HYGIENIC ASSESSMENT OF WATER QUALITY IN DOMESTIC DRINKING WATER SUPPLY SYSTEMS OF SAMARKAND

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The article provides a comprehensive hygienic evaluation of drinking water quality in both existing and prospective domestic water supply systems of Samarkand. The research analyzes key hydrochemical and microbiological indicators, emphasizing the implications of anthropogenic and abiotic contaminants found in local water sources. The study utilized extensive analytical data derived from over 720 samples collected from wells, clean water reservoirs (CWR), and the Zarafshan River, resulting in approximately 6480 laboratory determinations covering microbiological parameters, toxicological elements, organoleptic properties, and radioactive contaminants.Results indicate that the groundwater primarily serving Samarkand is generally safe, showing minimal microbial contamination and compliance with established hygienic standards. Groundwater quality has remained consistently high, without significant anthropogenic pollutants detected. However, the assessment revealed a notable deficiency in fluoride concentrations (0.14-0.28 mg/L), raising concerns regarding increased risks of dental caries among the local population. Additionally, certain local water intakes demonstrated increased hardness and mineralization levels due to natural geological processes, particularly noticeable at the Bolibalandand Chupon-ota water intakes.The research highlights the necessity for maintaining rigorous sanitary protection measures, especially due to ongoing anthropogenic impacts such as agricultural activities and uncontrolled excavation operations near the water intakes. Furthermore, long-term data analyses (1990-2024) suggest potential fluctuations in groundwater mineralization linked to climatic variations and irrigation practices affecting the Zarafshan River's hydrological regime. Conclusively, the current Samarkand water supply sources are robust and reliable, yet the establishment of additional water intakes, especially near Chubot village on the Zarafshan River, is recommended. This strategic development could significantly enhance the sanitary reliability and long-term sustainability of the city's water supply infrastructure, ensuring public health safety and improving overall water quality management.

Keywords: domestic and drinking water supply systems, drinking water quality, hygienic assessment, public health, water intake structure, water pumping station.

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1. Introduction

The right to access to quality drinking water is of key importance for health, and one of the basic human rights, an integral part of an effective health policy in Uzbekistan [1, 2]. However, the lack of quality drinking water not only dramatically reduces the level of comfortable living of the local population, but also significantly increases the risk to their health [3, 4]. According to the World Health Organization (WHO), today the greatest risks to the safety of drinking water are associated with pollution by arsenic, fluoride or nitrates, but new sources of pollution such as pharmaceuticals, pesticides, polyfluoroalkyl substances and microplastics, as well as climate change are of growing concern [5].

In the Samarkand Declaration of the Council of Heads of State of the Shanghai Cooperation Organization on 16 September 2022, the member states emphasized that the lack of safe drinking water, lack of access to basic sanitation services and the ability to maintain healthy hygiene are serious problems for the countries of Central Asia [6]. In this regard, the problem of preserving existing and searching for new water supply sources for citizens of Uzbekistan, in particular for residents of large cities, including Samarkand, is particularly relevant [7,8].

Fresh groundwater is used to provide consumers with drinking water in Samarkand. It is traditionally considered a more reliable source of high-quality drinking water, protected from anthropogenic pollution, especially in terms of microbiological and parasitological indicators. Groundwater is mainly fed by filtration of surface waters of the Zarafshan River, irrigation canals and ditches. Feeding by underground runoff from the mountainous part of the valley, from the foothill plains and by precipitation is of secondary importance. A characteristic natural feature of the chemical composition of groundwater is its compliance with the requirements of SanPiN (Sanitary rules and regulations) RUz No. 0211-06 "Hygienic criteria and quality control of water in centralized systems of domestic and drinking water supply to the population of Uzbekistan." However, global climate change will significantly affect the flow of the Zarafshan River, which over time may lead to a shortage of groundwater at existing water intakes and affect the chemical composition of the water.

In this regard, the problem of preserving existing and searching for alternative water supply sources for a sustainable and reliable supply of residents of Samarkand with drinking water is especially urgent. At the same time, a comprehensive hygienic assessment of the quality of drinking water in existing and potential domestic and drinking water supply systems, taking into account the presence of chemicals of abiotic and anthropogenic nature, allows us to make a scientifically sound forecast of the impact of water quality on public health, as well as to establish trends in changes in the chemical composition of water based on long-term observations.

The objective of the study is a hygienic assessment of the quality of drinking water in the planned and existing domestic and drinking water supply systems of Samarkand, an assessment of its physiological adequacy and trends in change.

2. Object, subject and methods of the study

The object of the study was the existing and potential water intakes, distribution nodes and networks of domestic and drinking water supply in Samarkand. The subject of the study was the hygienic indicators of drinking water to assess their compliance with the regulatory requirements of Uzbekistan and the impact on the health of the local population.

The study used the results of laboratory studies of drinking water supplied to the population of Samarkand over a long period, carried out in accordance with the approved schedule of analytical control in accordance with the requirements of regulatory documents of Uzbekistan [2, 9-14], as well as within the framework of the implementation of the program for the modernization of the infrastructure of Samarkand under DP-372 dated 09/08/2022. The quality of surface water in the Zarafshan River was also analyzed as a potential source of water supply for Samarkand. In total, over 720 samples from wells, clean water reservoirs (CWR) and the Zarafshan River were analyzed and statistically processed, in which 6480 analytical determinations were made. Mathematical processing of materials was carried out using MS Office programs on a personal computer.

