Environmental Contaminants and Their Impact on Groundwater Quality, in three area of Taiz, Yemen

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Abstract

The main aim of this study is to evaluate the quality of ground water supplies of three areas Central, Al-Howban and Dabab in Yemen. Initially, we used ARC / Info geographic information systems (GIS) software to analyze the distribution of different pollutants in the study area. Secondly, The one way Anova was used in the analysis of the data To study the difference between three regions in content of different phisico-chemical parameters.

The results shows that the all parameters analyses in the study samples such as Electrical Conductivity, TDS, chloride, Fluoride etc. were significantly higher in the Central and Al-Howban area and significantly lower in the Dabab area region and higher than the permissible limit according to WHO (Wold Health Organisation). High concentration of population, industrial, agricultural activity and runoff water that carries wastewater mainly in the Central and Al-Howban area are the main anthropogenic sources of water contamination. As a consequence, highly saline water may migrate down and contaminate groundwater in nearby wells. The exacerbations of the problems are the lack of proper treatment of city wastewater, a good drainage system around the wells, and there is no proper surrounding of the city's wells.

Keywords: Water Samples, Dabab, Al-Howban, Central, Physical Measurement, Chemical Analysis, contamination.

I. INTRODUCTION

Water is the universal solvent and human survival depends on the use of uncontaminated and cleaned water. The physical, chemical and bacterial characteristics of ground water determine its usefulness for domestic, industrial, municipal and agricultural applications. The quality of water is more important compared to quantity in any water supply planning, especially for drinking purposes [1]. Water quality analysis is an important issue in groundwater studies. Variation of groundwater quality in an area is a function of physical and chemical parameters that are greatly influenced by

geological formations and anthropogenic activities.

The parameters of water quality i.e. pH, EC, TDS, TH, fluoride, chloride, nitrate, sulfate etc. should be in permissible limits [2.3]. If these parameters cross the permissible limit of concentration, it may causes serious health hazards and such water is known as contaminated water.

The present study tries to identify the intensity and the spatial of the existing groundwater contamination in the study area and try to identify sources pollution responsible for the current pollution of the affected areas through an analytical study in the southern part of the upper valley Rasyan of Taiz governorate in Yemen.

II. MATERIALS AND METHODS

Study area

The study area is a southern part of upper Wadi Rasyan catchment, it's densely populated and includes Taiz city which represented the third largest and important cities in Yemen (Figure 1). Taiz, a city located in the republic of Yemen, 100 km east of the red sea, and away from the city of Sana'a is estimated at a distance of 253 km to the south, surrounded by highlands, especially from the south, such as mount Sabir, which rise up to 3,000 meters above sea level, while Taiz city center is located at an altitude of 1300 meters from almost sea level. The study area contains three sub-basins as shown below:

• TAIZ CITY FIELD (Central sub-basin) (213.698 km2).

• AL-HAWBAN FIELD (146.08 km2).

• AL-DABAB FIELD (112.42 km2).

