Analysis of some Physiochemical Parameters to Evaluate the Drinking Water Quality in Al-Qutai wells Hodeida- Yemen

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Abstract

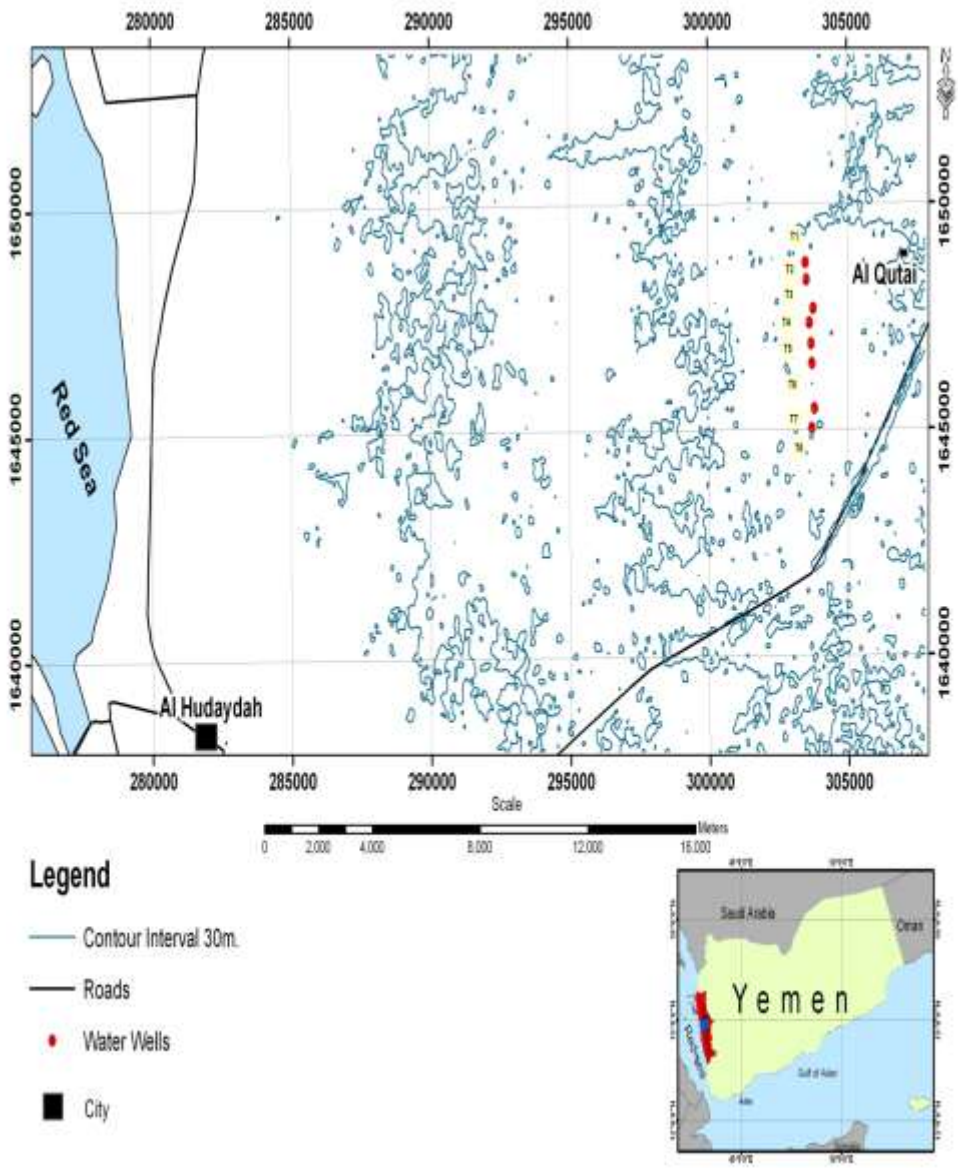
Analysis of some Physiochemical Parameters to Evaluate the Drinking Water Quality in al-Qutai wells Hodeida- Yemen. In this regard, a physical and chemical analysis of drinking water samples was carried out in Al-Qutai from 8 wells. A pH, turbidity, Electrical conductivity, total dissolved solids (TDS),Na, K, Ca, Mg, SO_4, NO_3, Cl, PO_4 and heavy metals such as Cu, Fe, Mn and Cr, were analyzed for each water sample. The obtained values of each parameter were compared with the standard values set by the World Health Organization WHO Standard and local standards. 50% A water samples have nitrate concentration higher than the maximum limit. PH, TDS, EC, major and minor ion, are with the permissible limit, However, it is also important to investigate other potential water contaminations such as chemicals and microbial and radiological materials for a longer period of time, including human body fluids, in order to assess the overall water quality of Hodeida government .

