METHODOLOGY FOR CREATING A REGIONAL GIS INVENTORY OF AGRICULTURAL LAND

МЕТОДОЛОГИЯ СОЗДАНИЯ РЕГИОНАЛЬНОЙ ГИС-ИНВЕНТАРИЗАЦИИ ЗЕМЕЛЬ СЕЛЬСКОГО ХОЗЯЙСТВА

УДК 332.54:528
DOI:10.24411/2588-0209-2021-10311

Ruslana V. Zdanova, candidate of economic Sciences, associate Professor, associate Professor of the Department of land use and cadastres, State University of land management (105064, Russia, Moscow, Kazakova str., 15), ORCID: http://orcid.org/0000-0002-9069-1559, zhdanova1604@yandex.ru
Marina A. Smirnova, Candidate of Economic Sciences, Associate Professor, Dean of the Faculty of Real Estate Cadastre, State University of Land Management (105064, Russia, Moscow, Kazakova str., 15), ORCID: http://orcid.org/0000-0002-0416-4008 smmarina@rambler.ru
Natalia P. Ruleva, Candidate of Economic Sciences, Associate Professor, Associate Professor of the Department of Land Use and Cadastre, State University of Land Management (105064, Russia, Moscow, Kazakova str., 15), na.ruleva@mail.ru

Жданова Руслана Валерьевна, кандидат экономических наук, доцент, доцент кафедры землепользования и кадастров Государственного университета землеустройства (105064, Россия, г. Москва, ул. Казакова, 15), ORCID: http: // orcid .org / 0000-0002-9069-1559, zhdanova1604@yandex.ru
Смирнова Марина Александровна, канд. Экон. Наук, доцент, декан факультета кадастра недвижимости Государственного университета землеустройства (105064, Россия, г. Москва, ул. Казакова, 15), ORCID: http://orcid.org / 0000-0002-0416-4008 smmarina@rambler.ru
Наталья Петровна Рулева, канд. Экон. Наук, доцент, доцент кафедры землепользования и кадастра Государственного университета землеустройства (105064, Россия, г. Москва, ул. Казакова, 15), na.ruleva@mail.ru

Report

In the article, the authors consider the method of creating a regional GIS for the inventory of agricultural land, the use of GIS technologies in its implementation,

ways of presenting graphical data in geoinformation systems, show examples of using raster maps in GIS, consider a combined approach to the construction of maps, analyze the basics of creating GIS for the inventory of agricultural land, which is based on modern concepts of the methodology of system analysis, the latest achievements in the field of geoinformation technologies, as well as the creation and use of means and methods of remote sensing, computer technology and high-precision navigation and time support.

Реферат

В статье авторы рассматривают методику создания региональной ГИС для инвентаризации сельскохозяйственных земель, использование ГИС-технологий в ее реализации, способы представления графических данных в геоинформационных системах, показывают примеры использования растровых карт в ГИС, рассматривают комбинированный подход к построению карт, анализ основ создания ГИС для инвентаризации земель сельскохозяйственного назначения, в основе которого лежат современные концепции методологии системного анализа, новейшие достижения в области геоинформационных технологий, а также создание и использование средств и методов дистанционного зондирования, компьютерной техники и высокоточной навигации и поддержки времени.

Keywords: digital maps, experience, GIS technologies, agricultural land, factors of agricultural land use, satellite remote sensing, standard electronic maps.

Ключевые слова: цифровые карты, опыт, ГИС-технологии, сельскохозяйственные угодья, факторы использования сельскохозяйственных земель, спутниковое дистанционное зондирование, стандартные электронные карты.

Purpose of (the) study: to analyze the methods of creating a regional geoinformation system for the inventory of agricultural land.

Object of study: geoinformation systems.

Objectives of (the) study:

- consider the methodology for creating a regional geoinformation system for the purpose of conducting an inventory of agricultural land;
- to identify the features of the agricultural land use management system
- to formulate the tasks of geoinformation systems;
- consider ways to represent graphical data in geographic information systems;
- identify sources of information for the purposes of agricultural land inventory;
- to determine the role of geoinformation systems in the management system of agricultural land use.

Results of (the) study:

- the method of creating a regional geoinformation system for the inventory of agricultural land is considered;
- the main tasks of geoinformation systems are formulated;
- methods of representation of graphic data in geoinformation systems are considered;
- identified sources of information necessary for the inventory of agricultural land;
- examples of the use of geoinformation systems are considered;
- the role of geoinformation systems in the management system of agricultural land use is determined.

