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SPRING WATER QUALITATIVE ASPECTS IN THE CENTRAL JORDAN VALLEY / EASTERN CATCHMENTS - PALESTINE

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Abstract

The objective of this study is to investigate the hydrogeological characteristics of the spring aquifer system in the central eastern Jordan valley in Jericho areas and to determine the influence of its hydrochemical characteristics in qualitative potentials. The springs are used for domestic water supplies and irrigation in Jericho areas, which is considered as one of the most important areas in the West Bank feeding from the "spring system complex". From the geological and structural point of view, the area is considered to be as complex in regards to the major structural features of faults and folds. The physical properties (pH, DO, temperature, TDS and EC) were interpreted. The hydro-chemical concentration major ions of Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, SO_4^{2-}, NO_3^{-} and HCO_3^{-} were analyzed for the spring water system samples. The microbiological parameters of total and fecal coliforms were analyzed for the targeted springs and indicates of no detected pollution.

Obiettivo dello studio è stata l'indagine delle caratteristiche idrogeologiche del sistema acquifero sorgivo nella valle centro-orientale del Giordano (aree di Gerico), analizzando l'influenza delle sue caratteristiche idrochimiche nei potenziali qualitativi. Le sorgenti di questa zona, considerata una delle aree più importanti della Cisgiordania, alimentata dal "complesso del sistema di sorgenti", sono usate sia per l'approvvigionamento idrico domestico, sia per l'irrigazione nell'area di Gerico. Dal punto di vista geologico e strutturale l'area è complessa per le sue caratteristiche strutturali. Dopo aver analizzato le proprietà fisiche (pH, DO, temperatura, TDS e EC) dei campioni di acqua sorgiva, sono stati analizzati gli ioni principali della concentrazione idrochimica di Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, SO_4^{2-}, NO_3^{-} e HCO_3^{-} Si sono poi analizzati i parametri microbiologici dei coliformi totali e fecali per le sorgenti target e non è stato rilevato alcun inquinamento.

Keywords

Spring, Jericho, water quality

Introduction

The hydrochemical parameters are the leading indicators of water quality for the springs. Springs water has been the primary drinking source in rural Palestinian communities throughout the previous decades (Ahmad & Ghanem 2021). The quality of spring water is controlled by naturalistic activities such as geology, water-rock interaction, and water residence time in the aquifer. Springs played a significant role in localizing the majority of the Palestinian villages

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according to their water needs (World Bank 2018). The southern part of the Jordan Valley (Jericho-Auja area) is considered to be an essential outlet of the underground water and comprises the springs of Auja, Nwai'mah, Dyuk, Ein Sultan and Qilt (Figure 1). These springs sometimes differ significantly in their hydrological, physical and chemical characteristics/indicators. The groundwater of the study area generally flows towards the Jordan Valley. These springs constitute around 40% of the total annual spring discharge in the West bank.

