RESEARCH OF HYDROGEOLOGICAL PROCESSES ON THE BASE OF STRUCTURAL MODELING

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Abstract. *In the article has presents the improvement of research work on the basis of structural modeling of geofiltration processes of hydrogeological systems and structural and informational analytical methods for determining geofiltration and geomigration indicators based on the transition to mathematical models of groundwater with the development of computer technologies and artificial intelligence systems are presented.*

Keywords: *groundwater, hydrogeological systems, geofiltration processes, structural modeling, geofiltration planning.*

INTRODUCTION

It is characterized by the increasing role of automated monitoring, geofiltration and mathematical modeling of geomigration processes in the development of hydrogeological process research. Such importance of mathematical modeling in the general complex of hydrogeological research is predetermined by the ever-increasing requirements for the reliability and accuracy of hydrogeological calculations for the purpose of rational use of underground water deposits and resources. Extraction of underground water, flood protection of quarries, reclamation areas, protection of underground water from pollution - these are the main hydrogeological studies, and mathematical modeling of geofiltration and geomigration processes are important issues.

Decree of the President of the Republic of Uzbekistan of May 4, 2017, No. PD-2954 "On measures to regulate the control and accounting of the rational use of underground water reserves in 2017-2021" and in the Decree of the President of the Republic of Uzbekistan dated January 28, 2022 No. PD-60 "On the development strategy of the new Uzbekistan for 2022-2026" "... in the long-term perspective, the drinking water supply system implementation of comprehensive measures and targeted programs on development and modernization" to provide the population of our republic with quality drinking water, to further develop and improve the system of medical and social assistance, to ... the implementation of targeted programs related to the improvement of the supply system justifies the relevance of this research" [1, 2].

With the development of computer technology and artificial intelligence systems, there has been a widespread shift to mathematical models, which are based on energy or equilibrium principles, often called structured dynamic models, with parameters determined from empirical data. is based on the description of the object through differential equations.

In their practical work, hydrogeologists deal with more and more complex systems, the components of which differ by the parameters of the main rocks, the properties of the aquifer, the temporal and spatial scales of hydrodynamic processes, and the methods of anthropogenic influence. In this case, it is necessary not only to obtain reliable quantitative estimates of their current state, but also to provide a reasonable forecast of regional and local changes in hydrogeological conditions, taking into account the dynamics of anthropogenic loads, water exchange and pollution migration. between components. The use of traditional approaches to modeling such systems, based on the creation of a single model of a complex environment, requires large material costs, large technical resources and, as a rule, does not allow to achieve optimal accuracy of the obtained solutions. In this regard, the issues of creating effective technologies for modeling natural and man-made hydrogeological systems, which can be used by a wide range of specialists, are becoming extremely important. This dissertation is dedicated to their solution. The work uses a systematic approach as a methodological basis. The main idea of the approach is to present complex hydrogeological conditions as a set of interconnected components, for which models and problem-solving algorithms are known.

From a scientific and methodological point of view, the transition to the formation of a multi-scale continuously operating model system, the solution of issues related to the structural planning of geofiltration processes in heterogeneous porous media, the integration of various monitoring networks, the integration and synchronization of various monitoring networks and monitoring of hydrodynamic processes, combining their limiting assumptions leads to a synthesis of modeling scenarios. Including, many of these special cases have already been the subject of some research to one degree or another, but thinking from the point of view of a single system of various proprietary methods to create a complete technology covering all stages of natural-man-made hydrogeological process modeling, should be reviewed and summarized.

The purpose of the work is to create the conceptual basis, instrumental tools and methodological base of the technology of structural modeling of complex natural and man-made systems, to develop practical developments in the study of real hydrogeological processes.

formation and justification of the main principles of the structural approach to the modeling of such systems in hydrogeology;

formation and justification of basic principles of structural approach to modeling of such systems in hydrogeology;

development of a set of instrumental tools for implementation of structural modeling technology on personal computers.

MAIN PART

In hydrogeological research, the main part of designers is engaged in the study and description of specific objects, their activity is not primarily aimed at discovering general laws, but at creating a detailed integrated image (model) of the studied object and determining its unobservable properties. directed. The leading role of modeling in these areas comes from the fact that the field knowledge of pictorial thoughts and images can be represented by the following complex functions on a regional scale, that is, the structural structure [3, 5, 11]

$$CHO_B = \langle \mathrm{GM}_B, \mathrm{OB_B}, \mathrm{SB_B}, \mathrm{UB_B} \rangle$$

here: CHO_B - consideration of the hydrogeological object as a basis for the voluntary project, GM_B - geological database of the field under study, $\mathrm{OB_B}$ - knowledge base about objects of the subject field; $\mathrm{SB_B}$ - knowledge base about specialized field issues and their solution scenarios; $\mathrm{UB_B}$ - is a methodological knowledge base that regulates the specific features of task assignment and implementation for various class objects.

