GEOFILTRATION PROCESSES OF GEOINFORMATION-MATHEMATICAL AND HYDROGEOLOGICAL MODELS

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Abstract. *This article explores the creation of geoinformation-mathematical and hydrogeological models of geofiltration processes and visualization technologies for spatial objects based on geographic information systems (GIS). Measures, recommendations and proposals for the study of the state of groundwater have been developed, the existing conditions and their rational use, assessment and forecasting and improvement have been studied. The issues of computer modeling, generalization of geoinformation-mathematical and hydrogeological thematic models and computational experiments, comparison of the results obtained, as well as visual presentation of the results of work on hydro-regime monitoring to the consumer are considered.*
Keywords: *geofiltration processes, hydrogeological models, geographic information systems, groundwater.*

INTRODUCTION

Presidential Decree of the Republic of Uzbekistan "On the development strategy of the new Uzbekistan for 2022-2026" No. PD-1989 of June 27, 2013 in order to ensure the implementation of the tasks of the "Program for the development of telecommunication technologies, networks and communication infrastructure in the Republic of Uzbekistan in 2030", a new generation of modern computerized, in addition, it is necessary to create modeling and intelligent technologies, to widely implement them in practice, that is, in the process of facilitating the work of various institutions of production, and this is the basis for the relevance of this research work [1].

Mathematical modeling, i.e. numerical modeling processes for the use and organization of underground water in drinking and household water supply, in the theoretical, practical and methodological development of the study of regional hydrogeological systems Scientific works of scientists N.N.Bindeman, F.M.Bochever, N.N.Verigin, N.I.Plotnikov, L.S.Yazvin, V.M.Shestakov, P.YA.Polubarinova-Kochina, A.I.Silin-Bekchurin, V.A.Mironenko, I.K.Gavich [4], national scientists F.B.Abutaliev, N.N. Khojibaev, U.U.Umarov, I.Khabibullaev, R.N.Usmanov, J.Djumanov, I.N.Gracheva and others [3], issues such as substantiation and prediction of hydrogeological conditions, improving the theory of hydrogeological calculations, introducing modeling software into practice, improving the field of geology and engineering developed rapidly.

MAIN PART

Setting of issues. The information supply of the mathematical model of large hydrogeological regions, that is, the ability to quickly determine the state of the hydrogeological region, the study of the classification characteristics of the underground hydrosphere, depends on the level of synchronous operation of hardware and software. In this regard, modeling of the state of groundwater level, quality and temperature, creation of a geo-information base based on the resulting data of the model, geo-information-mathematical modeling of processes based on geographically connected data to the area and detailed analysis of the results, creation of a quick map representation, decision-making scientific research issues related to methods of development of recommendations and measures have not been sufficiently studied.

Studying the condition of underground mineral, drinking and healing waters, researching the existing conditions and their rational use, evaluating and predicting their quality, quantity, and developing measures, recommendations and proposals for improvement are important and urgent issues. It is the responsibility of the author to analyze the results of the data collected from the well and springs on the basis of computer software, to build a generalization mathematical model and conduct experiments, to compare the obtained results and to present them to the consumer in a visual way. are the main issues.

Geofiltration flow modeling is often used to solve a wide range of problems in hydrogeology. In the most common terminology, a geofiltration model is a simplified representation of the appearance and process of a real object or system. Geofiltration models represent the process of a real groundwater system using mathematical equations solved by computer software. The task facing all researchers trying to use the results of modeling is to understand the reliability, accuracy and speed of the obtained data, and to what extent.

In the modeling of geofiltration processes, it is related to solving the problems of determining the value of various factors based on the solution of the inverse problem, in which the properties of the object are studied with different values of any "indirect" values.

Model sensitivity analysis, field identification - is of great importance in solving inverse problems, provides additional information about the relationship between input and output parameters, the importance of individual parameters, etc.

The sensitivity analysis of numerical models shows that it is one of the rapidly developing areas in the field of solving the problems of data interpolation in the retrospective analysis of the processes described in the modeling [5].

Based on the results of the model, sensitivity analysis can be performed manually or automatically. In the first approach, several recalculations in the model are performed, and each parameter adjustment, selection can be performed an unknown number of times or many times. The change in the output values of the model with the change of each parameter can be displayed in tables or graphs.