The quality of water from wells, CWR and the Zarafshan River was studied by the following indicators:

- microbiological indicators (total microbial count, number of coliform bacteria);
- toxicological indicators according to MAC (lead, cadmium, fluorine, nitrates, nitrites, ammonium);
- organoleptic indicators and MAC of components standardized by the effect on the organoleptic properties of water (taste, odor, turbidity, color, pH, total mineralization, iron, total hardness, manganese, copper, polyphosphates, sulfates, chlorides, zinc);
- indicators of radioactive contamination (total beta radioactivity).

3. Results of the research and their discussion

Existing water intakes. To provide consumers with drinking water in Samarkand, there are two main water intakes, Chupon-ota and Dagbit (Fig. 1), as well as several local water intakes of low productivity, intended for water supply of individual microdistricts not connected to the main ring network of domestic and drinking water supply [14].

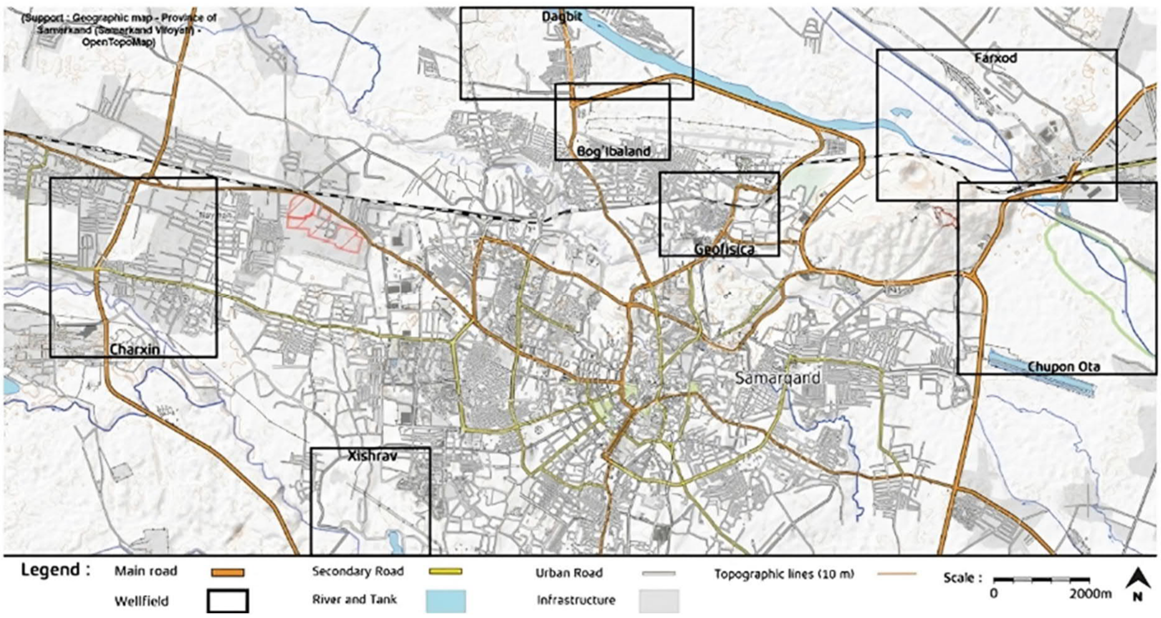

***Fig. 1.** Layout of water intakes in Samarkand*

Analysis of long-term observations of drinking water quality indicators in Samarkand shows that groundwater is classified as hydrocarbonate in chemical composition, less often as sulfate, and is safe in epidemiological terms, harmless in chemical composition, has favorable organoleptic properties, and is safe in terms of radiation. No anthropogenic organic pollution (aromatic hydrocarbons, pesticides, petroleum products, etc.) was detected, or their concentrations were much lower than the maximum values, indicating the absence of significant external influence of urban (sewage) or agricultural (nitrates, phosphates, pesticides) factors, including from the surface waters of the Zarafshan River. No cases of significant pollution of drinking water with iron ions were recorded either at water intakes or at the final consumption sites, indicating an insignificant level of corrosion of domestic and drinking water supply pipelines.

Microbiological parameters in groundwater are regularly monitored by the water utility and sanitary and epidemiological station laboratories. Water samples are regularly taken from operating wells before disinfection, as well as from the CWR (clean water reservoir) after water treatment with liquid chlorine. The sampling results show the presence of a very low, constant number of bacterial colonies (from 15 to 30 colonies) in groundwater over a long-term observation period (Table 1). No significant changes in the microbiological parameters of groundwater were observed in the period from 1990 to 2024, which indicates a high degree of protection of water intakes from contamination.

Table 1. *Indicators of the Microbiological Adequacy of Drinking Water*

Parameter	1990-1999	2000-2009	2010-2014	2015-2024
Chupon-ota				
Number of samples per year	60	60	60	100
Coliform index	3	3	3	3
Coliform titer	320 – 333	320-333	320-333	320-333
Total colonies	17 – 30	15-30	16-30	17-30
Dagbit				
Number of samples per year	60	60	60	100
Coliform index	3	3	3	3
Coliform titer	320 – 333	320-333	320-333	320-333
Total colonies	15 – 30	15-30	15-30	15-27

Deterioration of groundwater quality in terms of microbiological indicators is possible only in the case of a long break in the operation of wells, however, according to the technological regulations, stagnant water from wells is discharged onto the terrain and does not enter the CWR.