Keywords: Ground water, Hodeidah, Yemen, Physiochemical Parameters

Introduction

The public health significance of water quality cannot be over emphasized. Many infectious diseases are transmitted by water through the fecal-oral route. (WHO, 2004). Water is vital to our existence in life and its importance in our daily life makes it imperative that thorough physio-chemical examinations be conducted on water. Potable water is the water that is free from disease producing microorganisms and chemical substances that are dangerous to health (Lamikanra, 1999) , (Osuinde and,Enuezie 1999). Drinking water quality is paramount for public health. Despite improvements in recent decades, access to good quality drinking water remains a critical issue, (Villanueva, C.M (2014)).drinking water quality is regulated and monitored in many countries, increasing knowledge leads to the need for reviewing

standards and guidelines on a nearly permanent basis, both for regulated and newly identified contaminants, (Villanueva, C.M. (2015)). Clean drinking water is now recognized as a fundamental right of human beings.(UN-Water, 2013)).Water quality and suitability for use are determined by its taste, odor, colour, and concentration of organic and inorganic matters. (Majam, Mohamed T. and Usama A. A. Radwan (2015)) and (Dissmeyer G. E., (2000)).Water is important to the mechanic of the human body and the body cannot work without it. Water quality is essential for the wellbeing of all people; different pollutants such as, chemical, biological and physical, can affect the quality of water. Contaminant such as bacteria , virus, heavy metals ,nitrate and salt have found their way into water supplies, the water pollution occurs when a body of water is adversely affected as being a point source or non-source point of pollution, point source occurs when there is runoff of pollutants into a water way (Manhan S.E. -2008). In Yemen, ground water is considered as the first water source for irrigation and other usesTehama basin , is located in the west of Yemen map (1), along the Red Sea coast, the climate of the Tihama plain can be described as being hot, windy and arid with humidity due to the influence of red sea. Mean annual rainfall in the Tihama range (100- 600mm/year), the air temperature is over 33ºc in the period from May to September (Faqeh-2008). The source of drinking water in Hodeida city is only ground water from two sits, the first in the city and the other in Al-Qutai wells. Well's location, and geology in map [1]. The aims of this study were toanalysis of some physiochemical parameters to Evaluate the Hodeida drinking water. (some Hodeida's wells drinking water quality). Samples were collected from Al-Qutai wells.



Map [1] Tihama basin and Well's location.

Materials and Methods

The 8 water samples were collected using 1L polyethylene container after cleaning by acid (6mol L^{-1} HNO_3) the pH (pH meter Hanna Model H19025) and the Electrical conductivity (conductivity meter HACH Model 862) has been used for direct measurement during collecting the samples, all samples were collected in September 2017and stored in cool environment (4ºC) to prevent the vaporization and biodegradation (WHO-1996). The

temperature of the water samples were determined at the same time of sampling. In this research we used spectrophotometer (HATH, Model DR2004) and the chemicals and reagents (metallo chromic indicators) used were purchased from BDH, HACH and Merck (A.R.,99,9%) to determined by flame emission spectroscopy, while the remaining alkalinity and ions (Ca^{++}, Mg^{++}, and Cl^{-}) were analyzed by titration method (UNEP-2004). The precision of measurements was checked taking three replicates from the sample. (Maahan S.E. -(2000)).

Results and discussion.

The analysis results of drinking water samples for eight water sources wells in Al-Qutai field is showed in tables (1) and (2), the values indicate that the physical measurements**,** temperature T**,** Electrical conductivity EC, total dissolved solids T.D.S**,** pH and turbidity. The values fall within allowable limits according WHO and YS.

Table (1) Physical parametersof drinking ground water samples from Alqutai wells, Yemeni and WHO Standards.

No. of wells	Physical parameters				
	T (^{0}C)	E.C (μS cm^{-1})	T.D.S (mg L^{-1})	PH	Turbidity (NTU)
1	39.9	1620	972	7.91	NIL
2	39.9	1630	978	7.89	NIL
3	38.8	1600	960	7.75	2
4	37	1606	963.6	7.61	2
5	37.8	1630	978	7.92	3
6	37.8	1550	930	7.59	1
7	37.8	1330	798	7.63	NIL
8	37	1430	858	7.66	NIL
WHO.S	-	-	1000	6.5-8.5	5
Y.S	-	450-2500	650-1500	6.5-9	5

(A) Physical parameters

1. Temperature (T)

Table (1) and figure 1(D) shown the temperature at the time sampling, the range was between 37 -39.9 ^{0}C.