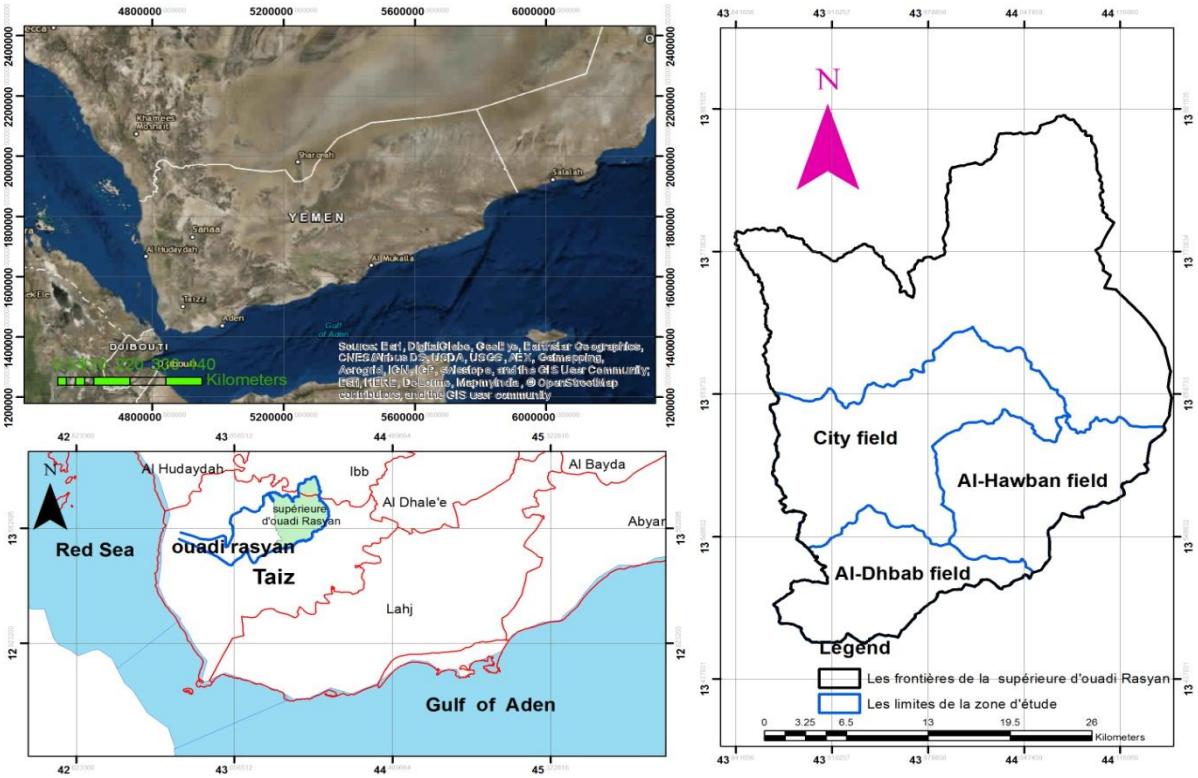

Figure 1 location of the study area

Sampling

In order to evaluate the extent of groundwater contamination with Chemical pollutants, was selected 93 wells based on the inventory of wells in the study area (Figure 3), which included samples of all types of aquifers, and the type of wells, groundwater samples were collected in polyethylene bottles of 1000-ml capacity after rinsed with distilled water and the water of the well, through months in August, September and October 2014. The fluoride concentration of groundwater samples was determined using DR 2800 spectrophotometer.

Statistical methods

The Anova test was used in the analysis of the data. The test Anova is a parametric test used to compare three or more samples. In the study, Al-hawban, Central and Dabab areas were all different samples. A p-value of less than 0.05 at 95% confidence level was considered as statistically significant.

III. RESULTS

Chemistry of groundwater

The mean, ranges of physico-chemical parameters of analysed groundwater samples are presented in Table 1.

Chemical Analysis

The results of studied samples given in the table…showed that the lower average concentration of Calcium was 118 mg / l in the samples taken from Dabab and the highest concentration of calcium was 192 mg/l in the sample taken from Central region. The result of the ANOVA analysis shows that significantly higher calcium content was observed among samples of Central area. While significantly lower fluoride content was observed among samples of Dabab area.

Magnesium average concentration ranged from 61,68 mg / l as a minimum value in the samples taken from Dabab to 155,4 mg / l as a maximum value of the samples taken from Central region table ... Magnesium content was significantly higher among Al-Howban and Central and significantly lower among Dabab area.

On the other hand, the results of chloride, sulphate, bicarbonate and fluoride in the studied samples showed that average concentration ranged respectively between 74,42 mg/l, from 88,12 mg/l, 574,62 and 0.850±0.202 mg/L as a minimum average concentration in samples from Dabab to 850,5, 426,9 mg / l, 809 and 2.8340±1.82 as a maximum average concentration of the sample taken from Central region. The results of nitrate content was 20,40 mg/l as minimum among samples of Central region and the highest content was 57,20

mg/l among Howban area. Sodium and potassium were respectively significantly higher in Central (543,18±330) and Al-Howban area (412,62±277) and significantly lower in Dabab area (62,67±25,36).

Physical analysis

pH average values of the study samples ranged from 7,30 as a minimum at Al-Howban to 7,48 as a maximum value at Dabab which indicates groundwater samples are of slightly alkaline in nature.

TDS was calculated by multiplying the value of the electrical conductivity (EC) by (0.64) factor. The Total Dissolved Solids (TDS) trend physical Characteristics in the study area demonstrates that concentrations of TDS in the samples were significantly dominant in central area (central (TDS)> Al-Howban (TDS) > Dabab (TDS)) table 1.

The results of the study samples showed electrical conductivity ranged from (1398.5±238) µs/cm as a minimum value in the sample taken from Dabab area to (4609±2327) as a maximum in sample taken from Central area.

Table1: Groundwater quality parameters of the Taiz environs.

	Region	Moy± σ	Min-Max	(I) region-(J) region		MD(I-J)	p-value
Ca	Howban	135,5± 77,1	6,0-360,70	Howban	Central	-56,80	0,056
	Dabab	118±27,71	76,5-160,32	Howban	Dabab	17,47	0,449
	Central	192,3±116	40,0-450,00	Central	Dabab	74,21*	0,009
Mg	Howban	102,8±70,4	6,0-360,00	Howban	Central	-52,63	0,056
	Dabab	61,68±21,9	24,10-87,7	Howban	Dabab	41,10*	0,005
	Central	155,4±107,5	18,0-348,00	Central	Dabab	93,74*	0,000
Cl	Howban	512,4±374	29-1456	Howban	Central	-338,11*	0,022
	Dabab	74,42±43,5	35,0-157,9	Howban	Dabab	437,97*	0,000
	Central	850,5±599	99-2034,00	Central	Dabab	776,1*	0,000
F	Howban	2.31±1.163	0.98-5.81	Howban	Central	-0.51502	0.277
	Dabab	0.850±0.202	0.58-1.11	Howban	Dabab	1.46898*	0.017
	Central	2.8340±1.82	0.10-10.0	Central	Dabab	1.98400*	0.001
SO4	Howban	299,7± 317	21,0-1740	Howban	Central	-127,20	0,385
	Dabab	88,12±69,7	30,0-240,00	Howban	Dabab	211,57*	0,000
	Central	426,9±460,1	96,0-1710	Central	Dabab	338,77*	0,002
NO3	Howban	57,20± 99	3,16-527,1	Howban	Central	36,86*	0,034
	Dabab	30±48,20	2,39-146,19	Howban	Dabab	27,22	0,436
	Central	20,40±29,64	0,00-132,45	Central	Dabab	-9,64	0,855
pH	Howban	7,30±0,406	6,40-8,30	Howban	Central	-0,036	0,913
	Dabab	7,48±1,01	6,40-8,80	Howban	Dabab	-0,181	0,872
	Central	7,33±0,40	6,15-8,00	Central	Dabab	-0,14	0,917