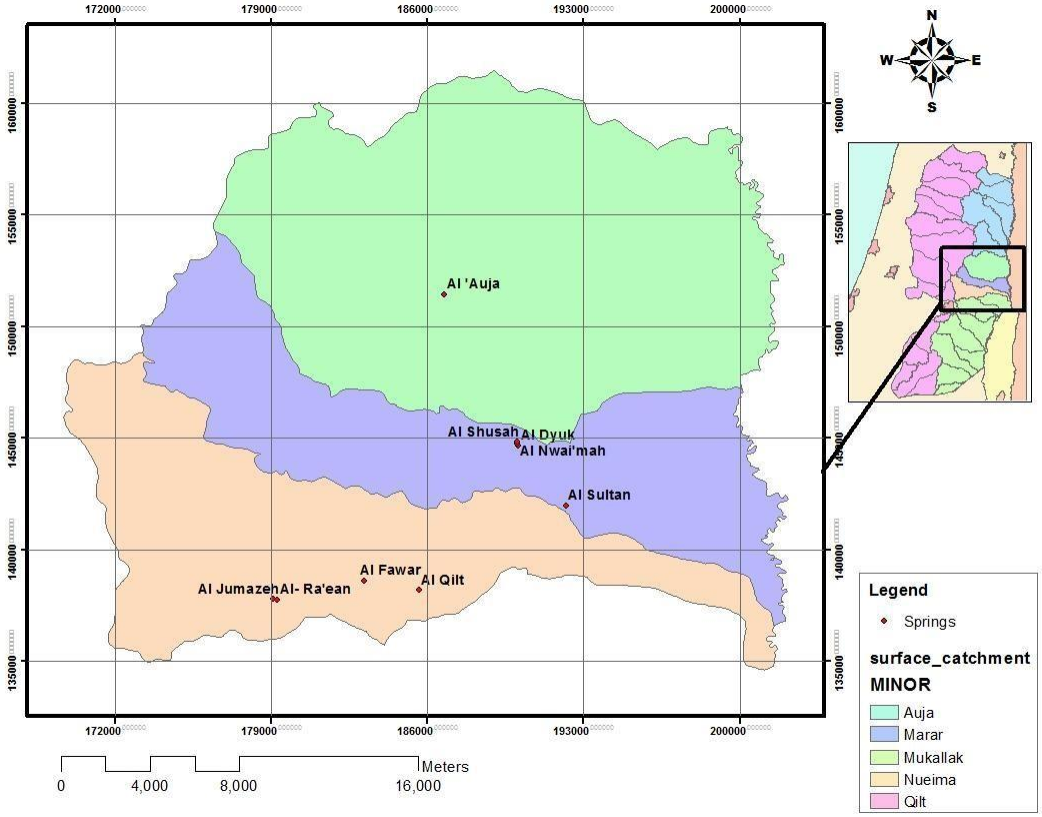

Figure 1 - The location map of the study area where the spring water was sampled

There are four main spring systems in the Jericho district emerging from the eastern groundwater basin underlying the Jericho area; Al-Qilt, Ein Al-Sultan, Al Dyuk and Al-Auja Spring System. The main aquifer systems in the Jericho region are Lower Albian, Upper Cenomanian-Turonian, Tertiary and Quaternary (Figure 2). The emerging spring's formations consist of limestone to dolomitic rocks.

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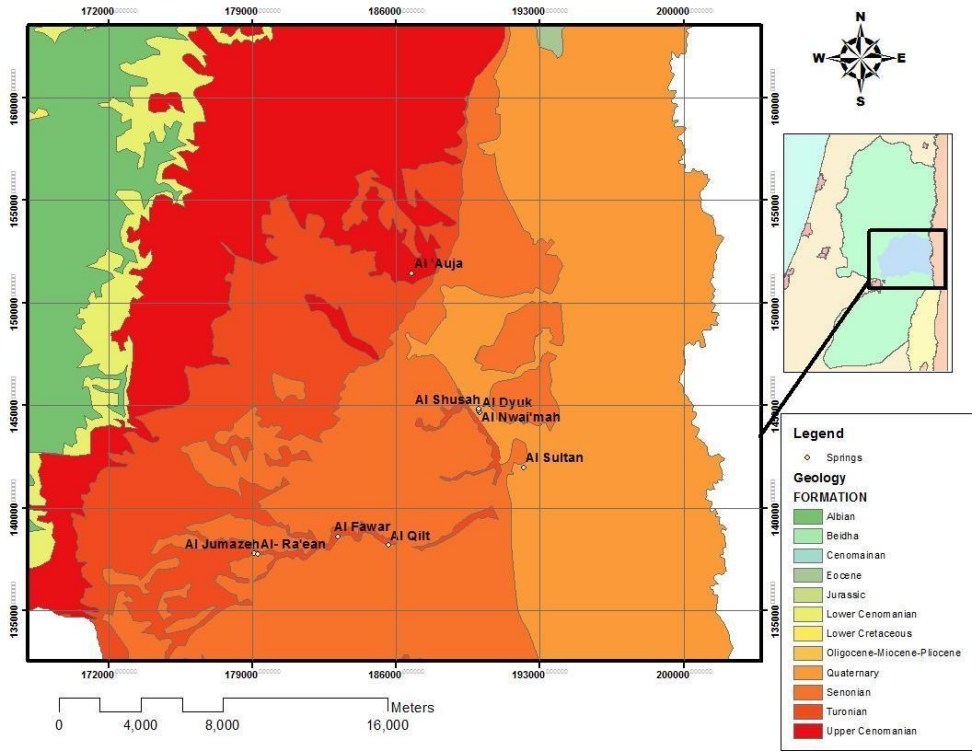

Figure 2 - The geological map of the study area

Materials and Methods

The sampling campaigns was carried out in March-2022; 9 samples were collected. The water samples were collected in one-liter polyethylene bottles and refrigerated in the laboratory at 2°C. A Sharewood 4010 flame photometer was used to determine calcium, sodium and potassium. A HP 8453 Diode Array Spectrophotometer was used to determine nitrate and sulfate concentrations. A Metrohm 716 titrator used to determine chloride and bicarbonate concentrations. The spring water samples were analyzed at the Birzeit University labs in Ramallah.

