Hydrogeological Conditions and Features of the Ferghana Valley

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Abstract:
The role of groundwater in general water resources and water supply of the population, industry and agriculture is characterized. The main part of modern environmental problems is associated with the geological and hydrogeological structure of the region. The international experience of studying the protection of groundwater from pollution is analyzed and modern methods of assessing and mapping their vulnerability to pollution are presented. Particular attention is paid to the state and prospects of fresh groundwater use in Uzbekistan.

Key words: environment, geoecology, geology, hydrogeology, groundwater, aquifer, chemical composition of water.

Introduction

Deposits of groundwater, especially mineral, industrial and thermal, have much in common with deposits of any other minerals, but at the same time have some specific characteristics that are associated with the characteristics of groundwater as a mineral. In modern hydrogeology, trends are developing in the use of a systematic approach in the study and assessment of hydrogeological objects and processes [3, 4]. At the same time, objects of hydrogeological study (hydrogeological basins and massifs, groundwater deposits and their sections, aquifers and horizons, strata and layers) are considered as single and integral hydrogeological systems of different orders, characterized by their characteristic structures of their constituent elements, the type of internal and external connections these elements and certain indicators of their properties.

So, for example, if a groundwater deposit is considered as a hydrogeological system, then aquifers and aquicludes separating them act as its constituent elements; their shape and size, conditions of occurrence, distribution and their ratio characterize the structure of the system; the interaction of aquifers with each other is the internal connections of the system, and their interaction with the external environment and neighboring hydrogeological objects is the external connections of the system; properties of rocks and underground waters contained in them, expressed in the form of quantitative or qualitative indicators, are indicators of the properties of a hydrogeological system. With this approach, the main goal of hydrogeological research carried out in the study of a hydrogeological object as a system is to obtain reliable hydrogeological information about its properties, structure and inherent internal and external connections and processes, which is necessary for the correct, scientifically grounded solution of the assigned tasks with minimal labor costs. time and money [4, 6].

Materials and Methods

In Uzbekistan, groundwater is also an important part of water resources and is used in the domestic sphere, industry, and agricultural production. However, the accelerated development of agriculture may be the reason for the deterioration of the state of groundwater in the region. One such negative example can be seen in the Aral Sea region, where water, as it moves through the landscape, collects soluble salts in the regions of agricultural production. And where inadequate drainage systems of surface aquifers exist, this results in rising groundwater levels that approach the surface of the earth and in lower areas, causing common problems such as soil degradation and salinization.

Therefore, the government of Uzbekistan is making a lot of efforts that are very important from the point of view of the use of water sources, the country is developing an effective legal framework in this direction, For example, to strengthen partnerships between government and non-governmental organizations for the sustainable use of groundwater and the development of research and education in this area. There are about 100 groundwater deposits in Uzbekistan, of which 77 are fresh groundwater [1].

The Fergana Valley, an ancient irrigation oasis and an important socio-economic region of Central Asia, is the object of study by many researchers. A wide range of issues on the geopolitical, economic and social aspects of water management problems, as well as the theory of integrated water resources management in Central Asia, are presented in the works. The most valuable sources for assessing the efficiency of water use for irrigation in the Fergana Valley are works [3, 6]. The Fergana Valley is an intermountain depression located in Central Asia between the ranges of the Central and Southern Tien Shan. With a length of 475 km from west to east, and 260 km from north to south, it resembles an oval in shape, the area of which is 78 thousand square meters. km. together with the adjacent mountainous area. Fergana Valley - surrounded by mountain ranges, with a single narrow passage in the west, along which the Syrdarya river diverts water from the valley.

From the north, the valley is approached by the high ridges of the Kuramin and Chatkal ranges, from the east - the Fergana and Atoynak, and from the south - the Alai and Turkestan. 6500 rivers with a total length of 2800 km flow from the slopes of the Fergana depression. The density of the river network varies from 0.28 to 0.95 km / km^2. The territory of the Fergana Valley is divided among themselves by three states: Tajikistan, Uzbekistan and Kyrgyzstan. The flat part of the depression is located within Uzbekistan, Kyrgyzstan owns a large marginal part from the east and south, Tajikistan - the southern slopes of the Kuraminsky ridge and the western territory of the plain part of the valley [2].

The main tasks of prospecting and exploration work on underground waters, regardless of the nature of their national economic use and significance, are the following: identifying the conditions for the formation and distribution of underground water deposits; their geological-structural, hydrodynamic, hydrogeochemical and other patterns and specific manifestations; a comprehensive study and assessment of groundwater either as a mineral resource or as a factor complicating the implementation of other engineering measures; forecast of changes in hydrogeological and other natural conditions during the exploitation of underground waters or their regulation and disposal; substantiation and development of a system of measures for the most comprehensive and rational use of water and other mineral resources in the national economy.

