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RESEARCH ARTICLE

Assessment of Heavy Metals in Some Ground Water Wells at Baghdad City /Iraq

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Abstract

Occurrence the heavy metals in water is one of the most important concerns. may cause savior health problems. In this work we made an attempt to know the quantity of six heavy metals in groundwater in different locations of Baghdad city. Examinations were made on groundwater of the review region to assess the heavy metals. Groundwater samples were gathered and analyzed utilizing Atomic Absorption Spectrophotometer for their Manganese, Iron, Zinc, Cadmium, Copper and Lead content and their levels compared with World Health Organization (WHO) specified maximum contaminant level. In order to accomplish this, water samples were obtained from 10 randomly selected wells in the region, in February and August, 2016. The study showed that the groundwater in the study area were generally alkaline (moderate) and contained Cu^{+2}, Fe^{+2}, Pb^{+2}, Cd^{+2}, Cu^{+2} and lead concentrations that are higher than the permissible limits suggested by the (WHO). The study can then be concluded to be contaminated with some heavy metals because of the effect of many activities in the survey area. Decreased the operation of Industrial treatment, laws and the integrated management led to deteriorating the groundwater quality. Also the study inclusion the TDS and EC in the groundwater in these locations.

Keywords: *Determination, Heavy metal, Atomic absorption, Groundwater wells.*

Introduction

Groundwater is an important source for multipurpose, drinking, industrial, Agriculture etc. the groundwater quality in some areas gradually decreases because of unsustainable of water resources. Generally, groundwater is cleaner than surface water yet the irregular development of urbanization, Industrialization additionally influenced the groundwater quality [1].

Heavy elements constitute a natural component of the earth crust (e.g. eroded minerals within sediments, leaching of ore deposits and volcanism extruded products) and they are most certainly not biodegradable, hence continue in the environment, and may be might be filtered from rocks and soils as per their geochemical portability or originated from anthropogenic sources, aftereffect of human land occupation and industrial pollution i.e. solid waste disposal, industrial or domestic effluents, [2, 3, 4, 5, 6, 7].

Heavy metals are elements having atomic weights between 63.546 and 200.590 g/mol and a specific gravity greater than 4.0 i.e. no less than 5 times that of water. They exist in water in colloidal, particulate and dissolved phases [8].

The heavy metals released by industries, traffic, city wastes, and dangerous waste sites as well as from fertilizers for agricultural purposes and accidental oil spillages from tankers can result in a steady rise in pollution of groundwater [9, 10, 11]. These heavy metals get into the environment by air emissions from smelters, industrial smokes, waste incinerators, lead in household plumbing, old house paints and industrial waste [12, 13, 14, 15].

Heavy metal pollution in the groundwater is a major concern because of their toxicity and threat to human life and the environment.

Heavy metals such as Al, Cr, Mn, Fe, Ni, Cu, Z n, As, Cd, Hg and Pb are potential soil and water pollutants in little amounts, certain heavy metals are nutritionally essential for a healthy life. Some of these are referred to as the trace elements (e.g., Fe, Cu, Mn, and zinc).

These components, or some type of them, are normally found naturally in foodstuffs, in fruits and vegetables, and available in commercially multivitamin products (International Occupational Safety and Health Information Centre 1999).

Heavy metals become toxic when they are not metabolized by the body and gather in the soft tissues. Heavy metals may enter the human body through nourishment, water, air, or absorption through the skin when they come in contact with humans in agriculture and in manufacturing, pharmaceutical, industrial.

Heavy metal can cause serious health effects with varied symptoms relying upon the nature and amount of the metal ingested [16]. High concentrations of trace elements are hazardous because they tend to bio-accumulate resulting in heavy metal poisoning (The most common heavy metals that humans are exposed to be Aluminum, Arsenic, Cadmium, Lead and Mercury [17].There is thus the need to assess the quality of groundwater sources. The (WHO) has determined Maximum Contaminant Level for the nearness of heavy metals in water. The aim of this study is to assess the quality of groundwater sources in Bagdad city, center of Iraq.

Materials and Methods

Study Location

The looking study area lies within longitude (44 09- 44 33 E) and latitude (33 10 -33 29 N), (Figure 1). It is the largest city in Iraq, with an area of 5159 km². The study zone has changed lithological formations ranging in age. The geology of Bagdad varied from Quaternary deposit (Pleistocene) to recent (alluvium).And covered mainly by the Holocene deposits [18].

The main source of water supply, residential and industrial uses in the Baghdad city, is provided from the Tigris River and wells in some area. The climate throughout the review area is with warm, dry summers and cool, moist winters.

