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MONITORING AND MAPPING THE CHANGE IN GROUNDWATER LEVELS

Abstract. *The article presents information on mapping the current state of groundwater in the Republic of Karakalpakstan, a theoretical study of the mapping process, monitoring of groundwater through GIS software, a geoinformation system, studying the quality of groundwater, monitoring changes in groundwater levels using GIS technologies to ensure the rational use of water resources in Karakalpakstan.*

Keywords: *mapping, groundwater, GIS technologies, irrigated areas, drainage, database, ArcGis software, collector.*

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МОНИТОРИНГ И КАРТИРОВАНИЕ ИЗМЕНЕНИЯ УРОВНЯ ГРУНТОВЫХ ВОД

Аннотация. *В статье представлена информация о картировании текущего состояния подземных вод в Республике Каракалпакстан, теоретическом изучении процесса картирования, мониторинге подземных вод посредством программного обеспечения ГИС, геоинформационной системы, изучении качества подземных вод, мониторинге изменения уровня подземных вод с использованием технологий ГИС для обеспечения рационального использования водных ресурсов в Каракалпакстане.*

Ключевые слова: *картографирование, грунтовые воды, ГИС-технологии, орошаемые территории, дренаж, база данных, программное обеспечение ArcGis, коллектор.*

Mapping the current state of groundwater is crucial for sustainable water resource management, environmental protection, and policy development. Theoretical foundations and foreign experience contribute to the formation of an effective system for monitoring and mapping groundwater.

Groundwater, as the most important component of nature, plays an invaluable role in socio-economic development. The process of in-depth study and mapping of their current state is theoretically based on the integration of hydrogeology, geoecology, and geoinformation systems (GIS). The main theoretical approach in groundwater mapping is the analysis of quantitative and qualitative indicators of water resources in connection with the regularities of territorial distribution. This requires taking into account natural-geographical factors, geological structure, climatic conditions, and anthropogenic impacts.

In foreign experience, a number of modern methods for mapping groundwater have been introduced. In particular, in the USA and European countries, groundwater monitoring maps are being created based on remote sensing technologies and GIS. In the experience of Japan and Korea, the practice of forecasting the water balance and assessing environmental risks using geoinformation models has been established. At the same time, a number of international projects are being implemented in the countries of Central Asia in the direction of integrated management of transboundary water resources and the compilation of common electronic maps.

One of the GIS software is the ILWIS software, which is used to predict the potential zone of groundwater in the study area. For the development of a forecast map of potential groundwater zones, a system of overlapping or combining all thematic maps based on weight values was used. For processing data influencing the formation of remote groundwater and mapping the potential zones of

groundwater in the studied territory, methods of probing and GIS are used.

The works of Professor S.Sh.Mirzaev, one of the well-known scientists of the republics of Central Asia and Russia, are mainly devoted to methods for determining groundwater reserves.In ancient Greece, Rome, China, and Egypt, the first scientific concepts about the water cycle in nature and its properties appeared.

To monitor changes in groundwater levels in the Republic of Karakalpakstan and map them using GIS technologies, we will need to collect data on the hydrogeology of the region, especially on the level, distribution, flow direction, and quality of groundwater. Subsequently, this data can be used to create groundwater maps using GIS technology.

Such maps help in planning the sustainable use of water resources and making decisions on managing the water balance of the territory.

In the Republic of Karakalpakstan, irrigated areas are fully provided with drainage, and the length of the collector per 1 hectare is 31.88 p.m. The level of groundwater removed from irrigated land areas by collectors is monitored by an engineer and technical specialist of the existing land reclamation department in each district every 10 days. Analysis of chlorine and solid residues in collector and irrigation water is carried out once a month in the chemical laboratory. One of the main sources for assessing the melioration state of lands is the operation of 3,583 observation wells for monitoring the groundwater level.

Groundwater monitoring through the geoinformation system is carried out by studying the quality of groundwater and modeling it using algorithms and software. In this case, we consider two indicators: the first is an increase in the water level and the second is a decrease in the water level. Based on these two main indicators, we can analyze the overall water situation in the region. In these processes, the following conditions are controlled: spatial distribution of geofiltration parameters; spatial distribution of the aquifer balance of groundwater; spatial distribution of the initial conditions of geofiltration and hydrogeochemistry; boundary conditions of groundwater flows. The data obtained as a result of this

analysis are combined in an automated system in the form of analysis results and maps, and computational experiments are conducted to determine geofiltration examples, initial and boundary conditions. The obtained data are entered into a computerized system as layers by geographical coordinates, and based on the "Geoinformation Modeling" method, the relationship between thematic layers is determined.

In the Republic of Karakalpakstan, the design and construction of maps using GIS technologies is an important engineering project aimed at improving wastewater collection and treatment infrastructure. Geographic Information Systems (GIS) As an example, we can take the KC-3-4 collector system for creating dot maps, analyzing territories, optimizing network routes, and managing backup system data.

This will allow improving the planning and monitoring of the system's construction and operation, as well as increasing the efficiency of resource management. To minimize the negative impact on the environment, it is also important to consider the environmental situation of the project.

Creating a database for the KC-3-4 collector system includes several stages, mainly:

1. Data collection: collection of all necessary information about the existing collector system, mainly geographical coordinates, topographic maps, utilities, and other information.

