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The Study of some trace elements and some related environmental factors of groundwater in Karbala province, Iraq

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Abstract:

Background: Iraq relies on the Tigris and Euphrates rivers, but in last years, these rivers were exposed to sewage drains and agricultural wastes affecting the quality of water. The current study was designed to investigate some of the chemical properties (chloride, sulphate, phosphate, nitrate, sodium, potassium) and some trace elements contamination (lithium, iron, lead, cobalt, cadmium) of groundwater indicators in Karbala province.

Methods: Nine wells were studied for the period from September 2017 to April 2018.

Results: Current study showed that there were local and seasonal variations in some chemical factors. The values of chloride were (112,36-1939)mg/l, sulphate(346,56- 493,04)mg/l. For phosphate values were between(0- 0,918) mg/l. For nitrite was between (0,19- 34,80)mg/l. Values of sodium were between (161- 1490) , potassium values between(8- 86 mg/l) and trace element tests for (lithium, iron, lead, cobalt, cadmium) were between (0,4- 2.3) mg/l. (0,61- 2,56) mg/l, (0,78- 1,81) mg/l, (nil) and (nil), respectively. **Conclusion**: None of the wells was valid for drinking, however, some of them are valid to animal drink and irrigation. There should be maintenance of the wells and rehabilitation by the bureau competent with a focus on wells in rural areas.

Key words: Trace elements, heavy metals, groundwater, irrigation.

INTRODUCTION

Iraq relies on the Tigris and Euphrates rivers as a main source of water used for varies uses, but in last years, these rivers were exposed to sewage drains and agricultural wastes affecting the quality of water [1]. In addition, the dams constructed on these rivers by Turkey have significantly decreased the quantities of water entering the two rivers. The future need for water has been estimated to be around 82 billion m^3 annually of which 60 billion m^3 for irrigation, 6.7 billion m^3 for drinking purposes, 0.7 billion m^3 for industrial purposes, 5.6 billion m^3 to preserve the environmental life of the river and 8.7 billion m^3 as annual evaporation, but the future arrival after construction of the Turkish dam will reach the Tigris river 9.16 billion m^3 and 8.45 billion m^3 for Euphrates river. Therefore, there will be a drop in the amount by one third. So that, there has to be a thinking about other sources of water for drinking and other purposes [2]. One of the commonly used water resources is groundwater. The quality of groundwater is as important as its quantity. Water quality concept has been evaluated in the last years owing to greater understanding of water mineralization process and greater concern about its origin [3]. Water quality shows water-rock interaction and indicates residence time and recharge zone confirmation [4]. The required quality of ground water supply depends on its purposes of use such as drinking, irrigation and industry. The quality properties of groundwater expressed by chemical and trace elements analysis of a groundwater sample include the obtaining of the constituents concentrations as well as chloride, sulphate, phosphate, nitrate, sodium and potassium. The trace elements analysis of groundwater includes lithium, iron, lead, cadmium and cobalt which indicate the sanitary quality of water for human consumption [5]. In a chemical analysis of a groundwater, concentrations of different ions are determined by weight or by chemical equivalence. Briefly, the concentrations of ions are expressed commonly by weight per volume units [6]. The movement of groundwater through the soil tends to develop a chemical equilibrium by chemical reactions with its environment, such as artificial recharge, movement of pollutants and clogging of wells [7]. In order to study the quality of groundwater of large regions, a large number of wells should be constructed to reflect the more reality feature of the groundwater basin for these regions. Therefore, the results of quality tests of groundwater can be represented by a variety of graphic techniques developed to display and detect the major chemical constituents [8]. Groundwater is replenished by precipitation and depending on local climate and geology. The study of groundwater contamination is one of the most important studies due to its relationships with the living organisms, especially when water is used for drinking or irrigation purposes. Unfortunately groundwater is susceptible to pollutants such as industrial and houses waste without enough treatment to reduce contamination which affects groundwater. So that, it has toxic effects on living organisms such as plants that are irrigated by groundwater with high contaminations of heavy metals [7].

