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Physicochemical Parameters and Heavy Metals in Groundwater from Hajjah Governorate, Yemen Current Challenges and Future Perspectives

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Abstract

The present study aimed at analyse a comprehensive descripton of physicochemical parameters and heavy metals in groundwater from Hajjah Governorate, Yemen: Six ground water samples were collected in the area of Hajjah city during the period from December (2017) to February (2018). Physicochemical parameters were analyzed (pH, temperature, EC, TDS, HCO3, SO4, NO3, total hardness, nitrogen and phosphorous, essential minerals and turbidity) which were important for water quality of groundwater. The heavy metal analyses of Cr, Zn, Fe, Co, Cu, Mn, Ni, and Cd, As, Cn, Al and Pb were performed for the water samples. The obtained results indicate a high significant differences in all Physicochemical parameters ($p<0.001$), except water temperature and ammonia among different water sources of Hajjah city ($p>0.05$). Concerning heavy metals, results indicated very highly significant differences in the levels of iron, manganese and zinc among the studied water sources ($p<0.001$), but all of them did not exceed the permissible levels suggested by WHO/YAMSO. Hence great attention must be paid to drinking water systems in the area of Hajjah city. Because to improper management, overpumping can deplete groundwater aquifers and lower water table.

Keywords: Groundwater; Physio-chemical Parameters; Heavy Metals, Yemen

Introduction

Yemen (15.5527° N, 48.5164° E) is the southern shield of the Arabian Peninsula, occupying 527,970 km2. This amazing country possesses diverse and fantastic geological and topographical features in the form of grand mountains, fertile plains, roomy valleys, spacious coasts and open desert biomes. The coastline coating Yemen stretches for about 2,000 km along the Red Sea and the Gulf of Aden. According to Yemen encompasses 5 main ecological landscapes, namely the hot humid coastal plain, temperate highlands, Yemen high plateaus and Hadramout and AlMmahrah uplands, Desert Interior and Islands Archipelago. Apart from this highly important geopolitical position, unfortunately Yemen as well as some countries of the Arabian Peninsula are deprived of rivers, freshwater canals, ponds and lakes [1]. These water-stressed countries depend primarily on fast flowing, temporary shallow streams that penetrate the harsh desert across a number of interconnecting valleys (wadis) to meet the growing needs of Yemenis.

Hajjah City (15°41′42″N 43°35′51″E) is the capital of Hajjah Governorate (15.58333°N 43.66667°E) and is located in the northwestern region of Yemen. It is located 127 km northwest of Sanaa, at an elevation of about 1800 m. Nowadays and ongoing, the water sector in Hajjah as well as in other Yemeni governorates face great challenges, among which poverty, ever growing population, extreme water scarcity and lack of access to clean water, inadequate infrastructural water utilities, and socioeconomic and political threats of the military conflict. Approximately 90% of the Yemeni natural water resources are devoted to grow chat (Qat), an unprofitable plant which is chewed by the vast majority of the inhabitants. This unhealthy and water-depleting crop must be gradually replaced by more beneficial and health-promoting crops to meet the fundamental requirements of the Yemeni society [2-4].

Materials and Methods

Study area and Sampling sites

Hajjah City (15°41′42″N 43°35′51″E) is the capital of Hajjah Governorate (15.58333°N 43.66667°E). It is located in the northwestern region of Yemen (Fig. 1). It is located at an elevation of about 1800 meters. Hajjah City occupies 43.10 km2 in Hajjah Governorate [5].

Purification Plant water

The purification plant accommodates water transported from Wadi Khaifa (Al Aman City) at the northwestern region of Hajjah City. Wadi Khaifa receives water coming from high mountain lands in Hajjah, Najrah (Al-Aman City), Ash Shaghadirah, Mabyan and Wadhrah districts; it is one of the feeding sources of Wadi Laa. Wadi Mawr (Fig. 3) receives water flowing from Wadi Laa; it is one of the prime rain flood run-off in western Yemen and has a large catchment areas in Amran, Hajjah and Hodiedah Governorates. This valley pushes approximately 2,400-3,100 m3 per one second and discharges its overflow to the Red Sea coast at Luhayyah. Wadi Khaifa water is extracted from many local boreholes dug at 10-50 m depth.

Hydrogen ion concentration (pH)

The pH value of water was measured in the field, at the time of sampling, using a digital pH-meter (Orion Research Model 555A).

Water Temperature

These physicochemical factors were measured immediately in water samples in the field by a mercury glass thermometer.

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Water Turbidity

The turbidity of water was measured with the aid of a portable field turbidity meter (Digital Portable Turbidity Meter U.K. Range; 0-1000 NTU), with turbidity range of 0 - 19.99 NTU and resolution of 0.01/ 0.1/1 NTU. The units of turbidity from a standardized nephelometer are named Nephelometric Turbidity Units (NTU). According to the World Health Organization (WHO), the turbidity levels in drinking water should not be more than 5 NTU, and must perfectly be below 1 NTU.

Electrical conductivity (EC)

Electrical conductivity (EC) was determined in water samples using HANNA EC-meter Model H199301.

Discussion

The discussion section of the study on physicochemical parameters and heavy metals in groundwater from Hajjah Governorate, Yemen, presents a comprehensive analysis and interpretation of the findings. Here, the researchers delve into the implications of the observed results, comparing them with existing literature and addressing any discrepancies or similarities [6].

One key aspect of the discussion is the assessment of the physicochemical parameters of the groundwater. This includes parameters such as pH, conductivity, total dissolved solids (TDS), and turbidity. The researchers analyze these parameters in relation to established standards and guidelines, highlighting any deviations and their potential causes. For instance, they may discuss how the pH level of the groundwater compares to the World Health Organization (WHO) standards and what factors could be contributing to any observed variations [7].

Additionally, the discussion focuses on the presence of heavy metals in the groundwater samples. The researchers identify the specific heavy metals detected and their concentrations, discussing their potential sources and the risks they pose to human health and the environment. They may explore factors such as industrial activities, agricultural runoff, and natural geological processes that could be influencing the levels of heavy metals in the groundwater.

Furthermore, the discussion section may address any trends or patterns observed in the data, such as seasonal variations or spatial distribution of contaminants. The researchers may also discuss the potential impact of these findings on public health and the need for mitigation measures to protect groundwater quality in the region [8-10].

Conclusion

In the conclusion section, the researchers summarize the key findings of the study and their implications. They reiterate the significance of assessing physicochemical parameters and heavy metals in groundwater from Hajjah Governorate, Yemen, and highlight the importance of addressing current challenges to ensure the sustainability of water resources in the region. The researchers emphasize the need for continued monitoring and management of groundwater quality, especially in light of the observed contamination by heavy metals. They may propose recommendations for future research directions, such as conducting long-term monitoring studies, investigating the sources of contamination in more detail, and implementing remediation strategies to mitigate the impacts on human health and the environment. Overall, the conclusion serves to underscore the importance of safeguarding groundwater quality in Hajjah Governorate, Yemen, and provides a call to action for stakeholders to collaborate in addressing the identified challenges and working towards sustainable water management practices for the benefit of present and future generations.

Acknowledgment

None

Conflict of Interest

None

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