The research of hydrogeological systems, that is, the process of modeling, is mainly an individual cognitive process, which is associated with the measurement, collection, analysis and processing of a large amount of heterogeneous data. The results of modeling directly depend on the set of knowledge available to the research subject and their ability to form acceptable answers to questions about the object, understand new information and draw correct conclusions. is liq.

The problems of developing a new conceptual modeling scheme, especially the structural modeling of hydrogeological systems, should be automated due to the sharp complexity of these objects and the problems solved on them, taking into account previous experiences, such schemes should also meet three main requirements. First, to take into account the specific features of the research process when describing important objects. Secondly, to ensure the possibility of providing and sharing a consistent and sufficient database of various thematic and personal knowledge bases. Finally, it is to make the most of the knowledge accumulated in the earlier stages of automation. Here, among the various approaches, the most attractive is the creation of structural modeling laws, based on a certain (regular) sequence of solving simple problems in simple objects, solving a complex problem on a complex object.

These knowledge bases form the informational and intellectual basis of the modeling process. Each geodatabase differs not only in the nature of knowledge, but also in its implementation algorithm and presentation form. Thus, one of the main issues of automation of descriptive sciences is the need to jointly present and use various knowledge organization systems [4, 7, 10].

The prerequisites for applying the structural modeling approach are:

- the possibility of dividing the studied hydrogeological systems into parts (structural components), each of which can be considered as an independent object when solving applied problems;

- the ability to synthesize a holistic solution to the problem from the solutions obtained for individual structural components, in particular, taking into account the relationships between them.

The transition to structural modeling technologies is in many ways close to the transition to structural methods in programming, and in practice, this means the transition to a discipline of practice based on the integration of a set of standard parts and the rules for combining them into more complex projects. As a result, not only the modeling of real hydrogeological systems, taking into account the diversity of their configurations, but also the process of geofiltration and geomigration modeling itself will be technologically advanced and requirements will be met. The issue of adding, removing or changing system components will be simplified, it will be possible to form, improve and collect individual models in a private way, to "build" complex structures from well-functioning parts and develop them simply and naturally.

In the methodology of structural modeling of geofiltration processes, that is, the structural approach is based on the scheme of modeling geofiltration processes of hydrogeological systems generalized using neural networks shown in Fig. 1. Its implementation includes the following [7, 9, 10]:

- Systematization of models of hydrogeological objects (HGO) based on hydrogeological issues (HGI) solved in them;

- modeling of continuous processes describing geofiltration processes (GFP) undisclosed function models describing geofiltration areas (GFA);

- determination of real hydrogeological systems based on the integration of geoinformation technology and structural modeling. For informational and intellectual support of structural modeling technology, the following are necessary: a knowledge base about objects of science, a knowledge base about practical problems and scenarios for their solution, and a methodological knowledge base that regulates properties installation and resolution issues for various types of objects are considered. It is proposed to express methodological knowledge through a production system, and knowledge about objects and tasks with special calculations.