2. Electrical Conductivity (EC).

Electrical conductivity is the ability of any medium; water in this case, to carry an electric current. The presence of dissolved solids such as calcium, chloride, and magnesium in water samples carries the electric current through water. The measured conductivity values of all the drinking water samples are plotted in (Figure 1(A)). According to (TDA Yemen2002),use yemen standard for drinking water andWHO standard, (WHO/UNICEF, (2019)) the maximum allowable level of conductivity is 1000 μS/cm. The results show that the measured conductivity of all water samples ranges from 1330 (μS cm^{-1}) to 1630 (μS cm^{-1}, (Table 1). The lowest and highest conductivity values correspond to 7 and 2 well samples, respectively. Conductivity does not have direct impact on human health. It is determined for several purposes such as determination of mineralization rate (existence of minerals such as potassium, calcium, and sodium) and estimating the amount of chemical reagents used to treat this water, (Azrina et al.(2011), (Khan.S., M. Shahnaz et all (2013)) , (Kavcar, P. A. Sofuoglu, et all (2009)) , (Cidu, R., F. Frau, and P. Tore, (2011)), and (Muhammad S., et all, (2011)).

3.. Total Dissolved Solids (TDS).

TDS are the inorganic matters and small amounts of organic matter, which are Present as solution in water. Figure 2(B) shows TDS values for all 8 drinking water samples. The WHO and Yemeni standard or allowable value of the TDS is 1000mg/L and 650 -1500 mg/L(WHO (2011)).The values found from the drinking water samples are all less than the maximum limit, TDS ware the range , (798 - 978) mg/L^{-1} respectively, it is within the permissible limits given by WHOS and YS .

4- pH

pH is classed as one of the most important water quality parameters. Measurement of pH relates to the acidity or alkalinity of the water. A sample is considered to be acidic if the pH is below 7.0. Meanwhile, it is alkaline if the pH is higher than 7.0. Acidic water can lead to corrosion of metal pipes and plumping system. Meanwhile, alkaline water shows disinfection in water. The normal drinking water pH range mentioned in WHO and Yemen guidelines is between 6.5 and 8.5 (Table 1). The pH values of all the drinking water samples are found to be in the range between 7.61 and 7. 91 (Figure 1(C)) there are in the range of WHO.s and Y.S, where the lowest and highest values are from well 5 and 6 respectively (Table 1). For al-qutae wells sample.

5-Turbidity.

Turbidity is the cloudiness of water caused by a variety of particles and is another key parameter in drinking water analysis.(Rahmanian N., et all, (2015)) It is also related to the content of diseases causing organisms in water. The standard recommended maximum turbidity limit, set by WHO.s and Y.S, for drinking water is 5 nephelometric turbidityunits (NTU),(WHO (2011)).The lowest turbidity values of 1 NTU and highest value of 3 UNTU were found for samples 5 and 6 respectively (Table 1).The mineral water, which was expected to be the cleanest water, thus had lowest turbidity values. The results indicate that the turbidity of all the wells studied werewithin the permissible limit of WHO and Yemeni standard**.**