The annual ranges of rainfall in the studied range reaches are 0.05 mm to 24.66 mm, mean monthly, temperature values range from 9.64 to 35.39 °C, Evaporation range of 66.85 to 530 mm, while relative humidity has an adverse trend as compared with temperature and evaporation. It ranges from 27.6% to 78%. Hydrogeology Good sand aquifer can be found at depth 8-20 m underground in the studied area.

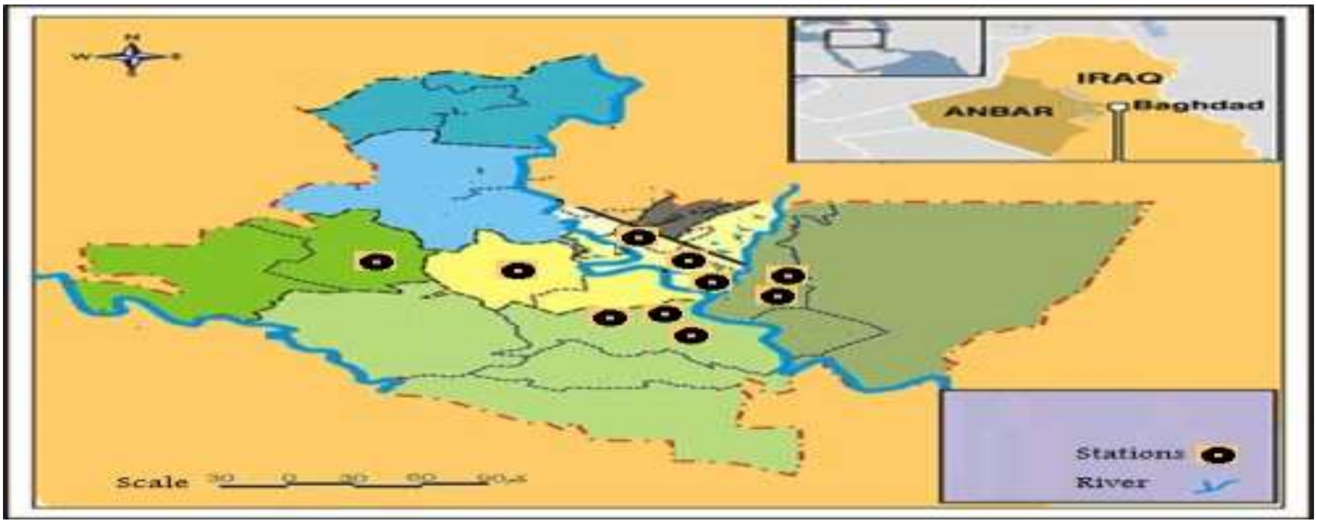

Figure 1: Study area with the sample location points

Samples Collection

Groundwater samples were randomly collected from 10 sampling sites (the depth between 13-20 m) in ten different areas of Bagdad at two periods February and August, 2016. These areas include; Doura, Saidia, Bayaa, Gazalia, Abu-Greeb, Dyala ridge, Jadria, Zafrania, Shaap and Shik Amer. The samples are gathered in clean polyethylene bottles. The bottles are prewashed with laboratory grade detergent followed by adequate rinsing with deionized water.

One sample is gathered in each sample site and the samples are acidified with 1.5 ml of nitric acid per liter. And these samples are stored at 4°C before analysis. Samples were collected in different areas.

Samples were collected in various places.

Sample – 1: Doura near high way
Sample – 2: Saidia Near high way
Sample – 3: Bayaa near Industrial region
Sample – 4: Gazalia near High way
Sample – 5: Abu-Greeb near Masab Al-Aam
Sample – 6: Dyala ridge Near Riystmia Plant
Sample – 7: Jadria near Baghdad unversity
Sample – 8: Zafrania near Discharge of Factories
Sample – 9: Shaap near Shaap market
Sample – 10: Shiak Amer Near the police center

Analytical Methods

The samples were analyzed using the Atomic Absorption technique (AAS, Shimadzu AA-6300. The sample analysis was carried out in water research, ministry of science and technology Laboratories, Iraq.

The processed specimens were examined in duplicates with the average concentration of the metal present being shown in mg/L by the instrument after extrapolation from the standard curve. 1000 mg/L stock solutions of studied heavy metals were prepared. Calibration solutions of the focus metal ions were prepared from the standard stock solutions by serial dilution. And The AAS was calibrated with relevant Shimadzu AAS spectroscopic grade standards.

Results and Discussion

The six elements studied in this research namely: Manganese, Iron, Zinc, Cadmium Copper and Lead have Maximum Pollutant Levels of 0.050 mg/L, 0. 300 mg/L ,3.000 mg/L, 0.003 mg/L, 2.000 mg/L and 0.010 mg/L respectively (19, 20). All the 20 tests were named appropriately and investigated for the metal content. Sample were analyzed 5 times (n=5) the trace metal concentrations of six in different parts of the study zone has been presented in Table 1,2.