In the normal mode of operation of wells, a small number of bacterial colonies are destroyed by disinfecting water in the CWR before supplying it to the city's domestic and drinking water supply network. The content of free residual chlorine in drinking water was within the standard values of 0.2-0.5 mg/L, with the exception of rare cases of its slight excess.

The assessment of the physiological adequacy of the mineral composition of water was carried out according to the methodological recommendations [2], the results are presented in Table 2. Drinking water at all water intakes is characterized by a reduced content of fluoride ions at a level of 0.16-0.28 mg/L, which, according to WHO studies, increases the risk of developing caries, because fluorides participate in the formation and strengthening of bone tissue and tooth enamel [3,15,16].

The total hardness and mineralization of water are components of natural origin, their concentrations over the entire observation period were within the optimal values of 3.8-7.1 mg-eq/L. Only at the Bolibaland water intake the total hardness values been recorded at a level of 9.1-9.8 mg-eq/L over a number of years, which is higher than the optimal values, but does not exceed the approved MAC.

At some wells of the Chupon-ota water intake, elevated values relative to the average values of mineralization and total hardness were recorded, which may be associated with the erosion of deeper limestone aquifers.

For example, the level of total hardness at well No. 52 in 2023 was consistently high, 9.5-9.7 mg-eq/L, although the hardness of mixed water in the CWR for the same period was 6.7-7.1 mg-eq/L.

It should be noted that the recommendations of the European Union (EU) and WHO do not establish standards for total hardness in terms of its impact on human health [3,4]. With an increased level of hardness, the conditions for domestic use of water worsen, vegetables and meat do not cook well in it, soap does not lather well, and insoluble sediment forms in water heaters and hot water supply pipes [3].

However, the literature provides data indicating that a high level of hardness leads to the development of urolithiasis, impaired salt metabolism, and slower bone growth in children [17].

Table 2. *Indicators of physiological adequacy of mineral composition of water*

Name of the water intake facility	Physiological adequacy of the mineral composition of water in 2023						
	Total hardness, mg-eq/L	Alkalinity, mg-eq/L	Total mineralization, mg/L	Calcium content, mg/L	Magnesium content, mg/L	Bicarbonate content, mg/L	Fluoride content, mg/L
Main water intakes							
Chupon-ota	6.7-7.1	4.1-4.9	400-420	72	33	270	0.15-0.17
Dagbit	5.8-6.3	3.7-4.1	370-380	66	25	220	0.14-0.18
Local water intakes							
Farhod	6.1-6.3	4.4-5.0	380-390	–	–	–	0.14-0.20
Bogibaland	9.0-9.9	6.5-6.7	480-500	–	–	–	0.18-0.26
Khishrav	5.7-7.6	4.0-4.5	330-430	–	–	–	0.14-0.22
28 kvartal (Charkhin)	4.5-5.5	2.8-3.1	260-305	–	–	–	0.16-0.18
29 kvartal	6.0-6.3	2.9-3.1	360-400	–	–	–	0.16-0.18
Yangi Hayet	5.5-5.8	3.3-3.4	370-390	–	–	–	0.18-0.22
Vatanparvar	6.4-6.8	3.4-3.6	370-410	–	–	–	0.17-0.18
Regulation documents							
MPC according to SanPiN No. 0211-06 (RUz):	7.0-10.0	–	1000-1500	–	–	–	0.7
Recommended value according to MR 2.1.4.2370-08	1.5- 7.0	–	200-500	–	–	–	0.8-1.5
Normative Value according to SanPiN 2.1.4.1116-02	1.5-7.0	0.5-6.5	100-1000	25- 130	5- 65	30-400	0.5-1.5
WHO recommendations	–	–	600	–	–	–	1.5

An analysis of drinking water data at water intakes in Samarkand, carried out in January 2023, shows a close relationship between the total content and hardness of water and is described by a third-degree polynomial equation with a determination coefficient of $R^2 = 0.938$ (Fig. 2).

Consequently, there is a high probability of exceeding the MAC standards for drinking water for total hardness only when the level of water mineralization at water intakes reaches above 600 mg/L.

