International Journal of Geology, Earth & Environmental Sciences ISSN: 2277-2081
An Open Access, Online International Journal Available at http://www.cibtech.org/jgee.htm
2025 Vol. 15, pp. 27-33/Ruzimov
Research Article

ASSESSMENT AND STUDY OF THE PROPERTIES OF THE OSH-ARAVON GROUNDWATER DEPOSIT

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ABSTRACT
This article analyzes key aspects such as the geological characteristics of the area, data from hydrological and chemical analyses, results of long-term monitoring observations, and the impact of climate change to assess and study the characteristics of the Osh-Aravon groundwater deposit. In particular, the formation of groundwater in the territory, the features of its formation, the level and depth of occurrence of groundwater, quality and quantitative indicators, which are the basis for maintaining the monitoring system, are presented.

Keywords: *Groundwater Deposit, Groundwater Resources, Atmospheric Precipitation, Air Temperature, Operating Well, Groundwater Level, Global Climate Change, Mineralization*

INTRODUCTION
Studying and assessing global changes in groundwater and the impact of other natural and technogenic processes on it is considered one of the priority areas worldwide. For this reason, developed countries are devising and implementing state programs aimed at identifying the causes of changes in groundwater and mitigating their negative consequences.

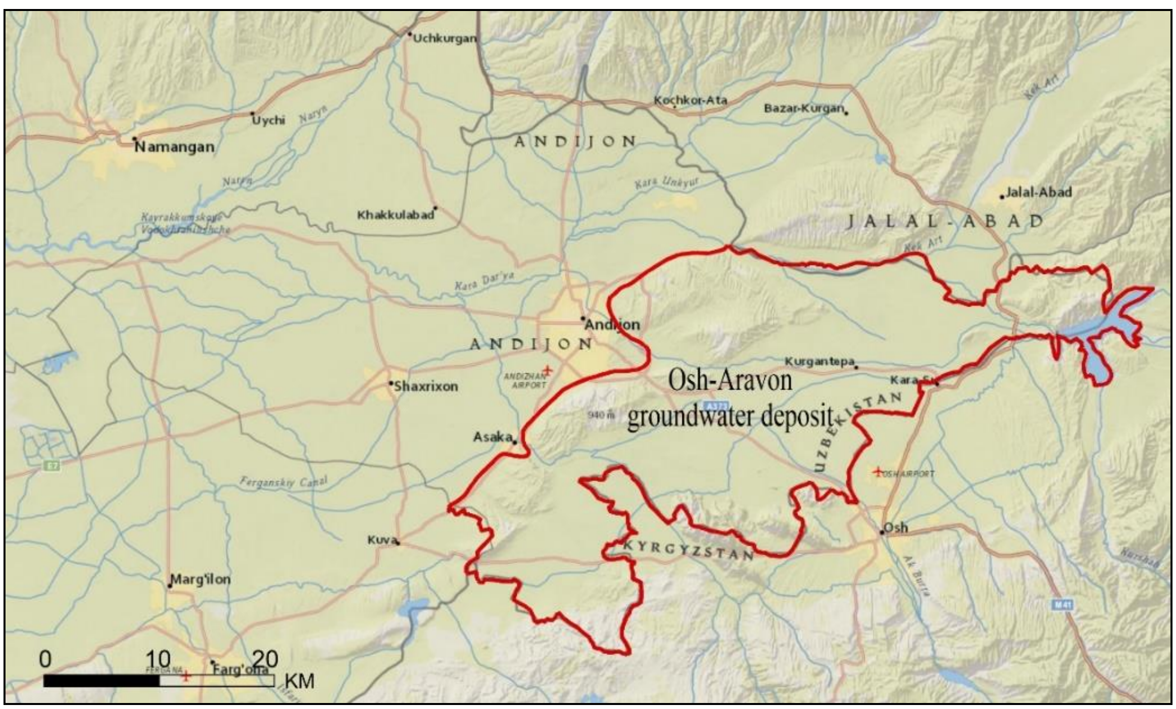

Figure 1. General location map of the research area

The Osh-Aravon groundwater deposit is located in the east of the Andijan region, in the southeastern part of the Fergana Valley, and geologically in the hilly depression of the same name (Figure 1). The boundaries of this groundwater deposit are the Polvontosh-Andijan-Alamushuk range in the west and north, the natural boundary of the Kagart Basin and the Sugandi Range in the northeast, and the Osh hills and the Karachatur Mountains in the south. It borders the Jalal-Abad and Osh regions of the Kyrgyz Republic to the north, south, and east, the Kuva district of the Fergana region to the southwest, and the Andijan and Asaka districts to the west.