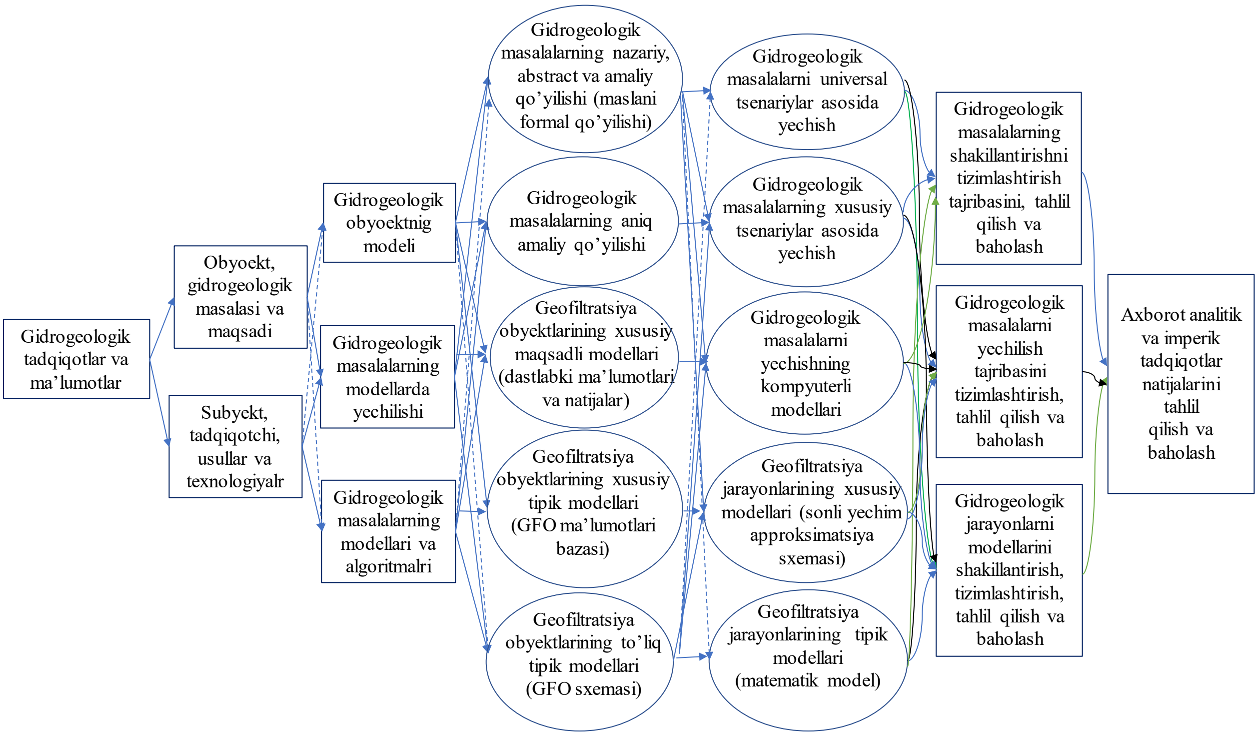

Figure 1. Scheme of structural approach in modeling geofiltration processes of hydrogeological systems

In the structural modeling of geofiltration processes (MGFP), hydrogeological objects HGO, that is, the general model of geofiltration areas (GFA) is expressed (described) as follows [3, 7, 11]:

$$MGFP = \{HGO, GFA, GHS\}$$

here: GFA is a geofiltration area, a set of selected instant states of water, that is, in certain cases, it can be one (initial) state; GFP is a process of geofiltration, a set of features that determine the patterns of changes in the values of GFH parameters in real time; Mathematical models of GFM are usually ordinary differential equations with eigenvalues.

CHS are boundary conditions, which represent the scheme of the environment outside the object at the entrance-exit part of the object. The description of CHS implies the spatial location of boundary contours and the display of interaction processes with the external environment.

Basically, the same HGO can be schematized with different goyas. The choice of the type of schematic (demonstration) depends not only on the size and complexity of the HGO structure, but also on the research objectives, requirements for accuracy and reliability of the results, and others.

All the preliminary data for the development of the structural model of the organized field are provided by the hydrogeological departments of the Tashkent and Okhangaron hydro-regime stations, and the Okhangaron underground water deposit was taken as an object [6, 7].

The hydrodynamic limits of the model and their physical-mathematical expression were established in the digital scheme taking into account the hydrodynamic structure of the area formed today, the available information on the distribution of hydrogeological units, as well as the principles and general principles of hydrogeological planning. The outer contour of the model is set on the surface of the basin along the water basin corresponding to the border of the catchment area of rivers such as Chirchik, Keles, Okhangaron in the region near Tashkent. In the installation of external contacts in the model, the second type of boundary condition is established on the basis that the normal part of the filtering current is zero to this boundary.

Thus, the modeling area covers the catchment area of five-six large river basins and tributaries of the Chirchik river in the region near Tashkent: Chirchik, Okhangaron, Zakhsuv, Ankhor, Karasuv, as well as a number of ditches. In this case, rivers and valleys are internal hydrodynamic boundaries.

The intensive method of using the natural resources of the geofiltration stream implies the determination of the optimal mode of groundwater consumption, which leads to the need to increase the number of active factors taken into account in solving hydrogeological problems. Study of modeling of hydrogeological objects, analysis of the main stochastic graphs of the studied systems, and creation of effective digital algorithms and programs that implement the methodology of structural modeling were studied by means of simulation modeling of complex hydrogeological systems.

CONCLUSION

The accumulated experience on the use of modeling in hydrogeological research shows that the use of structural modeling introduces certain changes and additions to the methods of their organization and implementation, which should be taken into account when designing hydrogeological research works: 1) structural include a list of tasks that are planned to be used in modeling and are intended to be solved by planning a hydrogeological research project, indicate possible ways to solve them, and justify the reliability of the predictions being made; 2) planned experimental geofiltering works and observations for use in solving inverse problems in the model should be carried out taking into account the provision of initial data in sufficient quantity and appropriate quality; 3) if it is necessary to clarify the parameters of geofiltration, make maps of their distribution and justify the reliability of the model, the work project should ensure the creation of hydroisopietic maps for all studied and hydraulically connected aquifers; 4) carrying out a set of additional works to ensure the determination, reliable determination and quantitative assessment of the nature of the boundaries of the filtration zone and the boundary conditions affecting them; 5) it is necessary to adjust and implement a complex of hydrogeological and other studies to ensure the successful solution of the identified issues using the method of structural modeling.

Modeling allows reliable and effective solving of hydrogeological issues only by its correct formulation on a scientific basis, fulfillment of the requirements and positive application.

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