Table 1: Physical characterizes of water samples for two periods February and August, 2016

Locations	Sub location	pH		*Ec μs/cm		*TDS mg/L	
		February	August	February	August	February	August
Doura	Karakh Side	6.90	7	6200	6430	5000	5231
Siydia		6.8	6.9	5100	5412	3200	3323
Baaya		7.2	7.23	1882	1910	1380	1465
Gazalia		7.8	7.9	1700	1778	1210	1354
Abu-greeb		7.7	7.8	2300	2387	1521	1687
Shaap	Rassafa Side	7.1	7.2	1020	1120	7543	7771
Dyala		7.4	7.41	8000	8200	5900	6002
Jadria		7.3	7.33	2100	2198	1650	1712
Zafrinia		6.8	7	4900	4978	3890	3932
Shik Amer		6.9	7.1	6890	6945	5320	5428
WHO, 2006		6.5-8.5		1400		500	

*(TDS) Total dissolved solids.
*(EC) Electrical conductivity

Table 2: Heavy metals concentration of water samples for two periods February and August, 2016

Locations	Sub location	Mn^{2+}		Fe^{2+}		Zn^{2+}		Cd^{2+}		Cu^{2+}		Pb^{2+}	
		Feb.	**Aug.**	**Feb.**	**Aug.**	**Feb.**	**Aug.**	**Feb.**	**Aug.**	**Feb.**	**Aug.**	**Feb.**	**Aug.**
Doura	Karakh Side	0.39 ±0.02	0.32 ±0.03	0.01 ±0.002	0.03 ±0.004	0.04 ±0.003	0.03 ±0.002	0.001 ±0.001	0.002 ±0.001	0.9 ±0.03	0.98 ±0.05	0.001 ±0.001	0.006 ±0.001
Siydia		0.03 ±0.002	0.04 ±0.002	0.03 ±0.001	0.03 ±0.003	0.01 ±0.005	0.03 ±0.002	0.003 ±0.001	0.003 ±0.001	0.9 ±0.01	0.089 ±0.006	0.003 ±0.001	0.0034 ±0.001
Baaya		0.1 ±0.03	0.12 ±0.02	0.51 ±0.07	0.52 ±0.008	0.02 ±0.002	0.02 ±0.003	0.02 ±0.001	0.021 ±0.002	3 ±0.08	3 ±0.05	0.03 ±0.002	0.032 ±0.002
Gazalia		0.01 ±0.001	0.02 ±0.002	0.01 ±0.003	0.011 ±0.001	0.01 ±0.03	0.02 ±0.003	0.0002 ±0.004	0.002 ±0.001	1 ±0.02	1.2 ±0.04	0.002 ±0.001	0.003 ±0.001
Abu-greeb		0.11	0.23	0.04	0.04	0.04	0.03	0.002	0.002	0.9	0.99	0.002	0.002

		±0.01	±0.03	±0.001	±0.006	±0.003	±0.001	±0.001	1 ±0.001	±0.06	±0.06	±0.001	1 ±0.001
Shaap	Rassafa Side	0.01 ±0.001	0.01 ±0.001	0.01 ±0.002	0.01 ±0.001	0.03 ±0.005	0.04 ±0.002	0.002 ±0.001	0.002 ±0.001	1 ±0.04	1 ±0.04	0.001 ±0.001	0.002 ±0.001
Dyala		0.07 ±0.002	0.07 ±0.002	0.02 ±0.003	0.023 ±0.005	0.051 ±0.002	0.052 ±0.004	0.05 ±0.002	0.051 ±0.005	2 ±0.03	2.1 ±0.05	0.002 ±0.001	0.003 ±0.001
Jadria		0.021 ±0.003	0.02 ±0.001	0.01 ±0.002	0.01 ±0.003	0.01 ±0.002	0.021 ±0.001	0.002 ±0.001	0.002 ±0.001	1 ±0.05	1.1 ±0.02	0.002 ±0.001	0.0023 ±0.001
Zafrinia		0.9 ±0.05	0.98 ±0.06	0.04 ±0.001	0.041 ±0.002	0.04 ±0.001	0.041 ±0.002	0.06 ±0.001	0.062 ±0.003	2 ±0.07	3 ±0.05	0.012 ±0.001	0.02 ±0.003
Shik Amer		0.91 ±0.11	0.93 ±0.02	0. 51 ±0.009	0. 52 ±0.008	0.056 ±0.003	0.057 ±0.001	0.06 ±0.003	0.08 ±0.004	3 ±0.06	3.5 ±0.08	0.05 ±0.002	0.07 ±0.004
WHO,2006		**0.05**		**0.3**		**3**		**0.003**		**2**		**0.01**	

*Measurement's = mean ± SD

The pH of all samples for two periods are falls below limitation of WHO, 2006, permissible standard, as appeared in Figure 2. The E c (Electrical conductivity) and TDS (Total dissolved solids) of water samples for two periods higher than of WHO (2006), and the values of E c and TDS in the wet season are higher than the wet season because of evaporation process as appeared in Figure 3 and 4.