Introduction

Land inventory is provided by carrying out a set of measures: preparatory work for the collection and analysis of existing title documents, aerial photography, topographic and geodetic, cartographic work, other necessary surveys and surveys, coordination of land boundaries, the formation of reporting land management documentation.

Providing the land inventory system with objective, timely, systematic information of state authorities, local governments, and other management structures will be the scientific and practical basis for creating effective management accounting, which is the basis for creating a scientifically based land management system.

Today, the use of satellite remote sensing data is to obtain objective and timely information about the state of land resources in large areas. This resulted in the development of research, methods and systems for the inventory of agricultural land based on the use of satellite data.

The geoinformation system solves the problems of agricultural land, its basis is digital maps with databases linked to them.

GIS consists of two large blocks: electronic maps with databases and tools for ensuring the functioning of GIS.

The best option for the basic GIS shell for solving tasks on the inventory of agricultural land is the MapInfo program, which is most compatible with other GIS applications and provides normal working conditions in raster and vector coordinate systems.

The GIS of the land inventory should be purposefully selected, processed and systematized for the corresponding territorial entities of the federal, regional (zonal-provincial) and local levels.

Agricultural land use is characterized by such factors as high natural and economic diversity and this requires well-organized, competent and prompt processing of large amounts of information.

The initial data on the state of the object, resources, including design standards should be clearly structured and presented in the form of a standard package of framework thematic databases, as well as standard electronic maps that are used for conducting an inventory of agricultural land.

Many scientists note that an important role in the GIS inventory of agricultural land is played by the creation of databases of scientific and industrial field experiments conducted in the territories of the regions in research, experimental, educational institutions, including the traditional network of agrochemical stations.

The use of GIS technologies for the inventory of agricultural land is also associated with the digitization of cartographic material.

In geoinformation systems, both vector and raster methods of representing graphical data are widely used. The ways to provide graphical data are shown in table 1.

Table 1 - Ways to provide graphical data

Geoinformation systems	Characteristics

Raster GIS	they are based on the coordinate system of the same name-a solid grid (gird) placed on the map with a standard sampling step, each cell (pixel) of which has two unique (in this combination, unique only to it) coordinates (x and y).
Vector GIS	based on a point-based (rather than grid-based) representation of information

As an example of using raster maps in GIS, one of the versions of the Tsunami Modeling System developed in the Laboratory of Tsunami Wave Modeling of the SB RAS Computing Center can be cited.

Table 2 below demonstrates the use of geographic information systems.

Table 2-Use of geoinformation systems

Geoinformation systems	Application	Opportunities
Raster GIS	suitable for geoinformation support of inventory of agricultural land at the level from the region to the farm	they allow you to easily visualize tabular information from related databases on maps, perform logical (if..., then...) and algebraic operations (addition, subtraction, etc.) of various thematic map layers (for example, soils and slope steepness), often having different spatial organization (mismatch of the boundaries of the original cartographic selections), with the formation of new thematic layers.
Vector GIS	it can be used in vector packages of geoinformation support for the inventory of agricultural land - to clarify the real areas of distribution of agroecological groups of land, fields	areal and linear measurements of land groups, fields (working areas and crop rotations), planned amounts of fertilizers, ameliorants and plant protection products, gross harvest, total and differentiated costs for its production, rational placement of forest belts, field road network and production infrastructure facilities are determined with great accuracy

When building maps, some GIS use a combined approach. To pre-select an area, you can use the overview raster map of the region. Further, subsequent maps of the selected areas are constructed using the vector principle.

Local GIS is used for small amounts of data and a small number of users. The choice is determined by the complexity of the queries and the size of the databases (< 1GB).

As a rule, personal GIS is not used for building corporate information systems. However, if, for one reason or another, you need to use a desktop GIS as a system building tool, we recommend using ArcView (ESRI), since the ESRI product line provides the opportunity to further expand the system.

The creation of GIS inventory of agricultural land is based on modern concepts of the methodology of system analysis, the latest achievements in the field of geoinformation technologies, the creation and use of remote sensing tools and methods, as well as computer technology and high-precision navigation and time support. The image of the GIS inventory of agricultural lands formed in the framework of these studies. It is a powerful and spatially distributed multi-level system that corresponds to the accepted administrative-territorial division and the structure of the existing services (management bodies) of consumers of inventory information. At the same time, the system should implement the inventory for the following levels: federal; regional (republic, region); local (administrative district, city); object (economy, land use, landfill). Accordingly (at least for the top three levels), the distribution and use of technical resources, the creation of organizational structures and GIS services were assumed.