Results and discussions

The water spring samples were analyzed for their hydrochemical parameters of Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, SO_4^{2-}, NO_3^{-} and HCO_3^{-}, as major ions, and pH, DO and EC, in order to understand the hydrochemical characteristics of the water springs as well as to understand their variability trends in the east-west directions. The physical parameters of EC and TDS values are ranging between 682 to 520 and 330 to 254 mg/L respectively (Figure 3). Their values proofs their suitability for drinking purposes. The pH concentration values are ranging between 6.8 to 7.7 and their temperature values are ranging within 21.5 and 23.8 degree centigrade (Figure 4). There is a variability in DO from 2.7 in Fawwar spring to 9.4 mg/L in Al Dyuk cluster springs (Figure 4).

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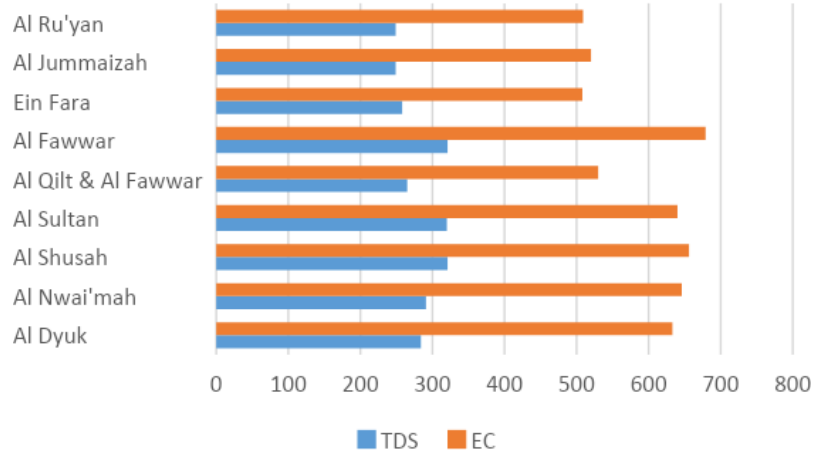

Figure 3 - The EC in micro Siemens per cm versus TDS in mg/L

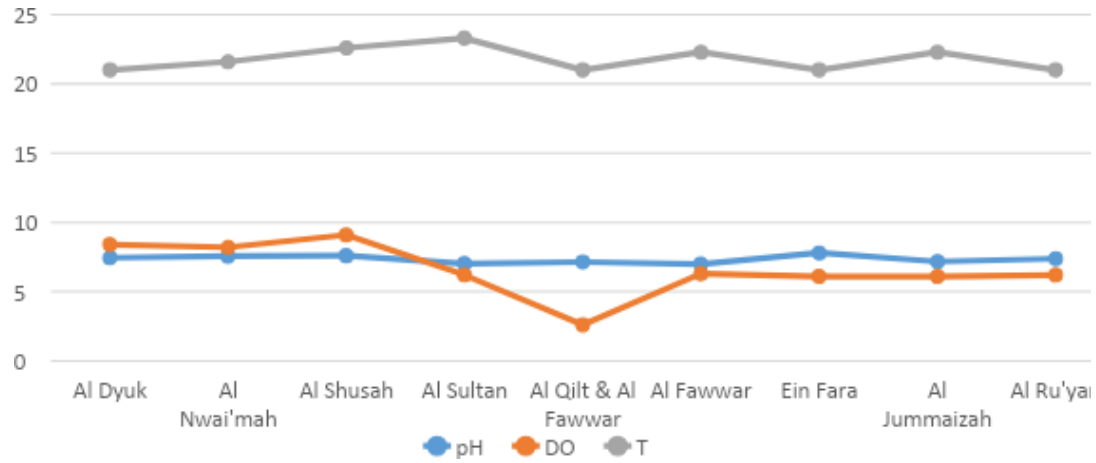

Figure 4 - The variability of the physical parameters of pH, DO (mg/L) and T (^{0}C)

