Environmental monitoring in construction for hydro-technical structures and land reclamation facilities of Uzbekistan

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Abstract. The article is devoted to the urgent topic of creating a comprehensive geographic information system for environmental monitoring and decision support for hydro-technical structures and land reclamation facilities of Uzbekistan. The research results allow a more substantial assessment of the environmental situation, the fundamental features of the arid zone. For monitoring, a methodology is disclosed, which will help water and water organizations to plan and predict the environmental status in the water sector. The results of a comprehensive analysis of the Aral Sea basin using geographic information systems will help in creating a decision support system. The excessive use of water resources within the Aral Sea basin for agricultural, industrial, and wastewater needs has resulted in the contamination of water resources by a diversity of hazardous chemicals from anthropogenic. Expert questionnaires for environmental measures developed during the reconstruction of hydro-technical structures and land reclamation facilities. They are using the methodology of environmental monitoring. It is possible to evaluate and improve the hydro ecological situation of hydro-technical structures and land reclamation facilities in Uzbekistan.

1. Introduction

One of the strategic tasks set for scientists and government institutions of Uzbekistan is to determine the way to more efficient use of natural energy resources for the agricultural and energy sectors of the economy of Uzbekistan. A methodology of environmental monitoring can help here to analyze the ecological situation of hydro-technical structures and land reclamation facilities. Particular attention in our work was paid to the study of the environmental status of hydroelectric power plants (HPPs). Shortly, the construction of hydropower plants will be in demand in Uzbekistan, and there are all the prerequisites dictated by market conditions in the field of fuel supply. The problem of reconstructing old hydropower plants and building new hydropower plants is currently one of the most pressing issues for the entire national economy of many countries of the world [1].

The surface waters of the Amudarya and Syrdarya river basins are in a dynamic state. Because large-scale water management construction carried out in this region, knowledge of the specifics of operating hydroelectric power stations is required-assessment of hydraulic engineering. Hydrological and hydro-chemical status is an essential component for planning in future work. The HPP network requires systematic hydro-ecological and hydraulic engineering monitoring to study the negative
impact of the HPP on the environment. Energy students of our department during the summer practice study the environmental situation of many hydropower plants in Uzbekistan. Inspection of the trash grids of the hydroelectric power station allows you to discover which primary polluting objects are floating in the rivers. What can be done to improve the work of trash racks? The solution to these issues will increase the efficiency of hydropower plants and mitigate the anthropogenic pressure on the environment.

Recent studies have shown [2], showed that the hydro-chemical and hydro-ecological regime of surface waters in Central Asia changes under the influence of physical and geographical factors (primarily climatic) and anthropogenic factors (agriculture, operation of irrigation facilities and industry). To new solve the problem of modernization of hydropower plants and improve environmental monitoring. It proposed to obtain accurate, up-to-date information through an independent survey of hydropower plant personnel using expert questionnaires that will complement the integrated methodology of hydro-ecological and hydraulic engineering monitoring. When creating the method, we used the existing geographic information technologies [3-10] the choice of technological, environmental protection schemes [11-16]. The political and economic stability of Uzbekistan depends on the actual consumption of water resources and environmental policy. Over the past decade, we have been engaged in hydro-ecological monitoring, which resulted from GIS (Geographical Information System).

This article examines an example of the problem of selecting and making use of environmental monitoring technologies that take into account the arid climate of Uzbekistan. The high human population growth rate makes the scarcity of water resources within the region and dry weather of paramount importance within Uzbekistan. The implementation of a GIS-based digital water balance model and map as part of dynamic water master planning presented for the case of Uzbekistan. The model application enables the spatially differentiated prediction and presentation of future water resources development. It considers both the qualitative and quantitative factors of water resources planning and serves as a fundamental tool for decision-makers in charge. A complicated method of hydro-ecological monitoring was in presented in the block-scheme. It is showing the dynamic system through the use of the diagram. The first stage of the investigations is hydro-ecological monitoring of the Aral Sea Basin, which fixes the surface water chemical composition. Changes were taking into account two critical sets of factors - those anthropogenic and those based on physics-geographical data [17-22].

2. Methods
The before starting the research, an analysis of existing work on environmental problems on hydro-technical structures on the methodology of using geographical information systems (GIS) [3-7] and many other authors was carried out. A Geographic Information System (GIS) for the Amudarya delta region (Aral Sea GIS) was compiled by Micklin et al. [20] based on maps, satellite images, statistics, data bases and ground truth data. Most digitized maps were of a scale of 1:200,000 (canal net-work, lakes, collectors, streets, cities, etc.). The mapped irrigation network contains 7,500 channels in the delta area with a length of 22,000 kilometers. The GIS also provides a map of elevation contour lines based on a topographic map at a scale of 1:200,000.