Na	Howban	412,62±277	8,05-1201	Howban	Central	-130,56	0,174
	Dabab	62,67±25,36	39,10-110,4	Howban	Dabab	349,95*	0,000
	Central	543,18±330	131,0-1254	Central	Dabab	480,51*	0,000
K	Howban	7,90±6,30	0,59-28,10	Howban	Central	-1,32	0,769
	Dabab	2,92±3,30	0,59-8,19	Howban	Dabab	4,98*	0,009
	Central	9,21±9,15	0,33-45,05	Central	Dabab	6,30*	0,012
HCO3	Howban	720±295,72	171-1464	Howban	Central	-88,94	0,395
	Dabab	574,62±67	488-671,00	Howban	Dabab	145,46*	0,007
	Central	809±297,1	0,00-1525	Central	Dabab	234,41*	0,001
EC	Howban	3357±1753.9	447-7340.0	Howban	Central	-1252.4*	0.037
	Dabab	1398.5±238	1160-1807	Howban	Dabab	1958.14*	0.000
	Central	4609±2327	1677-952	Central	Dabab	3210.53*	0.000
TDS	Howban	2148.1±1126	291-4771	Howban	Central	-813.73*	0,036
	Dabab	909±154.66	754-1174.6	Howban	Dabab	1239.1*	0,000
	Central	2962±1500.1	1091-6188	Central	Dabab	2052.8*	0,000

*The mean difference is significant at the 0.05 level.
MD: Mean Difference (I-J)
all values in mg l-1 except pH and EC in µs/cm

IV. DISCUSSION

Calcium concentration which is almost in the permissible limit of 200 mg/l [4.5]. And this was attributed to the composition of the rocks formation in the study areas, sewage disposal surroundings.

The average concentration of magnesium, was almost at the limit of permissible limit of 150 mg/l [4.5]. The reasons behind of the higher concentration of this element in these regions are the sewage disposal and the overpumping of water scarcity as a result of an increase in the concentration of magnesium.

The chloride and sulphate content was significantly dominant in the central region and Al-Howban but particularly high in the central region than the permissible limit of 250 mg/l [4]. The reason for the high concentrations of this in these wells is the location of the wells, where the waste carried out from various surroundings areas. While, Central area have content exceeded the permissible limit of 400 mg/l according to WHO and YSMO guidelines. The reasons for the high concentrations of sulfates, especially in Central was the contamination of those areas from sewage which contains high concentrations of this element.

It was found throughout the results that, Al-Howban area contained high concentration of nitrates exceeded the permissible limit of 50 mg / l [4.5]. It is noticed that the high concentrations of this element because of the influenced of High concentration of population, industrial, agricultural activity, sewage disposal and by water runoff near these sites that contain also some fertilizers from agricultural areas near the sites. It was found throughout the results of samples studied that, all samples of central and Al-Howban and many samples of Dabab area contained high

concentration of nitrates exceeded the permissible limit of 50 mg / l [4.5].

Many of samples in Central and Al-Howban have concentration more than permissible limit of 1.5 mg/l [4.5] except a sample of Dabab area which have lower concentrations of this element. The reason of the high concentration of fluoride in those samples was due to the composition of rock formation that contains this element surrounding study areas. Many citizens on those studied areas affected by fluoride element.

The results also showed that the concentrations of Al-Howban and Central samples studied were higher than the permissible limit of 400 mg/l [5] and 200 mg/l [4]. The high concentration of sodium, especially in Central and Al-Howban was due to geological rock's composition of these areas. The study results showed that the concentration of potassium in the studied samples of Dabab area is less than the permissible limit and few wells showed high concentrations of this element in Central and Al-Howban areas (12 mg/l) [4.5]. This is due to the composition of the rocks containing this element in those areas.

The variation on pH of the studied samples remains within the permissible limits (6.5-8) [4.5]. The results also showed that the concentrations of dissolved solids in many of the samples studied were higher than the permissible limit of 1500 mg/l according to WHO and YSMO.

The electrical conductivity exceeded the permissible limit of (2500 μmos / cm) [5]. This could be explained by different liquid waste by runoff and sewage disposal.

CONCLUSION

From the present study, it is concluded that, most of the ground water, especially in the al-howban and central areas unsuited for drinking and for most of other uses because of its high content of different chemical pollutants.

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