

GROUNDWATER QUALITY PHYSICO-CHEMICAL ANALYSIS FOR SUSTAINABLE WATER MANAGEMENT

Ruzimurod Jurayev^{a,*}, Bekzod Eshkulov^b

^aDepartment of “Chemical Engineering and Quality Management”, Karshi State Technical University Shahrissabz Faculty of Food Engineering, 20, Shakhrisabz str., Shakhrisabz 181306, Uzbekistan; jurayevorganikqdu-1992@mail.ru (J.R.);

^bStudent of “Chemical technology”, Karshi State Technical University Shahrissabz Faculty of Food Engineering, 20, Shakhrisabz str., Shakhrisabz 181306, Uzbekistan; bekzodeshqulov49@gmail.com (E.B.);

*Correspondence: jurayevorganikqdu-1992@mail.ru

INTRODUCTION & AIM

Water scarcity affects nearly two-thirds of the global population for at least one month annually. In Uzbekistan, particularly in the southern regions like Kashkadarya, limited surface water and over-reliance on groundwater heighten the need for effective water quality management. Groundwater is increasingly at risk due to agricultural runoff, poor waste handling, and high mineralization.

This study evaluates the **physico-chemical parameters** of groundwater samples from Koson District to assess their **potability and suitability for sustainable use**, focusing on factors such as **pH, EC, TDS, total hardness, alkalinity**, and **ion concentrations**, compared to WHO standards.



a



b



c



d

Water sample sites taken for physicochemical analysis. a) Water sample 1 (water comes from a depth of 380 meters); b) Water sample 2 (water comes from a depth of 100 meters); c) Water sample 3 (water comes from a depth of 1650 meters; boiling water; temperature 45° C); d) Water sample 4 (water comes from a depth of 100 meters).

METHOD

The groundwater located in the Koson district of the Kashkadarya region, situated on the southern border of the Republic of Uzbekistan, was selected as the research object. Artesian water from a depth of 300 meters in this area was examined to monitor water quality. Monitoring groundwater quality, identifying changes in a timely manner, determining the causes of deterioration in water characteristics, and quickly addressing them allows for the prevention of negative impacts on human health [29,30].

This study examined a range of groundwater physical parameters, including pH, electrical conductivity, total dissolved solids (TDS), total alkalinity (TA) and total hardness (TH), in order to assess their chemical properties. Standard procedures (standard ionometric method) were followed to collect data on magnesium (Mg^{2+}), sodium (Na^+), potassium (K^+), chloride (Cl^-), nitrate (NO_3^-), and sulfate (SO_4^{2-}) (Table 1). Additionally, micro and macroelements were also analyzed.

Parameters and Methods Used in the Physico-Chemical Analysis of Water Samples

Nº	Parameters	Unit	Method employed
1.	pH	-	pH-meter- ionometr (PXSJ-216F)
2.	Elektrical Conductivity	μmho s/cm	Conductivity-meter (HI5321)
3.	Total alkalinity	mg/l	Titrimetric method (Titrator-HI901C; with EDTA
4.	Total hardness	mg/l	Titrimetric method (Titrator-HI901C; with EDTA
5.	Total dissolved solids	mg/l	Gravimetric Method

Through mathematical computations, the ionometer's results are translated into concentrations. This is accomplished by taking into consideration that the values represent the outcomes acquired in the inverse logarithm and converting them into a numerical expression in the following sequence.

$$pX = -\log_{10} X$$

$$-\log_{10} X = 10^{-X}$$

The value of X is reduced to a fraction. For example, if $X = \frac{2}{3}$

$$10^{\frac{2}{3}} = \sqrt[3]{10^2} = C \text{ (concentration)}$$

RESULTS & DISCUSSION

The flavor of the water samples being studied is distinct. Currently, samples 1 and 3 are consumed and used for human needs. Water sample 3 is water from a depth of 1650 meters and is considered boiling water. Its temperature is 45° C. As a result, the water samples were allowed to reach room temperature before beginning any physicochemical tests.

Analysis of groundwater quality parameters in the villages of Khalqabad (Kosan, Kashkadarya, Uzbekistan).

Nº	Code	pH	EC $\mu c/cm$	Alk. Mg/l	TH mg/l	CaH mg/l	MgH mg/l	TDS
1	S1	7.33	2768	750	320	140	180	2180
2	S2	6.885	6295	690	930	400	530	7600
3	S3	6.84	2144	430	670	290	380	3520
4	S4	7.262	743.8	760	240	100	140	1520

The results of the study were compared with the standards and permissible limits for drinking water recommended by the World Health Organization. The standards and permissible limits for drinking water recommended by the World Health Organization (WHO) are presented in Table 3 [31,32].

Standards and permissible limits for drinking water recommended by the WHO.

Nº	Parameters	WHO: 2011
1.	pH	6.5-8.5
2.	Elektrical Conductivity	1400
3.	Total alkalinity	120
4.	Total hardness	500
5.	Total dissolved solids	500
6.	Cl^-	200
7.	NO_3^-	45
8.	F^-	1.5

Results of studying ion concentrations in water samples (20° C).

Water samples	Conc. NO_3^- ions, mol/l	Conc. Na^+ ions, mol/l	Conc. Cl^- ions, mol/l	Conc. Ag^+ ions, mol/l	Conc. NH_4^+ ions, mol/l
Sample-1	$9.75 \cdot 10^{-5}$	4.286	$5.51 \cdot 10^{-3}$	$5.12 \cdot 10^{-1}$	$8.42 \cdot 10^{-3}$
Sample-2	$2.5 \cdot 10^{-4}$	10.1	$1.125 \cdot 10^{-2}$	$2.85 \cdot 10^{-1}$	$6.93 \cdot 10^{-4}$
Sample-3	$4.458 \cdot 10^{-4}$	1.472	$2.548 \cdot 10^{-3}$	1.425	$5.08 \cdot 10^{-4}$
Sample-4	$8.142 \cdot 10^{-1}$	4.946	$1.321 \cdot 10^{-2}$	$5.618 \cdot 10^{-1}$	$5.12 \cdot 10^{-3}$

The data indicate that most groundwater in Kashkadarya region meets established sanitary standards, making it suitable for drinking. Elevated levels of certain ions such as NH_4^+ and NO_3^- emphasize the need for continuous monitoring to prevent potential health risks. Differences in ion activity across various sources can be linked to geochemical characteristics and anthropogenic influences.

In general, these studies can be used to inform local authorities and inhabitants about the existing condition of water resources, as well as to design strategies for monitoring and improving the quality of the water in the investigated locations.

CONCLUSION

Thus, the analysis of groundwater quality in Xalqobod village (Koson, Kashkadarya, Uzbekistan) revealed significant variations in the samples (S1–S4) based on key parameters such as pH, electrical conductivity (EC), alkalinity, total hardness (TH), calcium hardness (CaH), magnesium hardness (MgH), and total dissolved solids (TDS). These were compared with the World Health Organization (WHO) drinking water standards (2011). All samples fell within the permissible pH range of 6.5–8.5, indicating an acceptable acidity level. However, three samples (S1, S2, S3) exceeded the WHO limit of 1400 $\mu S/cm$, indicating potential salinity issues.

FUTURE WORK / REFERENCES

- Expand analysis to include microbiological and seasonal variations
- Evaluate filtration and desalination technologies
- Collaborate with local authorities for region-wide monitoring
- UNICEF, Water Scarcity Reports (2023)
- Wetzel, G.W. “Limnology”, 2001
- Rakhmatullaev et al., “Groundwater Management in Uzbekistan,” Open Geosciences, 2012