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Ecological State Of Groundwater In The "Avval" Township Of Fergana District

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Abstract: This article is devoted to assessing the ecological state of groundwater in the territory of Avval town. The paper examines the hydrogeological conditions of the area, factors influencing groundwater formation, anthropogenic impacts, sources of pollution, and the results of ecological monitoring. Laboratory analyses showed that some groundwater quality indicators deviate from sanitary standards, revealing, in particular, a potential risk related to nitrate levels.

Keywords: Groundwater, ecological state, Fergana district, Avval town, pollution, legislation, monitoring.

INTRODUCTION:

Groundwater is one of the most important natural resources for meeting the drinking water, agricultural, and industrial needs of the population. In the conditions of the Fergana Valley, especially in Avval town, the volume and quality of groundwater play a decisive role in the socio-economic development of the area. In this region, groundwater is mainly formed within alluvial deposits and the process of natural recharge is quite intensive; however, in recent years, the increase in anthropogenic pressure has had a negative impact on water quality.

The presence of more than 510 water intake facilities in the area and the abstraction of 611 thousand m³ of water per day exert serious pressure on the level and quality of groundwater. Therefore, this study is aimed at determining the ecological state of groundwater in Avval town, identifying existing problems, and assessing them.

The Avval area, where these fresh groundwater resources are formed, has been granted the status of an "Avval Ecological Village," included among specially protected natural areas, and its total area is 17,036 ha.

METHODS

As noted in scientific sources, in the Fergana Valley the changes in groundwater levels, pollution trends, and anthropogenic impacts are intensive (Rustamova, 2023; Tursunova, 2024). One of the main ecological problems of groundwater is the transfer of nitrates into aquifers as a result of excessive use of nitrogen fertilizers in agriculture.

Khojanazarov (2018) and Karimov (2020) have scientifically substantiated the influence of structural changes in hydrogeological layers, infiltration processes, and flow velocity on water quality. The "State Groundwater Monitoring Guidelines" (2022) developed by Uzhydromet define the mandatory directions of monitoring (dynamics of groundwater levels, chemical composition, sources of pollution, hydrogeological processes, and GIS-based control).

In our country, the use and protection of groundwater are regulated by the "Water Code of the Republic of Uzbekistan" adopted on 30 July 2025 and by Resolution No. PQ-439 of the President of the Republic of Uzbekistan dated 7 December 2022 "On additional measures to regulate the protection and rational use of groundwater resources." On the basis of these legal documents, water resources have been declared state property and their monitoring is mandatory.

Based on the above documents, the main directions of monitoring for determining the ecological state of groundwater were formulated in accordance with scientific and legal requirements. In this context, the main content of monitoring for assessing the ecological state of groundwater is studied on the basis of the following aspects (Table 1).

Table 1

Ecological monitoring of groundwater

(“State Groundwater Monitoring Guidelines”, Uzhydromet, 2022)

Monitoring area	Main content
1. Monitoring changes in water level	Recording maximum and annual fluctuations of the piezometric level; analysing dynamics caused by anthropogenic impacts (wells, drainage, irrigation).
2. Analysis of water quality and chemical composition	Measuring pH, mineralization, hardness, chlorides, sulfates, hydrocarbonates; monitoring heavy metals (Pb, Cd, Cu, Hg), nitrate, nitrite, pesticides, phenols, petroleum products; assessing compliance with drinking and technical water standards.
3. Monitoring hydrogeological processes	Tracking changes in direction, velocity and pressure of groundwater flow; analysing infiltration and recharge processes; assessing changes in the structure of hydrogeological layers (fracturing, density of sandy layers, etc.).
4. Identifying sources and risks of pollution	Identifying industrial, municipal and agrochemical pollution sources; monitoring emergency (accidental) pollution zones; delineating areas with violated sanitary-protection zones.
5. Assessing environmental impact of water abstraction	Studying the impact of wells and hydraulic structures on groundwater level; identifying conditions causing drawdown cones, water scarcity and deterioration of water quality.
6. Assessing environmental safety indicators	Determining natural rates of groundwater renewal; assessing impacts on ecosystems (rivers, springs, wetlands); calculating ecological standards for water.
7. Control based on GIS and remote sensing	Preparing thematic maps of groundwater distribution, level and pollution; identifying infiltration and soil-moisture zones using satellite data.
8. Entering monitoring data into the state register	Regularly entering data into the state water cadastre; preparing annual and quarterly reports; transmitting operational monitoring information in emergency situations.