The major cations and anions concentration of the analyzed springs are illustrated in Figures 5 and 6. The average concentration of Ca^{2+} and Mg^{2+} are 48.4 and 29.9 mg/L, respectively which reflects the carbonate nature of these springs. The average concentration of Na^+ is 25 mg/L and the least values are found in the Qilt spring system. The average values of K^+ is 3.2 mg/L and the springs values are of slight variance which reflects the same source of origin of these springs. The average values of Cl^- is 67 mg/L and the values are ranging between 35 to 111 mg/L, while the average value of HCO_3^- is 222 and ranging between 186 – 274 mg/L. This will reflect the calcic origin of these springs. The SO_4^{2-} values are ranging between 13.2 and 77.3 mg/L with an average of 24.7 mg/L. The low contents of NO_3^- reflects the no pollution processes with human activities with an average of 21.1 mg/L. All springs analyzed concentrations are lying within the WHO standards for drinking purposes (WHO 2017).

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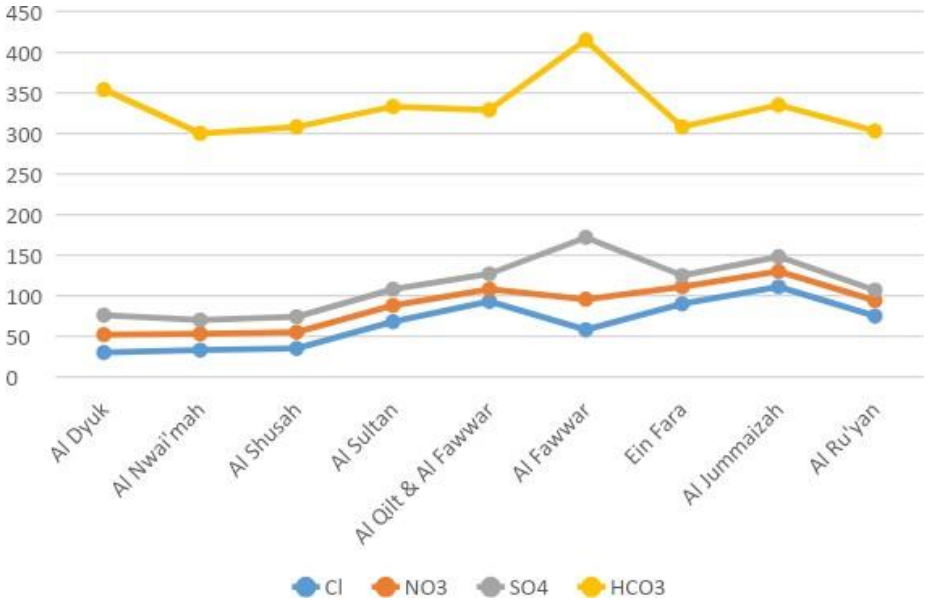

Figure 5 - The anions concentrations of the analyzed springs in mg/L

Piper diagrams were plotted for all the water samples analyzed in terms of major ions using AquaChem 5.1 software. It is clear from the graph that most of the samples fall into the normal earth alkaline water group with prevailing bicarbonate and sulfate or chloride (Figure 7).

The microbiological parameters of total and fecal coliforms were analyzed for the springs samples and show that not all springs water is polluted from human activities and they are fit for drinking purposes.