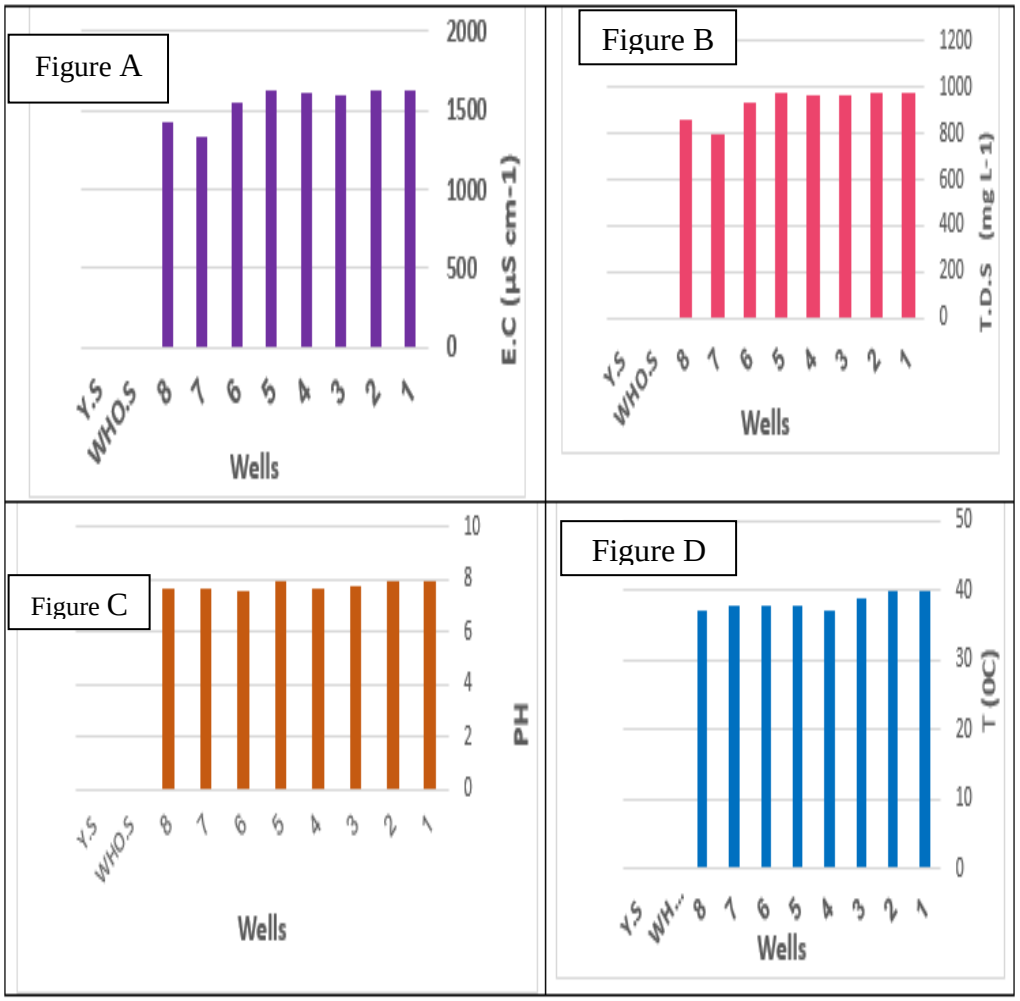


Figure (1) Some Physical parametersof drinkingground water samples from Al-qutai wells

(B) Chemicals parameters

The values indicate that the Chemicals measurements**,** Cl , (TH) as $CaCO_3$, Ca^{++} , Mg^{++}, T Alkalinity, NO_3^- , SO_4^{--}, Na^+, K^+ , PO_4^{---}, T Hardness . The results values of chloride ion for eight ground water wells showed range (140-235) mg L^{-1}, within the permissible limits for WHO and YS, the value was (235 mg L^{-1}), may be due to the increase in the depth of well, which gives the greater concentration of salts.Water hardness is defined as the concentration of calcium and magnesium ions expressed in term of calcium carbonate,

(Looper M.L., (2017)), the values of TH were in the range of (295-480) mg L^{-1}, within the permissible limits for WHO and YS, the hardness scale is shown value more (180mg L^{-1}), water is very hard (Turky N., Mcginely P. , (2006)), these mineral in water can cause some everyday problems, they react with soap and produce a deposit called "soap curd", the calcium and magnesium ions were found to be in the range of (52-96) mg L^{-1} and (41-60) mg L^{-1} respectively, these values were within optimum limit.Alkalinity is an important parameter because it measures the water's ability to resist acidification, the value for alkalinity ranged from 135 to 240 mg L^{-1}, all wells have values within the permissible limit.

Table (2) Chemicals parametersof drinkingground water samples from Al-qutai wells and Yemeni , WHO Standards.

No. of wells	chemical parameters									
	Cl (mg/ L^{-1})	TH (mg/ L^{-1}) as $CaCO_3$	Ca^{++} mg $CaCO_3$/ L^{-1}	Mg^{++} mg $CaCO_3$/ L^{-1}	T. Alkalinity (mg/ L^{-1})	NO_3^- (mg/ L^{-1})	SO_4^{--} (mg/ L^{-1})	Na^+ (mg/ L^{-1})	K^+ (mg/ L^{-1})	PO_4^{---} (mg/ L^{-1})
1	235	460	240	220	135	46.5	350	150	3.08	0.012
2	230	480	240	240	135	47.96	320	150	3.3	0.1
3	205	440	220	220	165	70.4	280	140	3.25	0.18
4	210	460	235	235	165	66	270	136.5	3.25	0.16
5	205	375	230	235	175	86	210	155	3.57	0.05
6	215	420	190	230	190	62.5	200	140	3.4	0.1
7	140	295	100	195	240	46.2	160	95	2.2	0.17
8	160	350	160	190	200	42	170	98	2.3	0.19
WHO.S	250	500	200	–	200-250	50	250	200	–	–
Y.S	200-600	100-500	75-200	–	–	10-50	200-400	Max400	8-12	–