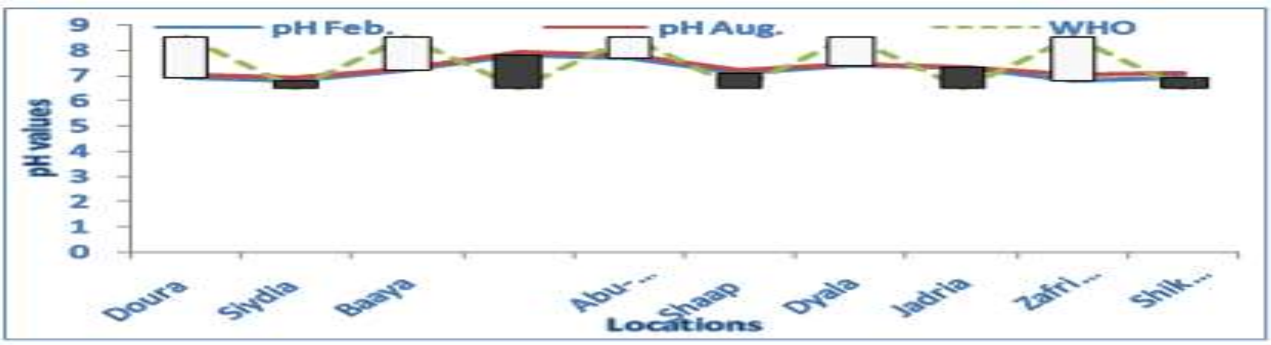

Figure 2: PH-values in the study area during two periods, February, August 2016

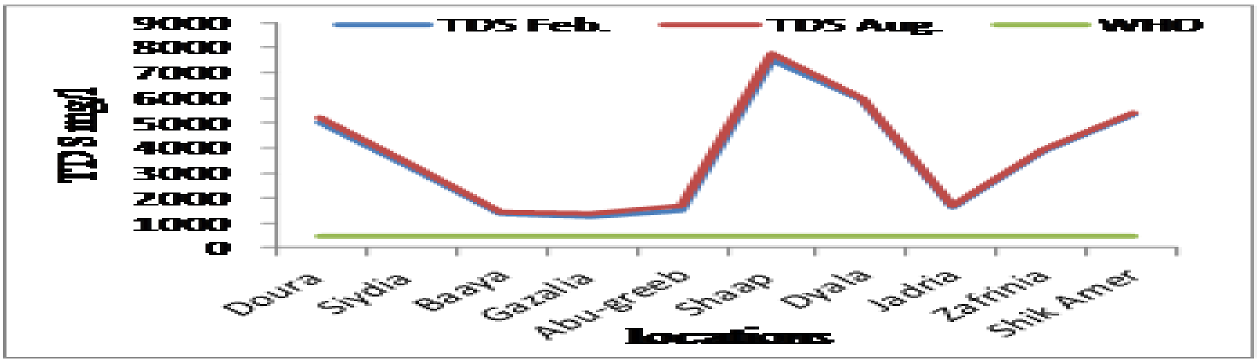

Figure 3: E c values in the study area

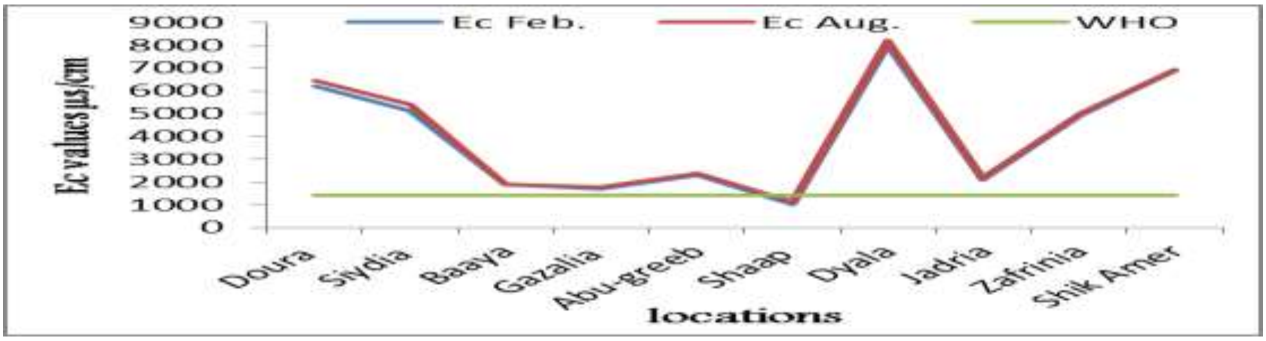

Figure 4: TDS values in the study area

Figure (5) shows the mean of spatial variations in the distribution of the investigated heavy metals (Mn, Fe, Zn, Cd, Cu and Pb) in the study zone.

