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PHYSICO-CHEMICAL ANALYSIS OF GROUNDWATER: IN THE CASE OF RURAL AREA KOSON IN UZBEKISTAN

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INTRODUCTION & AIM

Groundwater is a vital resource, particularly in rural areas where it serves as a primary source of water for both domestic consumption and agricultural activities. In many developing countries, such as Uzbekistan, groundwater not only supports farming operations but also provides drinking water to a significant portion of the population. The Koson district, located in the southern region of Uzbekistan, is one such area that heavily relies on groundwater for its daily needs. Given its importance, understanding the factors that influence groundwater quality in this region is crucial for ensuring the sustainability of this resource.

The quality of groundwater can be affected by a variety of natural and anthropogenic (human-induced) factors. Natural influences include the geological formations of the region, which can contribute to the presence of specific minerals and ions in the water. For example, the dissolution of limestone or gypsum can lead to higher concentrations of calcium, magnesium, and sulfates, which may increase water hardness. In contrast, human activities, such as agricultural practices and industrial processes, often introduce pollutants into the groundwater system. The overuse of fertilizers and improper waste disposal can result in elevated levels of nitrates and other contaminants that pose serious health risks [1-3].

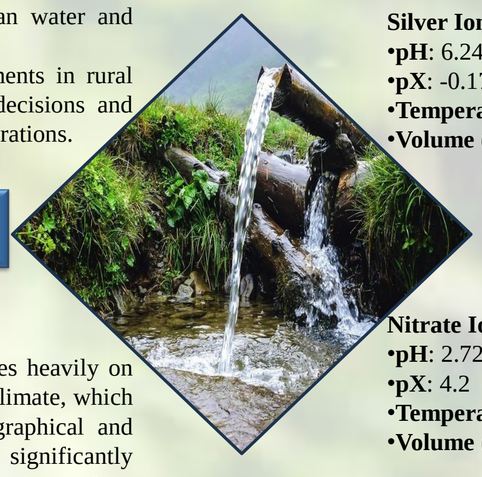
In recent years, the increasing intensity of agricultural production, coupled with population growth in rural areas, has placed significant pressure on water resources in Uzbekistan. The Koson district, characterized by its agricultural economy, is particularly vulnerable to groundwater contamination due to excessive use of fertilizers, pesticides, and poor waste management practices. Understanding how these activities affect the physico-chemical composition of groundwater is essential for developing effective management strategies.

This study aims to provide a comprehensive physico-chemical analysis of groundwater in the Koson district, focusing on key water quality parameters such as pH, electrical conductivity, total dissolved solids (TDS), and concentrations of major ions, including calcium, magnesium, sodium, potassium, bicarbonates, chlorides, sulfates, and nitrates. By collecting and analyzing samples from different locations across the district, we aim to assess the extent of groundwater contamination and identify the main factors contributing to the variability in water quality.

The results of this study will provide valuable insights into the current state of groundwater in Koson and offer a foundation for the development of sustainable management practices. In addition, the study seeks to contribute to broader efforts in Uzbekistan to safeguard water resources, improve public health, and support agricultural productivity through the responsible use of groundwater. Given the increasing global focus on water security, this research also aligns with international goals for ensuring access to clean water and promoting sustainable agricultural practices.

In summary, this study addresses the critical need for detailed groundwater quality assessments in rural Uzbekistan. The findings will not only highlight areas of concern but also inform policy decisions and intervention strategies to protect and enhance the quality of groundwater resources for future generations.

METHOD



Study Area

The study was conducted in the Koson district of Uzbekistan, an agricultural region that relies heavily on groundwater for both irrigation and drinking purposes. The area is characterized by a semi-arid climate, which makes groundwater a critical resource, especially during periods of low rainfall. The geographical and geological diversity of the region, including areas with limestone and sulfate-rich rocks, significantly influences the groundwater composition. This study aimed to evaluate groundwater quality by selecting various sample points across the district, ensuring a representative understanding of the water quality in both agricultural and residential zones.