The sodium and potassium ions are investigated in studied water samples, the concentrations were in the range of (95-150) mg L^{-1}, (2.20-3.57) mg L^{-1} respectively. These results were within the permissible limits by WHO and YS, the concentration of phosphate ion due to the effect of phosphate fertilizers at the cultivation regions. The nitrate ion in the investigated samples were found to be in the range four samples exceed the maximum limit 50 mg/L. For nitrate suggest the mixing between water samples to decrease

the concentration of nitrate as a solution, (42-86) mg/ L-1, these results were within the permissible limits by (WHO) and (YS).

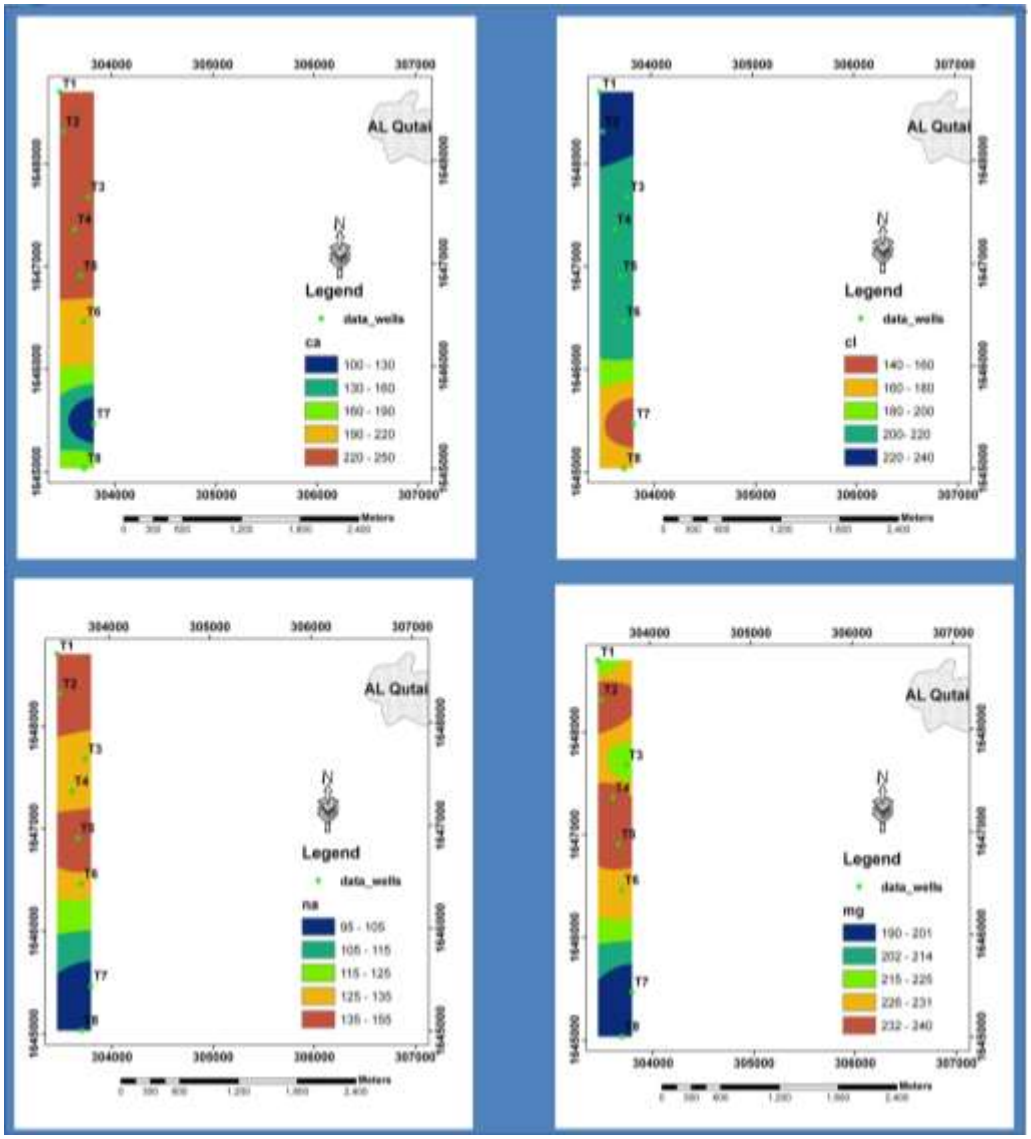


Figure (2) Concentration of Ca^{++} , Cl , Na^{+} , Mg^{++}, at drinking ground water samples from Al-qutai wells.

