UDC 911.3: 330.15

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GEOGRAPHIC INFORMATION SYSTEM OF EVALUATION AND MANAGEMENT OF REGIONAL NATURAL-RESOURCES POTENTIAL

Ukraine's transition to sustainable development requires a review of the conceptual foundations of methods of analysis of environmental and natural resource information and guidelines for the preparation of administrative decisions in the relevant field on the basis of using the potential of geographic information systems and technologies, which are able to carry out the synthesis and summarize of information on the natural-resources environment to solve governance problems of nature management.

The article is devoted to developing Geographic information system for evaluation and managing of the natural-resources potential of the region, the justification of the goals, objectives and functions of its creation and development of the structure of hardware, software, information and analytical systems. Methodical development of creation and functioning of regional geographic information systems is one of the most important tasks in ensuring the operative reception of data and use them to build a possible regional development models.

Key words**:** natural-resources potential; information technologies, automated information-analytical system, geographic information system of evaluation and management of regional natural-resources potential, socio-economic development, regional management.

Вікторія Яворська, Дар'я Світлична. ГЕОІНФОРМАЦІЙНА СИСТЕМА ОЦІНКИ І УПРАВЛІННЯ ПРИРОДНО-РЕСУРСНИМ ПОТЕНЦІАЛОМ РЕГІОНУ

Стаття присвячена розробці геоінформаційної системи оцінки та управління природно-ресурсним потенціалом регіону, обґрунтуванню цілей, завдань і функцій її створення, а також розробці структури апаратного, програмного, інформаційного та аналітичного комплексів. В умовах загальної інформатизації та в контексті переходу України до сталого розвитку застосування традиційних методів та інструментів в соціально-економічному розвитку та регіональному управлінні повинно ґрунтуватися на використанні потенціалу нових інформаційних систем і технологій.

Ключові слова**:** природно-ресурсний потенціал, інформаційні технології, автоматизована інформаційно-аналітична система, геоінформаційна система оцінки та управління природно-ресурсним потенціалом регіону, соціально-економічний розвиток, регіональний менеджмент.

Виктория Яворская, Дарья Светличная. ГЕОИНФОРМАЦИОННАЯ СИСТЕМА ОЦЕНКИ И УПРАВЛЕНИЯ ПРИРОДНО-РЕСУРСНЫМ ПОТЕНЦИАЛОМ РЕГИОНА

Статья посвящена разработке геоинформационной системы оценки и управления природно-ресурсным потенциалом региона, обоснованию целей, задач и функций её создания, а также разработке структуры аппаратного, программного, информационного и аналитического комплексов. В условиях всеобщей информатизации и в контексте перехода Украины к устойчивому развитию применение традиционных методов и инструментов в региональном менеджменте должно основываться на использовании потенциала новых информационных систем и технологий.

Ключевые слова: природно-ресурсный потенциал, информационные технологии, автоматизированная информационно-аналитическая система, геоинформационная система оценки и управления природно-ресурсным потенциалом региона, социально-экономическое развитие, региональный менеджмент.

Introduction. The modern development of the country and regions is characterized by increasing of anthropogenic pressure on the environment, depletion of many types of natural resources, increasing the volume of hazardous waste, which causes necessity of creation science-based system of rational development of natural-resources potential of the territory. As an indicator that reflects the totality of natural resources, natural-resources potential is a background, factor of development and operation of the socio-territorial complexes, the foundation of rational territorial organization of natural resources, the productive forces as a whole [5].

Currently, the society faces the real issue of organizing the use of natural-resources potential of the territory in such a way that to stop its degradation and to be able to achieve a significant improvement of its ecological state. It requires processing and analysis of huge amounts of statistic, departmental, cartographic information about the qualitative and quantitative, natural and cost resource's parameters. For a full analysis of this information modern computer tools, technologies and tools are required. Considering the high specific gravity of spatially distributed data in the information support of the socio-economic development of regions, the most appropriate tools for automated operation with such information provides geographic information systems, that are an integration environment that allows to combine and organize flows of a wide range of information about the natural-socio-economic system of the region. Therefore, it seems appropriate to consider the automated information-analytical system of the natural-resources potential of the region as a specialized geographic information system - GIS of natural resources potential of the region, in abbreviated form GIS of NRP of the region.