In almost all cases, the study of groundwater is a complex study, including various types of not only hydrogeological, but also other works. The main types of hydrogeological research include the following: 1) collection, generalization and targeted analysis of materials from previous research; 2) reconnaissance hydrogeological research; 3) hydrogeological surveys and mapping; 4) drilling and mining operations; 5) field experimental filtration work; 6) modeling of groundwater filtration; 7) laboratory work; 8) observation of the groundwater regime [3, 6, 7].

When solving individual hydrogeological problems (identifying and assessing the relationship between groundwater and surface waters, justifying measures to protect groundwater from pollution, identifying the hydrogeological role of tectonic disturbances, determining the age of water, studying heat and mass transfer processes, etc.), there may be a need for balance-hydrometric and hydrological works, as well as special research methods [5, 7].

The modern topography of the Fergana Valley is the result of a long geological evolution, which can be divided into two main periods, the time boundary of which is the Paleogene. During the period from the Permian to the end of the halogen, the described region was a typical peneplain with areas flooded by a shallow sea. From the end of the Paleogene to the present time, the activation of endogenous processes and processes of uplift of the Tien Shan mountains was the cause of the formation of the intermountain Fergana depression, and the further development of this region as a separate physical and geographical unit. From the ridge of the Alai ridge towards the sands of Central Fergana, numerous transitions of relief types are observed: the deeply dissected denudation relief of high mountains is replaced by a relief of a middle mountainous appearance, which is replaced by the relief of typical foothills and low mountains, turning into widely developed foothill plains and in the central hilly-ridge parts of aeolian forms of relief. Several morphological zones are distinguished in the Fergana Valley: 1. Zone of high mountains: a) alpine relief with glacial and nival processing (3500-6500 m) b) alpine relief with erosion-gravity processing (2000-3500 m) 2. Zone of foothills (1000 -2000 m) 3. Zone of the central plain part of the valley (below 1000 m) [6, 7].

The geological structure of the Fergana Valley is extremely complex. The mountain frame is represented by powerful folded-block uplifts of Paleozoic sandstones, shales, limestones, conglomerates, gneisses, and volcanic tuffs. Foothill and forward ridges of ridges are composed of sedimentary Meso-Cenozoic rocks (conglomerates, sandstones, limestones, clays, siltstones). On the plains, they are buried under a thick layer of Quaternary deposits. Adyr ridges are composed of undivided strata of Upper Neogene Lower Quaternary deposits, represented by conglomerates, pebbles, gravel; in Southeastern Fergana, they are in places covered with a layer of loess. In terms of its significance, the subzone of low adyrs, the flat zone of fans and inter-cone depressions, composed of Quaternary deposits, is of interest. The deposits are represented by alluvial-proluvial formations of ancient and modern fan alluvial cones, covered in some areas with a layer of alluvial valleys. The orographic features of the Fergana Valley have led to a wide variety of hydrogeological conditions. Taking into account the slopes of the terrain, the level of occurrence and mineralization of groundwater, the susceptibility of soils to salinity and the availability of water, the territory of the Fergana Valley is subdivided into 10 hydrogeological zones.

In the aquifer of Paleogene sediments in the south of the Fergana artesian basin, the following horizons are distinguished: Bukhara (VIII layer), Alai (VII layer), Turkestan (V layer), Rishtan (IV layer) and Sumsar (II layer). The complex is underlain by a thick stratum (40-50 m) of waterproof gypsum, isolating the aquifers from the underlying chalk strata. Sediments of the Paleogene emerge in places on the surface in the axial parts of the structures of the adyr zone or are overlain by a conglomerate pebble stratum of continental sediments of the Sokh-Bactrian age (Chimion) or Massageta. In the clayey carbonate strata of the Bukhara stage, there are insignificant water showings of highly mineralized and brine waters. In areas of an active hydrodynamic environment of tectonically weakened and fractured zones, conditions are created for the activation of biological sulfate reduction in the rocks [6, 7].

As a result, the waters of the Bukhara deposits of a number of structures in South Fergana are enriched with hydrogen sulfide. Its maximum concentrations are noted in area I of the Shor-Su anticline (1 g / l), on more closed structures, Chimion and Obi-Shifo, they are somewhat lower (200-500 mg / l) [1, 2, 4]. Two aquifers are confined to the sediments of the Alai stage - carbonate (layer VIIa) and lime-sandy (layer VIIb). Sediments of the Alai stage were penetrated by wells in Shor-Su, Rishtan, Khankyz, Kashkarkyr, Chimion, Auval, Palvantash, etc., where brine waters of calcium-sodium chloride composition were obtained mainly. In some structures, where there are favorable conditions for the formation of hydrogen sulphide, these deposits can contain a fairly significant volume of hydrogen sulphide waters. In the rocks of the Alai Stage, they are also found in Shor-Su, Palvantash, Andijan, Chimion with H2S concentration from 100 to 300 g/l. The V formation, allocated in the clay-carbonate sediments of the Turkestan stage, is used for oil production in some fields. Basically, hydrogen sulphide waters are found on the northern side of the ledge part in each oil and gas bearing field on the southern side of the Fergana depression [3, 4, 6].