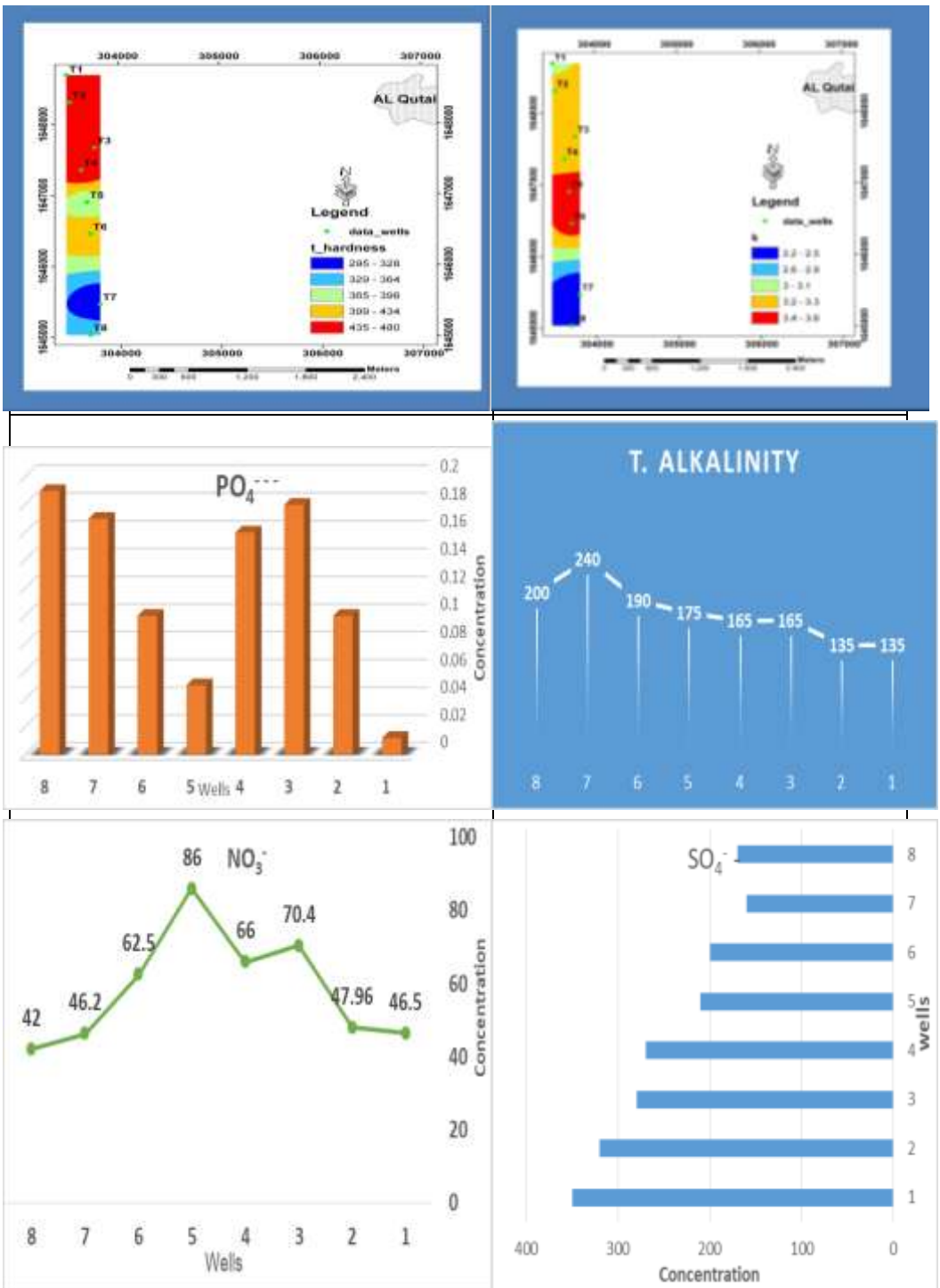


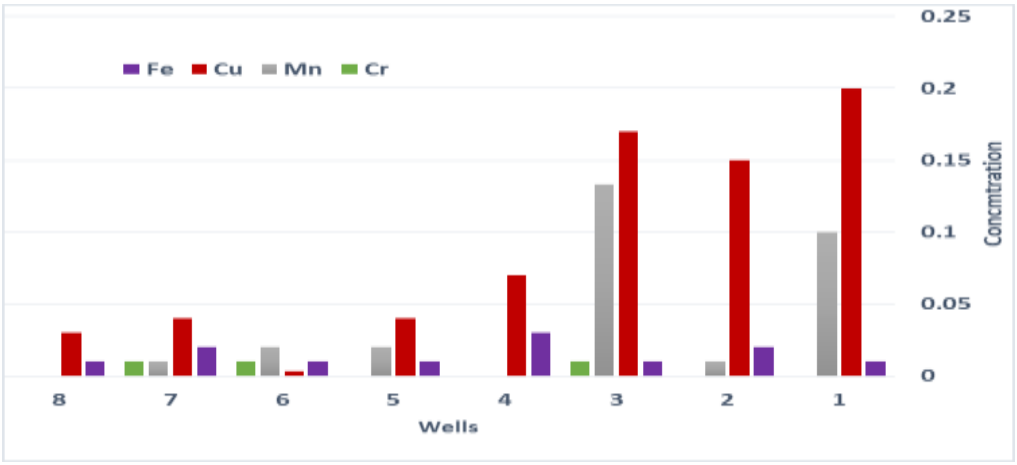
Figure (3) Concentration of T Hardness, K^+, PO_4^{---}, T Alkalinity, NO_3^-, $SO4^{--}$, at drinking ground water samples from Al-qutai wells.

(C)Heavy Metals Analysis.

The presence of heavy metals in drinking water higher than a certain concentration can cause detrimental impacts on human health , Hanaa M, et al. (2009) and Abdul Razzak B. I. and Atta I. A. (2008) . Therefore, the analysis of heavy metals in drinking water is an important parameter, and most of the studies on drinking water quality involve investigation of heavy metals. In the present study, the results of heavy metals such as Fe, Cu, Mn, and Cr, (Table 3 and Figure 4) are compared with the safe limits set by WHO and YS (Table 2). There is no pollution of heavy elements, the values fall within allowable limits according WHO also YS.

Table (3) The analytical results of heavy metals in drinking ground water samples from Al-qutai wells and Yemeni , WHO Standards.

No. of wells	heavy metals			
	Fe ($mg\ L^{-1}$)	Cu ($mg\ L^{-1}$)	Mn ($mg\ L^{-1}$)	Cr ($mg\ L^{-1}$)
1	0.01	0.2	0.1	NIL
2	0.02	0.15	0.01	NIL
3	0.01	0.17	0.133	0.01
4	0.03	0.07	NIL	NIL
5	0.01	0.04	0.02	NIL
6	0.01	0.003	0.02	0.01
