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ANALYSIS OF THE USE OF THE METHOD OF HYDROECOLOGICAL MONITORING IN ORDER TO IMPROVE THE ECOLOGICAL CONDITION OF THE HYDROTECHNICAL CONSTRUCTIONS OF UZBEKISTAN

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Abstract

The article discusses the experience of using the methodology the hydroecological monitoring technique to obtain the results of the analysis of the ecological conditions of hydraulic structures in Uzbekistan.

- The examples of the methodology for creating digital maps for information support, for the study of the technical parameters of hydropower and irrigation facilities at the level of the Amudarya and Syrdarya river basins;

- Improved trash-holding devices necessary to protect the pumps of hydraulic structures from getting litter and floating objects into them (plastic requires special attention) that can interfere with the normal operation of the units, eliminated during preliminary water treatment;

- The results of hydroecological monitoring using geographic information systems, digital maps are shown, which allow for the design, repair and repair of hydraulic structures to take into account terrain, hydrography and other factors.

The obtained methodology allows a more realistic assessment of the hydroecological situation, taking into account their influence on hydraulic structures. The methodology of hydroecological monitoring will provide people with information in search of actions to develop environmentally acceptable modes of operation of hydraulic structures in Uzbekistan. Water management organizations can use this system to plan work and predict the environmental situation at all water objects in the Aral Sea basin. This system can be considered as a scientific tool for a decision support system for decision makers.

Key words: geoinformation technologies and ecology, hydraulic structures, waste disposal devices, pumps, hydroecological and hydraulic monitoring.

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The power industry of Uzbekistan is the main basic industry that determines the development of the country's economy. There is every reason to believe that in the near future the society in our country will again demand the construction of hydropower plants, there are all the prerequisites dictated by market conditions in the field of fuel supply. Currently, the efforts of many organizations are aimed at resolving issues of improving the operating modes of hydraulic structures in Uzbekistan. The surface waters of the Amu Darya and Syr Darya river basins are in an extremely dynamic state. Due to the fact that large-scale water management construction is being carried out in this region, knowledge of the features of the formation of operating modes of hydraulic structures, assessment of the hydraulic, hydrological and hydrochemical status at a given time is an important component for planning future work. A dense network of canals requires systematic hydroecological monitoring, since both crop production and public health depend on water pollution.

The republic’s energy base consists of 42 power plants of the company with a total installed capacity of more than 12.0 million kW, including 10 thermal power plants with a capacity of

10.6 million kW (85.1%) and 29 hydraulic power plants with a capacity of 1.4 million kW (11 , 4%), other 480 million kW (3.5%). Most hydropower plants are combined into cascades of hydroelectric power stations. The power and electricity generation at each hydroelectric power station and, accordingly, the total indicators of the hydroelectric power station cascade depend on the flow of water and pressure (the difference between the levels of the upper and lower pools). The largest hydroelectric power stations - Charvak hydroelectric power station (620.5 MW), Khodzhikent hydroelectric power station (165 MW) and Gazalkent hydroelectric power station (120 MW) have reservoirs that allow hydroelectric power stations to operate in the capacity control mode, the remaining hydroelectric power stations operate in the basic mode.

Chirchik-Bozsu hydropower plants are divided into five stages: Urta-Chirchik hydropower plants (885 MW), Chirchik hydropower plants (190.7 MW), Kadyrinsk hydropower plants (44.6 MW), Tashkent hydropower plants (29 MW), Nizhne-Bozsu hydropower plants (50, 9 MW). The total installed capacity of all hydroelectric power stations of the cascades is 1,200.2 MW, the average annual output is 4.67 billion kWh. Urta-Chirchik hydropower plants are located on the Chirchik river, the remaining hydropower plants are located on the Derivational canal and the Bozsu canal fed by the Chirchik river (while the sections on which some Bozsu hydropower plants are located can be considered as independent channels). Below are the characteristics of the Nizhne-Chirchik cascade of hydroelectric power stations (Table 1).

Table. 1.