2. Defining the database structure: defining the database structure, especially tables, relationships between them, attributes, and keys.

3. Creating a database: creating a database using specialized database management software (e.g., PostgreSQL, MySQL, Oracle, etc.).

4. Data upload: Uploads all collected data into the database, especially geographical information, topographic maps, utility programs, and other data.

5. Development of a GIS interface: development of a user interface based on GIS technologies for convenient use of collector system data.

6. These stages require a comprehensive approach and cooperation of various specialists, for example, specialists in geodesy, geology, databases, and GIS technology.

The KC-3-4 collector in the Karauzyak and Takhtakupyr districts of the Republic of Karakalpakstan was mapped. When creating the map, a database, i.e., a chp file, was created using the ArcGis program and brought to the map's appearance. The map shows the boundaries of the districts, views of the district observation well and the collector. In the attribute data of the Arc GIS program, the length of the collector is recorded at the time of excavation.

When creating a map using ArcCatalog, a database (container) was created, the necessary shp file was created, and the district boundary, collector, and observation wells were mapped (Figure 1).

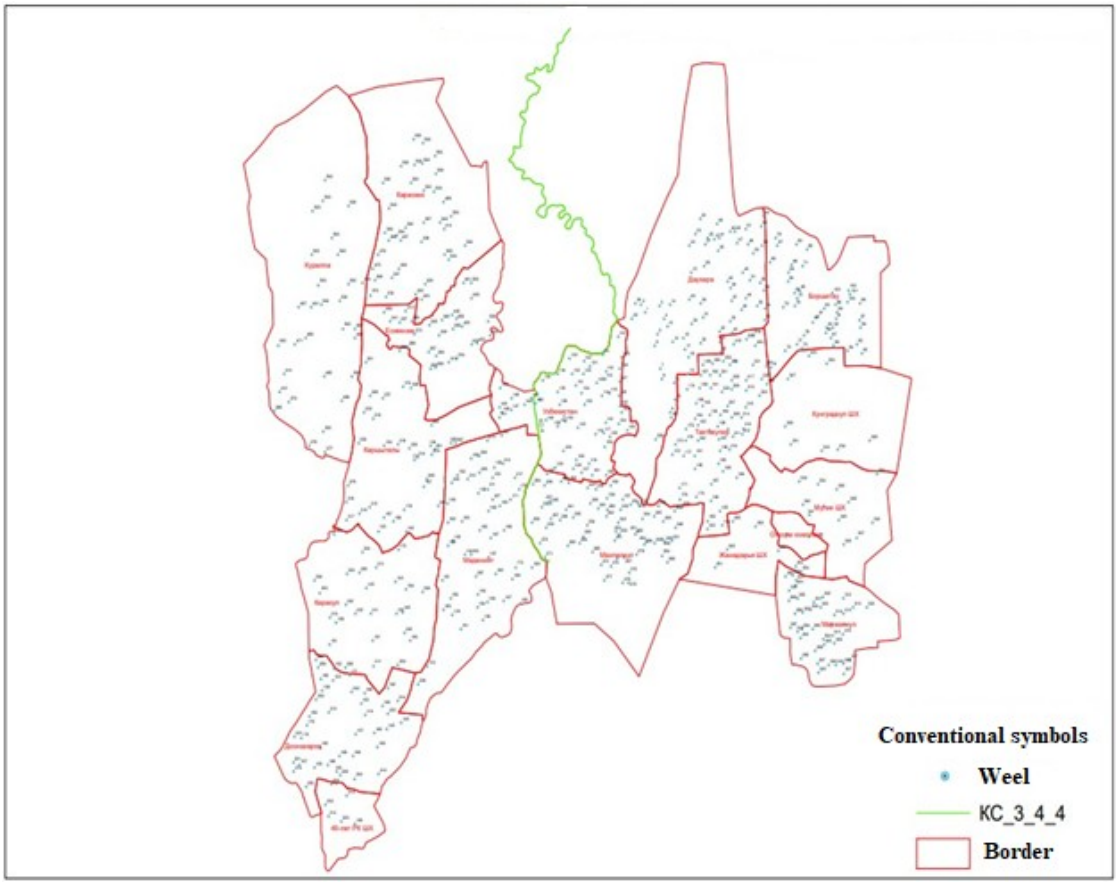

Figure 1. Map of the KC-3-4 collector, passing through the Karauzyak and Takhtakupir districts of the Republic of Karakalpakstan

In conclusion, since the world in which we live is developing day by day, the technologies used and the hydrological cycle must be adapted for effective management. It is necessary to ensure the interdisciplinary exchange of information about all layers of the planet. The constant development of GIS software and remote sensing technology contributes to the quality and accuracy of the models we create and the forecasts we provide, as well as the development of new research methods. This increases important opportunities for improving our analysis and forecasting by integrating the data model, real-time learning, and recursive future prediction.

In Karakalpakstan, the introduction of best practices into the processes of management and protection of groundwater is of great importance. In particular, the possibilities of sustainable management of groundwater resources can be expanded by adapting modern geoinformation systems, satellite observations, and modeling methods to national conditions.

An important task in ensuring the rational use of water resources in Karakalpakstan is the observation of changes in groundwater levels using GIS technologies and the compilation of a map of their distribution. GIS technologies help decision-makers better understand groundwater problems and develop more effective water management plans.

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