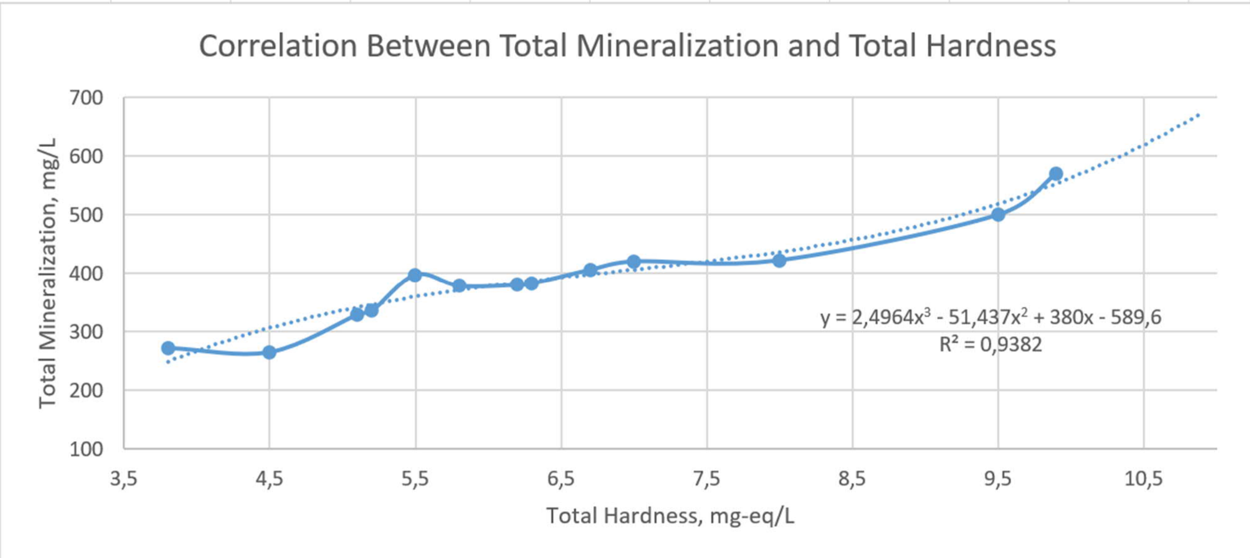

Fig.2. *The relationship between total mineralization and total hardness at water intakes in Samarkand*

At the Chupon-ota and Dagbit water intakes, in addition to operational wells, there are also monitoring wells where the hydrological service of Samarkand regularly records the total mineralization indicators of the water.

Figure 3 shows the variation in the total mineralization levels of groundwater at the active monitoring wells No. 44, No. 46, and No. 47 of the Chupon-ota water intake over the period from 1994 to 2024. Samples were collected 1–2 times per year. During the observation period, the groundwater mineralization fluctuated significantly, ranging from 180 mg/L to 616 mg/L. The dynamics of the changes in total groundwater mineralization at these three monitoring wells are described by third-degree polynomial approximations with determination coefficients (R^2) ranging from 0.12 to 0.34.

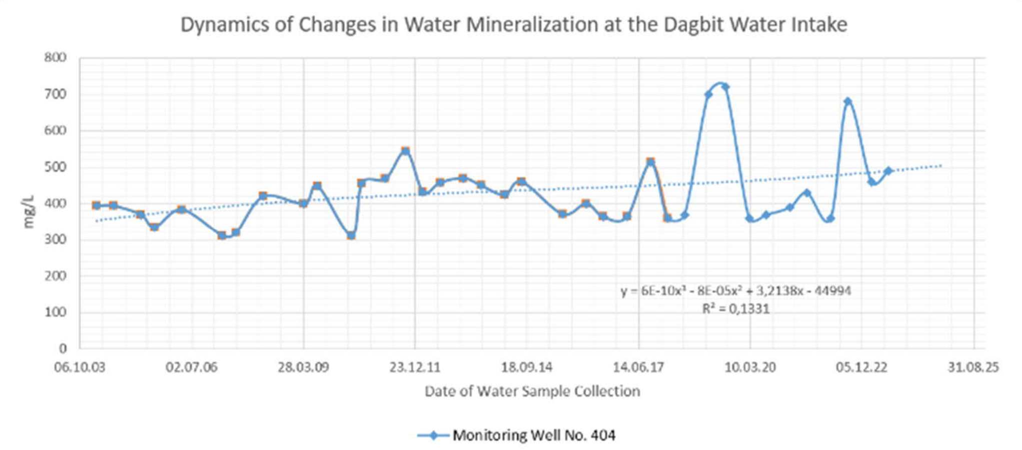

Fig. 3. *Dynamics of total mineralization of groundwater at Monitoring Well No. 404, Dagbit water intake.*

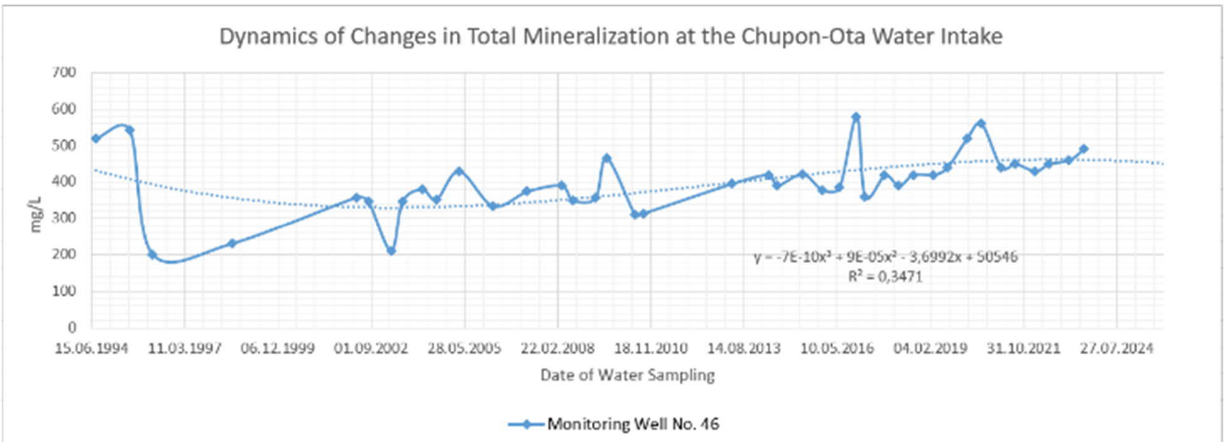

Fig. 4. *Dynamics of total mineralization of groundwater at Monitoring Well No. 46, Chupon-Ota water intake.*