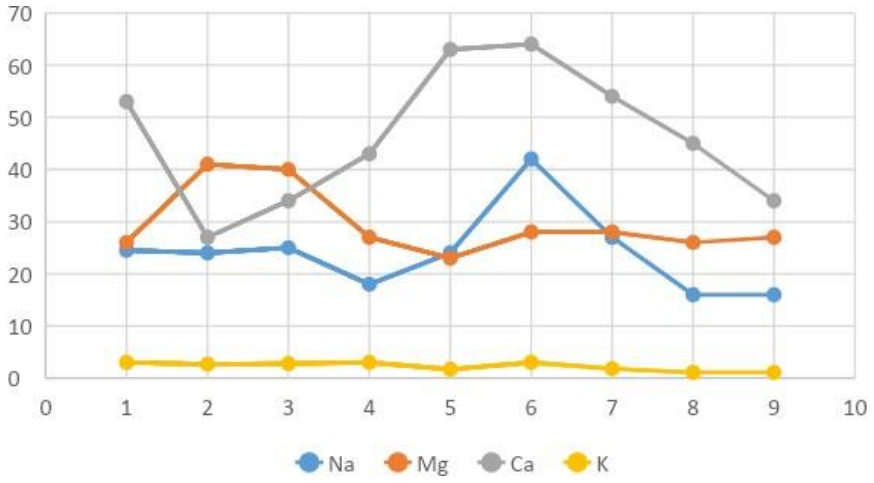

Figure 6 - The cations concentrations of the analyzed springs in mg/L

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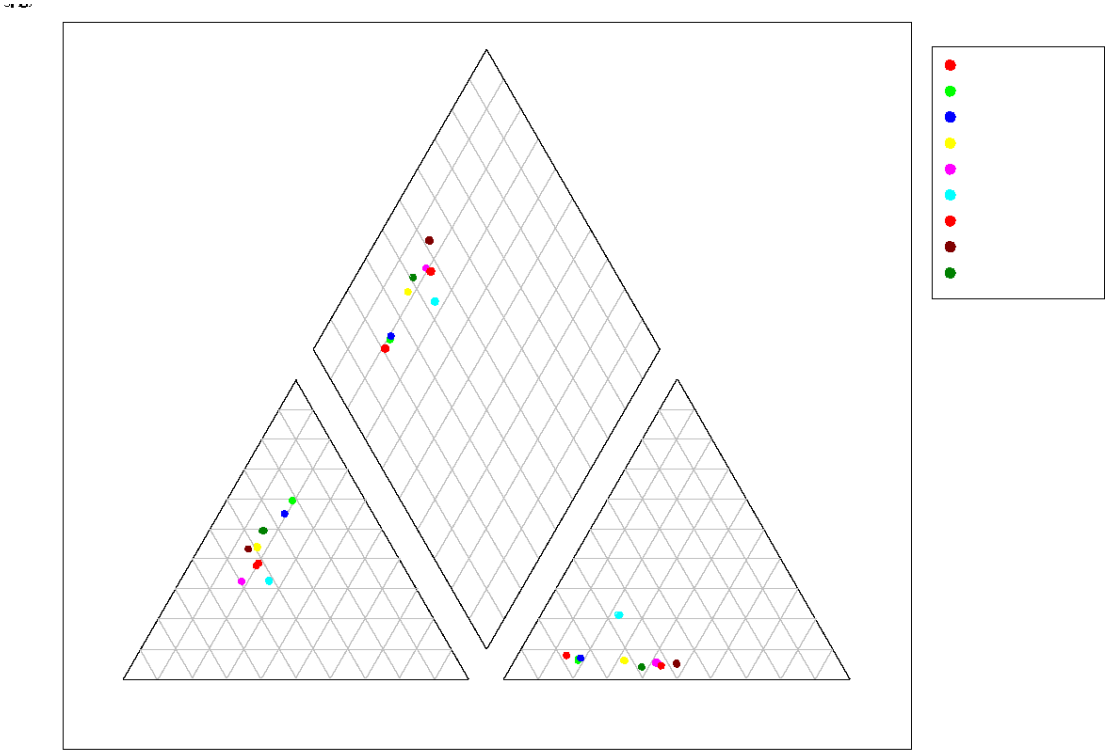

Figure 7 - Piper diagram of the springs analyzed

Conclusion

The spring water of the central Jordan Valley was assessed qualitatively for their hydrochemical characteristics. The spring water quality will influences the integrated water resources management. The spring's water type is found to be Ca-HCO_3 in all springs reflecting its limestone origin with the exceptional of Al Nwai'mah spring system, which is found to be Mg-HCO_3 reflecting its dolomitic origin. The calculated total hardness were 359.1, 335.4, 347 and 342 mg/L for Al Dyuk, Sultan, Al Nwai'mah and Auja spring systems. All of them are classified as very hard from Hardness scale of classifications (McGowan 2000). Accordingly, all samples collected from different springs are considered to be of fresh water type. Calcium concentration in the most of the springs are in the range that reflects limestone aquifer origin. It is noticeable that high concentrations of Mg^{2+} usually accompany high concentrations of Ca^{2+}, which may indicate dolomitization, especially for the Al Nwai'mah springs. The low Mg^{2+} concentrations reflect the carbonate origin. All sampled springs are within the WHO range standards. The HCO_3^- concentration results in the sampled springs reflect the Ca-HCO_3 water type. The nitrate results of the water samples are within the range of the WHO limits.

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