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Original paper

Evaluation of Ground Water Quality of Ras Al Khaimah (United Arab Emirate) by Physico-Chemical Characterization

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Abstract

Background and aim: Groundwater occurs almost everywhere underneath the earth's surface is a highly substantial resource for the provision of good quality drinking water. However, the utility of water is more or less limited by its quality which makes it unbefitting for particular purposes. Assessment of water quality is therefore an important aspect of water resources survey.

Materials and methods: Five groundwater samples were collected from five different areas within Ras Al Khaimah. The physicochemical parameters were determined such as pH, salinity, nitrate, nitrite, sulphate, phosphorous and heavy metal concentration. The results were assessed statistically and compared with the International standards.

Results: The assessed groundwater samples from five different sites had physicochemical properties whose levels were generally within tolerant and safety levels. Hence, the research was undertaken to determine the physicochemical qualities of ground water for the usage purposes like irrigation, farms, household in the Emirates of Ras Al Khaimah.

Conclusion: It is recommended to embark on consistent routine monitoring of groundwater in urban and rural areas in order to ascertain the state and quality of the water.

Keywords: *Groundwater, Physicochemical parameters, Water quality, Public health, Heavy metals*

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Introduction

Water is an indispensable part of human nutrition, as drinking water and as a constituent of food. Groundwater is a vital renewable source for water supplies around the world. It occurs almost ubiquitously under the earth's surface as a multiple-layer aquifer [1]. Drinking, irrigation, and industrial purposes depend on groundwater resources. Groundwater is one of the more reliable and extensively used natural resources. Twenty percent of the world's fresh water supply is from ground water, which is about 0.61% of the entire world's water. This makes it a significant resource which can act as a natural storage that can be exploited during water scarcity periods [2]. Ground water gratifies about 91 percent of overall drinking water demand and is considered the more consistent source of water as compared to surface water [3].

Ground water utilisation continued not only quantitatively but also qualitatively. Ground water quality is deteriorated commonly by two factors; external factor, that encompasses meteorological events like floods, earthquake etc, they cause pollution and chemical discrepancy in the water body. Secondly, internal factors, which includes plankton population present in the water body, they disturb the biochemical processes which take place in water and affect the optimal range of physicochemical parameters [4]. The discarding of waste product into aquatic system is the man made factor of pollution [5]. That waste product contains organic runoff or heavy metals. Those heavy metals drift to food chain where they can prove very injurious to human health [6].

Imbalance of all physicochemical parameters in water that occurs by various factors has harmful effects on consumers. If, magnesium and total dissolved solids are above optimal value, they create gastrointestinal irritation in human beings. Deviation from normal pH value causes corrosion and disagreeable taste. Extreme amount of calcium increase water hardness and results more scale formation. Copper if present in excess creates unpleasant taste and corrosion of pipes, fittings and utensils that carry water to the public sector. Likewise, presence of extreme amount of Iron can cause discoloration of clothes, pipes and utensils. Nitrate is one of the most common groundwater contaminants in rural areas; it can enter the system from a variety of natural and anthropogenic sources (mainly fertilizer usage) [7] Nitrate is regulated in drinking water because high levels may cause serious illness and sometimes death, and it also has the potential to cause shortness of breath, methemoglobinemia or "blue baby" disease, an increase in starchy deposits and hemorrhaging at the spleen.

Due to rapid population growth, urbanization, industrialization, and agriculture, the groundwater is qualitatively and quantitatively under pressure [8].

Assessment of water quality is therefore a significant aspect of water resources survey. Water quality depends on the physical, chemical, microbial or bacteriological composition of water [9], [10], [11], [12]. Ground water quality fluctuates from place to place and from one environment to another on the basis of various factors such as land use, local climate, slope of the land, type of rocks at the surface, which may more or less affect the quality of suitability for human consumption [13]. Polluted/contaminated groundwater resource brings about possible invitation of water-borne diseases such as cholera, typhoid and even gastrointestinal infections.