A study in south Iraq showed that there was a positive relationship between heavy metals concentration and the well age. Heavy metals are elements with atomic weights between 63.5 and 200.5, and a specific gravity greater than 4.0 [9] . Heavy metal refer to any metallic chemical element that has a relatively high density (more than 5 g/ml) and is toxic or poisonous at low concentrations. They are natural components of the earth's crust [10]. Heavy metals are mainly introduced into surface and ground waters by agricultural (fertilizers and pesticides) and industrial activities, mining, and transportation. There are various possibilities for the fate and transport of heavy metals in soil and groundwater [11]. Heavy metals and trace elements in subsurface environments come from natural and anthropogenic sources. The weathering of minerals is one of the major natural sources [12]. The groundwater contaminations by water irrigation which has chemical fertilizers, therefore, identification of heavy metal ions in the system helps to control groundwater pollution, especially they are difficult to decompose, they are transferred through food series via different pathways and they have the ability to accumulate in the tissues of the living organisms [13]. The difference in the containment of water to the elements is of importance for humans, animals and plants but within limited percentage, according to standard international measurements not to exceed those limits as its effects can be toxic to plant growth and productivity [14].

The aim of current study was to estimate the contamination of groundwater by chemical characters and trace elements and to analyse their validity for drinking and irrigation according to international Iraqi specification to make adequate solution to treat and reduce the contamination of this water for drinking and irrigation uses.

Description of study area:

Karbala is an Iraqi province that is located about 100 Km south-west of Baghdad, the capital of Iraq (Figure 1). It locates between latitude (32°06´ to 32°46´) and longitude (43°10´ to 44°19´) (estimated by Google earth program) and it covers an area of 52856 Km^2 with a population of 974000 people in 2016 [15]. The study area is composed of three formations stockiest ground water (Dibdiba formation, AL-Dammam formation and sediment modern).

1-Well (1): this well is located in the northwest of Karbala province, a depth of 18 m. The well is located in sediment modern formation and used for drinking, irrigation and other purposes.

2- Well (2): this well is located in the northeast of Karbala province, a depth of 24 m. The well is located in sediment modern formation and used for irrigation.

3- Well (3): this well is located in the west of Karbala province, a of depth 280 m. The well is located in AL-Dammam formation and used for irrigation.

4- Well (4): this well is located in the west other direction of Karbala province, a depth of 235 m. the well is located in AL-Dammam formation and used for irrigation.

5- Well (5): this well is located in the southwest of Karbala province, a of depth 36 m. The well is located in Dibdiba formation and used for irrigation and other purposes.

6- Well (6): this well is located in the southeast of Karbala province, a depth of 18 m. The well is located in Dibdiba formation and used for irrigation.

7- Well (7): this well is located in the east of Karbala province, a depth of 25 m. The well is located in sediment modern and used for irrigation.

8- Well (8): this well is located in the east other direction of Karbala province, a depth of 17 m. The well is located in sediment modern and used for irrigation and other purposes.

9- Well (9): this well is located in the city Center of Karbala province, a depth of 15 m. The well is located in Dibdiba formation and used for irrigation.

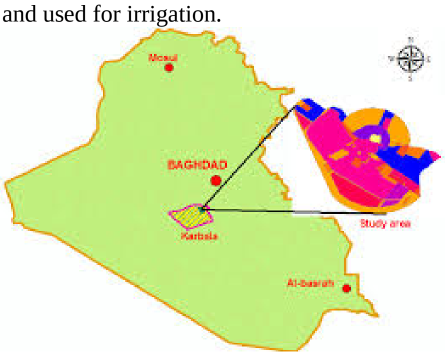


Figure 1 Map of Republic of Iraq showing the location of Karbala Province.

Material and Methods

The groundwater samples were collected monthly from September 2017 to April 2018. Chloride, sulphate, phosphate, nitrite, sodium, potassium and lithium as well as the trace elements Iron, lead, cobalt and cadmium were performed according to the procedures outlined in the standard for examination of water and waste water [16,17].

The collected data were statistically analyzed to compare water quality of the wells using ANOVA and Duncan multiple range tests at $P \leq 0.05$ level of significance. Also, correlation coefficient Pearson multiple range test was used at $P \leq 0.01$ and $P \leq 0.05$ levels of significance.