The GIS maps of landscapes, geomorphology, soil properties and dominant vegetation formations are based on a satellite image of the delta of the year 1987 and field data by Novikova [22] and colleagues (personal communication). Various already completed GIS projects were used: Internet source of satellite images, terrain and terrain maps https://www.google.com/earth/, www.gisa.ru, ArcGIS Resources, WARMIS,http://www.resources.arcgis.com http://homepage.buryatia.ru/rmeic/gis.htm, EU/TACIS(1997).WaterResource Management and Information System. http://www.riob.org/ag2000/WARMIS.htm and other (Fig 1).
Currently, there are many models in the world in the form of block diagrams. The author has studied the block diagrams used in Germany at the Institute of Environmental Systems in Osnabruck. There was a project to create a model of the Elbe River [19, 20].

The author has been engaged in hydro-ecological monitoring using GIS for twenty years. So his scientific work experience was necessary for practical use in applied research. The objective: to investigate new environmental conditions.

The object of research: of the Aral Sea Basin, quality of shallow waters. In 1995, a comprehensive hydro-ecological monitoring technique was proposed in the form of a block diagram; later on, the diagram was developed in more detail based on GIS [11-15].

This bloc-scheme that elaborated in 2000 will be filled up of the data of hydro-technical construction because the problem of water quality and quantity depends on the risk criteria of hydro-technical constructions.

All computer models required outside of the geographical data handling generated, used GIS maps with ARC-View.

The combination of all data, monitoring efforts and computer storage of all data in the GIS, simultaneously for particle distribution analyses in surface waters and for solving many socio-economic issues. In order to construct a pilot simulation model, we used data from the period 1978-2018, the period from which we have a sufficient amount of information.

All computer models required outside of the geographical data handling were the decision support service that we develop for the Aral Sea basin based on three different activities:
1st - The computerized data bank using the formats of the ESRI GIS and the modelling provisions by ARC-VIEW.
2nd - The questions our clients identify and ask us to help to answer. These questions come in various forms and different levels of details. We need to elaborate our data bank in such detail. That the apparent problems can serve directly and that new one can be investigated with our models or with new data assessments.
3rd - Intensive discussions of the modelers with specialists and decision-makers in which the data banks will provide at an instant the data required for a meaningful discussion, for the fast presentation of simulations under known and expected conditions.
4th - Reentering results of the discussion into the data bank and presenting the results of the discussion on a home page on the internet for frequent utilization.
The methodology of environmental monitoring based on scientific research, and consists of several stages:

- On the method of creating digital maps for information support, for researching the technical parameters of hydroelectric power plants at the level of the Amudarya and Syrdarya river basins
- The use of the results of environmental monitoring based on geographic information systems, in the form of digital maps, allowing for the design and repair of hydraulic structures to take into account terrain, hydrography and other factors;
- The need to improve the trash holding devices necessary to protect the pumps of hydraulic structures from the ingress of litter and floating objects (plastic requires special attention) that can interfere with the regular operation of the units;

To conduct an expert assessment of the Chirchik-Bozsu cascade hydroelectric power station. The method of expert questioning used, having received the opinion of people who are directly working HPP.

Year of commissioning (year of reconstruction) - for design /actual or after reconstruction (if carried out)

Technical monitoring of hydroelectric power stations (installed capacity, MW, annual average power generation, mn. kW / h, turbines and generators, type of turbines and number, MW capacity, water flow m³/s, rotation speed, rpm, generator type and etc.)

Hydraulic monitoring of hydroelectric power stations (reservoir volume, normal reference level (NLP) mark in m, reservoir area, sq. Km, full and useful, ULV mark in m, head, m, maximum, calculated, minimum, maximum calculated flow rate through structures 0.1% security, cubic meters / etc).

Environmental monitoring HPP of hydropower plants - what are the main environmental measures that need to be included in the list of works during the reconstruction of hydropower plants. The main zones for hydro-ecological monitoring of hydroelectric power stations:
1) in the upper basin area of the reservoir: 2). in the zone of the main hydraulic structures:
3) in the downstream area of the watercourse.

Key measures to optimize environmental status:

a) Removal of debris, flooded and floating objects (which dominates, floating wood or plastic), whether reconstruction of the trash racks is required, including mechanisms for cleaning the racks;

b) Whether coastal destruction protection is required: Mechanical or biological protection;
c) Water quality control (treatment of drainage water filtered through hydroelectric power plants, treatment of oily effluents, etc.);

d) The fight against flooding and flooding of land (anti-filter screens and curtains, drainage, etc.);

e) Ensuring the life of hydrobionts (fish, plankton and other aquatic organisms), which includes the creation and reconstruction of fish passage facilities;

f) Combating flowering water (aeration);

h) Prevention of pollution of water bodies during the operation of hydroelectric power stations (purification of oil-containing liquids);

i) Maintenance of the natural regime of solid runoff in the downstream of the hydroelectric station (leaching of the reservoir, mechanical cleaning of sediment, etc.);

j) Ensuring hydro-ecological safety with increased seismicity of hydroelectric power stations (strengthening landslide sections of the coast, reconstruction of spillway structures in order to reduce vibration of the base of the hydroelectric power station, increasing the seismic resistance of structures and equipment, etc.);

k) Control of blood-sucking insects (changes in the level regime, the use of chemicals, breeding of insectivorous fish);

l) Measures to reduce the area of land flooding (deboning and drainage of shallow water, etc.)