 DOI: 10.26565/2076-1333-2016-20-11

Analysis of previous researchers and publications. In the economic and social geography to the investigation of certain aspects of natural-resources potential devoted fundamental researches of M.T. Agafonov, V.A. Anuchin, M.V. Bagrov, P.Y. Baklanov, G.A. Bachinsky, A.P. Golikov, I.A. Gorlenko, B.M. Danylyshyn, Y.D. Dmitrevsky, F.D. Zastavny, R.A. Ivanuha, M.G. Ignatenko, I.V. Komarov, S.B. Lavrov, C.A. Lisovsky, A.A. Mintz, Y.P. Mikhailov, A.A. Nedeshev, Y.B. Oliynyk, M.M. Palamarchuk, O.M. Palamarchuk, V.A. Popovkin, G.A. Privalov, V.P. Rudenko, L.G. Rudenko, I.L. Saveliev, A.G. Topchiev, A.I. Shabliy, M.D. Sharygin and others. However, methodological and technological aspects of the application of geographic information systems and technologies for the evaluation of the natural-resources potential of the region, as well as the principles and methods of management of the natural-resources potential of the region using geographic information systems and technologies not yet been sufficiently considered and developed.

The purpose of this article is to develop Geoinformation system of evaluation and management of natural-resources potential of the region, as well as foundation of the principles and methods of GIS of NRP application for solving problems for the management of natural-resources potential of the region.

The main material. Due to the fact that in modern conditions the basis for planning and management of natural-socio-economic system of the region is the automated information-analytical system (IAS), an important part of such information system should become IAS natural-resources potential.

The purpose of GIS of NRP of the region is to improve the quality, relevance and availability of data about the state of natural-resources potential of the region, as well as improving the efficiency and validity of managerial decision-making in the sphere of nature management by attracting the potential of modern information technologies.

Created GIS of NRP of the region should solve the following problems:

1) establishment and maintenance of banks of spatially coordinated information;
2) economic component-wise and integrated evaluation of natural-resources potential;
3) the creation of high-quality maps of the results of componentwise and comprehensive evaluation of natural-resources potential;
4) spatial-temporal analysis and modeling of application of natural-resources potential;
5) providing government at all levels, enterprises, organizations, businesses and individuals with reliable information about the state and dynamics of the natural-resources potential;
6) information and analytical support for the preparation of administrative decisions in the sphere of nature management;
7) predicting ecological-economic and socio-economic consequences of decisions about a particular method of using the natural-resources potential of territories;
8) planning of natural resources rational usage.

Functions implemented by GIS of NRP of the region:

- information-reference;
- automated mapping;
- spatio-temporal analysis and modeling;
- decision support in the planning, design and management;
- fiscal;
- predictive.

The definition of consumer of generated product has great importance because "functional, structural, technological and resource development of system should focus on the end-users - the persons and organizations involved in the elaboration, analysis and management decisions at the object level" [4].

As it follows from the foregoing, the designed GIS should solve functions of different hierarchical rank - from information-reference and to support management decisions. Accordingly, the circle of end-users will be quite wide, since it is known that the types of information systems and organizational levels of management are interrelated: the higher category of the information system corresponds to a lower level of management. For example, detailed information systems are not suitable for high-level executives and better suited to the operational level. Control Department Managers, who need to choose an alternative, want for information systems that are able to answer the questions "what if" and "what is the best." For top-level managers, who are required more general aggregated information for establishing the purposes and forming of political programs, as a rule, is enough the installation of information-reference system with good interface's capabilities [4].

Region's GIS of NRP should provide reliable information of all participants of regional territorial development management process. In this regard, users of GIS of NRP of the region (within the authorized access to the information) may be: public authorities and local self-government; various ministries and departments; investors; design, research and development, design and research organizations; organs of State Statistics; Service of conducting the state cadastres, registers; individuals and legal entities.

