Geometric modeling of underground water deposits

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Abstract. The article considers one of the important problems of modern applied geometry - the development of geometric modeling methods, typification and schematization of topographic, hydrogeological, and geological surfaces, on the basis of which many theoretical and applied problems of engineering geometry are solved. The results of observations of groundwater status indicators are analyzed, which are carried out by measuring the level, pressure, flow, and selection of water from observation wells, springs located in natural and disturbed conditions. The permissible convergence of resource estimates by the amplitudes of fluctuations in the level of groundwater and by the geometric modeling of groundwater deposits has been established.

1. Introduction

An important direction in increasing the efficiency of the agricultural and industrial sectors of the economy is the use of modern geoinformation technologies for the information integration of processes. According to various estimates, the preparation and support of design models in high-tech production take up to 80% of the production cycle time. This is primarily due to the high complexity and complexity of preparing geometric (visual-shaped) information [1, 2].

Advances in science and technology allow for three- and four-dimensional geometric modeling, however, the pace of transition to a new level of geometric modeling is constrained, despite the arrival of modern computer, hardware, and software. This is caused, first of all, by the lack of quality information, as well as the presence of the “old” ideology of geometric modeling (descriptive geometry).

In the process of introducing new methods of geometric modeling, the systematic, economically feasible development of natural resources and their effective use is important. The uneven distribution of industrial facilities and consumers across the Republic of the Republic contributes to the progressive shortage of reserves of both surface and groundwater and there is also a danger of their pollution by the technogenic process [3, 4].

Performing assessment and monitoring studies by traditional methods is associated with high labor and material costs due to subjective dependence on the performer and untimely (inertia) information, so solving modern, complex engineering problems based on new computer technologies for three-dimensional geometric modeling is an urgent problem.

Groundwater is the property of the state and is protected by laws on nature management, About the bowels, etc. In the arid climate of the Republic of Uzbekistan, the main sources of fresh water are river valleys, in which significant groundwater reserves are concentrated, which are formed mainly due to filtration losses from surface watercourses and irrigation water infiltration.

The object of research was the river valley of the Akhangaran River, in which large industrial units with intensive agriculture, characterized by densely populated areas, are located. Industrial water
supply is provided by water intake facilities from groundwater, in particular in the territory of the Tashkent region [5, 4, 6].

The subject of research is hydrogeological processes (state and assessment of groundwater) that occur under the influence of natural and technogenic factors.

2. Methods
The method of geometric modeling is the creation of an information basis, that is, the preparation of more or less reliable facts and a cartographic database of data necessary for compiling a geometric model using the complete most convenient modeling environment and advanced software, and processing the results based on GIS technologies.

The method for calculating individual items of groundwater balance is as follows. On a specific area of groundwater research for a certain period, a balance is determined (annual, seasonal, long-term, etc.). Which includes elements of water inflow (infiltration, groundwater inflow into the balance circuit, flow from other aquifers) and water flow (groundwater outflow, withdrawal, wedging - hidden in rivers, drains, and open – spring; total evaporation). In the research area, it was found that a significant amount of infiltration occurs not only from water bodies but also from the irrigation network when irrigating land (and plantations) [7, 8, 9].

Typization is the allocation of the same type of sites according to hydrodynamic features and possible design patterns. They are distinguished by the generality of the flow structure, bedding conditions, and the hydraulic state of aquifers, by the generality of the reservoir structure and the boundary conditions acting on them.

Schematization - identification of the main factors:
- determining the most reliable reservoir structure and design parameters;
- simplification of filtering and replacing spatial filtering with a planned or flat vertical;
- simplification of the forms of boundaries and laws of change in levels and costs of flows.

Schematization takes into account the physical and theoretical foundations of the processes under study, at the beginning the type of filtration and the size of the region under study are estimated, then the structure of the complex under study, internal and external boundaries and boundary conditions are established [9].

In general, the physical and geographical situation of the region, taking into account the foregoing, is characterized by factors influencing the formation of hydrogeological conditions. In the mountainous and foothill parts of the region, a significant amount of precipitation falls, feeding a dense hydrographic network and fractured waters of Paleozoic rocks. Submitting to the general slope of the terrain, the flows of surface and groundwater from the mountains enter the foothills, being consumed by absorption into friable fragments of the foothill plume, large sais, and partly by evaporation.

The relief structure of the described area and a significant slope of its greater part (0.07-0.05) favor the accumulation of groundwater due to the infiltration of precipitation and surface water, which contribute to the flow of groundwater in the Ahangaran basin. The water content of the basin depends on its altitude and the amount of precipitation. The catchment basin occupies a command position above the terrain, located at an altitude of 3.0-4.5 thousand m above sea level.

According to hydrological zoning, the described object is part of the Pristashkent artesian basin and is located on the border of the mountain-folding and platform regions. The mountainous part of the area, composed of Paleozoic rocks, is part of the Chatkalo-Kuramin group of fissure water basins, the plain part is covered with a thick cover of the Pristashkent artesian basin [10, 11, 12, 13].

Technogenic objects affecting the hydrodynamic state of groundwater are diverse. For targeted analysis, assessment, and identification of manifestations of the impact of technogenic objects on the hydrodynamic state of groundwater and the consequences of their impact on the ecological and hydrogeological situation of the territories, the need arose for typing them.

