ABSTRACT

of the dissertation for the degree of Doctor of Philosophy (PhD)

specialty 6D070300-Information Systems

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Development of information-analytical monitoring system of groundwater pollution state

Water reserves and its quality is the issue of the day. The President of The Republic of Kazakhstan in his "Address of the President to people of Kazakhstan, "Kazakhstan-2050" Strategy: new political course of the established state" has determined the serious water stress as the global challenge of 21st century:

"World water resources are under the huge pressure. In the last 60 years, drinking water consumption has increased by 8 times. By the middle of this century many countries will have to import water". Water - is the extremely limited resource, and the struggle for sources has already became the most crucial geopolitical factor, being one of the reasons of the tension and conflicts.

Kazakhstan also faces an acute water supply issue. A number of regions experience an urgent need for drinking water.

In this regard, solution to this problem has a high priority in the strategy of Kazakhstan development until 2050.

East-Kazakhstan region is known as the richest region of Kazakhstan in water resources, due to its climatic conditions. Nevertheless, its water contamination level is among the highest in Kazakhstan. Because of heavy concentration of industrial and agricultural companies on the territory of this region, as their emissions are leading to pollution of groundwater system.

Introduction of pollutants into the water basin cannot be fully eliminated, however this process can be managed. It is insufficient to just monitor the environment for a successful management of water quality, also it is necessary to predict human impact and elaborate security measures.

Pollutants of various hazard categories can get into groundwater through the unsaturated zone, that's why it is the most unprotected aquifer. Furthermore, groundwater is exactly what is considered by a number of researchers as the most sensitive environmental indicator, which signals to us when the pollution begins.

Nowadays, researches on the regional assessment of groundwater exposure to various polluters has become particularly relevant. The result of such research is a vulnerability index of groundwater towards any or certain pollutant.

Groundwater plays a key role in the water cycle and maintaining the balance of ecosystems. It is the source of clean drinking water supply for many localities. A 75% of the surface of the Earth is water, 97% of them is a salt water. 2 of remaining 3% is glaciers. And only 1% of global water resources fits human needs. This amount of

water is presented as surface water and groundwater, which are 96% of resources. The groundwater, though, couldnt avoid the problem of environmental pollution, since it is in close interaction with atmosphere, ground surface and surface water sources.

Since the treatment of groundwater is a very expensive undertaking, the prevention of groundwater pollution should be the main protection method, i.e. identification of contamination level and sources, together with development of measures to avoid the pollution. Particularly, this applies to pollution, which is caused by industry and human settlements.

The one of the main conditions to preserve water from contamination is the presence of an improved monitoring system, which tracks a state of groundwater pollution.

In the modern world, the definition "monitoring" has deeply ingrained in all spheres of human activity. Monitoring includes the following items: observation of research objects, accounting and control of their state, evlotuion analysis of this state, assessment of the object state based on monitoring information, presentation of monitoring activity results at different levels of detail. Regardless of the scope of application, monitoring systems have common properties, which make it possible to highlight the monitoring as a single information essence.

Lately, improvement of ecological monitoring system has become a priority area in environmental protection, owing to development of information technology. Monitoring system of groundwater state is based on data, which has a retrospective character. Information about monitoring object is characterized by a large amount of data, diversity, spatial affection, inavailability of objects for a direct study. Monitoring objects has a wide area-based set-up. The greatest impact in the implementation of monitoring task of researchable objects can be achieved through the use of modern information technologies in order to automate gathering, accumulation and analysis processes of the data on the state of the objects themselves.

Information and analytical system, information management of which is integrated by database of monitoring objects, should become a tool to support monitoring of resource state and groundwater quality. Its mathematical provision includes mathematical and optimization models, its software - graphical and dialogue interface, which allows objectives to be implemented.

The foregoing does condition a validity of research topic, namely that on purpose to improve the quality of monitoring, it is necessary to develop an information and analytical system, which will implement an integration of modern information technologies, mathematical methods and models of an assessment process, state of groundwater pollution according to data from hydrogeological party of the region.

In addition, relevance of thesis work is reaffirmed by the fact, that research was carried out within research work under contract №61-420-17 on the theme "Development of an information and analytical system to monitor quality and

resource of groundwater of the Republic of Kazakhstan" of budget programme 217 "Advancement of science" (appendix A).

