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COMPARATIVE ANALYSIS OF THE CHEMICAL COMPOSITION OF IRRIGATION AND GROUNDWATER

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Abstact : This study investigates and compares the chemical makeup, degree of mineralization, and concentrations of primary anions and cations (Cl^-, HCO_3^-, CO_3^{2-}, SO_4^{2-}, Ca^{2+}, Mg^{2+}, Na^+) found in surface water (irrigation canals) and groundwater (wells) in the Kogon district of the Bukhara region. Laboratory analyses revealed that both water types exhibit elevated hardness and mineralization levels, making them unsuitable for direct use in drinking and industrial applications. Notably, groundwater demonstrated higher salinity. Prolonged consumption or agricultural use of such water could negatively affect both human health and soil productivity. The paper also provides recommendations for assessing, purifying, and safeguarding the ecological safety of local water sources.

Keywords: groundwater, total mineralization, gravimetry, cations, anions.

The chemical composition and hydrochemical characteristics of groundwater are closely linked with those of surface waters and are influenced by a variety of natural geographic factors. This connection is especially significant when groundwater lies close to the surface. The properties of these waters are directly shaped by geographical location, geological structure, terrain, climate, and soil composition. For instance, groundwater in northern regions tends to be less mineralized and purer, whereas in southern zones, higher temperatures, increased evaporation, and soil characteristics contribute to a higher concentration of dissolved salts.

Mineral content in water primarily results from chemical interactions between water and geological formations. Depending on these interactions, the total dissolved solids in groundwater can range from 100–150 mg/L to several grams per liter. The concentration of these dissolved substances determines the water's mineralization level, which in turn affects water density—higher mineralization leads to greater density.

Waters can be classified by mineralization as follows:

Table 1. Classification of water by mineralization level

1	Freshwater	Up to 1 g/l
2	Brackish water	1–25 g/l
3	Saline water	Above 25 g/l

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The overall chemical profile of water is shaped by its main anions and cations (Na^{+}, K^{+}, Ca^{2+}, Mg^{2+}, HCO_3^{-}, SO_4^{2-}, Cl^{-}, CO_3^{2-}), which are the macro-components defining water quality.

Chloride ions (Cl^{-}) are highly mobile and soluble, entering water from rocks like halite and sylvite, as well as from volcanic gases, precipitation, industrial discharges, and gas wells. They are major components in heavily mineralized waters.

Sulfate ions (SO_4^{2-}) are less mobile and often bind with calcium to form slightly soluble gypsum ($CaSO_4$). Their levels are influenced by the presence of gypsum-bearing sediments and oxidation of sulfide gases.

Bicarbonate (HCO_3^{-}) and carbonate (CO_3^{2-}) ions derive from carbonic acid and vary in dominance depending on pH. Bicarbonates are more common in neutral to slightly alkaline waters, while carbonates dominate in strongly alkaline conditions.

Sodium ions (Na^{+}), widespread in nature, are highly soluble and mobile. They are less common in freshwater but abundant in mineralized and seawater, mainly originating from rock weathering.

Potassium ions (K^{+}), unlike sodium, have limited mobility and are typically present in lower concentrations, entering water primarily through soil leaching.

Calcium ions (Ca^{2+}) are sourced from rocks like limestone and dolomite and are important in biological processes. They are prevalent in low-mineralized waters and are key in determining water hardness.

Magnesium ions (Mg^{2+}), though similar to calcium, are less reactive and usually found in mineral-rich waters, originating from rocks like dolomite and marl.

Research Findings:

Laboratory tests conducted in Kogon district revealed the following ion concentrations:

Table 2. Ion concentrations in canal (surface) water (hardness: 12–14 mg/L):

Cl^{-}	HCO_3^{-}	CO_3^{2-}	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na^{+}	M/d
mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
200-220	590-610	48-60	340-360	150-170	30-45	290-310	1650-1900

Table 3. Ion concentrations in well (groundwater) samples (6 m depth):

Cl^{-}	HCO_3^{-}	CO_3^{2-}	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na^{+}	M/d
mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
260-287.2	730-744.4	102-106	470-485.1	250-260	127-130	245-260	2200-2400

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Note: Average total hardness for groundwater: **18–23 g/L**.

The findings demonstrate that groundwater has significantly higher mineralization (2200–2400 mg/L) and hardness (18–23 g/L) compared to canal water, rendering it unsuitable for drinking purposes. Although canal water exhibits lower salinity, it still exceeds desirable quality thresholds.

Conclusion:

Both surface and groundwater in Kogon district contain elevated concentrations of chloride, sulfate, bicarbonate, sodium, calcium, and magnesium ions. These compositions suggest potential health risks, particularly to the kidneys and cardiovascular system, if consumed over long periods. Furthermore, their use in agriculture could lead to soil salinization.

Given these results, it is essential to develop integrated measures for water purification, continuous monitoring, and ecological safety assurance. Ensuring access to safe drinking water remains a critical issue for the local population.

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