7	0.02	0.04	0.01	0.01
8	0.01	0.03	Nil	Nil
WHO.S	0.3	1	0.1	0.05
Y.S	**0.3-1**	**0.5-1**	**-**	**-**



Figure(4) The analytical results of heavy metals in drinking ground water samples from Al-qutai wells and Yemeni , WHO Standards.

Conclusions

1) The analytical data of TDS, T.H, chloride ion and sodium ion concentration were in the permissible limit by WHO and Y.S.
2) 50% A water samples have nitrate concentration higher than the maximum allowable limit.
3) The concentration of sulphate ion was the permissible limit given by (WHO), except well (7&8) and all within the permissible limit of YS.
4) The results of heavy metal ions indicate being far from pollution.

References

1) Azrina A., H. E. Khoo,M. A. Idris, I. Amin, andM. R. Razman, “Major inorganic elements in tap water samples in Peninsular Malaysia,” Malaysian Journal of Nutrition, vol. 17, no. 2, pp. 271–276, 2011.
2) Abdul Razzak B. I. and Atta Ibraheem Atta (2008). Chemical and physical analysis of some ground water sample in Al-Quti wells Hodiedah, Yemen, J. Iran. Chem. Res. 1 (2008) 141-144.
3) Faqeh, E,A.(2008) . Performance and Impact Evaluation of IFAD' s Tihama Environmental Protection Project , Republic of Yemen. Phd , thesis, University of Khartoum, Sudan, January 2008.p13