Object of research:

Processes of automated accounting, storing and use of data from groundwater monitoring, database "Groundwater" of State data bank

Topic of research:

Monitoring methods of groundwater state according to data

Objective of the work:

Design and development of informational analysis system on purpose to increase an efficiency of groundwater monitoring process

Methods of research:

-Methods of systematic analysis;

-Methods of assessment and forecasting of groundwater quality;

-Methods of identifying pollution source;

-Technology of design and development of informational analysis system;

Task of research

To achieve the objecective of research there have been set following tasks:

- analysis of problems and perspectives of an application of mathematical and computer modeling methods, as well as informational technologies for a monitoring of groundwater system;
- figuring out which mathematical methods and models of assessment and forecasting should be used, and also their adjustment to the environment of a region;
- development of data preprocessing technology to improve its quality;
- development of solution alghorithms and numerical alghorithm for an implementation of methods and models;
- design of infromational system architecture for monitoring of groundwater pollution state;
- development of informational and analytical system for monitoring of groundwater pollution state;

Scientific novelty and clauses submitted for protection:

-concept of information and analytical system of groundwater pollution state monitoring;

- algorithms for the implementation of methods and models for assessing, predicting the state of pollution of groundwater, determining the sources of pollution;

-infromational technology, which bases on complex application of informational resources and methods of mathematical and computer modeling of environmental process of groundwater monitoring;

-architecture of information and analytical monitoring system;

Practical significance of dissertation results lies in the application of suggested infromation and analytical system in hydroecology.

Evidence-based theoretical and experimental results of dissertation are used in science project on the theme "Development of information and analytical monitoring system of quality and deposits of groundwater of the Republic of Kazakhstan", of budget programme 217 "Advancement of science", it is testified by the act of implementation (Appendix B). Certificate of State title registration over the object of copyright "Information and analytical monitoring system of quality and deposits of groundwater"(ЭВМ programme) has been requested.

Information and analytical system, which is developed within the thesis work has been successfuly used in LLP "Centre of ecological safety" lab, it is testified by the act of implementation (Appendix C) and the studying process at the department of "Information Technology" of VKGT University of D.Serikbayev (Appendix D).

Methods used in research. During the research within thesis work there was used:

-Methods of system analysis;

-Methods of assessment of groundwater pollution state;

-Methods of forecasting of the groundwater pollution state, which are based on models of pollutants transport;

-Methods of identifying pollution source;

-Technologies of design and development of information and analytical system.

Results of research:

-Conception of information and analytical system has been developed as a result of the research;

-Mathematical methods and models of assessment and forecasting have been defined on the use and adjusted to the environment of the region;

-solution alghorithms and numerical alghorithm for an implementation of methods and models have been developed;

-informational and analytical system for monitoring of groundwater pollution state has been developed;

Testing of the results of the thesis work.

10 scientific publications has been issued on the results of performed scientific research, including 4 works in scientific publication, which falls under the Scopus | international database (3 of them are in materials of the International scientific-practical conferences and 1 is in the academic journal), and 4 articles are in research editions, which are recommended by Comitee on control in the sphere of education and science of Ministry of education and science of the Republic of Kazakhstan. The results of research are tested on international and republican scientific conferences. Main results of the work were reported and discussed on the following conferences: International scientific-practical conference "Green economic - is the future of humanity", VKGTU of D.Serikbayev, city of Ust'-Kamenogorsk, 2014, International conference " Global Conference on Computer Science, Software, Network & Engineering COMENG 2014", Turkey, 2014, International conference

"15TH Ininternational multidisciplinary scientific geoconference SGEM 2015", bulgaria, 2015, international conference "9th international conference on application of information and communication technologies AICT 2015", city of Rostov-on-Don, russian federation, 2015, international conference "10th international conference on application of information and communication technologies AICT 2016", Azerbaijan.

Publication on the theme of research. 10 scientific works on the theme of the dissertation are published, 4 of them are in academic journal, which are recommended by Comitee on control in the sphere of education science MES of the Republic of Kazakhstan, 4 - in the materials of the International scientific-practical conferences, 4 publications are indexed in the SCOPUS international database.

Structure and volume of the thesis work. Thesis work includes introduction, 3 chapters, conclusion, list of used sources consisted of 91 titles and attachments.