The overexploitation of aquifers and reduced natural recharge due to high urbanization and anthropogenic activity have caused a decrease in groundwater quality. Therefore, to continue our further research and also to meet the increasing demand of water, we explored natural sources. Hence, the objectives of the study were designed to examine the ground water quality of Emirates of Ras Al Khaimah from five different locations by considering physico-chemical parameters to highlight all those factors which are damaging water quality. This study will provide a valuable data concerning the assessment of ground water quality of Ras Al Khaimah. The result will be

supportive in unveiling the ground water contamination in the study area and will be considered as the initiative for possible management of ground water.

Material and Methods

Sample Collection

Five groundwater samples were obtained from five different sites within the Emirates of Ras Al Khaimah (labelled GW1, GW2, GW3, GW4, GW5) in the month of March, May and October 2022. All water samples were collected in sterile glass bottles (1 litre). All samples were stored and transported in a cool box kept below 4°C. Analyses were performed as soon as the samples were carried to the laboratory.

Physico-Chemical Analysis

Groundwater samples were analysed for pH, salinity, Nitrate, Nitrite, Sulphate, Phosphorous and heavy metal concentration. The pH, salinity was measured with WTW 3430 multimeter, Germany. Nitrate, Nitrite, Sulphate, Phosphorous concentration was measured by using HACH spectrophotometer DR 3900, USA. Heavy metal concentration was measured by using ICP-OES Plasma Quant PQ 9000 (Analytik Jena, Germany).

Statistical Analysis

The tests were performed in triplicates. Data are expressed as mean. Pair wise comparisons were performed. Experimental error was determined for triplicate and expressed as standard deviation (SD).

Results and Discussion

The objective of this research was to examine the ground water quality of Emirates of Ras Al Khaimah from five different locations by considering physico-chemical parameters to highlight all those factors which are damaging water quality. This study provided a valuable data concerning the assessment and awareness of quality of ground water quality of Ras Al Khaimah. Figure 1 showing the location map of study area.

Figure 1. Location map of study area (Google image)

Physicochemical parameters of ground water samples

Table 1. Physicochemical parameters of five ground water samples of Ras Al Khaimah, United Arab Emirates compared with EPA standard reference limit

Parameters	GW 1	GW 2	GW 3	GW 4	GW 5	EPA Limits
pH	7.79	7.78	6.96	6.77	7.93	6.5-9.2
Salinity (ppt)	1.4	2.1	0.2	0.92	0.64	-
Nitrogen-Nitrate (ppm)	2.8	3.0	15	2.2	0.7	Not more than 50 ppm
Nitrogen-Nitrite (ppm)	0	0	350	5.0	3.0	Not more than 0.5 ppm
Phosphorous (ppm)	0.01	0.02	0	0.045	0.065	-
Sulphate (ppm)	100	150	-	88	161	-
Boron (ppm)	0.221	0.242	ND	0.915	1.182	-
Calcium (ppm)	24.373	43.696	19.53	136.16	71.21	Not more than 100 ppm
Copper (ppm)	0.001	ND	0.39	0.025	0.015	Not more than 1.3 ppm
Iron (ppm)	0.006	ND	0.25	0.53	ND	Not more than 2.0 ppm
Potassium (ppm)	15.391	16.522	48.8	17.645	3.225	-
Magnesium (ppm)	17.907	34.084	17.9	103.985	5.88	1-20 ppm
Manganese (ppm)	0.066	ND	ND	0.009	0.011	Not more than 1.0 ppm
Sodium (ppm)	-	-	531.7	311.07	343.62	-
Nickel (ppm)	0.005	ND	ND	0.008	0.013	Not more than 0.9 ppm
Lead (ppm)	ND	0.001	ND	0.009	0.004	Not more than 0.05 ppm
Zinc (ppm)	0.291	0.205	ND	0.47	0.295	Not more than 5.0 ppm
Mercury (ppm)	-	-	ND	0.001	0.001	Not more than 0.002 ppm
Arsenic (ppm)	-	-	ND	0	0.001	Not more than 0.10 ppm