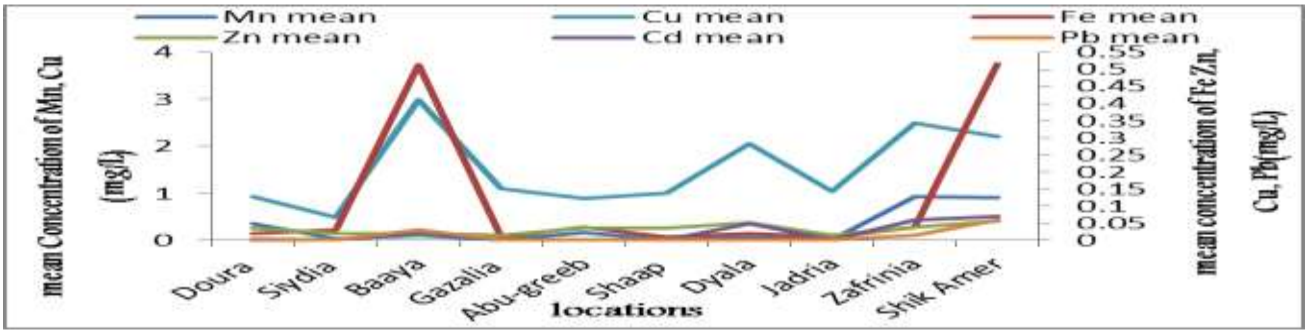

Figure 5: Mean values of special variation of heavy metals in the study area

Manganese is occurring naturally as a mineral from sediment and rocks or from mining and industrial waste. The levels of the Manganese in Karakh side in our study area ranged from 0.01 – 0.39 mg/L, 0.02-0.032 mg/L in two periods February and August, respectively, while The levels of the Manganese in Rasafa side in our study area ranged from 0.01 – 0.91 mg/L, 0.01-0.093 mg/L in two periods February and August, respectively. The groundwater quality standard of Manganese desirable and maximum permissible limit (WHO) is 0.05 mg/L. In our study area all sampling zone were Manganese concentrations less then (WHO) permissible limit. Highest concentration observed at Doura, Zafrinia, Baaya, Abu-Greeb, Dyala and Shake Amer locations due to human body. The concentration of Iron in all the samples and the comparison levels of Iron in study zone as appeared in Figure-6.

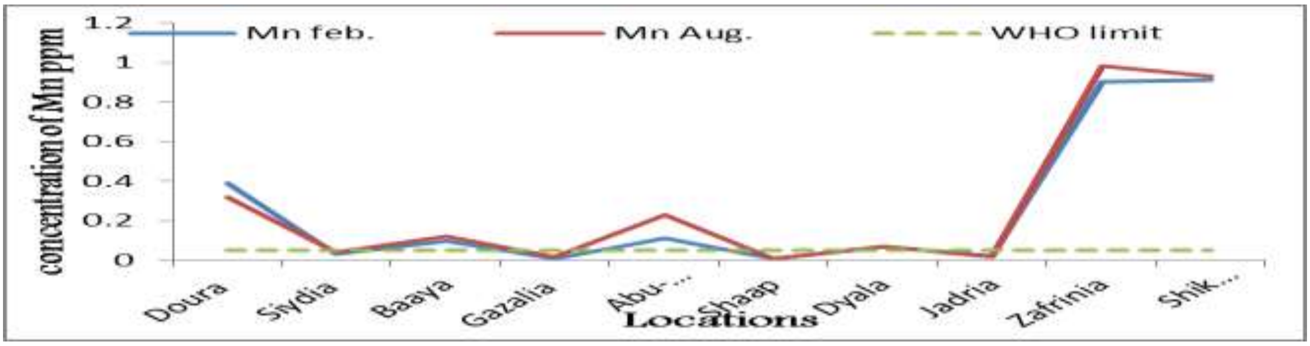

Figure 6: Concentration of manganese in the study area during two periods

Iron it may also be released to water from natural deposits, industrial wastes, refining of Iron ores, and corrosion of Iron containing metals. The minimum and maximum concentrations of Iron at Karakh side were 0.01 to 0.51 mg/L, 0.011 to 0.52 mg/L for two periods February and August respectively. Whereas The minimum and maximum concentrations of Iron at Rasafa side were 0.01 to 0.51 mg/L, 0.01 to 0.52 mg/L for two periods February and August respectively. The maximum allowable limit for Iron as per WHO guidelines is 0.3 mg/L. Iron concentration levels in all studied samples except Bayaa and Shak Amer are exceeding then compared WHO Standards. The concentration levels of Iron in all the samples and the comparison levels of Iron in study area is shown in Figure 7.