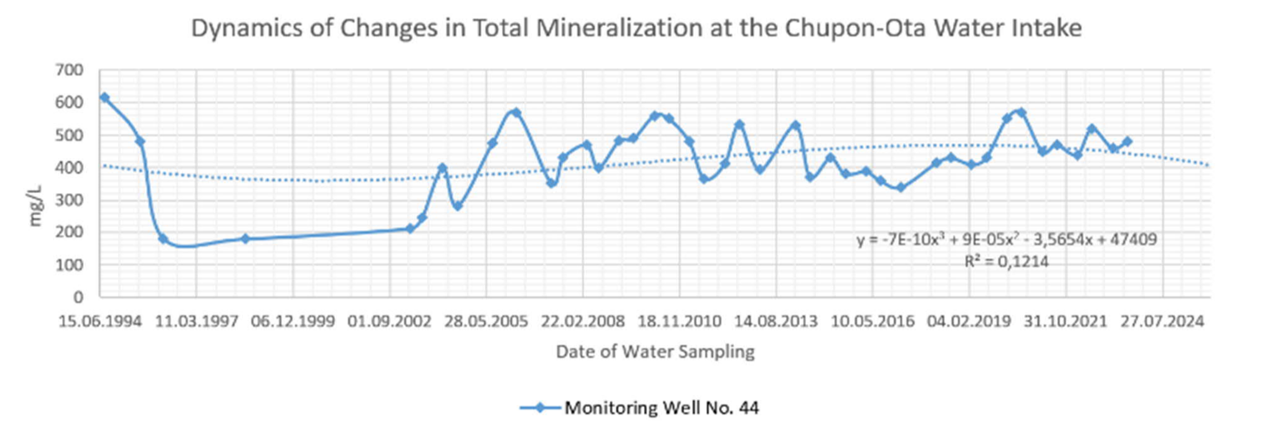

Fig. 5. *Dynamics of total mineralization of groundwater at Monitoring Well No. 44, Chupon-Ota water intake.*

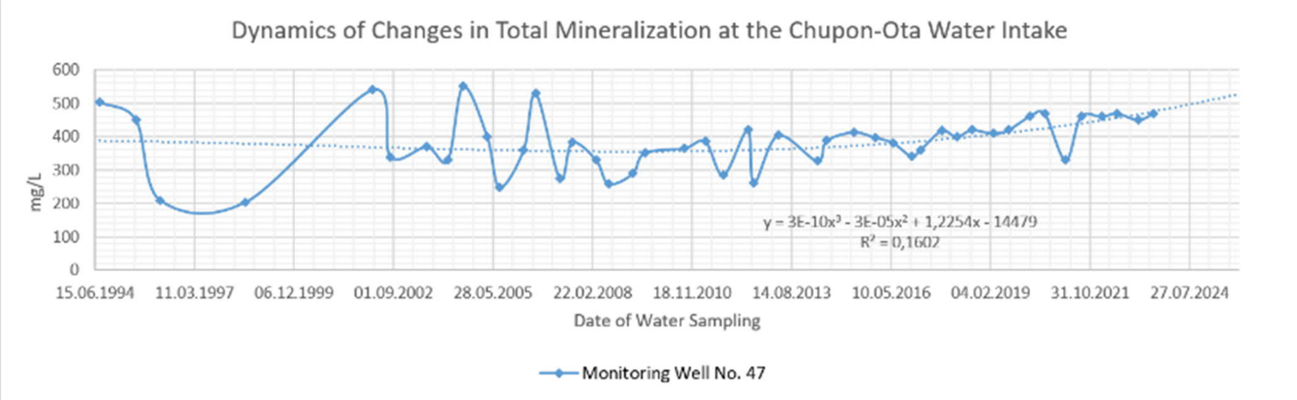

Fig. 6. *Dynamics of total mineralization of groundwater at Monitoring Well No. 47, Chupon-Ota water intake.*

Figure 3 illustrates the variation in the total mineralization levels of groundwater at the active monitoring well No. 404 of the Dagbit water intake over the period from 2004 to 2024. Samples were collected 1–2 times per year. According to the observations, the groundwater's total mineralization ranged from 312 mg/L to 544 mg/L, showing a lower degree of fluctuation compared to the Chupon-ota water

intake. The collected data are best described by a third-degree polynomial equation with a determination coefficient R^2 = 0.13.

An analysis of the regression equations in Figure 3 indicates that the approximation of the data regarding changes in total mineralization in the drinking water of the Chupon-ota and Dagbit water intakes over the period from 1994 to 2024 is weak. The observed changes in total mineralization over time may be related to variations in the overall water flow of the Zaravshan River and its mineralization levels during different seasons, which warrants further study, given that the monitoring wells are shallow and have a close hydraulic connection with surface waters.

A slight increase in total mineralization at the Chupon-ota and Dagbit wells may be attributed to anthropogenic factors such as soil flushing aimed at improving the ameliorative conditions of agricultural lands in the Zaravshan River valley, followed by the discharge of drainage waters into the river. This is evidenced by the consistent rise in mineralization indicators in the river's control sections from the Ravatkhuzha post to the Akkaradarya hydroelectric complex, which are located in close proximity to the water intakes (see Table 3). Additionally, the development of quarries for inert materials in the Zaravshan Riverbed and the drilling of agricultural wells negatively impact water quality. Therefore, regular monitoring is necessary to prevent illegal drilling of agricultural wells in the sanitary protection zones of the water intakes, thereby avoiding hydraulic connections between different groundwater layers and their cross-contamination, and to enforce a moratorium on sand and gravel extraction in the Zaravshan Riverbed [18].