The following tabulation outline the content of our data banks as we have them available but not yet in the full compatible format. We expect however to achieve compatibility of data storage and retrieval during the coming years.
1 DATA BANK
1.1 Physical Parameters (Table and Maps)
1.2 Management Parameters (Table and Maps land and water)
1.3 Socio-economical Parameters (Table and Maps)
2 Questions of the client
Outputs (expected results):
- The determined qualitative characterizations water resources and ecosystem Uzbekistan Rivers [2, 17].
- The hydro-ecological monitoring, the evaluation criteria and applications of the concept to the environment protection [11-12].
- The contamination distribution regularities for the water of the basin of the Aral Sea [14].
- Development of practical recommendations for solving different scientific and actual problems for environment protection aims; estimation of natural resources [16, 21-26].

3. Results and Discussion
During researches on blocks following problems was be solved:
- Reception is of great importance for carrying out of effective water saving up policy during the information on the necessary region. Applied workings out on studying of water problems of basin of Aral Sea on the basis of GIS technologies here can help. The author on an extent of many years was engaged in hydro-ecological monitoring with use GIS, therefore the received experience will be useful to experts at studying of waters of basin of the large rivers. Over the past years, when developing individual blocks of the hydro-ecological monitoring scheme, the following results are already available, in new researches already there are following results:
- The basic laws of a hydrochemical situation are revealed, is created GIS on a hydrochemical and hydrological situation of basin Aral Sea (Fig 2);

Figure 2. Example of usage a GIS (system ArcView. GIS with the purposes of hydro-ecological safety of Uzbekistan. A system of monitoring of quality of river waters of basin of the Aral Sea.

Experience of use GIS for studying of bioresources (primarily fish and tugai) deltas of river is received; Experience in the European project Intas “Restoration and management options for water and tugai ecosystems of the northern delta of the Amu Darya River” project was used (project Intas Aral Sea Project Call 00-1039 Ecosystems on the Northern Amudarya Delta Region http://ww.usf.uos.de/projects/aran/
The two priority areas most concerned with the issue of water conservation of the Amudarya river resources are monitoring of hydraulic structures and water quality.

- On the basis of GIS the interfaced analysis of a modern ecological condition of region for creation of system of acceptance of decisions is made;
- The hydro-ecological monitoring and mapping technique and a hydro-chemical situation in the conditions of destabilization of natural and environment is developed;

The main task of hydro-ecological 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 Energy of Tashkent State Technical University are in practice at various hydropower plants in Uzbekistan. There was the possibility of questioning experts who know all the problems from the inside, analyzing and photographing trash racks, how they can be improved, what types of litter dominate in water, etc. (see fig. 3-4).

During the practice, students explore the hydro-ecological aspect of the operation of hydroelectric power stations. 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 regular operation of the unit, as well as for preliminary water treatment. 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 millimetres in diameter, which is comparable to rice grain - mean that more species of living creatures can swallow it.

![Figure 3. Training and production practice at the hydraulic engineering structures of the Chirchik-Bozsu cascade](image-url)
Figure 4. The students checked the trash grids of the hydroelectric station, what kind of garbage prevails there, whether there are plastic bottles.

Along with small plastic objects, large objects found. As a result, small waterfowl, as well as extensive fish and mammals, are endangered. In the body of a living creature, plastic waste can cause significant harm to internal organs by accumulating hazardous chemicals. In time to neutralize and remove plastic bottles is a significant environmental problem. 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 provide reliable protection of pumps and process equipment from litter and floating bodies.

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 [16]. Currently, rubbish and garbage falling into trash racks have changed qualitatively and quantitatively, plastic bottles are the most dangerous.

4. Conclusions
The creation of an extensive supervising network of the surface and underground water quality for the early detection of changes. The establishment of water protection zones along lakesides and riversides.

Substantial reduction or stopping of sewage water influx from irrigated fields.

Our next scientific goal is presently the establishment of the most efficient monitoring system, in order to support those five actions.

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.

The GIS-based tool presented in this work offers a simple, problem-oriented method to evaluate alternative water management strategies for the Aral Sea Basin from an ecological perspective. It provides an interactive framework a comprehensive exploration of potential water management measures to improve the ecological situation in the area of the Aral Sea Basin. Water management in the Aral Sea Basin today has the single objective to provide irrigated agriculture, by far the largest water user, with its water needs. Environmental monitoring has great potential in the future, which
will help the relevant departments in more rational use and conservation of water resources, ensuring sustainable operation of hydropower facilities in Uzbekistan

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