Results and Discussion

The concentration of CL^- in the groundwater samples ranged between (112.36-1939.40) ppm. The source of chloride in the groundwater is from solution of halite and related minerals in evaporate rocks and from ancient sea water entrapped in sediments [18]. Analysis of variance showed significant spatial difference for the different wells ($P \leq 0.05$) while there were no temporal difference for the study period. Correlation coefficient Pearson showed positive relationship with sodium ($P \leq 0.01$). The concentration of $SO4^-$ in the groundwater samples ranged between (346.13-487.73) ppm, The main source of sulfate ion in study area is solutions of sulphate minerals that exist in evaporate rocks like gypsum and anhydrite [19]. Analysis of variance showed significant spatial difference for the different wells ($P \leq 0.05$) while there were no temporal differences for the study period. Correlation coefficient Pearson showed positive relationship with sodium ($P \leq 0.01$). Phosphates enter the groundwater through thawed rocks, that contain an apatite metal (calcium phosphate), and from animal waste, chemical fertilizers used in agriculture, industrial wastewater as well as detergents in domestic wastewater [20]. Analysis of variance showed no significant spatial difference at the different wells and no temporal difference during the study period ($P<0.05$). The concentration of nitrate ion in the groundwater samples ranged between (0- 45.32) ppm. The main source of nitrate in the groundwater samples is from oxidation of the nitrogen in the soil by bacteria to nitrate [21]. Analysis of variance showed no significant spatial difference for the different wells and no temporal difference during the study period ($P<0.05$). There was positive relationship with potassium ($P<0.01$).

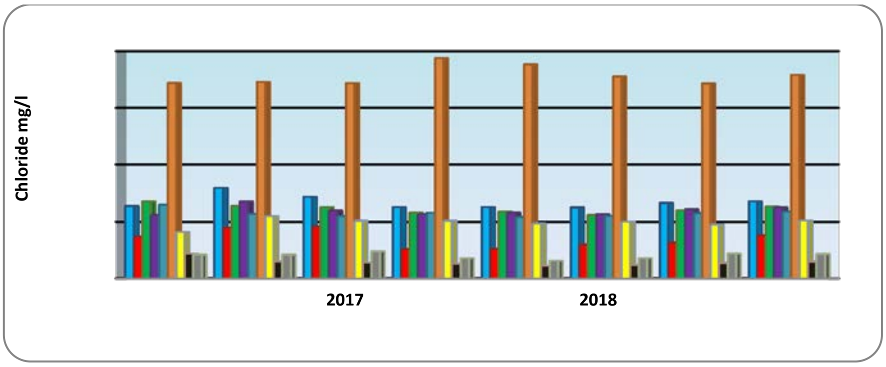
WHO 2011	IQS2009	Factors
200	200	Na
10	-	K
250	350	CL
250	400	SO_4
50	50	NO_3
0.3	0.3	Fe
0.01	0.01	Pb
0.003	0.003	Cd

Table 1 The standards of drinking water

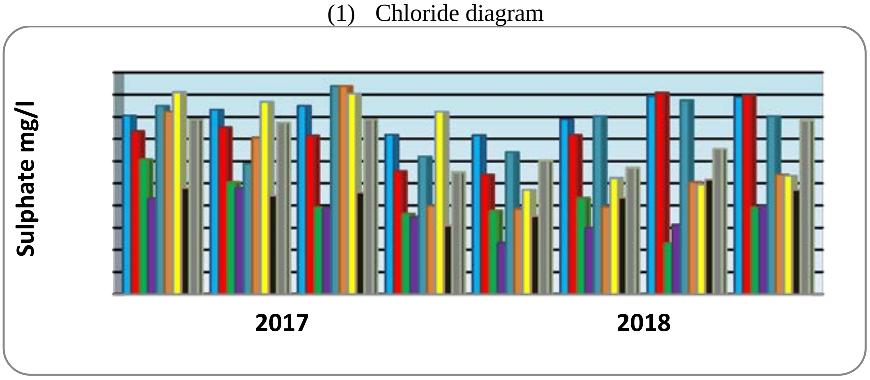
Sodium is the most abundant member of the alkali metal group in nature. In igneous rocks, halite in evaporate sediments and human activities such as domestic needs [22]. Na^+ concentration in groundwater were between 161–1490mg/l. This ion has the tendency exists in solution and not precipitate until its concentration reached several thousands of ppm, therefore, it is accumulated in solution [23]. Analysis of variance showed significant spatial difference for the different wells ($P<0.05$) while there were no temporal difference for the study period. Correlation coefficient Pearson showed positive relationship with chloride ($P<0.01$). Potassium is commonly present in clays, within the structure such as illite or adsorbed on other clay minerals, evaporate rocks, including sylvite, are a main source of K [24]. The solubilities of potassium salts are all high and, generally, similar to the solubilities of sodium salts. The values were between 10–86 mg/l. The high concentration of potassium caused by low level of groundwater, lack movement and decomposition of organic materials by bacteria [24]. Analysis of variance showed significant spatial difference between the wells ($p<0.05$) while there were no temporal difference for the study period. Correlation coefficient Pearson showed positive relationship with nitrite ($P<0.01$).