It can be assumed that over time, the total mineralization of the water will not undergo significant changes and will remain within its natural range of 300–500 mg/L, provided that the aforementioned reasonable environmental protection measures related to anthropogenic activities near the water intakes are observed. Consequently, the total mineralization in the foreseeable future should remain within the permissible values of the MPC.

Potential subsurface water intake on the Zaravshan River. The water resources protection program of Samarkand includes the creation of a new water intake on the Zaravshan River, which could operate in parallel with the existing main water intakes Chupon-ota and Dagbit. According to previously conducted studies [14], constructing a water intake in the area of Chubot (Ravatkhuzha), located 40 km from Samarkand, will help achieve significant energy savings by ensuring the supply of water to the urban system by free flow. Alternatively, the construction of an additional well-type water intake 16 km upstream from the Chupon-ota intake is also being considered. These potential water intakes should have a capacity sufficient for the additional supply of drinking water to the population of Samarkand in the amount of 80–150 thousand m³ per day.

The optimal location for a potential water intake depends, among other factors, on the water quality in the Zaravshan River and on the influence of anthropogenic factors on water quality along its course from the border with Tajikistan to Samarkand. In practice, a four-tier classification of the detected contaminants is most commonly used: acceptable, moderate, severe, and very severe [2]. Furthermore, depending on water quality and the required degree of treatment to achieve drinking water standards, water bodies suitable as sources of domestic and drinking water supply for the population are divided into 3 classes [12].

According to the monitoring data from 2002-2007, the condition of the Zarafshan River waters was assessed as satisfactory, but surface waters were suitable for drinking only within the Samarkand region. Downstream, an increase in the total mineralization of water and its hardness was observed, and in the Navoi and Bukhara regions, the chemical composition of the water was unsuitable for drinking without preliminary treatment. At the entrance of the river to the Republic of Uzbekistan, the presence of copper salts, phenol, and organochlorine pesticides was noted, the concentration of which increased downstream. At the same time, the authors of the study noted that the water quality during the monitoring period in some sections permanently improved, while in others it was unchanged and corresponded to classes II and III [19].

The results of monitoring the quality of surface water in the Zarafshan River from 2021 to 2024 showed that general sanitary, organoleptic and sanitary-toxicological parameters were within acceptable limits, the degree of water pollution was moderate and corresponded to class II. Sampling and analysis were carried out quarterly throughout the year. Concentrations of abiotic pollutants were recorded in the water in insignificant quantities and with concentrations much lower than the

MAC. However, along the river, a slight increase in the concentrations of nitrates, nitrites, BOD, permanganate oxidizability, total hardness and mineralization was observed, which indicates the impact of agriculture and other anthropogenic activities in the region on the quality of water in the river.

An analysis of the surface water data of the Zaravshan River, conducted during 2023 (see Fig. 4), also showed a close interdependence between the total mineral content and the water hardness, which is described by a second-degree polynomial equation with a determination coefficient R^2 = 0.975 (see Fig. 4). Consequently, there is a high probability of exceeding the MPC for total water hardness only when the mineralization level exceeds 850 mg/L. Long-term monitoring data indicate that the water mineralization in the Zaravshan River within the Samarkand region did not exceed 800 mg/L, demonstrating the stability of the surface water quality against abrupt changes and characterizing the source as reliable, especially in the area of the village of Chubot (Ravatkhuzha).

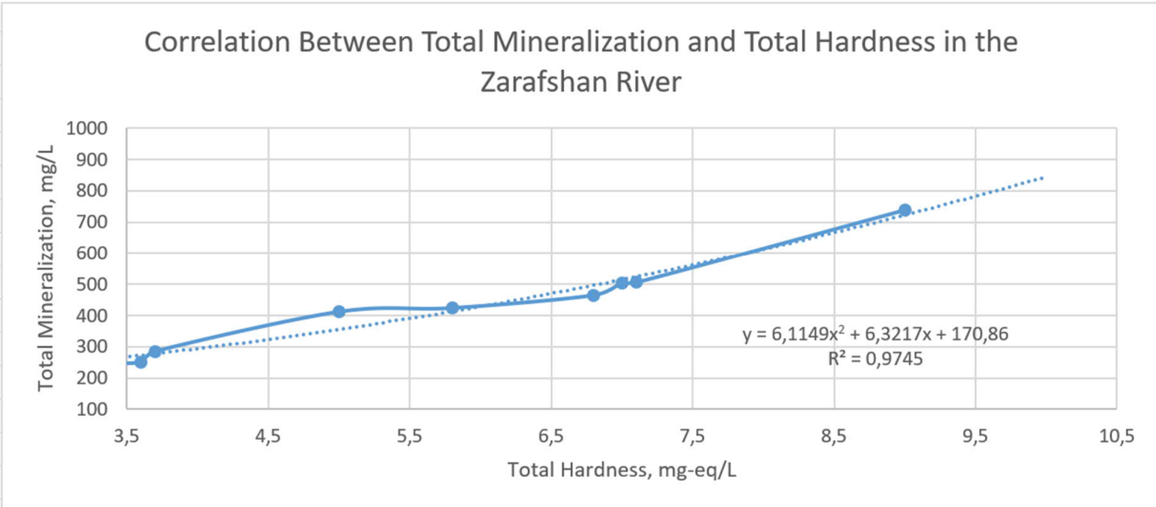

Fig 7. *Relationship between total mineralization and total hardness of the surface water of the Zaravshan River (Samarkand Region)*

Due to the close hydraulic connection between groundwater and surface water, the total mineralization and chemical composition of groundwater differ only slightly from those of the surface water of the Zaravshan River. Groundwater mineralization naturally increases as one moves down the valley and decreases with depth. For example, in the Samarkand area, the mineralization of groundwater in alluvial deposits averages 100–500 mg/L, while at the Karadaryin-Damkhozhin deposits it is 400–700 mg/L. Groundwater is classified as belonging to the bicarbonate and sulfate types, and to the calcium and sodium groups of types I and II.