The Osh-Aravon Trans-Adir Basin is a small hydrogeological structure, consisting of the Sokh, Tashkent, and Mirzachul Quaternary deposits of the alluvial fans of the Akbura, Aravansay, and Karadarya rivers, with areas of local groundwater recharge, transit, and discharge. This deposit is formed mainly due to the infiltration of surface waters (Mavlonov *et al.*, 2025).

The hydrographic network of the groundwater field area consists of numerous natural and artificial watercourses. The largest natural watercourses are the Karadarya, Akbura, and Aravansay rivers. The most abundant of them is the Karadarya River. The flow of the Karadarya is formed by the confluence of the Tar and Karakulja rivers, which collect water from the southwestern slopes of the Fergana Range and partly from the northern slopes of the Alay Range.

The Karadarya belongs to the category of rivers fed by hidden glaciation, with its maximum flow in July-August and its minimum flow in November-February. From the confluence of the Tar and Karakulja rivers to the village of Kampirravot, the river flows in a wide terraced valley, where its channel is heavily branched and mainly composed of gravel.

The Akbura and Aravansay rivers, flowing down from the Alay Range, are fed by glacial and snowmelt waters.

MATERIALS AND METHODS

Today, groundwater remains the main source of water supply for various needs. The growing demand for groundwater also increases the risk of groundwater depletion and pollution. This requires protecting groundwater from pollution and depletion. In this regard, the requirements for information on the state of rational use and protection of groundwater are increasing year by year.

Specialists of the Institute of Hydrogeology and Engineering Geology and the regional hydrogeological station conducted large-scale studies to monitor the hydrogeological conditions of the territory, develop proposals for the prevention and elimination of various negative processes. Initially, long-term data collected as a result of previously conducted research were studied and analyzed. The main goal was to study and assess the hydrogeological conditions of the territory, including the current state of groundwater, using modern computer programs and long-term observational data.

The process of studying and assessing groundwater resources is complex and comprehensive, and the analysis and assessment of water resources opens up opportunities for their rational and long-term exploitation. To assess and study the characteristics of the groundwater deposit, the main aspects of the area were analyzed, such as geological characteristics, hydrological and chemical analyses, the results of long-term monitoring observations, and the impact of climate change.

RESULTS AND DISCUSSION

The studied territory is distinguished by its unique hydrogeological conditions, and research has been conducted in this area in such key areas as providing the population with drinking water, searching for and using mineral and therapeutic waters, as well as searching for and exploring oil and gas deposits. The work of many scientists has contributed to the study of groundwater.

Research conducted by scientists and specialists of the State Establishment "Uzbekhydrogeology", the State Establishment "HYDROINGEO Institute", and the State Enterprise "Fergana Hydrogeological

Expedition" is of great importance in the study of groundwater in the region. Through their hydrogeological studies, the formation of groundwater, its movement, natural and man-made factors influencing it, and groundwater reserves were determined. This research work continues to this day. The main goal of the conducted research is to protect existing freshwater reserves, their rational use, and provide the population with clean drinking water. (Ruzimov *et al.,* 2022).

Hydrogeological studies on the study of the groundwater regime and balance of the Fergana Valley, conducted by the Fergana Hydrogeological Station since 1933, have also covered the area under consideration since the 1950s.

In 1945-48, the Fergana Hydrogeological Station conducted surveys of the observation network of water management organizations in the Fergana Valley. Based on these data, a map of groundwater depths at a scale of 1:200,000 was compiled.

Starting in 1947, the Fergana Hydrogeological and Engineering-Geological Party began stationary observations of the groundwater regime in the district, which are still carried out by the Andijan Hydrogeological Station.

In 1951, V.P. Gaines, using data from previous studies, compiled a general report for 1945-49 based on the materials of the Fergana Hydrogeological Station. This work was practically the first monographic collection, and also served as the basis for three-year and ten-year general reports on the groundwater of the Fergana Valley, its state and importance in the national economy (Ruzimov *et al.,* 2022).

From a hydrogeological point of view, the Osh-Aravon groundwater field contains everything from natural clean drinking water to highly mineralized and rare valuable components. They are used in all sectors of the national economy. Therefore, changes in the hydrogeodynamic and hydrogeochemical parameters of groundwater are characterized separately for each groundwater deposit. The regional hydrogeological station studies groundwater (groundwater and pressure) belonging to Quaternary aquifers (reaching a depth of up to 300 meters) (Ruzimov *et. al.,* 2022).