At present, it is becoming obvious that the development of proposals for the creation of GIS in such a branched form, especially for the regional and local levels, does not sufficiently take into account the economic aspects of the formation of systems of this scale and complexity.

In the conditions of existing restrictions, the implementation of work on the creation of the system and, above all, the financing of the necessary scientific and methodological developments, the purchase of the required equipment, the deployment of sufficient organizational structures, the training and involvement of qualified personnel, is associated with serious difficulties.

A simple calculation shows that to maintain the GIS inventory of agricultural land in this case, within one area, up to several hundred specialists are required who have the skills to operate a complex of heterogeneous and complex technical means. In this regard, there is a need for a certain correction of the general ideology of creating a GIS inventory of agricultural land, taking into account the realities of today, the forecast and prospects for the development of the country in the coming years. At the same time, it is necessary to distinguish two main directions for improving the views on the system development process.

First of all, the concept of creating a GIS in the region, along with rational organizational and technical principles of construction, should be based on the introduction of a system of legal and economic mechanisms that support and stimulate production and scientific and methodological activities for the inventory of agricultural land, i.e., the development and functioning of the system. The formation of real levers to ensure the inventory of agricultural land at the regional and local levels of management is the primary and mandatory condition for the creation of GIS in the conditions of limited development of the region and the country as a whole. At the same time, the system should be built on an "evolutionary" basis, in which a strong and stable "core" of GIS is created in the region in terms of methodology, technology, and personnel, and it is possible to expand and branch it as the economic potential of consumers at all levels increases.

Accordingly, at the regional and local levels, there are divisions (services) of the Federal Land Cadastre and various departments (the Ministry of Emergency Situations, Roskomgidromet, the Ministry of Agriculture, etc.), which, on the one hand, are interested in information on the inventory of agricultural land, on the other - are themselves responsible for the implementation of certain components of the global inventory of agricultural land.

An example of using such a GIS is OAO LUKOIL, one of the largest international vertically integrated oil and gas companies. Its interests cover vast territories extending beyond the borders of the Russian Federation. The company conducts exploration, production, processing and marketing of oil in many countries of the world. The complex structure of the Company requires a clear organization of information flows, providing its various departments with uniform, high-quality information in real time. Since most of this information has a spatial component, the

Company almost from the beginning of its existence turned to geoinformation systems as one of the central technologies for collecting, storing, processing and presenting information necessary for production and management needs.

Naturally, 10 years ago, neither software nor technical means allowed us to conceive of corporate use of information resources. Most of the departments in the field and in the center independently selected software tools, acquired and created digital data, and implemented local GIS. Geologists and surveyors with professional experience in working with cartographic information were particularly active in using these technologies. These divisions were the first to create the most developed systems and developments using local GIS.

When taking inventory of agricultural land on a regional scale, there is a need to provide access to common spatial and semantic data of different enterprises and services. The problem is complicated by the fact that changes made to the general data by one of the organizations should be made available to all other interested organizations.

When designing the structure of a distributed database, it is necessary to comply with certain requirements shown in Figure 1.