The monitoring system for assessing the ecological state of groundwater is based on a comprehensive study of groundwater levels, quality, chemical composition, and hydrogeological processes. During the monitoring, sources of pollution are identified and the impact of water abstraction on ecosystems is assessed. With the help of GIS technologies, detailed maps are created showing the distribution of water resources and their ecological risks, and all results are entered into the State Water Cadastre. This systematic approach makes it possible to protect groundwater, ensure its rational use, and guarantee environmental safety.

RESULTS AND DISCUSSION

In order to determine the quality indicators of groundwater located in the territory of Avval town, samples were taken from three different underground springs within the town, and monitoring was carried out on spring depth, water pH level, hardness, and nitrate and heavy metal content (Table 2).

Table 2

Quality indicators of groundwater samples taken in Avval town

Sample No.	Depth (m)	pH	Hardness (mg-eq/l)	Nitrate (mg/l)	Heavy metals (µg/l)	Comments
1	11.1	7.2	6.5	45	15	Within norms
2	12.0	7.5	6.8	51	18	Within norms
3	12.6	7.7	7.0	53	21	Within norms

The analyses were evaluated in accordance with Uzbekistan's sanitary norms and WHO standards.

As can be seen from the table, the depths of all three sampled wells range from 11.1 to 12.6 meters. This indicates that the groundwater is located in a relatively shallow layer.

- The pH values range from 7.2 to 7.7, which means that the water has a reaction close to neutral and slightly alkaline. This indicator fully complies with the current sanitary norms for drinking water in Uzbekistan.
- Water hardness is around 6.5–7 mg-eq/l. These values correspond to water of medium hardness and are considered acceptable for domestic use and agricultural needs.
- Nitrate concentrations range from 45 to 53 mg/l. According to the standards of Uzbekistan and the World Health Organization (WHO), the maximum permissible limit for nitrates is 50 mg/l. While samples 1 and 2 fall within the norm, the value of 53 mg/l in sample 3 is slightly above the permissible limit. This indicates a potential risk of slight nitrate pollution in the area.
- Heavy metal concentrations are between 15 and 21 µg/l, which is a safe level in all samples. Compared with the maximum permissible concentrations, these values are low, and no significant impact from industrial or other anthropogenic sources is observed.

In the table, the comment "Within norms" is given for all samples. Most indicators do indeed meet sanitary standards; however, a cautious approach is recommended regarding the nitrate level in sample 3.

The results show that the deterioration in water quality is mainly associated with agricultural activities and the uncontrolled disposal of household waste. It is necessary to strengthen legal control, use water resources rationally, and establish continuous hydro-ecological monitoring.

The situation observed in the Avval area is consistent with the results of other studies conducted in the Fergana Valley (Rustamova, 2023; Tursunova, 2024). The increase in nitrates confirms the high intensity of agricultural activity in the region. This may pose a risk to water consumers, especially young children and groups with weakened immunity.

Although water hardness and pH remain within the norm, the increase in nitrate concentration should be regarded as one of the early signs of groundwater degradation. The low level of heavy metals indicates that industrial impact in the area is minimal.

CONCLUSION

The ecological state of groundwater in the territory of Avval town is assessed as moderate. Signs of pollution have been identified in the chemical composition of the water. To eliminate these problems, it is necessary to strengthen environmental control and raise public awareness about the rational use of water. The general trend in groundwater is partial pollution and a decline in quality.

The main sources of groundwater contamination are runoff of agricultural chemicals (nitrogen, phosphorus, pesticides), insufficient sewage and waste management, and, in some places, salinization and the impact of industrial effluents. The main ecological hazards of polluted water are nitrate substances (nitrites) and microbiological contamination (coliforms), whose effects on human health pose a particular risk to young children and people with weakened immunity. Exceeding the maximum permissible levels of salts and metals can have a negative impact on soil, water, and local ecosystems.

Groundwater is a priceless gift of nature and is extremely important for human life and ecological balance. Today, groundwater pollution and depletion are among the global-scale problems. Therefore, protecting groundwater, ensuring its rational use, and maintaining its sustainability are urgent tasks for present and future generations. Through joint efforts of state bodies, scientific institutions, and the public, it is possible to preserve and protect this valuable natural resource.

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