The role of groundwater in the national economy is undoubtedly high. They are the main source for meeting the needs of the urban and rural population, as well as all industrial enterprises for drinking and industrial technical water supply. In recent years, the use of groundwater for irrigation has intensified, especially during the irrigation season.

In the head parts of the discharge cones, groundwater is located at a depth of 5-8 meters to 48-50 meters, while in the main part of the foothill zone, it lies at a depth of 1-3 meters.

Water-permeable gravel layers settle at the hypsometrically lower edges of the discharge cones, mixing with fine soil and forming layers. As a result, groundwater acquires a pressure character, and its level rises above +10 meters. The water flow rate of self-flowing wells can range from 3-5 l/s to 10-20 l/s and even more.

The Sokh aquifer complex is located at a depth of 200-220 meters in the upper parts, and at the edges of the alluvial fans at a depth of 240-260 meters, and its open thickness is 150-200 meters. The water flow rate of wells ranges from 5 to 36 l/s, and the specific water flow rate varies from 0.4 to 3 l/s. The filtration coefficients of the permeable layers fluctuate from 2.0 to 21 m/k-k. The water is fresh, with a mineralization level of up to 1 g/l and a total hardness of 3-5 mg-eq/l, sometimes up to 10 mg-eq/l.

The Tashkent water complex is located at a depth of 70-110 meters, and its thickness is 140-190 meters. Permeable rocks consist of coarse stones and gravel at the head of the alluvial fan, and fine gravel, crushed stone, and sand at the edges.

The flow rate of wells varies from 10 l/s to 60 l/s, the specific flow rate from 0.5-3 l/s to 10-20 l/s, and the filtration coefficient varies within 10-60 m/s. The waters are mainly fresh, with a mineralization level of up to 1 g/l, with the exception of some local areas.

The deposits of the Mirzachul aquifer complex are composed of large stones, gravel, crushed stone, and sand with a thickness of 3-5 meters to 110 meters. The water flow rate of wells varies within the range of 5-15 l/s in the interconical depression zone, 10-25 l/s in the head parts of the cones, and 25-70 l/s in the outer parts. The mineralization of groundwater is mainly up to 1.0 g/l.

In order to determine the impact of climate change at the Osh-Aravon underground water field, changes in air temperature were analyzed based on data from the Andijan meteorological station. A graph of chronological differences was compiled based on the average annual air temperature values of the Andijan meteorological station (Figure 2).

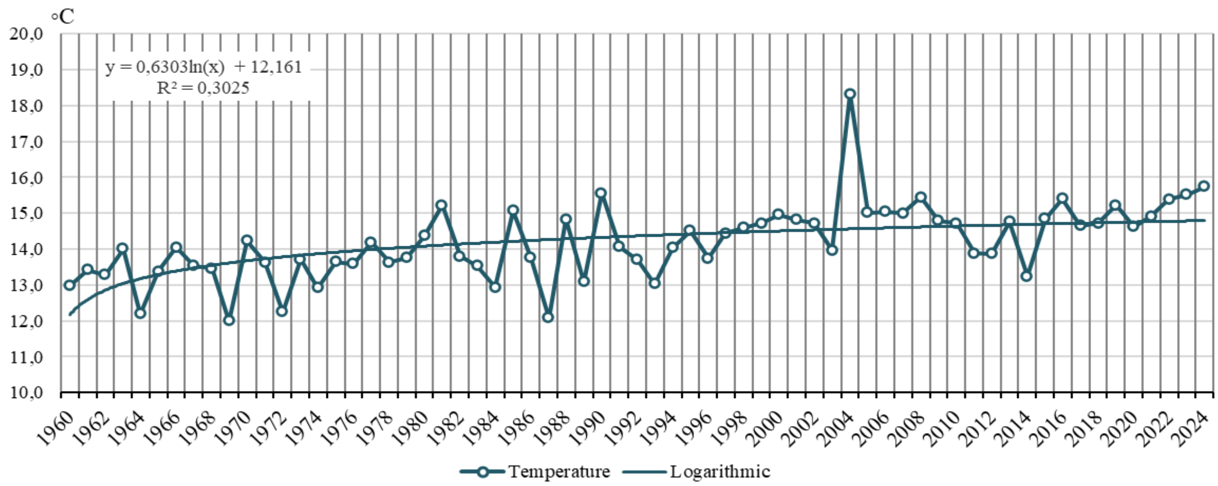

Figure 2. Graph of chronological differences in air temperature (°C) based on data from the Andijan meteorological station. (1960-2024)

The chronological graph shows an increase in the average annual air temperature at the Osh-Aravon groundwater field. Trend values clearly confirm this. During 1960-2024, the trend growth of air temperature was +1.4°C. During these years, the lowest average annual air temperature was +12°C in 1969 and the highest temperature was +18.3°C in 2004. The average long-term air temperature was +14.2°C.