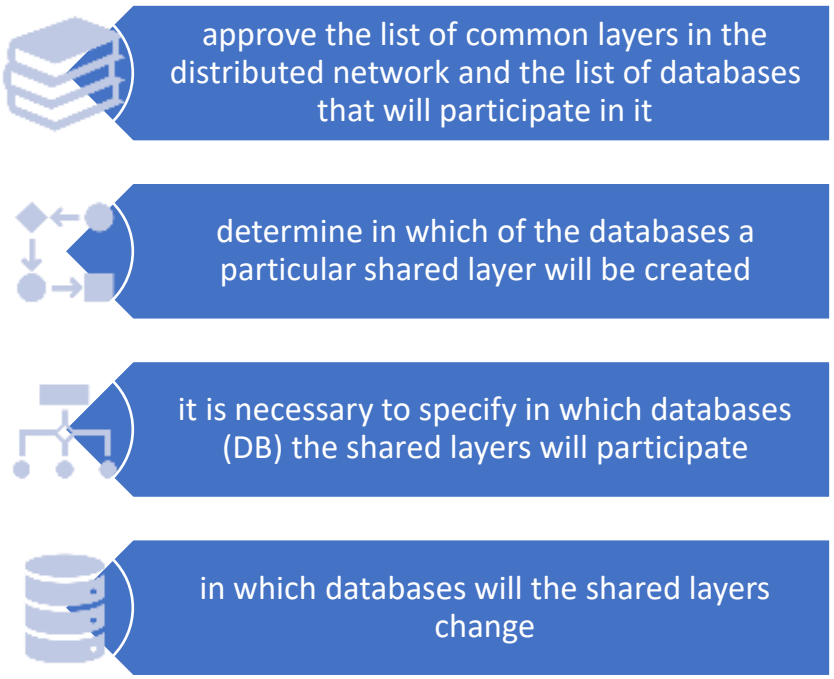

Fig 1. Conditions required when designing a distributed database structure

The peculiarity of the organization of interaction of services and information systems of various departments is that it is implemented within the framework of a single integrated information system to support the management of the region on the basis of a regional computer network. At the initial level, the interdepartmental exchange of information can be implemented through the district node of the information system for supporting the management of the region. Also of great importance is the use of the existing infrastructure of means and systems of information support of departmental affiliation.

As an example, we can cite the experience in which the technology of transmitting data on the volume of land monitoring data was tested in the Voronezh region, where the use of the distributed information system GAS "Elections"was very successful. Similar experience is available in the implementation of conversion programs, in which organizations and enterprises of the Ministry of Defense of the Russian Federation and defense industries provided land monitoring work to

existing scientific and technical tasks, as well as flight - lifting means of delivery and placement of remote sensing equipment.

Data replication. To keep the data up-to-date throughout the GIS server system, a data replication module can be developed that exchanges changes between GIS servers. Each server is constantly running a replication service that automatically exchanges change packets with the services of other servers using TCP/IP communication channels.

The period of updates throughout the system is determined by the requirements for data up-to-date and is regulated taking into account the capabilities of data transmission networks. In case of instability or lack of communication lines between the servers, manual replication is possible, which involves the transfer of individual files on physical media. The replication module monitors the correctness and order of transmission of changes in all modes and supports continuous updating of information throughout the server system. When developers deliver a new version of the program or a decision is made to change any settings that are common to all users, the chief administrator creates an update package and places it on the central update server. After a while, it is passed to all update servers. At each client location, the program is configured to update from its server. Before each launch, it checks for new versions and installs them, if necessary, without even requiring the user's participation.

The expediency of using high spatial resolution information for land inventory purposes is also due to the fact that in recent years, companies conducting satellite surveys have accumulated a large amount of archival data for all regions of Russia.

Maintaining high relevance (the age of archived data does not exceed 3 years) satellite images of this type have a cost that is two or more times lower than new images. At the same time, almost complete coverage of many territories with such images allows you to get data on the state of agricultural land extremely quickly.

It is expected that high-resolution satellites will partially occupy the market for aerial photography.

Currently, there is a great interest in the topic "GIS and the Internet"in Russia. We can say that the emergence of this direction is due to two reasons.

First, the creation of geographic information systems for the Internet follows the general logic of software development: the development of software from individual workstations to local networks, then to the Internet, from the unique interface of each program to the interface of browsers.

Secondly, geographical data is one of the types of reference resources, and the Internet is the most natural medium for delivering reference information at the present time.

So there are already a number of map sites that allow their users not only to search for objects, but also to see the search results on the map.

Advantages of web-GIS

- упрощ simplify the use of basic GIS functions by every person on Earth;
- now everyone can use GIS without leaving the computer;
- now everyone can use maps of all countries and cities and images.

Now everyone can use any information from the comfort of their home for free or by paying the minimum available cost.

Network technologies and the Internet provide a great advantage in the inventory of agricultural land. Since here it is necessary to create large-scale agricultural maps, which, by means of data exchange, are created from already available plans and maps of agricultural land of individual districts and farms, which in turn have the ability to update each of their information over the network.

Использованная литература

1. Болсуновский М.А. Спутники дистанционного зондирования высокого разрешения ORBVIEW.- Геопрофи, 2005, №2, с. 10-12.

2. Варламов, А.А. Теория и методы землеустройства в условиях различных форм собственности на землю / Монография / Под ред. А.А. Варламова // Итоги научно-исследовательской работы Государственного университета по землеустройству в 2001-2005-М .: ГУЗ, 2006. - с. 103-120.

3. Варламов А.А. Землеустройство / А. Варламов А.А., Гальченко С.А., Шаповалов Д.А., Смирнова М.А., Комаров С.И.-М .: ГУЗ, 2008.