The orographic isolation of the Fergana Valley and fluctuations in altitude give the climate a great variety. Evaporation from the water surface is 1166 mm. The Fergana Valley, especially the open western part, is characterized by an intense wind regime with a variable distribution throughout the year. In the spring, the invasion of the valley by air masses disrupts the normal mountain-valley circulation of the atmosphere, and at this time the winds often have the character of dust storms, causing erosion of not only virgin, but also irrigated soils. Especially intensified wind activity is typical for the Kokand region, where a strong wind ("kokandets") is observed 53 days a year. In the last decade, a tendency towards an increase in the frequency of droughts has already become noticeable, especially in the summer and autumn seasons. If in the 80-90s of the last century drought was observed on average 2 times in 10 years, then for the period 2000-2012. extreme meteorological drought was recorded 4 times (in 2000, 2001, 2008 and 2011) [2, 6, 7].

Results and discussion

The natural and climatic features of the Fergana Valley contribute to the formation of mudflows, floods and erosion processes. Dangerous exogenous processes in the form of mudflows and floods caused by heavy rains or prolonged rains, snow melting, etc. pose a great danger to lands and farmland. 40% of mudflows occurring in Central Asia are recorded on the slopes of the Fergana Valley mountains.

It is predicted that by 2030-2050. in Central Asia, the temperature will rise by 1-3 degrees. As you know, with warming, the intensity of evaporation from the water surface of oceans, seas, lakes, and reservoirs inevitably increases. This can increase the already established level of precipitation in the mountains. Erosion of mountain slopes is increasing, mudslides are becoming more active. The intensity of siltation of water bodies such as reservoirs will increase. To accumulate the increasing runoff of liquid and solid precipitation, the researchers propose to increase the volume of large reservoirs in order to avoid siltation.

The main sources of surface water resources in the Fergana Valley are the Naryn and Karadarya rivers and the Syrdarya formed by them, as well as mountain tributaries, the so-called small rivers. The water resources of the Syrdarya basin are very limited and are estimated at 24.62 km^3 for 90% years of supply. River runoff is characterized by significant irregularity, both intra-annual and long-term. Due to the snow-glacial nature of the feeding in the annual runoff regime, the maximum occurs in the spring-summer period, and the minimum in the autumn-winter period. In the long-term regime, there is an alternation of low-water and high-water years. Low-water years come after 4-7 years, have a protracted nature (up to 6 years), and high-water years - after 6-10 years and have a duration of 2-3 years, but more often occur singularly. The river runoff in the Syrdarya basin in a dry year (90% of supply) is 9.7 km^3 less than in a year with an average water content. The runoffs of the main rivers of the basin of various supplies (50%, 75% and 90%) and the variation coefficients characterizing runoff variability are shown in Table 1. [6].

Groundwater forms in all geological complexes and is ubiquitous. The total volume of groundwater in the Fergana Valley is determined at 6.5 million m^3, which is 38.6% of the operational reserves of all groundwater in Uzbekistan. The largest groundwater deposit is the Sokh River basin. A number of groundwater deposits have the status of protected areas, including the Chimyon-Avval deposit, which is being formed in the area of the Isfayram-Shakhimardan sub-project [8].

Table 1: River runoff of the river. Syrdarya of various supply, km^3

River	Security			c_v
	50%	**75%**	**90%**	
Naryn-Toktogul	13,76	11,75	10,18	0,23
Rivers of the Fergana Valley	11,61	9,69	8,22	0,25
Chirchik, Angren, Keles	6,59	7,11	5,95	0,27
Middle flow rivers	0,36	0,31	0,27	0,21
Total to Chardara reservoir	34,32	28,86	24,62	

Source: GEF Project Water Resources and Environment Management. National report of the Republic of Uzbekistan, 2001.

The analysis showed that the total replenishment of groundwater reserves is 1 250.6 thousand m^3/day, which is 85.6 thousand m^3/day. exceeds the total water use, including the expected consumption from new wells. This value is ecologically sustainable and does not pose any risk to the potential and level of aquifers. Groundwater is mainly used for drinking water supply and land irrigation, and in some parts of the basin is the only source of irrigation water.

The listed types of hydrogeological research allow solving the main tasks for the study of groundwater deposits. However, to ensure a more successful and effective solution of the tasks set and increase the geological and economic efficiency of the main types of hydrogeological studies in combination with them, various types of geophysical surveys are widely used, both ground-based (areal surveys from the surface, profiling, near-wellbore surveys) and borehole (a set of various types of logging studies in wells).

Conclusion

To modernize the irrigation system, it is necessary to systematically assess the soil-reclamation state of lands, clarify the irrigation regimes that correspond to these conditions and the requirements of the crops grown, select a technically optimal irrigation scheme suitable for a specific terrain, soil conditions, in which water losses due to discharge and infiltration will be minimal. The use of geophysical research turns out to be expedient at all stages of prospecting and prospecting for groundwater, and therefore, in recent years, they are considered as an integral part of the general complex of prospecting hydrogeological works, although in some cases geophysical research can be of independent importance [3, 4].

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