In general, a relatively low amount of precipitation is characteristic of the study area. The distribution of precipitation by seasons is very uneven. The amount of atmospheric precipitation increases in the southeastern and especially in the southern directions. According to the Andijan meteorological station, the average annual precipitation for many years (1960-2024) is 237.5 mm. Precipitation is mainly observed in the spring-winter period, i.e., in December-March. Therefore, the lowest value of moisture deficit is recorded in the winter season, and the highest - in the summer season.

Climate change destabilizes river flow, leading to sharp fluctuations in flow, sometimes severe floods, and sometimes prolonged droughts. This poses significant threats to river use, water resource management, and the conservation of natural ecosystems.

According to the data of long-term observations of the water flow of the Karadarya River (Figure 3), during 1974-2023, the highest average annual flow was recorded in 1979 (143 m3/s), 1999 (152.54 m3/s), and 2004 (135.3 m3/s), and the lowest in 2011 (14.33 m3/s), 2009 (12.51 m3/s), 2016 (13.36 m3/s), and 2023 (5.28 m3/s). During this period, the flow rate fluctuates from 5.28 to 152.54 m3/s. In the period from 1974 to 2023, the average multi-year flow decreased by 5.28 m3/s. Changes in the water discharge of the Karadarya River as the temperature increases, the river discharge decreases.

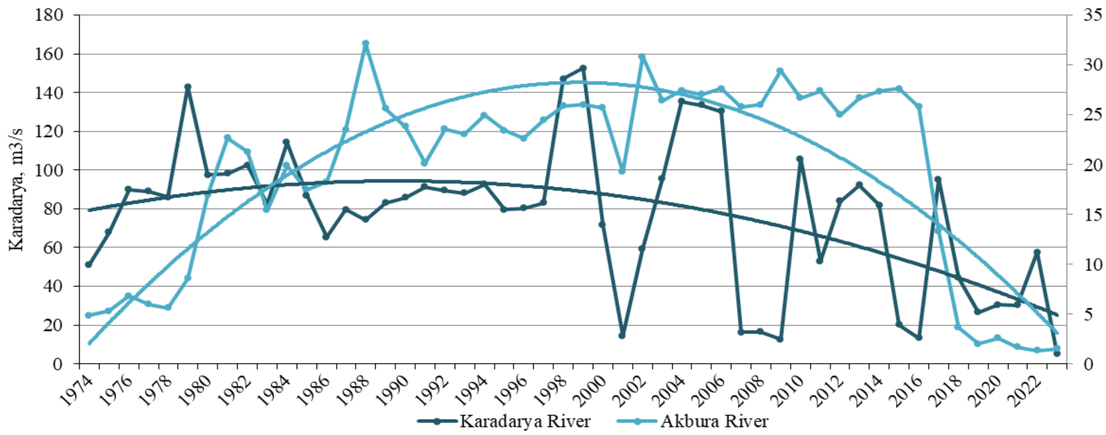

Figure 3. Graph of chronological differences in the average annual flow of the Karadarya and Akbura rivers. (1974-2023)

The results of long-term observations at the Tuleken hydropost show that the minimum average annual water discharge of the Akbura River was recorded in 1974 (4.87 m3/s), and the maximum in 1988 (32.11 m3/s). When analyzing the water discharge in the Akbura River for 1974-2023, it was noted that the flow rate gradually increased, and in 1979-2016, the flow rate increased almost 2 times.