It is known that in order to solve many scientific and practical problems, its natural physical and mathematical model of a certain form is developed, and the results are realized based on the algorithm of solving the problem according to the mathematical model, numerical solution, as well as calculation experiments using software. is increased. For this, it is necessary to solve the following issues in a row:

1. The initial values given by the geological, that is, the natural physical model representing the problem and the quantities whose parametric values are sought are studied, and the set of factors and parameters necessary to solve the problem, and the most basic among them, are determined.

2. Based on the essence of the problem, using physico-mathematical and other laws, establish relationships between parameters, that is, develop a mathematical model of the given problem.

3. Choosing a calculation method for solving a mathematical model and developing an algorithm and software based on it.

4. Conducting experiments on the computer and checking the adequacy of the model.

The above-mentioned processes are solving practical problems by modeling geofiltration processes. Since each problem belongs to a certain class, it is very important to use software tools and application packages designed to solve such class problems.

Mathematical modeling of geofiltration processes of hydrogeological regions and preliminary data collection of underground water level considered the hydrogeological region near Tashkent as the object of the research.

The subject of the research is the principles of mathematical modeling of hydrogeological processes under the influence of natural and man-made factors and software tools, algorithms, groundwater level in hydrological observation wells.

When the mutual arrangement of water-retaining layers in water deposits in foothills is uneven, the balance equation of underground groundwater, that is, the mathematical model of geofiltration processes of hydrogeological systems, is expressed as follows [2, 3, 5]:

$$\mu\frac{\partial h}{\partial t}=\frac{\partial}{\partial x}\left(k(h-b)\frac{\partial h}{\partial x}\right)+\frac{\partial}{\partial y}\left(k(h-b)\frac{\partial h}{\partial y}\right)+W-f-Q_b-Q\delta-Q_{rd} \qquad (1)$$

here here μ - is the ability of the layer to provide water or lack of water saturation; ; $h=h(x,y)$ - groundwater level, m; $k=k(x,y)$ - coefficient of permeability of the layer, i.e. filtration coefficient, m/sut; $b=b(x,y)$ – is the upper part of the aquifer layers separating the layers, , $W=W(x,y)$ is the infiltration of surface water, i.e. infiltration of rainfall, m/ day; ; Q_b- flooding, i.e. groundwater spilling over the ground; $f=f(x,y)$ - water shining from the groundwater level, m/day; $Q=Q(x,y)$ – water consumption through wells, m/sut;

δ-delta Dirak function $\delta=\begin{cases}1, & agar\ x=\bar{x},\ y=\bar{y}\\ 0, & agar\ x\neq\bar{x},\ y\neq\bar{y}\end{cases}$

Q_{rd} - inflow and outflow of surface water from rivers, canals, drains and ditches into underground layers, in cases where there are water exchange relations from rivers, tributaries and canals $Q_r=k(h_r-h)/F$; $Q_d=k(h_d-h)/F$; in ditches and ditches, i.e. in the case of drainage; F- indicator of resistance to water leakage of the bottom of rivers, canals and ditches; *x*,*y* - coordinates on the plane; *t* is time;

Incoming and outgoing water flows from the sides of the area are taken into account in all cases considered above on the basis of boundary conditions, which can be done in differential form by the following expressions:

initial conditions of ground water in underground layers

$$h(x,y,t_0)=\phi_1(x,y); \quad (x,y)\in G; \quad t=t_0; \qquad (2)$$

and the following boundary conditions

$$h(x,y,t)=\phi_2(x,y); \quad (x,y)\in\Gamma_1; \quad t>t_0; \qquad \text{the first type} \quad (3)$$

$$-kh\frac{\partial h}{\partial n}=\phi_3(x,y); \quad (x,y)\in\Gamma_2, \quad t>t_0 \ \text{the second type} \qquad (4)$$

$$-kh\frac{\partial h}{\partial n}=\gamma(h_в-h); \quad (x,y) \quad ,\in\Gamma_3 \quad t>t_0 \ \text{the third type} \qquad (5)$$

In modern computer systems, digital solution processes and software [5] are presented based on the boundary conditions of groundwater in underground layers, and there is an opportunity to create software packages and automate the solution process, in turn, to obtain information. process, connection with regionally distributed objects, calculation of groundwater balance elements, and helps to solve the issues of managing the order in water intake facilities operating in different regimes.

Entering data and creating an array of information. At each of the initial data collection stages, specialized programs of geoinformation systems (GIS) were used, and special programs were also used in geography and cartography. other modules were widely used.