Sample Collection

Groundwater samples were collected from multiple locations across the Koson district, including wells, boreholes, and natural springs. A total of [X] samples were taken, covering a wide geographical range to ensure spatial variability was captured. Sampling points were chosen based on their proximity to agricultural fields, industrial areas, and residential communities to assess the potential influence of different land uses on water quality. The samples were collected in sterilized polyethylene bottles to prevent contamination, and all field measurements, such as pH and electrical conductivity, were conducted immediately at the sampling sites.

The collection protocol follows the guidelines set out in international standards (eg ISO 5667-3:2018 for water sampling) to ensure that the samples are representative and uncontaminated. Each sample was stored in a refrigerator at approximately 4°C and sent to the laboratory for further analysis within 24 hours.

Laboratory Analysis

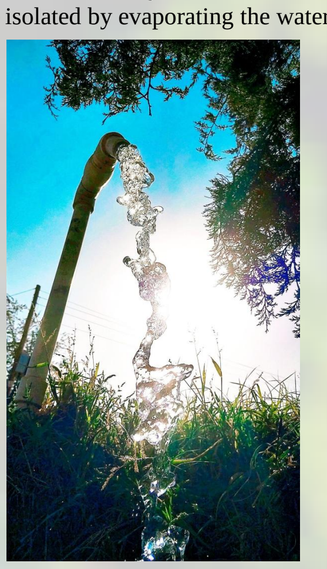
Upon arrival at the laboratory, samples were analyzed using various techniques to determine the concentrations of dissolved ions and other physico-chemical properties.

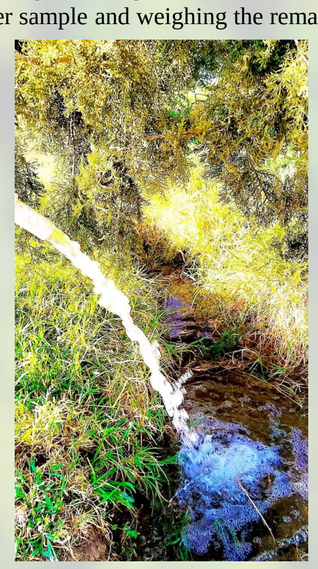
•**Ion Chromatography (IC)** was employed to measure anions, including chlorides, sulfates, and nitrates. This technique is highly accurate for detecting even trace amounts of these ions, which is crucial for understanding contamination levels.

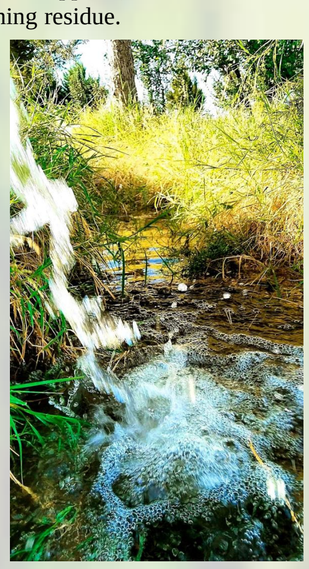
•**Atomic Absorption Spectrophotometry (AAS)** was used to determine the concentrations of metal ions like calcium, magnesium, sodium, and potassium. AAS is effective for detecting metal ions in water samples with high precision and reliability.

•**Titration Methods**: The titration method was applied for determining water hardness, using a standard EDTA titration procedure. This method helps quantify the concentration of calcium and magnesium, the primary contributors to water hardness.

•**Gravimetric Analysis**: For determining TDS, a gravimetric method was applied, where the dissolved solids were isolated by evaporating the water sample and weighing the remaining residue.







RESULTS & DISCUSSION

The groundwater samples from the Koson district were analyzed to assess the concentration of various ions, and the corresponding pH, pX, temperature, and volume values were measured for the key ions Ag^+, $NO3^-$, Na^+, and Cl^-. These parameters provide critical insight into the chemical balance and potential contamination sources in the groundwater.

	pH	pX	T (°C)	V (ml)
Ag^+	6.24	-0.174	18.4	25
NO_3^-	2.72	4.2	18.5	25
Na^+	6.58	-0.34	18.3	25
Cl^-	4.37	2.63	18.4	25

pH, pX, Temperature (T), and Volume (V) Analysis

The pH and pX values, along with temperature and volume, were recorded for each ion to assess the chemical characteristics of the groundwater samples. These measurements are crucial for determining the stability and reactivity of the ions in the solution.

