, build spatial queries and analyze.

At the final stage, an interactive map is formed, the database of soil and cadastral data is filled in, and a 3D model is created on the territory of the Soviet district of the Stavropol Territory using modern information and geo-information technologies.

3. RESULTS AND DISCUSSIONS

Based on interactive soil maps and soil database-soil data is the cadastral map of the Soviet district of Stavropol Krai of 1:100,000 scale and includes:

the structure of the base soil and cadastral data collection rules and content database, etc.;

− The attribute part, which consists of the elements of the map legend, morphological and analytical indicators of soil.

The cadastral part of the base soil inventory data is populated by obtaining information from the public cadastral map on the website of the state registry and request information in the Federal state information system unified state register of real estate.

The conceptual database organized according to the principles of geographic information systems (GIS). By these principles, any identified in nature, the soil is a specific geographic space that is represented in the form of its gridding. The soil has two types of features: semantic and geometric. The semantic description includes the identification number of the soil contour (ID), the name of soil (soil contour), mechanical composition, and underlying parent rock; occurrence on topography, area, soil contour. A geometric characterization, in General, includes a variety of spatial forms, such as polygons, lines, and points. The soil-geographic database of the semantic part is related to the geometric part, i.e. with the contours of the soil maps and presented in the form of an interactive map.

The results of the research developed a database of soil inventory data, which includes an interactive map and combines the digitized soil contours and parcel boundaries from the database of the state cadastre of real estate on the territory of the Soviet district of the Stavropol territory. The interactive map includes the following layers:

- Space image;
- Border of the district;
- Soil contours (based on the results of vectorization of the soil map of the district, scale 1: 100 000);
- Boundaries of land plots and cadastral quarters (based on materials from the state real estate cadastre) (Figure 2).

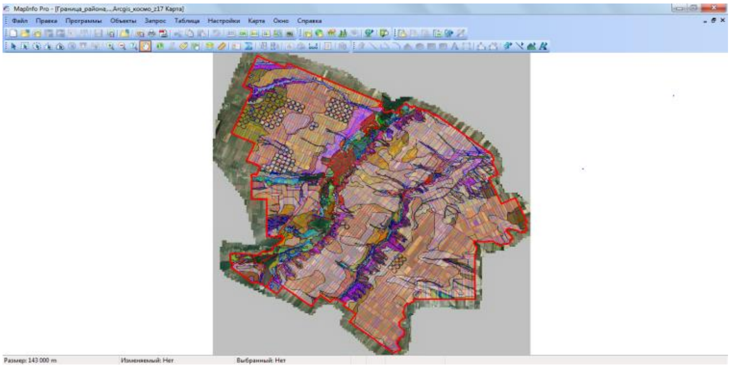

Figure 3: Interactive map of the soil and cadastral database

The geographic information system Mapinfo, taking into account the real size of the object, allows you to create a realistic 3D model of the territory of the Sovetsky district, using a layered representation of a satellite image and digitized soil map (Figure 3). To build a three-dimensional model of the territory of the Sovetsky district of the Stavropol Territory, a digital DEM SRTM terrain model (with a relief cross-section of 5 meters), topographic maps, and GPS / GLONASS geodetic equipment are used. The presentation of the model allows you to clearly and thoroughly present the project, as well as assess the situation of the terrain and the condition of land resources.

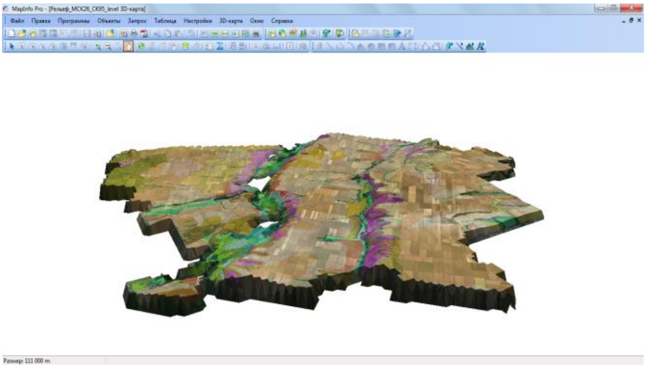

Figure 4: 3D-model of the territory of the Sovetsky district with a layered display of a space image and digitized soil map

Using the capabilities of the Mapinfo Professional geographic information system, satellite imagery, and soil map, relevant information was obtained on the soil area of the Soviet district of the Stavropol Territory (Table 1).

Table 1: Soils of the Soviet district of the Stavropol Territory

Name of soil	**Area, ha**
Southern black earth	7212
Liver-coloured	160699
Chestnut	6844
Chestnut-meadow	1752
Meadow chestnut	7753
Meadow	2667
Alluvial meadow	11973
Meadow black earth	58

Meadow bogs	181
Salt marshes	112
Gullies, beams	105
Total	**199356**

–The developed database of soil and cadastral data allows us to solve several important tasks:

– Receive timely and reliable information about the state of the soil cover of the district;

–Perform calculations, receiving data on the area of soils of any type;

–Both the original cartographic information and the electronic ones obtained as a result of data analysis, the layers can be arranged in the form of electronic or paper maps and issued to users;

–Display information about the land resources of the area on a 3D-model of the territory;

–Receive data on the qualitative condition of the soil cover, which is necessary for maintaining the land cadastre, when assessing the value of the land.

4. CONCLUSION

Developed a database of soil inventory data is one of the components of the developed land information system, which includes a comprehensive description of the state and use of land resources in the area. As a result of the development of the base soil and cadastral data of the Soviet district of the Stavropol territory:

− Developed the design principles and the structure of the base soil inventory data;

− The analysis of the condition of the archival materials of soil surveys and the proposed principles of transfer of the cartographic material in digital form;

− Developed an interactive map and database of soil and cadastral data as a component for a land information system based on modern information and GIS technology;

− Created the 3D model of the territory of the district according to the materials of the digital elevation model SRTM DEM with an interval of 5 meters.

Relevant information obtained as a result of the development of the base soil inventory data taking into account qualitative and quantitative characteristics of the land Fund is particularly important for local authorities as it determines the amount of the cadastral value of land, that is, the tax base and revenues to the budget from land tax are the basis of socio-economic development of the territory.

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