Table 3a. *Hygienic assessment of the degree of pollution of surface waters of the Zarafshan River*

Parameter	Water Pollution Level in 2023			
	village Chubot (Ravatkhuzha)	village Ilypak (Dargom Canal)	Akkaradarya hydroelectric complex	Siab Canal (Rowing Canal)
Hydrogen Index (pH)	6.25-7.15	6.28-7.16	6.2-7.6	6.9-7.5
Alkalinity (mg-eq/L)	2.0-2.6	2.0-2.6	2.5-4.0	4.7-5.4
Total Mineralization (mg/L)	247-410	247-385	247-740	465-506
Chlorides (mg/L)	5.0-6.0	5.0-7.0	11.5-45.5	12.0-13.5
Sulfates (mg/L)	72.8-135.8	72.8-96.7	135.8-211.6	143.9-154.4
Total Hardness (mg-eq/L)	3.0-3.7	3.0-3.7	3.3-9.0	6.8-7.1
Calcium (mg/L)	40-48	28-48	40-92	64-74
Magnesium (mg/L)	12.1-20.0	12.1-27.9	15.8-53.5	40.1-44.9
Sodium (mg/L)	16.5-19.5	16.5-21.5	35.6-92.0	27.1-48.3
Copper (mg/L)	<0.02	<0.0025	<0.0025	<0.02
Lead (mg/L)	<0.0025	<0.002	<0.002	<0.002
Cadmium (mg/L)	0	0	0	0
Zinc (mg/L)	0	0	0	0
Ammonium (mg/L)	0	0	0	0
Fluoride (mg/L)	0,1	0.11	0.11	0.1
Nitrates (mg/L)	3.5-4.8	3.5-5.0	10.5-18.8	14.5-21.5
Nitrites (mg/L)	<0.005	<0.004	<0.004	<0.004
BOD_5 (mg O_2/L)	2.6-2.8	2.6-2.8	2.8-3.0	2.9-3.0
Permanganate Oxidizability (mg O_2/L)	2.50-2.64	2.50-2.64	2.24-2.64	2.64-2.80
Total Beta Radioactivity (Bq/L)	0.01	0.06	0.02	0.08
Parasitological Indicators	None detected	None detected	None detected	None detected
Pathogenic Flora	None detected	None detected	None detected	None detected

Thus, the potential water supply source for Samarkand is recommended to be located in the area of the village of Chubot (Ravatkhuzha), as it exhibits the best and most stable hygienic water quality indicators. To enhance the sanitary reliability of this water source and improve the BOD and permanganate oxidizability parameters, it is recommended to design a subsurface water intake in the form of a horizontal drain positioned in close proximity to the Zaravshan Riverbed. This setup would enable the withdrawal of the calculated volume of water regardless of fluctuations in the river's discharge (see Fig. 5).

Fig. 8. *Proposed location for a potential subsurface water intake on the Zaravshan River (Samarkand region)*

4. Conclusions

As a result of assessing the quality of drinking water of existing sources of domestic and drinking water supply in Samarkand, no excess of hygienic standards for water quality was recorded over a long-term period. The chemical composition of drinking water does not pose a threat to public health, but it is necessary to correct the lack of fluorides in drinking water through additional sources of their intake, including with food products and food additives. The existing water intakes are quite resistant to external anthropogenic pollution factors and can be recommended for further increase in productivity. However, it is necessary to continue strict control over compliance with the relevant regime in the sanitary protection zones of water intakes to prevent deterioration of the hygienic indicators of water. The construction sites of the potential water intake on the Zarafshan River, according to monitoring data from 2021-2024, are characterized by satisfactory water quality and can be recommended for further hydrogeological study and design of a new water intake in the area of the village of Chubot (Ravotkhuzha) in order to increase the level of robustness and energy efficiency of the domestic and drinking water supply system of Samarkand.

References

1. Law of the Republic of Uzbekistan “On Drinking Water Supply and Wastewater Discharge”. https://cis-legislation.com/document.fwx?rgn=142406.
2. SanPiN RUz No. 0255-08 – Basic Criteria for the Hygienic Assessment of the Degree of Contamination of Water Bodies with Respect to the Danger to Public Health under the Conditions of Uzbekistan. https://lex.uz/docs/1820665
3. World Health Organization. *Guidelines for Drinking-water Quality*, 4th ed.; WHO: Geneva, **2017**. https://apps.who.int/iris/handle/10665/255762.
4. U.S. Environmental Protection Agency. *25 Years of the Safe Drinking Water Act: History and Trends*; EPA 816-R-99-007, **1999**. https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=200027R1.TXT.
5. World Health Organization. Drinking-water. https://www.who.int/ru/news-room/fact-sheets/detail/drinking-water.
6. Eurasian Development Bank. Regulation of the Water and Energy Complex of Central Asia. https://eabr.org/analytics/special-reports/regulirovanie-vodno-energeticheskogo-kompleksa-tsentralnoy-azii-/
7. PP-372 – On Measures for the Implementation of the Project Modernization of the Water Supply and Road Network of the City of Samarkand with the Participation of the Abu Dhabi Development Fund. https://lex.uz/en/docs/7458903.
8. PP-3286 – On Measures for Further Improvement of the Water Bodies Protection System. https://www.fao.org/faolex/results/details/en/c/LEX-FAOC173128/
9. SanPiN RUz No. 0172-06 – Hygienic Requirements for the Protection of Surface Waters in the Territory
17. *Access Maced. J. Med. Sci.* **2019**, *7*(1), 134–138. https://doi.org/10.3889/oamjms.2019.013.
18. Nemenko, B.A.; Kenasariev, U.I. *Communal Hygiene*; NIC Гылым: Almaty, Kazakhstan, **2003**.
19. DP-14 – On Measures for the Regulation of the Extraction of Non-metallic Materials in Water Bodies. https://lex.uz/en/pdfs/6764446