Characteristics of the Chirchik-Bozsu cascade hydroelectric station

Name of HPP	Power, MW	Perennial production million kWh	Type of HPP	Pressurem	Number of hydro-aggregates	Year of commencement of construction	Year of production of the first turbine	Year of completion
Cascade of Lower Bozsu HPPs (Lower Bozsu Canal)								
Lower Bozsu -1 (HPS-14)	10,7 (10,2)	41,4 (65)	Mixed	29	1	1943	1944	1944
Lower Bozsu -2 (HPS-18)	7 (7,2)	15,4 (13)	Mixed	13	3	1944	1950	1950
Lower Bozsu -3 (HPS-19)	11,2	40,8 (50)	Mixed	18	2	1945	1947	1955
Lower Bozsu -4 (HPS-23)	17,6	88 (99)	Mixed	37	2	1948	1954	1954
Lower Bozsu - 14 (HPS-22)	4,4	21,8 (30)	At dam	12	2	1950	1954	1954

Before starting the research, an analysis of existing work on environmental problems [1-10], on hydraulic structures [11-15], on the methodology of using geographical information systems (GIS) [16-25] was carried out. The studies used an integrated approach, the existing methodology of hydroecological monitoring [26-30], new technologies and methodologies developed at the department. The main task of hydroecological monitoring is to obtain and analyze changes in the geochemical, biological, geophysical environmental parameters associated with water resources, to protect it from negative, mainly anthropogenic, influences.

Much attention is paid to environmental aspects, each year, hydropower students of the

Faculty of Power Engineering of Tashkent State Technical University visit the various hydraulic structures of Uzbekistan in practice (see Fig. 1).

Fig. 1. Training and production practice at the hydraulic structures of the Chirchik-Bozsui cascade

Therefore, the environmental aspect of the operation of hydropower plants will be almost very visible. Here, the authors propose to pay special attention to the trash device. Waste holding devices are necessary to protect the pumps of hydraulic structures from the ingestion of litter and floating bodies that can interfere with the normal operation of the unit, as well as for preliminary water treatment in accordance with the requirements of the consumer [31]. Currently, rubbish and garbage falling into trash racks have changed qualitatively and quantitatively, plastic bottles are the most dangerous.

When plastic bottles lose their properties under the influence of sunlight, wind and waves, they break into smaller pieces. These pieces, like microfibre from synthetic fabric, as well as tiny plastic balls, which are decay products, are called microplastics. The insignificant sizes of microplastics - less than 5 millimeters in diameter, which is comparable to rice grain - means that more species of living creatures can swallow it. Along with small plastic objects, large objects are found. As a result, small waterfowl as well as large fish and mammals are endangered. In the body of a living creature, plastic waste can cause significant harm to internal organs, in addition, they carry hazardous chemicals that later accumulate in the food chain. In time to neutralize and remove plastic bottles is a big environmental problem.

In Uzbekistan, due to the intensive exploitation of river basins by hydraulic structures, such a dangerous ecological scenario as in India is impossible. With more stringent requirements for the quality of the supplied water, small impurities that have passed through the gratings are captured by nets or even micro grids installed immediately before the pump inlet.

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When modernizing hydraulic structures, one should take into account changes in the qualitative and quantitative composition of garbage. Waste holding devices should be designed in such a way that, at reasonable costs for their manufacture, they would provide the least energy loss during operation, along with reliable protection of pumps and process equipment from litter and floating bodies.

The use of geographic information systems makes it possible to take into account the landscape and terrain, design optimal construction sites, strengthen mudflow areas, and predict landslides and landslides when designing repairs to old and building new hydropower and irrigation facilities. Map making and geographic analysis are not completely new. However, GIS technology provides a new, more relevant to the present, more efficient, convenient and quick approach to the analysis of problems and solving problems facing humanity as a whole, and a specific organization or group of people in particular. As a result, these GIS automate the analysis and forecasting process.

As methodological support, this scientific work presents the work on creating digital maps for information support (see Fig. 2), while studying the technical parameters of hydropower and irrigation facilities at the level of the Amu Darya and Syr Darya river basins.

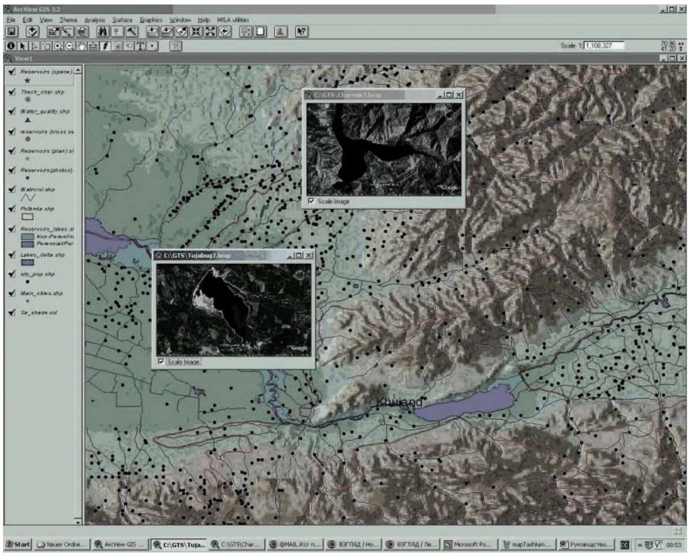


Fig. 2. An example of the use of GIS to study hydraulic structures, for example, after hovering over the corresponding map of the reservoir, you can get the desired image of the reservoir from the satellite, where its configuration is positioned in detail