The values of lithium were between 0,4-2,3 mg/l. Few concentrations of lithium have a positive effect on the human health [25]. Analysis of variance showed significant spatial difference between different wells ($P<0.05$) while there were no temporal difference during the study period. Correlation coefficient Pearson showed positive relationship with nitrite and sulphate ($P<0.05$). The common form in the groundwater is the soluble ferrous (Fe^{2+}), when exposed to the atmosphere, is oxidized to the insoluble ferric state (Fe^{3+}), which precipitates as ferric hydroxide causing a brown discoloration of the water [26]. The sources of iron in water are from weathering of igneous rocks, sedimentary rocks and clay minerals [27]. Also, corrosion of well casing and other pipes may contribute to increase the concentration of iron in the groundwater. The concentration of Fe in the groundwater samples ranges between 0.65-2.49 ppm. Analysis of variance showed no significant spatial difference for the different wells and no temporal difference for the study period ($P<0.05$). Correlation coefficient Pearson showed no relationship with any variable ($P<0.05$) ($P<0.01$). The quantity of lead ion in surface and groundwater is little because the minerals which contain lead ion have low solubility in water and also its natural mobility is low [28]. The values were between 0,79 –1,62 mg/l. Variations in lead concentrations due to the water filtering from the soil affect at chemical water or because of industries and vehicles chemicals [27]. Analysis of variance showed no significant spatial difference for the different wells and no temporal difference for the study period ($P<0.05$). Correlation coefficient Pearson showed positive relationship with potassium ($P<0.01$). Cd can present in groundwater through contact with dissolved rocks and minerals. It's soluble in oxidizing acidic environments, but in reducing environments it forms complexes with organic matter or present in the sphalerite and Cu ores as Cd (29). It's able to accumulate in human body tissues, especially tissues of digestive system, kidney, liver and lunges. In addition, new studies showed strong relation between cadmium concentration and infection of kidney, lung and liver [30] and the values in this study were non-significant (Nil). Regarding cobalt which was present at low rate in the groundwater and the values in this study were non-significant (Nil). Analysis of variance showed no significant spatial difference at the different wells and no temporal difference during the study period ($P<0.05$).

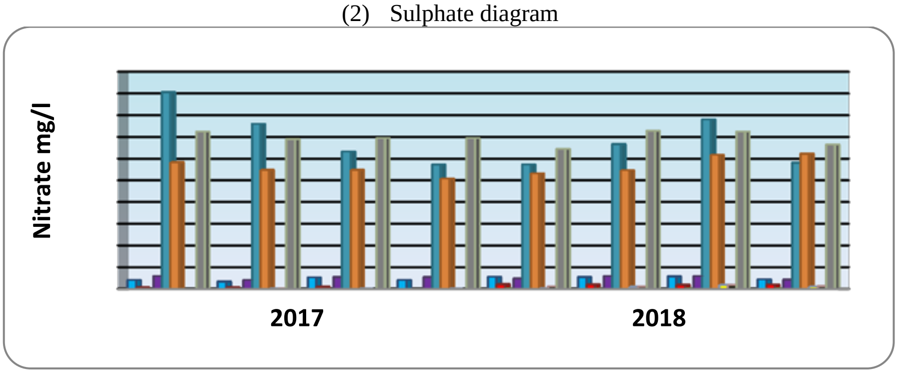
When comparing the results of the study with the WHO (2011) and Iraqi standards (IQS) 2009 for drinking water, the concentrations of elements Sodium, Potassium, Iron and Lead were unacceptable, the concentration of sulphate was in two wells (4 and 8) within the acceptable limit for IQS 2009, as for Chloride within the unacceptable limit except the well 8 within the acceptable limit for IQS 2009 and other elements within unacceptable limits. But it is valid for other uses.