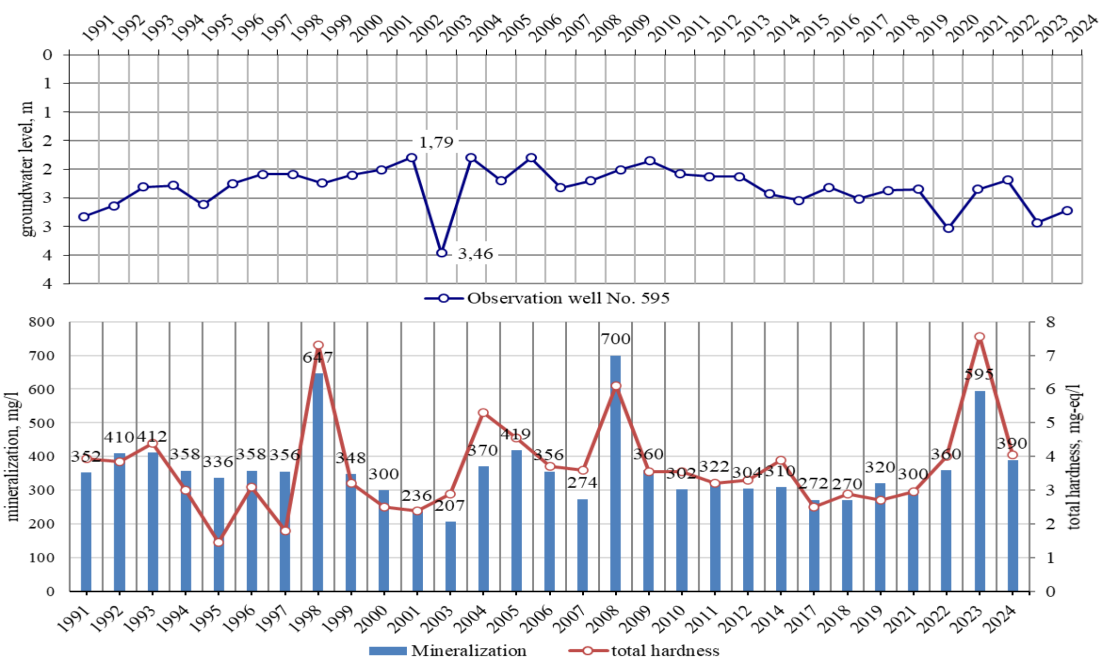

Figure 4. Graph of chronological differences in the hydrogeodynamic and hydrogeochemical indicators of groundwater of observation well No. 595. (1991-2024)

Changes in the hydrogeodynamic and hydrogeochemical parameters of groundwater were analyzed in relation to the decreasing rate of river flow. Based on long-term data from observation well No. 595, drilled in the groundwater formation zone to study the influence of the Karadarya River headwaters and the Andijan Reservoir, a graph of chronological differences in the hydrogeodynamic and hydrogeochemical indicators of groundwater was constructed (Figure 4). The observation well is 50 meters deep and is geologically situated in the Tashkent (QIII) complex. Against the backdrop of decreasing river discharge, the groundwater level in the observation well is also declining.

As a result of observations, it was noted that in the period from 1991 to 2024, the highest indicator of multi-year level changes was 1.79 meters, and the lowest indicator was 3.46 meters. Moreover, when analyzing data on the mineralization and total hardness of groundwater for 2002-2024, the trend of their change changes proportionally to each other.

The noted changes in hydrogeodynamic and hydrogeochemical parameters cause serious concern for the future of fresh groundwater in the field. From year to year, the boundary of solid water distribution shifts along the flow, reducing groundwater reserves suitable for domestic and drinking water supply.

No significant changes in the hydrogeochemical regime of groundwater in the main water-bearing layers of Quaternary deposits have been established, however, long-term observations have shown a slight increase in their mineralization (Kurgantepa, Pakhtakor water intakes). In the main part of the depression, the mineralization and total hardness of groundwater fluctuate within the range of 0.20-0.60 g/l and 3-6 mg-eq/l, in some sections of the head part of the alluvial fan and in interconical depressions - within the range of 0.6-0.7 g/l and 6-10 mg-eq/l. The latter situation requires detailed observations to identify the causes of pollution to develop reasonable methods for eliminating pollution.

Conclusion

About 83% of the average annual groundwater from operational wells in the territory of the Osh-Aravon underground water field is used for domestic and drinking water. In the groundwater field, from October 2021 to October 2022, the groundwater level in existing observation wells (598, 597, 593, 27b, 17b) decreased by an average of 1.30 meters, in some places by 1.80 meters. In non-irrigated areas, a decrease of up to 3.5 meters was observed in the foothill areas. The reason for this is the fact that the water of the Karadarya and the adjacent rivers of the Andizhansay, Shakhrikhansay and the flow of water from the neighboring Kyrgyz Republic is decreasing year by year, and at the same time, the amount of atmospheric precipitation is decreasing. In the southwestern part of the Osh-Aravon groundwater deposit, that is, in the foothill and mountainous areas bordering the neighboring Kyrgyz Republic, an increase in the chemical composition of groundwater from 1.2 g/l to 1.5 g/l was observed. Based on this, it would be advisable to pay special attention to the condition of the Osh-Aravon underground water field, which is considered a promising one in the region, and to strengthen monitoring work.

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