Results of the ground water analysis of Ras Al Khaimah for physicochemical are illustrated from Table 1, compared with EPA standard reference limit. After a detailed analysis of ground water, it is discovered that maximum parameters which determining water quality like pH, heavy metals were within prescribed limits of EPA in all water samples of Ras Al Khaimah. However, values of some parameters were not found according to prescribed limits. A higher amount of nitrite was found in GW3, GW4, GW5. Arsenic was absent completely in all water samples. Phosphate values were also found within the prescribed limits. In GW4, Calcium was slightly higher than the EPA standard reference limits. No deviation from suitable value was observed in any water sample of Ras Al Khaimah. Chemical imbalance in ground water was found in rare cases. Magnesium was

also found slightly more in GW4. Figures below describing the comparison between different ground water samples. Fig 2-7 describing values of sample's pH, salinity, nitrate, calcium, potassium, magnesium. The heavy metals found in the water samples specifically Nickel, Zinc, Copper and Lead were observed to have unelavated concentration values within standard target and intervention limits in each of the sites/areas.

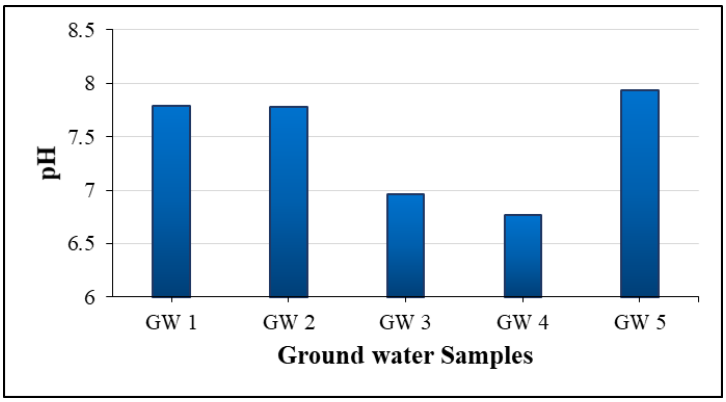

Figure 2. Showing values of pH in ground water samples of Ras Al Khaimah

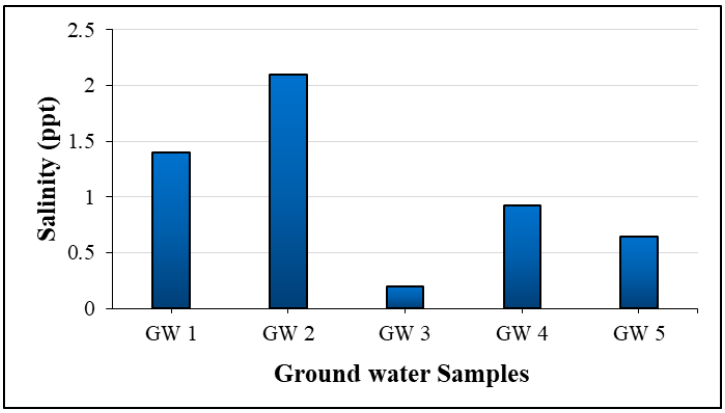

Figure 3. Showing values of Salinity in ground water samples of Ras Al Khaimah

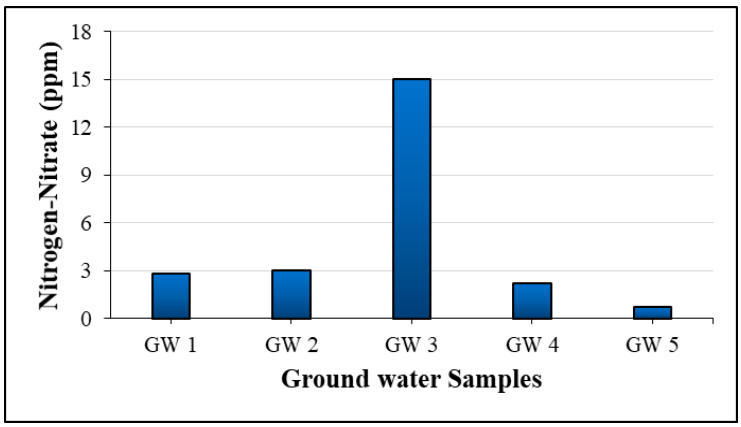

Figure 4. Showing concentration of Nitrate in ground water samples of Ras Al Khaimah

