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A V Epifanov[1], M A Epifanova[2] and M S Stroganova[2]

[1]Saint Petersburg State University of Aerospace Instrumentation, 190000, St. Petersburg, str. Bolshaya Morskaya, 67A
[2]Saint Petersburg State University of Industrial Technology and Design, 198095, St. Petersburg, str. Ivana Chernyh, 4

E-mail: epifandr@yandex.ru

Abstract. A functional model of an automated management decision support system for load rationing in the framework of water management systems is proposed. Its main blocks are: automated control systems for natural and industrial wastewater, the state register of objects that have a negative impact on the environment, mathematical models for the transfer of pollutants in water bodies, geo-information systems for visualizing geo-data and modeling results. The advantage of the proposed system is the possibility of operational control over the sources of pollution and the regulation of the load from water users in real time.

Rationing of wastewater discharges from enterprises of various industries within the framework of water utilities has so far been carried out on the basis of retrospective data on the parameters of enterprises' discharges and characteristics of water bodies. Accordingly, the established standards for permissible discharges of enterprises may not correspond to the real water situation [1].

Requirements for the regulation of the load on water bodies from 01.01.2019 have changed a lot. In accordance with federal law No. 7 "On Environmental Protection", it has been established that industrial environmental control programs (IEC) for the facilities of the first category should contain a program for creating an automatic control system. The automatic control system is understood as a set of technical means providing automatic measurements and recording of pollutant discharge indicators, recording and transmitting information on pollutant discharge indicators to the state register of objects having a negative impact on the environment (NIE).

The control is subject to the consumption of wastewater and the concentration of pollutants for all releases of wastewater. Requirements for automatic measurement and accounting tools, as well as technical means for recording and transmitting information should be established by the government of the Russian Federation. The rules for creating and operating an automatic control system are more likely to be approved during 2019. After the issuance of regulations about enterprises of the first category of environmental impact, it will have to implement automatic control systems within 4 years.

The modern market of automatic control systems is currently not sufficiently developed, however, the equipment presented on it allows the automatic control of most metals, nitrogen and phosphorus compounds, pH, temperature, electrical conductivity, etc., which is enough for enterprises in most industries. All automated control systems should be included in the state register of measurements and

checked in accordance with State Standard Russia 8.589-2001 "Control of environmental pollution. Metrological support. The main provisions" [2, 3].

The large-scale modern automated control systems consist of:

- sensor analyzers;
- tools of measuring the physical parameters of wastewater;
- tools of collecting, processing, storing and transmitting information;
- tools of recording and displaying measurement results;
- tools for analyzing, processing information and predicting environmental pollution in the area of controlled emission sources;
- supporting system equipment.

Oversimplified, the process of transferring data from an automated monitoring station includes: automatic calibration; data collection and processing; data transmission over a local network or an Ethernet network; data storage; pairing with the central database [1, 4].

The introduction of automated waste control systems at the production site will make it possible to receive information about the discharge parameters at least once a day and to instantly transmit this data over the Internet.

Based on the results of operational control over the parameters of discharges and natural water, according to the authors, it is advisable to develop an automated management decision support system for the water management complex (MDSS for WMC). The implementation of the MDSS within the water management complex is associated with the uniqueness of many water management systems and the impossibility of developing unified management solutions for all water bodies of the Russian Federation. Based on the proposed functional model MDSS for WMC, it is possible to implement the concept of basin rationing of the load on the water bodies (figure 1).

Systems of automated control of waste and natural waters (SAC-WW and SAC-NW) will be installed at the enterprises of the 1st category in the next 4 years. The installed automated systems will transmit chemical analysis data to the state register of objects of the NIE, at least once a day.