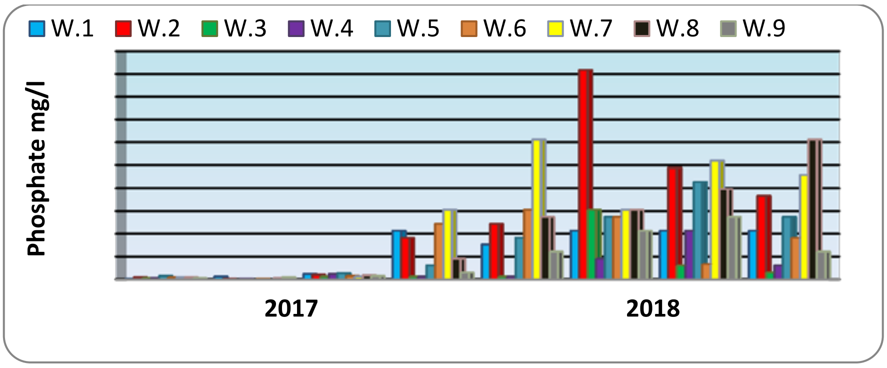
(1) Chloride diagram



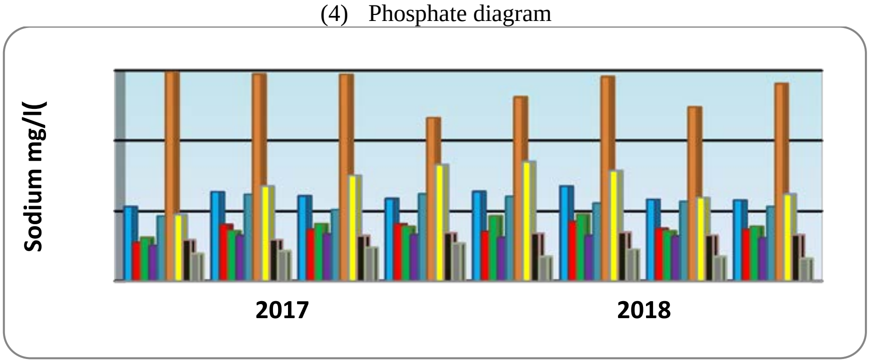
(2) Sulphate diagram



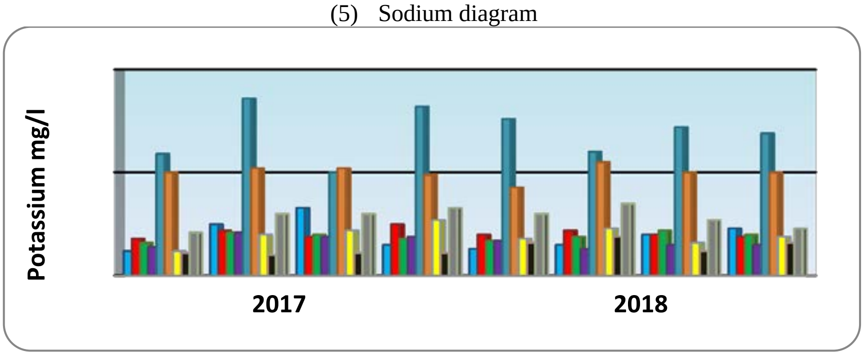
(3) Nitrate diagram



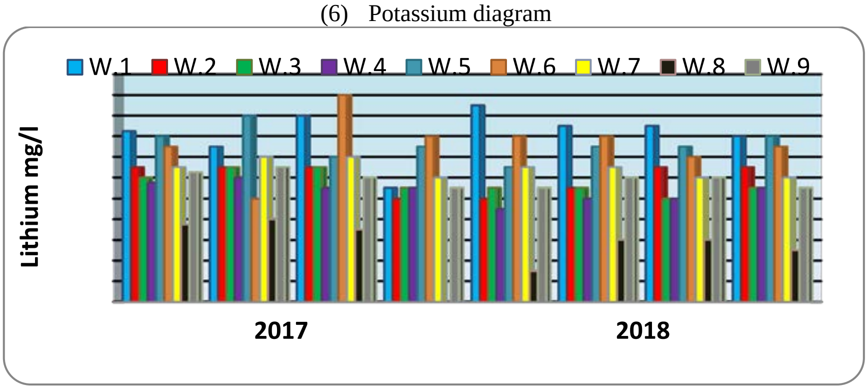
(4) Phosphate diagram



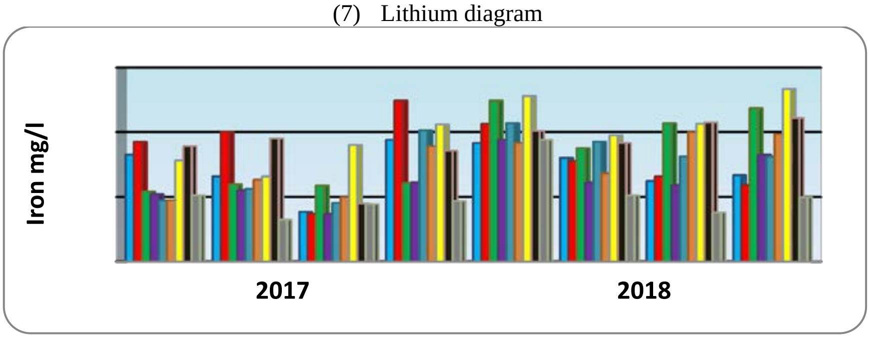
(5) Sodium diagram



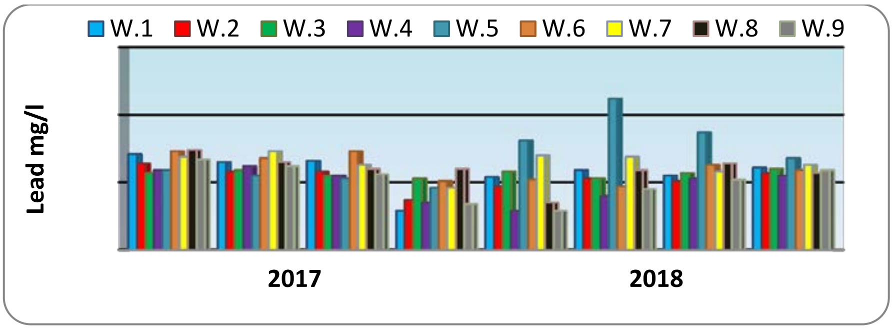
(6) Potassium diagram



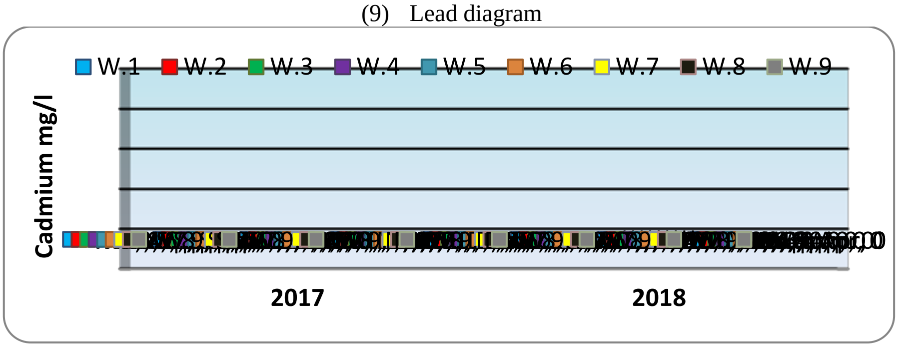
(7) Lithium diagram



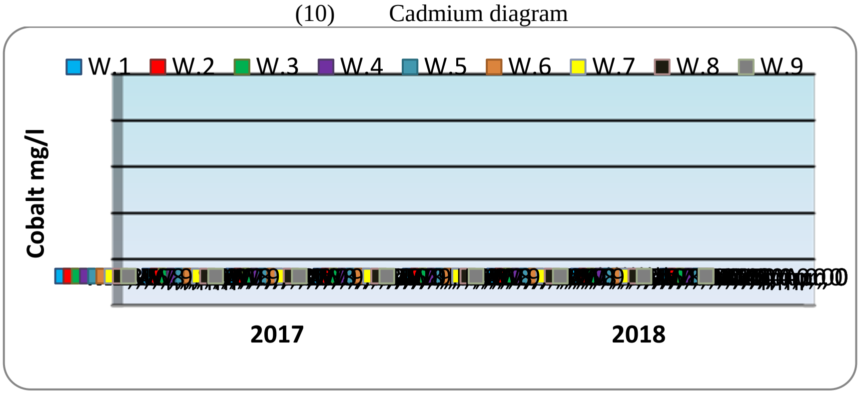
(8) Iron diagram



(9) Lead diagram



(10) Cadmium diagram



(11)Cobalt diagra

Table (2): Duncan test of multiple averages by wells- studied sites

W9	W8	W7	W6	W5	W4	W3	W2	W1	Wells / Factors
674.43 B	350.02 E	614.73 C	599.43 C	576.39 C	1784.58 A	494.43 D	144.99 G	207.77 F	Chloride