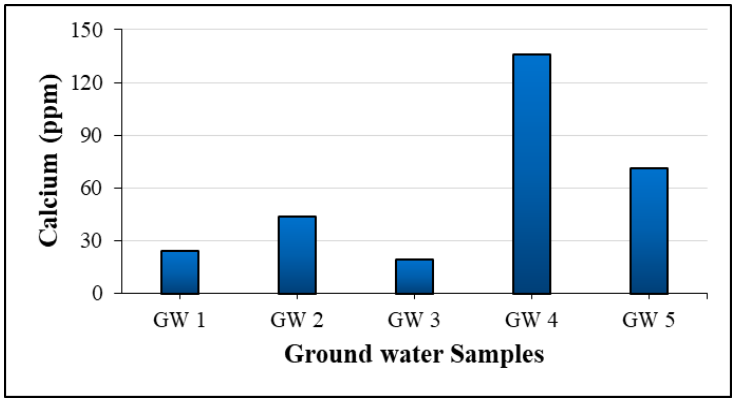

Figure 5. Showing concentration of Calcium in ground water samples of Ras Al Khaimah

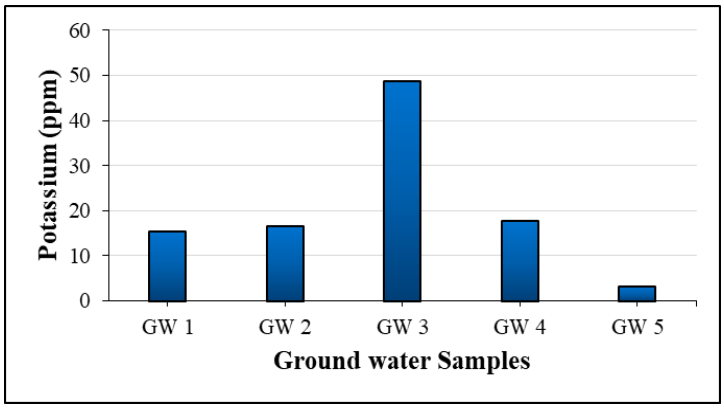

Figure 6. Showing concentration of Potassium in ground water samples of Ras Al Khaimah

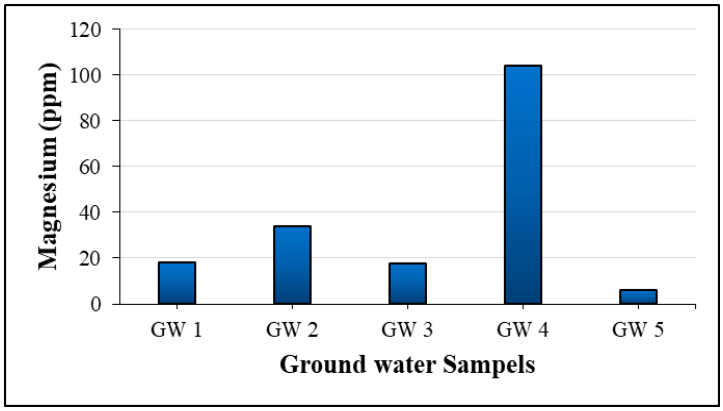

Figure 7. Showing concentration of Magnesium in ground water samples of Ras Al Khaimah

Conclusion

It is concluded that, the assessed groundwater samples from the five sites of Emirates of Ras Al Khaimah had physicochemical properties whose levels were generally within tolerant and safety levels. Following from the findings of this study, it was recommended to embark on consistent routine monitoring of groundwater in urban and rural areas in order to ascertain the state and quality of the water. Domestic/household use of groundwater from boreholes should always be subjected to standard purification process/methods before utilization for consumption purposes.

Acknowledgment
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Conflict of interests
The authors declare that they have no competing interests. All procedures followed were in accordance with the ethical standards (institutional and national).

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