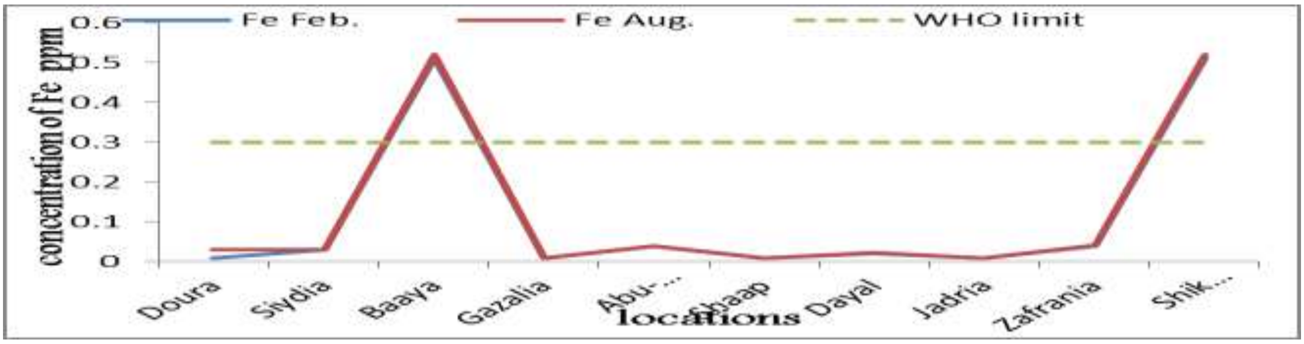

Figure 7: concentration of Iron in the study area during two periods

Zinc is found naturally in water, most frequently in areas where it is mined and from industrial waste, metal plating. The minimum and maximum concentrations of Zinc at Karakh side were 0.01 to 0.04 mg/L, 0.02 to 0.03 mg/L for two periods February and August respectively. Whereas The minimum and maximum concentrations of Zinc at Rasafa side were 0.01 to 0.051 mg/L, 0.021to 0.057 mg/L for two periods February and August respectively. The maximum allowable limit for Zinc as per WHO guidelines is 3.0 mg/L. Zinc concentration levels in all studied samples permissible limits of WHO Standards. May be indicate to no pollution to slightly pollution of the groundwater. The concentration levels of Zinc in all of the samples and the comparison levels of zinc in study area as appeared in Figure-8.

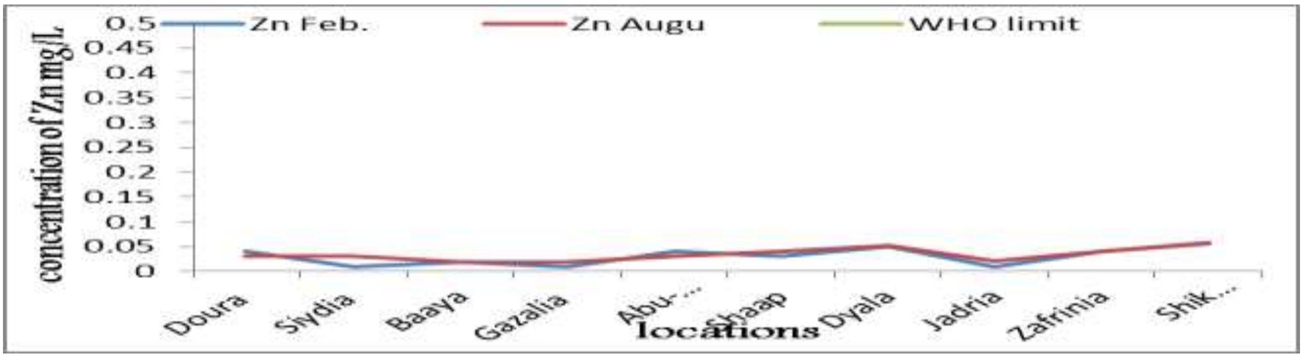

Figure 8: concentration of zinc in the study area during two periods

Cadmium is entering into drinking water due to corrosion of galvanized pipes; erosion of natural deposits; emptying from metal refineries; run off from waste batteries and paints. The level of the cadmium in Karakh side in our study area ranged from 0.001 – 0.02 mg/L, 0.002-0.021 mg/L in two periods February and August, respectively, while The level of the Manganese in Rasafa side in our study area ranged from 0.002 – 0.06 mg/L, 0.002-0.08 mg/L in two periods February and August, respectively. The groundwater quality standard of Manganese desirable and maximum permissible limit (WHO) is 0.003. In our study area all sampling sites were Cadmium concentrations less then WHO permissible limit. Highest concentration observed at Zafrinia, Dyala and Shake Amer locations due to human body. The concentration of Iron in all the samples and the comparison concentration scale of Iron in study zone as appeared in Figure-9.