3. Results and discussion
Taking into account the level, area, and specific features of the manifestation of the impact and their consequences, technogenic objects are divided into:
- irrigation systems;
- systematic reclamation drainage systems;
- reservoirs and large hydraulic units;
- large irrigation canals;
- groundwater intakes.

The basin of the Ahangaran River is one of the most favorable irrigated regions of the republic in terms of reclamation. This is due to the hydrogeological - reclamation conditions of the territory, as well as the security of the natural outflow of groundwater. The structural block diagram of the model is based on separate maps of the depths of the soles of the assigned layers relative to the surface of the relief (Fig. 1).

![Figure 1. Block diagram of the visualization of a 3D model of the object of study](image)

The geometry of the terrain model is determined by the coordinate system in which the digital surface model is created. The choice of a local rectangular coordinate system makes it possible to simplify the combination of terrain models and urban objects that are created in a rectangular coordinate system. To enter absolute marks of the earth's surface into the model, we used the shp file of relief contour lines prepared in Arcview in the Gauss-Krueger metric coordinate system (Pulkovo, 1942), from which the absolute elevation marks in each cell of the model grid were determined by interpolation. To specify the roof and sole of each selected layer, the model used xls-files containing the absolute marks of the roof and the sole of each layer at anchor points with known coordinates. To form a geofiltration model, filtration coefficients were introduced for each calculation layer. During the solution, the water conductivity was calculated using the introduced filtration coefficients and the absolute marks of the upper and lower boundaries of each layer. As a result of the work, several versions of the photorealistic model were obtained, but these are only the first steps on the way to an integrated system providing for the possibility of a three-dimensional display of the territory (Figure 2).
Figure 2. Digital 3D model of the research object

Consider the operations most characteristic of the boundary representation: calculating the overall volume, calculating the normal at a point, calculating the surface curvature, finding the intersection point with the ray or curve, determining the position of the point relative to the surface.

The basic operations include: creating a primitive, modifying it, local modifying curves and surfaces, automatically constructing rounding, joining and stitching surfaces, automatically searching for intersections, automatically trimming and lengthening primitives, converting, copying, and deleting objects, as well as canceling actions over objects [14, 15].

Surface modeling is the basis for constructing geometric models of parts, assemblies and assemblies, and the integration core. Construction of basic and analytical surfaces, surfaces based on basic ones, surface development, as well as import and processing of bicubic surfaces, bounded and trimmed surfaces and solids [16, 17, 18].

Analytical surfaces: plane, sphere, cylinder, torus, cone

Base surfaces: rotations, tabulated, ruled, expandable, punches, mating, side projections, kinematic. Surfaces based on the base: equidistant, quasi-equidistant, segmented, limited to cutouts, compound.

The construction of mating surfaces provides the formation of simple and complex mates of the surface with the surface, the surface with a curve, a curve with a curve, stitching, and angular conjugation of three surfaces. Simple pairing is a trace obtained during the “running-in” of mating objects by a sphere of constant, variable linear or according to the radius graph. The difficulty of extrapolating the data of point measurements over the area, as well as the impossibility of accurately determining the boundaries of measurements, is not always overcome. And if a suitable representation of the geometric model of the object for this problem is chosen, it will be solved efficiently, and vice versa [19, 20].

The task of geometric modeling of solid bodies is an important area of computer graphics. Since data on physical objects of the real world cannot be entirely entered into a computer, it is necessary a priori to limit the amount of information about an object within the framework of a question of interest. For example, the task of rendering an object with shading raises issues such as:

What parts of the object are visible?

What color should be assigned to each element of the object?

To represent geometric information, a technology for describing curves and surfaces using geometric formulas is used. In this case, the object is defined by a set of geometric shapes, depending on one variable, in the case of a curve description, and on intersecting if the surface is described. This method allows you to accurately describe the possible geometric primitives; segments, circles, arcs,
ellipses, flat cylinders, cones, spheres, tori, and more complex objects using a universal mathematical apparatus. The presentation of each method should occur according to one logical scheme, in a generalized form, it looks like this: a characteristic of the projection apparatus, image construction basic geometric elements, work with built images.

4. Conclusions
The calculated values of the natural resources of groundwater according to the parameters of their level regime in the river basin. Ahangaran allowed:
1. establish the permissible convergence (3.9-25.9%) of resource estimates according to the amplitudes of fluctuations in the level of groundwater and according to the geometric modeling of groundwater deposits.
2. Based on the assessment of changes in the hydrodynamic and hydrochemical parameters of groundwater, it was revealed that the level regime in the riverine zone and this natural sais is closely interconnected with runoff in the watercourse, where level fluctuations depend on the water content of the year. Relative to the last low-water 2014, the average annual groundwater levels are everywhere within the specified zones during 2015-2017. Tended to rise. The level regime of groundwater within the high terraces of deposits where irrigated agriculture is developed depends on the type of crops grown and the irrigation regime. Therefore, the rate of fluctuation of average annual levels and their absolute value are not unambiguous in individual areas and to a lesser extent depending on the water content of the year.

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