4. Варламов А. А., Гальченко С. А. Развитие системы землепользования в современной России // Международный сельскохозяйственный журнал. 2018. № 6. С. 8-9.

5. Гальченко С.А., Руководящий Н.П. Кадастровая деятельность с целью формирования эффективного землепользования [Текст]: сборник научных трудов «Современные проблемы эффективного землепользования» / С.А. Гальченко, Н.П. Рулева / Москва, 2016. С. 17-30. .

6. Галковский Э. А. Географическая информационная система как новая национальная онлайн-система России. - Геодезист № 4, 2001, с. 14-18.

7. Зелепугин А.Д. Научные основы управления землепользованием / А.Д. Зелепугин, Г.М. Русинова, С.В. Ломакин, П.С. Русинов, Р.В. Жданова, С.А. Рыбакова. Воронеж: Изд-во В. П. Антонова, 2011. - 264 с.

8. Штангенциркуль Ю. G. Комплексное картирование природных ресурсов с использованием спутниковых снимков / Географическое картирование: взгляд в будущее. - М .: ИЗДАТЕЛЬСТВО МГУ, 1986. - 130 с.

9. Мешалкина Л. Ю. Геостатистика как инструмент изучения пространственных вариаций свойств почв / Масштабные эффекты при изучении почв. - М .: ИЗДАТЕЛЬСТВО МГУ, 2001, с. 153-162.

10. Рулева Н. П., Смирнова М. А. Некоторые вопросы ограничения прав на земли сельскохозяйственного назначения при резервировании земель [Электронный ресурс] / Международный сельскохозяйственный журнал № 1, 2016-Москва.

Ispol'zovannaya literatura

1. Bolsunovskii M.A. Sputniki distantsionnogo zondirovaniya vysokogo razresheniya ORBVIEW.- Geoprofi, 2005, №2, s. 10-12.

2. Varlamov, A.A. Teoriya i metody zemleustroistva v usloviyakh razlichnykh form sobstvennosti na zemlyu / Monografiya / Pod red. A.A. Varlamova // Itogi nauchno-issledovatel'skoi raboty Gosudarstvennogo universiteta po zemleustroistvu v 2001-2005-M .: GUZ, 2006. - s. 103-120.

3. Varlamov A.A. Zemleustroistvo / A. Varlamov A.A., Gal'chenko S.A., Shapovalov D.A., Smirnova M.A., Komarov S.I.-M .: GUZ, 2008.

4. Varlamov A. A., Gal'chenko S. A. Razvitie sistemy zemlepol'zovaniya v sovremennoi Rossii // Mezhdunarodnyi sel'skokhozyaistvennyi zhurnal. 2018. № 6. S. 8-9.

5. Gal'chenko S.A., Rukovodyashchii N.P. Kadastrovaya deyatel'nost' s tsel'yu formirovaniya ehffektivnogo zemlepol'zovaniya [Tekst]: sbornik nauchnykh trudov «Sovremennye problemy ehffektivnogo zemlepol'zovaniYA» / S.A. Gal'chenko, N.P. Ruleva / Moskva, 2016. S. 17-30. .

6. Galkovskii EH. A. Geograficheskaya informatsionnaya sistema kak novaya natsional'naya onlain-sistema Rossii. - Geodezist № 4, 2001, s. 14-18.

7. Zelepugin A.D. Nauchnye osnovy upravleniya zemlepol'zovaniem / A.D. Zelepugin, G.M. Rusinova, S.V. Lomakin, P.S. Rusinov, R.V. Zhdanova, S.A. Rybakova. Voronezh: Izd-vo V. P. Antonova, 2011. - 264 s.

8. Shtangentsirkul' YU. G. Kompleksnoe kartirovanie prirodnykh resursov s ispol'zovaniem sputnikovykh snimkov / Geograficheskoe kartirovanie: vzglyad v budushchee. - M .: IZDATEL'STVO MGU, 1986. - 130 s.

9. Meshalkina L. YU. Geostatistika kak instrument izucheniya prostranstvennykh variatsii svoistv pochv / Masshtabnye ehffekty pri izuchenii pochv. - M .: IZDATEL'STVO MGU, 2001, s. 153-162.

10. Ruleva N. P., Smirnova M. A. Nekotorye voprosy ogranicheniya prav na zemli sel'skokhozyaistvennogo naznacheniya pri rezervirovanii zemel' [Ehlektronnyi resurs] / Mezhdunarodnyi sel'skokhozyaistvennyi zhurnal № 1, 2016-Moskva.