Currently, the state environmental monitoring (SEM) of water bodies is carried out on hydrological and hydrochemical indicators on automated and non-automated posts (SAC-HM and SNAC-HM) of the RUSSIAN HYDROMETCENTER network. [5] Monitoring data are accumulated in a single database in CSV format

According to the scheme (figure 1), the results of environmental monitoring of water bodies, together with the data of industrial environmental monitoring, are transmitted to the state-of-the-water complex state monitoring system (SWCSMS), containing a block for summarizing and analyzing data. The function of the unit is to obtain objective reliable information on the quality of natural and waste waters, adverse physical phenomena, to analyze and summarize data, to identify the main sources of water bodies pollution.

The block summarizing and analyzing data allows:

- to exercise operational control over the parameters of wastewater discharge;
- carry out primary processing of input information;
- to assess the observance by the enterprise of technological and environmental standards under routine and emergency procedures;
- to form enterprise reporting on pollutant discharges;
- to form a forecast of the ecological situation in the water basin;
- to store and transfer measurement data to a single database NIE;
- to assess and predict the sanitary and ecological state of water bodies;
- to timely identify emergency situations;
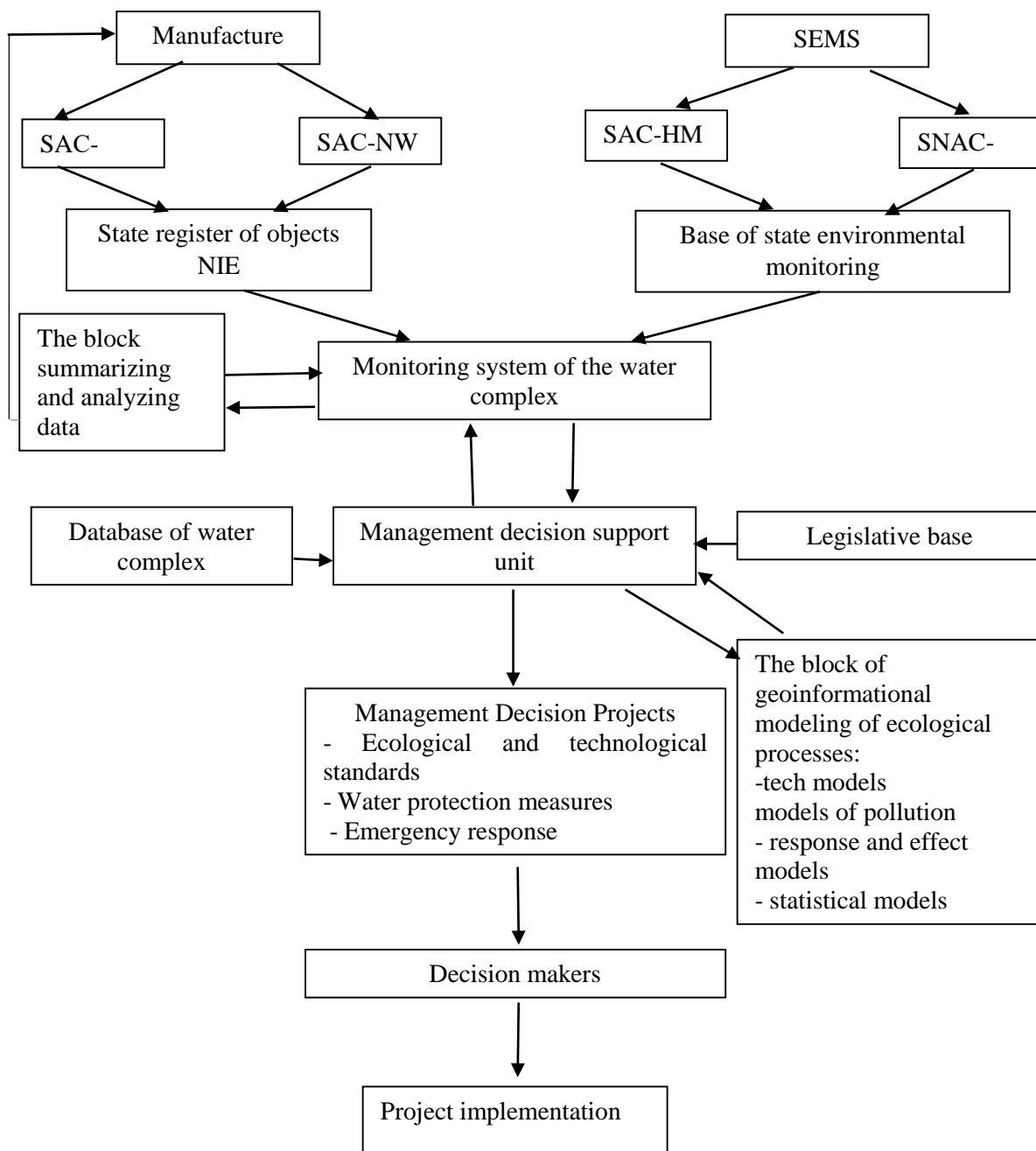- to assess the effectiveness of mitigation measures.