of the Republic of Uzbekistan. https://documents1.worldbank.org/curated/en/099515002042298059/pdf/P176017000Seco0ect000ESMF00030JAN22.pdf.

10. SanPiN RUz No. 0318-15 – Hygienic and Anti-epidemic Requirements for the Protection of the Water of Reservoirs in the Territory of the Republic of Uzbekistan. https://unece.org/sites/default/files/2024-04/2.%20wastewater%20standards%20overview_Viacheslav%20Shi-Syan_Engl%20%28automatic%29.pdf.
11. SanPiN RUz No. 0211-06 – Hygienic Criteria and Quality Control of Water in Centralized Economic–Drinking Water Supply Systems of the Population of Uzbekistan. https://lex.uz/ru/docs/1934624
12. SanPiN RUz No. 0200-06 – Hygienic Criteria and Quality Control of Water in Centralized Economic–Drinking Water Supply Systems of the Population of Uzbekistan. https://lex.uz/ru/docs/1933428
13. KMK 2.04.02-97* – Water Supply. External Networks and Facilities. https://www.uzbekistanlaws.com/p-76019-kmk-20402-97.aspx
14. Yakubov, K.A.; Yakubov, U.K. Development of the Water Supply System of the City of Samarkand. *Int. Acad. J. Web of Scholar* **2019**, *12*(42), 13–15. https://rsglobal.pl/index.php/wos/login
15. Arvin, E.; Bardow, A.; Spliid, H. Caries Affected by Calcium and Fluoride in Drinking Water and Family Income. *J. Water Health* **2018**, *16*(1), 49–56. https://doi.org/10.2166/wh.2017.139.
16. Yani, R.W.E.; Palupi, R.; Bramantoro, T.; Setijanto, D. Analysis of Calcium Levels in Groundwater and Dental Caries in the Coastal Population of an Archipelago Country. *Open*
20. Integrated Water Resources Management and Water Supply Plan for the Zaravshan River. https://centralasiaclimateportal.org/project/integrated-water-management-and-water-efficiency-plan-for-zarafshan-river-basin/

ГІГІЄНІЧНА ОЦІНКА ЯКОСТІ ВОДИ В СИСТЕМАХ ГОСПОДАРСЬКО-ПИТНОГО ВОДОПОСТАЧАННЯ САМАРКАНДА

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Стаття надає комплексну гігієнічну оцінку якості питної води в існуючих та перспективних системах господарсько-питного водопостачання міста Самарканд. Дослідження аналізує ключові гідрохімічні та мікробіологічні показники, акцентуючи увагу на впливі антропогенних і абіотичних забруднень, виявлених у місцевих водних джерелах. У роботі було використано значний обсяг аналітичних даних, отриманих з понад 720 проб води, відібраних зі свердловин, резервуарів чистої води (РЧВ) і річки Зарафшан, що включало близько 6480 лабораторних визначень за мікробіологічними, токсикологічними, органолептичними та радіоактивними показниками. Результати свідчать, що підземні води, які переважно забезпечують Самарканд, є в цілому безпечними, демонструючи мінімальний рівень мікробного забруднення та відповідність встановленим гігієнічним нормативам. Якість підземних вод стабільно висока, без значущих антропогенних забруднень. Водночас виявлено істотний дефіцит концентрації фторидів (0,14-0,28 мг/дм^3), що викликає занепокоєння через підвищений ризик карієсу серед місцевого населення. Крім того, на окремих місцевих водозаборах спостерігаються підвищені рівні жорсткості та мінералізації через природні геологічні процеси, особливо помітні на водозаборах Болібаланд і Чупон-ота. Дослідження підкреслює необхідність підтримки суворих заходів санітарної охорони, особливо через постійні антропогенні впливи, такі як сільськогосподарська діяльність і неконтрольовані земляні роботи поблизу водозаборів. Крім того, аналіз довгострокових даних (1990-2024) свідчить про можливі коливання мінералізації підземних вод, пов'язані з кліматичними змінами та практиками зрошення, що впливають на гідрологічний режим річки Зарафшан. Отже, існуючі джерела водопостачання Самарканда є надійними та стабільними, проте рекомендовано створення додаткових водозаборів, особливо поблизу села Чубот на річці Зарафшан. Цей стратегічний розвиток дозволить значно підвищити санітарну надійність і довгострокову сталість інфраструктури водопостачання міста, забезпечуючи безпеку громадського здоров’я та покращуючи загальне управління якістю води.

Ключові слова: *водопостачання, питна вода, гігієнічна оцінка, Самарканд, якість води, санітарна охорона*