1.87 Cd	0.67 D	0.24 E	2.60 C	34.22 Ab	28.19 B	0.29 E	0.33 de	34.80 A	Nitrate
19.5 D	20.63 D	19.13 D	16.63 De	69.25 A	50.13 B	19.63 D	13.25 E	28.63 C	Potassium
606.25 C	373.88 De	395.37 D	314.5 e	560 C	1376.88 A	698.63 B	326.25 E	208 F	Sodium
2.02 A	1.6 Bc	1.55 Bc	1.47 C	1.93 A	1.93 A	1.69 B	0.93	1.58 Bc	Lithium
462.46 A	454.64 Ab	382.67 D	372.49 D	459.75 A	417.38 C	436.11 Bc	386.78 D	437.86 Bc	Sulphate
0.131 A	0.28 A	0.06 A	0.05 A	0.16 A	0.14 A	0.28 A	0.21 A	0.10 A	Phosphate
1.46 Bc	1.66 Abc	1.68 Ab	1.26 Cd	1.53 Abc	1.52 Abc	2.01 A	1.81 ab	1.02 D	Iron
0 A	0 A	0 A	0 A	0 A	0 A	0 A	0 A	0 A	Lead
0 A	0 A	0 A	0 A	0 A	0 A	0 A	0 A	0 A	Cadmium
1.075 A	1.03 A	1.07 A	0.99 A	1.20 A	1.11 A	1.01 A	1.09 A	1.0 A	Cobalt

Table 3 Duncan test of multiple averages by months of study