Figure 1. Functional model of an automated decision support system for a water management complex.

In case of failure of the enterprise to fulfill water protection requirements, this information will be sent to production and environmental authorities.

In the future, the data are sent to the management decision support unit (SMDS). The functions of the SMDS are: collecting, processing and accumulating data, maintaining the information model of the water management complex, modeling environmental processes, generating the necessary reports.

As a result of the operation, the SMDS unit develops draft management decisions:

- permissible water user discharge rates;
- on projects of water protection measures at the enterprise and water body;

- emergency response programs.

For the implementation of the tasks, the SMDS block contains the following databases and program modules:

- The block of geo-informational modeling of ecological processes.
- Legislative base.
- Database of water management complex.

The block of geo-information modeling, allows you to display the results of calculations directly on a cartographic basis, includes a set of interrelated descriptive and prescriptive models designed to analyze processes in the ecological-economic system and search for optimal strategies and tactics for its development.

The system of models is built by hierarchical principle with sequential aggregation of information during the transition to higher levels. The multilevel nature of the structure of the block of models is isomorphic to the multilevel control of the state of the ecological-economic system. The system of models should be arranged so that the information received or transformed is part of the aggregate information exchange associated with the management of the ecological-economic system.

Based on the tasks of managing ecological-economic systems, in our opinion, the block of models should include:

Ml. Models related to approximate estimates of ecosystem sustainability and population dynamics; models of succession and territorial behavior of communities of organisms based on empirical variables.

M2. Economic and mathematical models of production management, in particular, models of optimization of material and energy flows with given economic parameters.

M3. Models of dispersion and transfer of substances in water bodies, based on the apparatus of continuum mechanics, mostly on the equations of turbulent diffusion, which allow to predict the state of natural systems under various scenarios of changing technological flows and mathematical tools for assessing the environmental and economic damage caused by man-made impacts.

M4. Models of environmental and technological regulation of load in the framework of water management systems.

The geo-information modeling complex can be developed on the basis of the «GIMS – River» software product developed by the authors of the article together with the specialists of St. Petersburg State University of Industrial Technologies and Design and St. Petersburg State Electrotechnical University of V.I. Ulyanov (Lenin), allowing to simulate the load from an unlimited number of water users with the presentation of the results on a cartographic basis [6, 7, 8].

The database on the water management complex contains information on all the characteristics of the natural environment of the territory, which determine their resistance to anthropogenic influences, their ecological technical intensity.

The legal framework includes a set of documented norms, rules and requirements necessary for the management of EES and determining the overall level of environmental culture.

At the final stage, the proposed water protection measures are transferred to decision makers.

The implementation of the proposed functional model of the automated management decision support system of the water management complex will allow monitoring the water quality of water bodies and the discharge parameters of industrial enterprises in on-line mode, displaying the state of water resources on a geo-information basis, monitoring compliance of environmental protection measures by nature users, and assessing the degree of influence of various water discharges on water quality water bodies to generate management decisions emergency situations and planned modes.

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