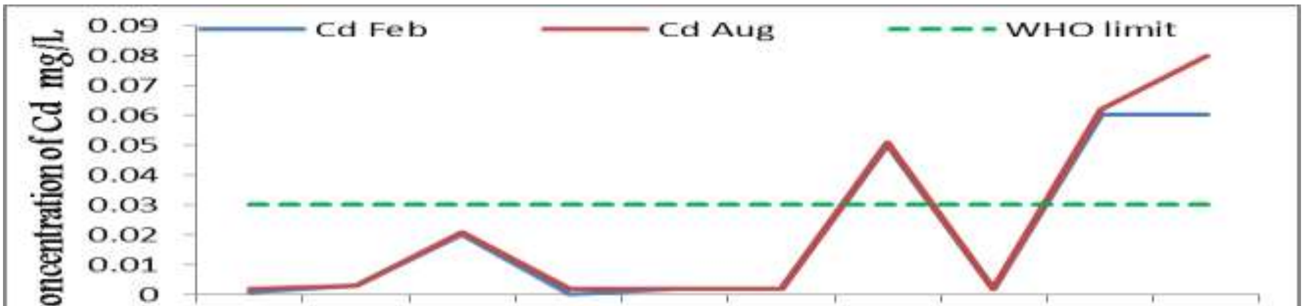

Figure 9: concentration of cadmium in the study area during two periods

Lead enters into environment from industry, mining, plumbing, gasoline, coal, and as a water additive. The minimum and maximum concentrations of Lead at Karakh side were 0.001 to 0.03 mg/L, 0.0021 to 0.032 mg/L for two periods February and August respectively. Whereas The minimum and maximum concentrations of Lead at Rasafa side were 0.001 to 0.05 mg/L, 0.002 to 0.07 mg/L for two periods February and August respectively. The ultimate allowable limit for Iron as per (WHO) are 0.003 mg/L. Lead concentration scale in all studied samples except Zafrania, Baaya and Shak Amer are exceeding then compared WHO Standards. High values may be due to the effects of discharge of industrial effluents 70 compounds including heavy metals into natural fresh water bodies without prior treatment such as textile factory, dyes factories and effects of the trocar the concentration levels of Lead in all the samples and the comparison levels of Iron in study zone as appeared in Figure-10.

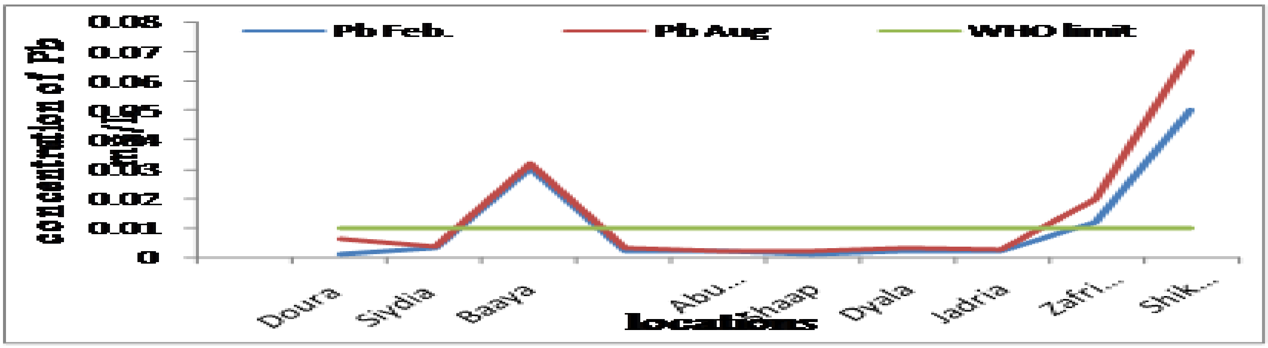

Figure 10: Concentration of Lead in the study area during two periods

Copper enters the water system through mineral dissolution, industrial effluents, due to of its use as algaecide, agricultural pesticide sprays and insecticide. The level of the Cu in Karakh side in our study area ranged from 0.9 – 3.0 mg/L, 0.089-3 mg/L in two periods February and August, respectively, while The level of the Cu in Rasafa side in our study area ranged from 1.0 – 3.5 mg/L, 1-3.5 mg/L in two periods February and August, respectively. The groundwater quality standard of Cu desirable and superior allowable limit (WHO) is 2 mg/L. In our study area all sampling sites were Cu concentrations less then WHO permissible limit. Highest concentration observed at Dyala, Zafrinia, and Shake Amer locations due to human body. The concentration scale of Iron in all the samples and the comparison scale of Iron in study area as appeared in Figure-11.