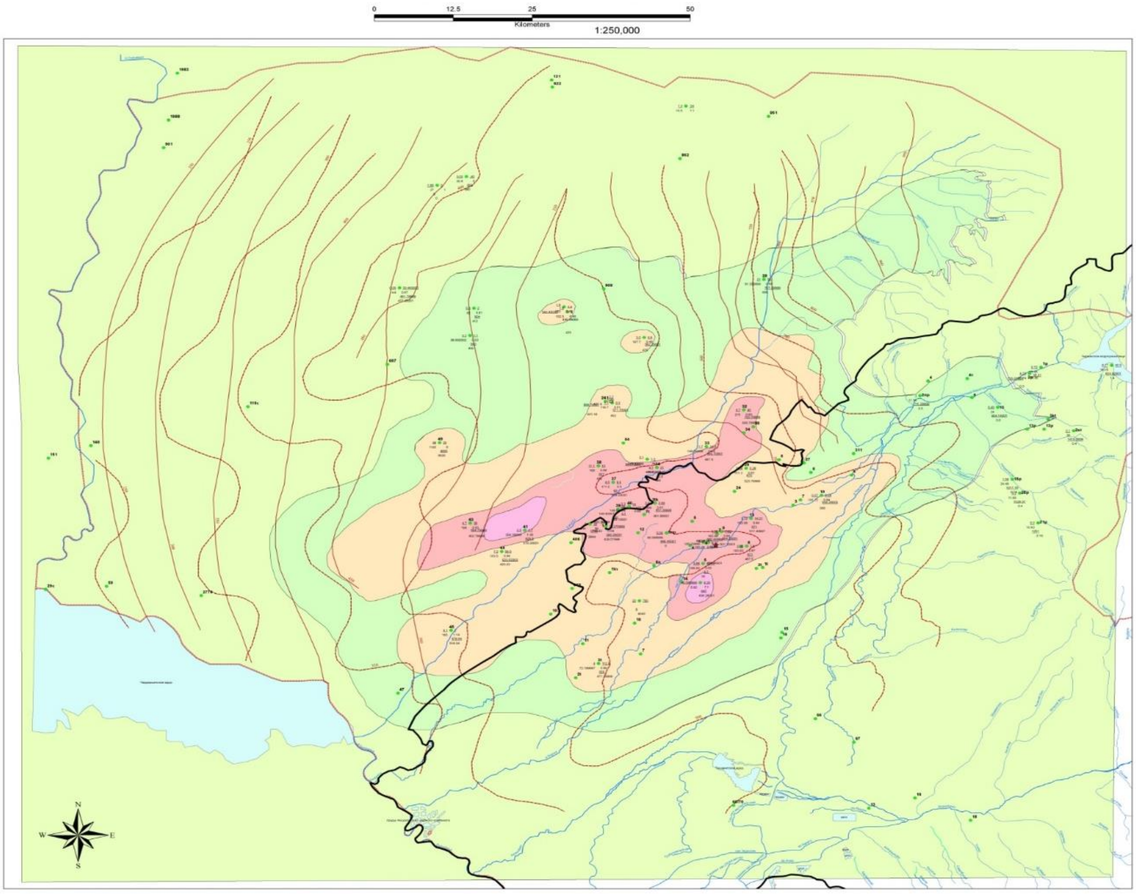

Figure 1. Geoinformation model of the studied area

The following methods of interpolation of model results to surfaces were used: Linear interpolation; Criking; Spline interpolation; Trend interpolation. Based on geoinformation technologies, creating thematic maps representing changes in the state of underground water, justifying the natural conditions of the studied area and its water resources, providing drinking water to its inhabitants, creating maps with the help of information technologies, wide and complete information intended to provide information (Figure 1).

CONCLUSION

Mathematical modeling of the geofiltration processes of the developed and implemented underground hydrosphere, along with visualization using modern software tools, along with a detailed analysis of hydrogeological systems and results, creation of a rapid map representation, assistance in the development of recommendations and measures for decision-making.

It is used in the study of the condition of underground mineral, drinking and healing waters, the research of existing conditions and their rational use, evaluation and forecasting, and the development of measures, recommendations and suggestions for improvement.

The practical significance of the obtained results lies in the creation of software tools and technologies for collecting and transmitting preliminary hydrogeological data into one system during the monitoring of the underground water hydrosphere, in the process of creating a geoinformation database.

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