GIS of NRP of the region as any Geographic Information System should consist of hardware, software, information and analytical modules or systems [1; 2; 6; 7; 8; 9].

The basis of *hardware complex* should be a PC – level Pentium 4, which has operative memory 2 GB or more, processor with a clock speed of 1.6 GHz or more (preferably 2.8-3.6 GHz) and memory (the hard drive) 320 GB or more. Listed characteristics are dictated on the one hand - by the requirements of the software platform, which it is advisable to use the latest versions of the most common in Ukraine Microsoft Windows operating system, and on the other - by requests of the selected GIS software package.

Besides the personal computer, the hardware complex should include a tablet or drum scanner with a spatial resolution of at least 300 dpi and a printing device (a

color wide format printer (plotter)). However, given the high price of such devices may be used ink-jet or laser color printer A3 or A4 size.

The *software complex* of GIS of NRP forms a specialized software, including GIS-package (instrumental GIS), software to convert analog and raster geoimages (cartographic materials, aerial and satellite images) into digital vector form and software to work with graphic data files.

Specific requirements are imposed on the choice of GIS-package - set of computer programs that provide work with spatially coordinated information. Given the absence in Ukraine of the competitive domestic multipurpose GIS packages, the choice should be made from imported commercial GIS packages common in Ukraine. From widely used in Ukraine commercial GIS packages for our purposes can be used MapInfo Professional package, which is currently available from Pitney Bowes, the US, and GIS package ArcGIS Desktop of the world leader in GIS software development - ESRI, the United States too. These GIS packages are well-known in Ukraine, the cost of their basic modules is approximately the same. However, a comparative analysis of their functional and a analytical capabilities speaks in favor of the latter. The decisive arguments in favor of desktop instrumental ESRI GIS is the support of raster and vector spatial data models, their much more extensive analytical capabilities and the possibility of three-dimensional modeling, including the creation of a digital terrain model and its analysis, that are of great importance in the evaluation of some types of natural resources, including land and mineral.

Software for converting analog and a raster images into digital vector form (program-vectorizer), providing automation of the process of creating digital thematic layers of spatial data can be represented by a specialized software package Digitals ("GeoSystem" of State Research and Production Enterprise, Ukraine), Easy Trase (company Easy Trace Group, Russia) and others.

Software tools for working with graphics files of data (such as Adobe Photoshop, CorelDraw, PhotoPaint and many others) are necessary for handling scanner copies of paper cartographical materials and other geoimages (brightness correction, geometric correction, stitching and a cutting of tablets and other) during the creation of digital maps.

The *information complex* should be a set of databases that characterize the administrative, natural, economic, social and other characteristics of the region. The structure of the information complex should reflect the information model of the concept "natural-resources potential", meaning to have a block structure, where each unit will correspond to a certain type of natural resources - land, water, recreation, etc. Due to the fact that there is a certain set of data that give a general idea of the region and can be demanded in the reference mode or in the implementation of analytical algorithms in several blocks (for example, the administrative division, physiographic and an economic regionalization, relief), while structuring GIS data bank it is advisable to select a basic set of data, calling it a "Basic information module".

The structure of the information complex of GIS of NRP of the region is represented as a set of following blocks:

1) basic information module;
2) land resources;
3) mineral resources;
4) water resources;
5) forest resources;
6) faunal resources;
7) recreational resources;
8) biosphere resources.

Important component of the data bank is spatially distributed and coordinated in space (mapping) data – hydrographic network, soil, forests, etc. and their characteristics. In GIS such data is stored in the form of homogeneous layers of thematic information in a formalized form, using a particular model of spatial data. With regard to spatial data, the scale of the original cartographical materials and used spatial data model have important meaning, but for raster models - the degree of generalization of spatial information, determined by the size of the raster cells.

The base scale for the initial cartographic materials for the region it seems appropriate to take the scale of 1:100 000 (in one centimeter is one kilometer) - currently the largest of the open (freely usable) in Ukraine cartographic scales, but some data may be presented in other scales.