4) Dissmeyer G. E., Drinking water from Forests and Grasslands, South Research Station, USDA Forest Service, Ashville, NC, USA, 2000.
5) Khan, M. Shahnaz, N. Jehan, S. Rehman, M. T. Shah, and I.Din, "Drinking water quality and human health risk in Charsadda district, Pakistan," *Journal of Cleaner Production*, vol. 60,pp. 93–101, 2013.
6) Lamikaran, A. (1999). Essential Microbiology for students and Practitioners of Pharmacy, Medicine and Microbiology. 2nd Edn. Amkra books, 406p.
7) Hanaa M., E. A. Eweida, and F. Azza, Heavy Metals in Drinking Water and Their Environmental Impact of Human Health, ," Environmental Science and Technology, vol. 43, no.5, pp. 1612–1617, 2009.
8) Majam Mohamed T. and Usama A. A. Radwan (2015) . Effect Of Floods On Soil Physical And Chemical Properties Of Wadi Zabid Tehama, Yemen, International Journal of Analytical and Bioanalytical Chemistry, 2015; 5(2): 45-47.
9) Looper M.L., D.N. Waldner, Water for Dairy Cattle, Cooperative Extension Service College of Agriculture and Home Economics, 2017.
10) Rahmanian N., Siti Hajar Bt Ali, M. Homayoonfard, N. J. Ali, M. Rehan, Y. Sadef, and A. S. Nizami3 . (2015): Analysis of Physiochemical Parameters to Evaluate the Drinking Water Quality in the State of Perak, Malaysia Hindawi Publishing Corporation Journal of Chemistry Volume 2015, Article ID 716125, 10 pages http://dx.doi.org/10.1155/2015/716125.
11) Turky N., P. Mcginely, D. Hoverson, Shawano Lake Watershed Project, University of Wisconsin- Steven Point, 2006.
12) Osuinde. M.I. and Eneuzie, N.R. (1999). "Bacteriological analysis of ground water." Nigeria Journal of Microbiology vol. 13:47-54.
13) Kavcar P., A. Sofuoglu, and S. C. Sofuoglu, "A health risk assessment for exposure to trace metals via drinking water

ingestion pathway," International Journal of Hygiene and Environmental Health, vol. 212, no. 2, pp. 216–227, 2009.

14) Cidu R., F. Frau, and P. Tore, "Drinking water quality: comparing inorganic components in bottled water and Italian tap water," Journal of Food Composition and Analysis, vol. 24, no. 2,pp. 184–193, 2011.
15) Maahan S.E. - (2000), Environmental chemistry, Lewis publishers, Boca Ration:CRCpress.
16) Muhammad S., M. T. Shah, and S. Khan, "Health risk assessment of heavy metals and their source apportionment in drinking water of Kohistan region, Northern Pakistan," *Microchemical Journal*, vol. 98, no. 2, pp. 334–343, 2011.
17) Tehama Development Authority ,TDA, Quality Standard, Engineering of Services Division, Ministry of agriculture, 2nd edition, 2002.
18) UN-Water, An increasing demand, facts and figures, UN- Water ,coordinated by UNESCO in collaboration with UNECE and UNDESA, 2013, http://www.unwater.org/water-cooperation-2013/en/.
19) UNEP – (2004) United Nation Environment Programme) , Anaalytical Method Water programme in collaporation with IAEA.
20) Villanueva, C.M.; Levallois, P. Exposure, Assessment of Water Contaminants. In Exposure Assessment in Environmental Epidemiology; Nieuwenhuijsen, M.J., Ed.; Oxford University Press: New York, NY, USA, 2015; pp. 329–348. ISBN 978-0-19-937878-4.
21) Villanueva, C.M.; Kogevinas, M.; Cordier, S.; Templeton, M.R.; Vermeulen, R.; Nuckols, J.R.;Nieuwenhuijsen, M.J.; Levallois, P. Assessing Exposure and Health Consequences of Chemicals in Drinking Water: Current State of Knowledge and Research Needs. Environ. Health Perspect. 2014, 122, 213–221. [CrossRef] [PubMed].

22) WHO/UNICEF Drinking-Water. Available online: https://www.who.int/news-room/fact-sheets/detail/ drinking-water (accessed on 11 February 2019).
23) World Health Organization (WHO), Guidelines for Drinking-Water Quality, WHO Press, Geneva, Switzerland, 4th edition, 2011.
24) WHO (2004). Water Sanitation and Health Programme. Managing water in the home: accelerated health gains from improved water sources. World Health Organization. www.who.int.
25) World Health Organization(WHO) – (1996), Anonymous, Guidelines for drinking Water Quality ..