The authors conducted an analysis based on the information on the chemical composition, technological schemes and tables of hydraulic and hydropower facilities. For example, Fig. 3 shows the use of GIS to analyze the operation of the Tuyabuguz reservoir.

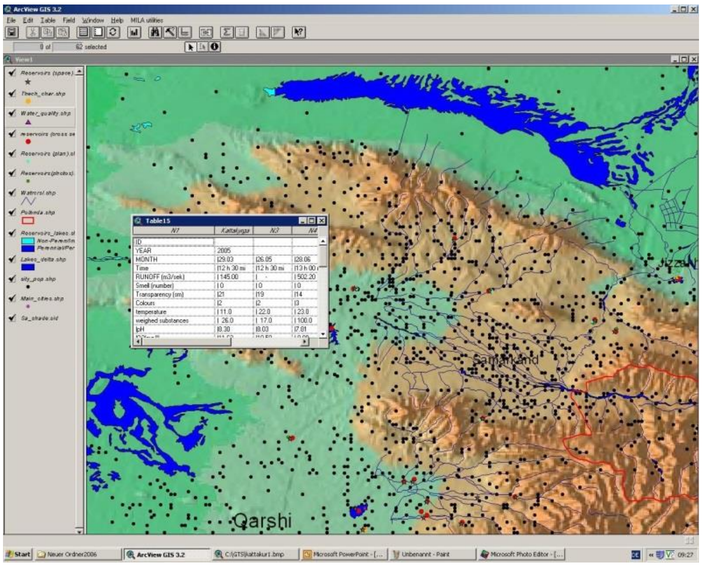


Fig. 3. Map of the Tuyabuguz reservoir with a table of chemical composition

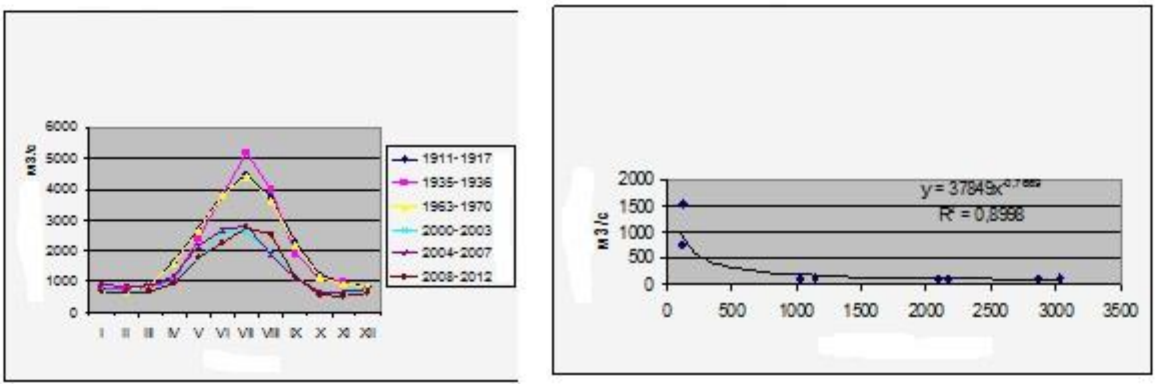
From satellite images from the Google global system in Fig. 2-3 clearly visible configuration of reservoirs. From them it is possible to determine ecologically vulnerable zones, directions of water flows, depending on the terrain

The composition and format of geographic information data for hydroecological monitoring includes: 1) Textual information (annotated reports, instructions for use); 2) digital information (statistics); 3) graphical information (diagrams, schemes, maps); 4) vector information (custom layers of thematic and topographic maps); 5) hyperlinks to files contained in infobases. System output: 1) image; 2) graphics; 3) texts.

Key parameters: 1) coordinate system; 2) filling the layers of electronic maps, raster and vector objects; 3) Creation of data bank files; 4) Graphic display of the studied objects using GIS technology; 5) Implementation of experimental field work using the created system

To carry out research work, a database of stock and literature data on the hydrology of rivers of Uzbekistan, materials on water consumption for different periods of the past years, and also based on the collection of average monthly data (precipitation, air temperature) for various climatic characteristics at weather stations located in the area of hydraulic structures.