Spatial data should be able to be formalized using both raster and vector model. And it is known that in the environment of ESRI's GIS packages raster data can be presented in the form of "images" - graphic files in TIFF, GIF, BMP, JPG and others, as well as the actual "rasters" – digital matrix consisting of N rows and M columns of values of a variable. Vector data can be represented as non-topological structures - "shapefiles" and topological structures in the form of - "coatings". Each of these models and their variants has its advantages and disadvantages. The main advantages of vector model is a compact storage and high accuracy of mapping of the spatial position of objects, crisp display of point and linear objects and, therefore, high-quality mapping.

The advantages of raster model is the possibility of implementing analytical algorithms of any complexity using map algebra and continuous two- and three-dimensional display of surfaces.

The structure of spatial database for each resource module is determined by the statement of the problem and nature of the implemented system of information and analytical procedures and should be considered at the next stage of development of GIS of NRP of the region - the logical design stage [2; 9].

Non-spatial semantic and attribute data stored in the GIS in tabular form. Given the relatively small amount of these data, management of these data can be by means of GIS software package, otherwise, for this purpose commercial database management system should be involved (DBMS), such as Microsoft Access, Informix, Oracle, and others.

The *analytical module* is a set of implemented analytical algorithms or software GIS package or additionally attracted funds programming (Delphi, C ++, Visual Basic, etc.), that implements the functions of database queries, spatial or temporal analysis and assessment based on the information, contained in a database of in-

formation-analytical system data.

Fig. 1 shows a generalized scheme of the structure and functioning of the Geoinformation system of natural-resources potential of the region.

It is important to emphasize that the GIS of NRP of the region should be an open system, admitting modification and expansion of the structure, as well as functional and analytical capabilities. At the same time the principles of creating IAS NRP should be unified with the principles of the creation of an integrated multipurpose automated information-analytical system of the region, providing a solution to a wide range of problems of regional planning, design and management with the use of geo-information technologies, as well as the proposals for the creation of National Spatial Data Infrastructure [3].

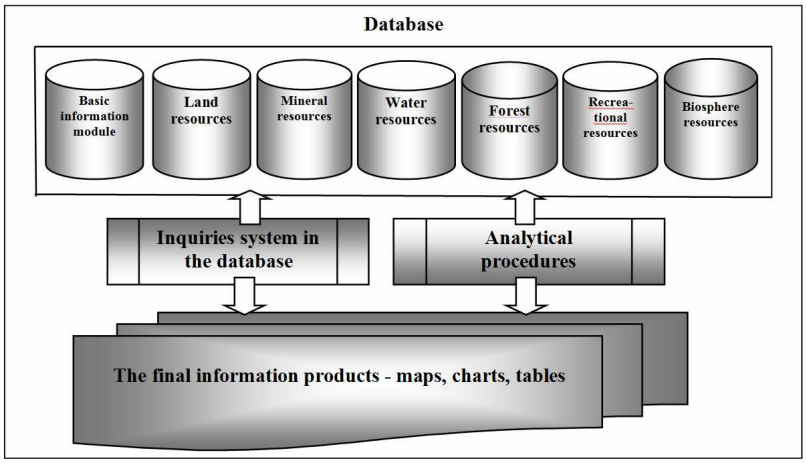

Fig. 1. Scheme of the structure and functioning of the Geographic information

The implementation of this concept considering [9] requires the following sequential steps:

1) collecting of input geospatial (maps, charts, satellite images) and attribute (statistics, reference, regulatory, etc.) data.;

2) creation of digital database in formats of selected GIS software;

3) development and implementation of information requests to the database;

4) implementation of analytical methods for obtaining final information products;

5) approbation of the system.

Conclusions. Given the diverse nature of the output information, the complexity and time consuming of evaluation algorithms, as well as a large proportion of the space-coordinated and diverse information that is needed for evaluation of natural-resources potential, modern geographic information systems with their advanced analytical capabilities are the tools that provides the necessary facilities for integration, spatial analysis and interpretation of different types of data.

Methodical development of creation and functioning of regional geographic information systems is one of the most important tasks in ensuring the operative reception of data and use them to build a possible regional development models.

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Надійшла до редколегії 08.04.2016 р.