Geoinformation and management systems for water management complexes

A V Epifanov¹³, I V Antonov² and G Y Frolov²

¹ Saint Petersburg State University of Aerospace Instrumentation, 67A Bolshaya Morskaya street, St.Petersburg, 190000, Russian Federation
² Saint Petersburg State University of Industrial Technology and Design, 4 Ivana Chernyh street, St.Petersburg, 198095, Russian Federation
³ E-mail: epifandr@yandex.ru

Abstract. The existing information and automated systems in the field of collecting and storing information about water users and water bodies are considered. The problems and the necessity of implement a unified information management system are analyzed. The list of necessary initial information for the work of «GIMS-water objects» and the sources of its receipt are defined. The structure and main functions of «GIMS - water objects» for the purposes of water management are described.

The current stage of management of surface water bodies is based on a large amount of information, including information obtained from automated measuring instruments. The legislative framework for water resources management is modern legislation in the field of technological and environmental regulation, which, in particular, regulates the need to determine the permissible anthropogenic load on water bodies, ensure the protection of water bodies, and determine the main activities to prevent negative impacts. There is a need to develop geographic information systems for water management systems.

At present, the following automated information systems are successfully functioning on the basis of the basin water departments: automated information system of the State Water Register, containing information from the State Water Register, information and analytical system 2-TP (water management), containing information about water users in the form of statistical reporting 2-TP (water management), unified automated system of state monitoring of water bodies, containing information on hydrometeorological monitoring at control points. The Federal Service for Hydrometeorology and Environmental Monitoring is responsible for maintaining the unified state fund of data on the state of the natural environment and its pollution, based on the control results obtained at the hydrometeorological observation points. The Russian Federal Service for Surveillance on Consumer Rights Protection and Human Wellbeing conducts sanitary and epidemiological control of water bodies. Water users monitor the content of pollutants, both in their wastewater and in water bodies above and below the outlet, according to the approved program of regular observations. Carrying out work in water areas requires the organization of industrial environmental control.

In the coming years, after water users receive comprehensive environmental permits, automated wastewater quality control systems will be implemented at enterprises of the first category of negative environmental impact, measuring the parameters of wastewater discharge every 2-3 hours [1]. The results of the control will be sent online to a single information database.
Thus, if we collect information from various sources, the majority of large water management complexes will be provided with information about the hydrological and hydrochemical regimes of water bodies, climatic conditions, information about anthropogenic load, hydraulic engineering and dredging operations. The available information can become the basis for the rational management of surface water resources. However, to date, there is no software that accumulates all of the above information [2-3].

The lack of comprehensive, up-to-date information makes it difficult to make informed management decisions on the sustainable development of the water sector in the Russian Federation. It is advisable to develop a geo-information management system for water management complexes for making environmentally sound management decisions in the field of water management.

The development of a unified geographic information management system will require efforts to overcome interdepartmental differences and develop a unified policy for providing data to interested parties [4]. It is also necessary to determine the structure of the system being developed, to justify the list of necessary data layers, to determine the structure of attribute information, to develop and implement mathematical models for calculating the permissible load on water bodies under various scenarios of anthropogenic impacts and natural conditions, to develop modules for exporting data from existing databases, to determine mechanisms for making management decisions, etc.

The paper presents a variant of the implementation of the unified geoinformation management system of the water management complex, which is implemented in the form of the program complex «GIMS-water bodies». This complex is based on a geodatabase that includes sets of classes of spatial objects about the water management complex, water user enterprises, the location of control posts, data on water basins, enterprises, hydrological and hydrochemical information about water bodies, best available technologies (BAT), as well as digital models of water bodies for modeling purposes (Figure 1) [5, 6].

The developed complex makes it possible to solve at the program level the issues of combining various information systems used for managing the water management complex, for collecting statistical data and solving the problems of assessing the anthropogenic load on the basins and the distribution of permissible norms among water users.

The use of geoinformation systems makes it possible to identify areas of the water management complex on a topographical basis with the allocation of zones of influence and zones of pollution from water user enterprises, with the possibility of determining water quality classes by hydrochemical and hydrobiological indicators and indices, as well as potential areas subject to flooding.

The geodatabase is a fundamental part of the «GIMS-water bodies» and is implemented according to the relational principle. Structurally, it consists of sets of classes of spatial objects that are basic for all water management complexes and thematic for specific conditions in the water basin. The main sets of spatial feature classes include: water bodies, water users, hydrological control lines, hydrochemical control lines, water outlet lines, water intake lines, settlements, landscape structure, special regime territories (specially protected natural territories, zones of sanitary protection zones of water intakes, etc.), hydraulic structures. The set of thematic classes of objects is determined by the tasks that are solved in a particular case, such as sets of spatial objects of transport infrastructure, objects reflecting seasonal changes in the water management complex, etc. [5].

The «Water Users» class of spatial objects contains information about the location of water-using enterprises in the water management complex; information about the production stages where water resources are used and wastewater is generated, and data sets from automatic wastewater quality control systems. This class of objects allows you to accumulate all the information for later analysis. All of the above classes of objects are used in the tasks of a comprehensive assessment of the anthropogenic load on water management systems.
The geodatabase has a separate section that contains the standards for production technologies in accordance with the information and technical reference books on the best available technologies for main and auxiliary production, which allows us to take into account the requirements of regulatory legal acts in terms of technological regulation of permissible discharge of pollutants [7, 8].
To take into account the state of technologies used in production, the criteria of the technological state of the main and environmental technologies are applied, which can be: specific water consumption for individual technological processes, rational use of water, specific values of the formation of pollutants per unit of output, etc. [9-11]. These criteria and normative values are also contained in the complex's geodatabase.

For the accumulation of data for automatic control of the composition of wastewater and the legality of their use, a register of methods and means for implementing automated control is provided, which have the appropriate approval for use.

When working in "GIMS-water objects", the boundaries of the water management complex are initially determined, in which the impact of water user enterprises on the water ecosystem or other anthropogenic impact, as well as the risks of flooding of territories, will be assessed. When working in «GIMS-water bodies», the zoning of the water management complex is carried out according to administrative, climatic characteristics and information about the anthropogenic impact on these water objects [5].

Modeling the complex allows during the numerical experiment to distribute the load among water users based on the results of zoning of the water industry, the assimilative capacity of water bodies, different modes of operation of hydraulic structures, as well as the matching criteria of the technological state of the main and auxiliary production indicators attribution BAT [12]. The modeling complex, thanks to the automated import of environmental and production control data, allows you to simulate various scenarios for the development of the water management complex in the short, medium and long term.

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