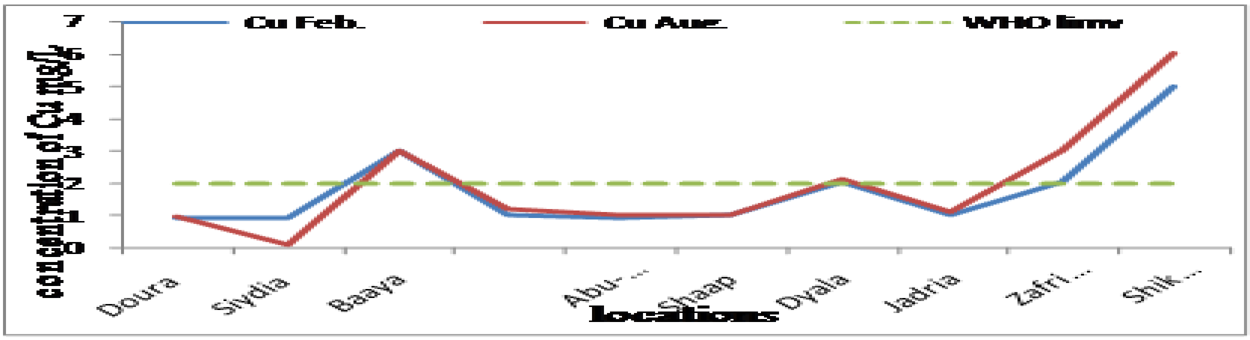

Figure 11: concentration of Copper in the study area during two periods

There were some spatial variations in concentrations of studied heavy metals among different stations which may due to the distribution of elements are affected by many important spatial factors such as, human population, density along the riverbanks, hydrological conditions of the bed, discharges by local industries, and sewage discharges [21].

Generally, the concentration of heavy metals in both side of Karakh and Rassafa changed according to many factors (lithology, wells depth, water level and human activities. Heavy metals concentration in groundwater samples at Rassafa side seems to be higher than the concentrations at Karakh side which may due to distribution of Industrial and sewage area. In Karakh side, the level of heavy metals in some wells (Bayaa, Abu-Greeb) is highest than that at remaining locations reflects the effects of industrial, agriculture waste respectively. In this present study the order of heavy metals in Karakh and Rasafa sides was Cu > Mn > Zn > Fe > Cd > Pb.

There is a same variation, but change on actual values in both sides may be due to the change on the activities in the last years. Also there were clear, low variation in concentration of the studied heavy metals in samples studies during February and August months, 2016 .it has been observed that low change in pH, temperature, TDS, runoff and climatic change. In this current study, there are many factors affect the concentrations, such as: the flow of the dredged materials from upper regions of the groundwater, dilution, direct drainage from farmlands, factories, sewage disposal plants, dissolution of sediments with organic matter.

The increase of heavy metal concentration may be due to multiple source of pollution such as sewage, pesticides, industrial waste, etc. Many other factors affect heavy metal concentration in groundwater such as grain size and porosity of sediments The behavior and distribution sediments in the studied area may be affected in water quality of groundwater. Comparing the results of groundwater samples with those of previous studies [22, 23, 24], its observes that it higher in heavy values may reflected by increasing the effects of stress pumping, sewage and human activities and leaching from Agriculture and Industrial system.

Conclusion and Recommendations

In this study, assessment of heavy metals in 10 location of groundwater wells were done by selected six elements for two periods (February and August, 2016). The results showed that no temporal variation with few special variation during study periods. The concentration of heavy metals nearly the industrial, sewage, agriculture area highest than that far from other area. According to this study, two group can be classified, the first group appeared to be near direct industrial, sewage and agriculture area those recorded high concentration in some heavy metals whereas, the second group is far indirect effects with low concentration.

Comparing the results of groundwater samples with WHO 2006, most concentration of heavy metals higher than that at acceptable limit which may reflect by increased human activities, leaching from agriculture and sewage as well as the possible contributions of technical operation of development of the wells. in this study enough waste system should be placed at strategic areas in the entire environment. And we can suggest that the Government should be adopted some treatment technologies in the following study areas to minimize these heavy metals in Groundwater for safe drinking water to the public.

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