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Geographic information systems usage for assess the state of water bodies

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ABSTRACT. In modern conditions, a constant improvement in the quality of management using new information technologies is required. To monitor water bodies, it is necessary to more widely use geographic information systems with analysis and forecasting capabilities. The main problems in this area are the integration of heterogeneous information about spatially extended water bodies, taking into account the dynamics of changes in time and space, forecasting and presenting the results in a convenient and accessible form for decision-making. To solve these problems, it is proposed to use a systematic approach in the construction of geographic information systems.

Keywords: Geographic Information Systems (GIS), water bodies, monitoring, forecasting

The state of the environment, the biosphere is constantly changing. These changes are different in nature, direction, magnitude, unevenly distributed in space and time. Natural, natural changes in the state of the biosphere have a very important feature; as a rule, they occur around a certain average, relatively constant level. Anthropogenic changes in the natural environment have a completely different feature, which can lead to a sharp, rapid change in the natural environment in a given region. Such changes can be divided into intentional (positive) and unintentional (negative). Intentional positive anthropogenic changes in the state of the natural environment include changes aimed at meeting the needs of human society. The unintentional negative anthropogenic changes in the state of the natural environment include the degradation of large tracts of land, the death or significant transformation of the ecosystems of many lakes, the pollution of the World Ocean with oil products, etc.

Monitoring includes the following main areas of activity: allocation (definition) of the object of observation; examination of the selected object of observation; drawing up an information model for the object of observation; measurement planning; assessment of the state of the object of observation and identification of its information model; forecasting the measurement of the state of the object of observation; presentation of information in an easy-to-use form and bringing it to the consumer (Nikitenkov and Lagutina, 2004).

The peculiarity of water bodies is the spatial extent and distribution throughout the country (Nikitin et al., 2006).

Inland water bodies are insufficiently studied in comparison with the seas and oceans. You need a full-fledged database that is kept up to date, including the following parameters: areal; hydrological; hydrochemical; hydrobiological (Dontsov and Sutorikhin, 2018).

Types of information in the form of presentation: cartographic; attributive; text; graphic.

Today there are several disparate geoinformation systems for monitoring water bodies and water protection zones of rivers and reservoirs. One of such GIS is a modular automated GIS for monitoring inland water bodies of Siberia (Dontsov and Sutorikhin, 2018). For its construction, data from the satellite systems Sentinel-1, Sentinel-2, Landsat-8, as well as data from terrestrial services and field tests are used. The data of satellite systems are in open archives, access to them is free. There are other space tracking systems, including Russian ones, but the data is provided on a commercial basis.

There is a general concept for building a corporate information system of Rosvodresursy. These information systems are not public, access to them is limited.

An automated decision support system for natural resource management and environmental protection based on integrated monitoring and GIS technologies is designed to perform a larger number of functions, therefore, it also contains more data on the region's territory: on forest resources, on the state of others (in addition to water resources) components of the environment, etc. Therefore, the data models of these systems differ quite strongly. However, the part

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of the data model that describes information about water bodies and related processes and relationships is common in systems (structurally, but not syntactically), and can serve as a typical data model in the field of water relations for the constituent entities of the Russian Federation (Nikitin et al., 2007).

The functional tasks of GIS of water resources are determined primarily by the functions assigned to one or another management body.

In general, GIS of water resources are designed to solve problems of various classes:

1. Information and reference tasks.
2. Tasks of analysis, modeling and forecasting of natural and man-made processes associated with water resources management.
3. Information support for strategic decisions.
4. Information support of operational activities (Nikitin et al., 2006).

Data processing in GIS is carried out in several stages:

1. obtaining snapshots from archives;
2. pre-processing:
   - corrections in the optical range;
   - corrections in the radio range;
3. transition from satellite images to quantitative assessment of water bodies:
   - decryption;
   - classification of objects of interest;
   - determination of quantitative characteristics;
4. converting the processing results into a vector format and writing to the database (Dontsov and Sutorikhin, 2017).

The problem of monitoring the water area of water bodies is solved using various methods, one of which is the use of the spectral indices of water NDWI (Normalized Difference Water Index) and MNDWI (modified NDWI) (Dontsov and Sutorikhin, 2017).

Monitoring of freeze-up and river opening is necessary to predict the establishment of strong ice cover and flood situation. It can be classified based on NDSI (Normalized Difference Snow Index). These calculations can be performed using data from the Sentinel-2 satellite system.

The developed GIS should become the basis for decision support systems for water resources management.

The quality of management decisions depends on information about the exact location of water bodies and their relative position, as well as the mutual location of water bodies and objects that create sources of pollution.

Significant efforts are required to create a decision-making system based on geographic information systems based on Earth remote sensing data and the results of expeditionary observations. Forecasting using space-time series is promising.

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