The authors analyzed the results of the monograph “Genesis, formation and regime of surface waters of Uzbekistan and their influence on salinization and pollution of agrolandscapes (on the example of the Amudarya river basin)” [10], which describes in detail the effect of various factors on the hydrological and hydrochemical regime of large rivers of Uzbekistan. When analyzing changes in the water regime of the Amu Darya river in time and along the length of the river, the following characteristics are considered: a) change in the average monthly water discharge for different years: 1997-2000; 2001-2005; 2006-2012; b) the dependence of the averaged average monthly water discharge on the averaged average monthly water levels; c) the dependence of the average monthly discharge of water of the lower sections on the average monthly discharge of water of the upper sections. Schedules of intra-annual water discharge for various periods of years were compiled, including the current state (see Fig. 4).



a) b)

Figure. 4. An example of an analysis of the water discharge of the Amudarya basin by years: a- Intra-annual changes in water discharges for different years of the Amudarya-Atamurat river (Kerky city) b- Dependence of average monthly average water discharges on the average daily water levels of the Amu Darya river / city Atamyrat (Kerki city) for May-August 2008-2009 years

From (see Fig. 4) it is seen that the lowest water discharge is observed in the July-November month, their slight increase occurs in February, from March to June the maximum water discharge is observed. Thus, there is a slight shift in the flood from the summer to the end of spring, due to the influence of climatic factors.

For the authors' studies, the above methodology is used for the Chirchik-Bozsui basin, where the hydraulic structures of the Lower Chirchik cascade of hydropower plants are located. The aforementioned methodology uses criteria for the limiting state under which the design is recognized as hazardous to the environment, including criteria for hydroecological stress (see Table 2).

Table. 2.

The list of criteria for hydroecological tension Indicator name Formula Indicator

Name indicators	formula	Indicator value for the Amudarya river basin
Drain coefficient W wi - water intake Wwr.- water resources	$K_i = \frac{W_{wi}}{W_{wr}}$	Surkhandarya region -1.24 Karakalpakistan - 0.8
The full chemical composition at the closing gauges, taking into account polluting ingredients. (Uzhydromet standards http://lex.uz)	The number of ingredients in excess of the MPC, the degree of their excess	Termez 6 (1,1-4) Nukus 8 (1,2-4)
Integral index of water pollution by average MPC Termez n= 7 и 6 Nukus n= 8 и 10	Termez 4,9 and 2,4 Nukus 3,8 and 2,7	

Sj- is the coefficient of the hydrochemical load of the territory caused by the municipal sewage	Sj = LHd.s.. Hd.s.. - specific removal of ingredients L - population

As a result of the analysis of the results of the study, we can draw the following conclusions:

According to the technical data obtained - specific hydropower and irrigation facilities, various models are built, for example, a model for studying the flow rate of water in the gates of hydropower and irrigation facilities and other parameters. Using the model, you can determine the most environmentally polluted areas.

Isolation of the most characteristic chemical ingredients serving as indicators characterizing the hydroecological state of river basins. Were the boundaries and sizes of different zones of migration of water-salt flows within areas adjacent to hydraulic structures. Taking into account the application of the morphohydrogeometric method on topographic maps, by drawing a line along the deflection points of the contour lines (morphoisographs), as well as using aerospace materials, “relief plastics” maps were compiled, which made it possible to identify the boundaries and sizes of different migration zones of water-salt flows that may have negative impact on hydraulic structures.

To determine the current state and prospects of operation of hydraulic structures, a more accurate hydroecological and hydraulic modeling is required. Therefore, hydroecological monitoring based on geoinformation technologies has great potential in the future, which will help the relevant departments in more rational use and conservation of land and water resources, ensuring sustainable operation of hydropower and irrigation facilities in Uzbekistan. In addition, during the study, much attention was paid to the chemical composition of river waters, in accordance with the digital map of the quality of river waters of Uzbekistan compiled (see Fig. 2-3).

Thus, the intensive use of water resources of the rivers of the Aral Sea basin for agricultural, municipal and industrial needs leads to anthropogenic pollution by waste waters containing various pollutants, which can increase the corrosion of the mechanical parts of hydraulic structures. This list of negative environmental factors affecting water reservoirs is not complete; attention is required to the problem of siltation, as well as emergency spillways and many others.

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