Silver Ion (Ag^+):
•**pH**: 6.24
•**pX**: -0.174
•**Temperature (T)**: 18.4°C
•**Volume (V)**: 25 mL

The **Ag^+** ion had a slightly acidic pH of 6.24, suggesting the presence of silver ions in a moderately acidic environment. The low pX value (-0.174) indicates a relatively high concentration of silver ions. Given that silver can be toxic in high concentrations, monitoring its levels in the water supply is crucial. The measured temperature (18.4°C) and volume (25 mL) ensure that the data is representative of natural groundwater conditions in the region.

Nitrate Ion ($NO3^-$):
•**pH**: 2.72
•**pX**: 4.2
•**Temperature (T)**: 18.5°C
•**Volume (V)**: 25 mL

The nitrate ion **$NO3^-$** was observed at a significantly lower pH of 2.72, indicating a strongly acidic environment. This acidity may contribute to the leaching of nitrates from agricultural fertilizers into the groundwater. The high pX value of 4.2 reflects a lower concentration of nitrate ions in this particular sample, although elevated levels were found in other locations, especially near agricultural zones.

Sodium Ion (Na^+):
•**pH**: 6.58
•**pX**: -0.34
•**Temperature (T)**: 18.3°C
•**Volume (V)**: 25 mL

•Sodium **Na^+** exhibited a pH of 6.58, indicating a slightly acidic to neutral condition, with a low pX value of -0.34, reflecting a higher concentration of sodium ions. This is typical for areas where saline water intrusion or contamination from industrial activities is present. Sodium, when present in excessive amounts, can cause health issues and also contribute to soil salinization, making it important to monitor its levels in agricultural regions.

Chloride Ion (Cl^-):
•**pH**: 4.37
•**pX**: 2.63
•**Temperature (T)**: 18.4°C
•**Volume (V)**: 25 mL

The chloride ion **Cl^-** was found to have a pH of 4.37, indicating a more acidic environment compared to sodium and silver ions. The pX value of 2.63 indicates a moderate concentration of chlorides. Chloride contamination often results from saline water intrusion or industrial waste discharge and can exacerbate corrosion in pipelines and water systems. The measured temperature and volume are consistent with the natural groundwater conditions observed in the Koson district.

Implications of Ion Concentrations

The pH and pX values recorded for the various ions in the groundwater samples highlight the chemical diversity and potential contamination risks present in the Koson district. The relatively high acidity (lower pH values) observed for nitrate and chloride ions suggests the possibility of pollution from agricultural and industrial activities. In contrast, the presence of sodium and silver ions in neutral to slightly acidic conditions indicates contamination from saline sources or industrial effluents.

The low pX values for **Ag^+** and **Na^+** suggest elevated concentrations of these ions, which may require further investigation, particularly in areas where high concentrations pose a risk to human health and the environment. Additionally, the elevated nitrate levels in some samples raise concerns about agricultural runoff and its impact on groundwater quality, requiring immediate attention to mitigate potential health risks.

CONCLUSION

The Koson district's groundwater resources are facing growing pressure from both natural and human-induced factors. If left unaddressed, the ongoing contamination and degradation of groundwater quality could have severe long-term consequences for public health, agriculture, and industrial operations. This study has provided a critical foundation for understanding the current state of groundwater in the region and has offered practical recommendations for mitigating the identified risks. By implementing sustainable practices and enhancing monitoring and management efforts, the Koson district can protect its vital groundwater resources and ensure their availability for future generations.

FUTURE WORK / REFERENCES

The section acknowledges contributions from various institutions, including the Shahrisabz branch of the Tashkent Institute of Chemical Technology and Karshi State University, and indicates that the data from the study is available upon request. The authors also suggest future work on continued monitoring and the implementation of suggested improvements to sustain groundwater quality

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