Apr	Mar	Feb	Jan	Dec	Nov	Oct	Sep	Date / Factors
620.50 A	591.63 A	576.13 a	582.86 a	597.52 A	618.75 A	647.63 A	606.53 A	Chloride
13.4 A	14.81 A	12.52 A	11.20 A	9.073 A	9.418 A	10.795 A	12.44 A	Nitrate
28.22 A	28.22 A	29 A	27.77 A	31 A	28.44 A	31.88 A	22.33 A	Potassium
522.11 A	505.44 A	587 A	561.88 A	550.11 A	558.66 A	557.22 A	466.22 A	Sodium
1.68 A	1.622 A	1.611 A	1.633 A	1.56 A	1.47 A	1.755 A	1.68 A	Lithium
426.96 A	419.91 A	410.45 A	396.05 A	400.97 A	443.07 A	438.32 A	443.04 A	Sulphate
0.004 D	0.25 A	0.29 A	0.32 A	0.21 Ab	0.12 bc	0.01 Cd	0.004 D	Phosphate
1.85 Ab	1.61 Bc	1.57 Bc	2.08 A	1.74 B	0.85 D	1.32 C	1.32 C	Iron
0 A	0 A	0 A	0 A	0 A	0 A	0 A	0 a	Cadmium
0 A	0 A	0 A	0 A	0 A	0 A	0 A	0 a	Cobalt
1.09 A	1.1 A	0.98 A	1.06 A	0.92 A	1.09 A	1.13 A	1.15 A	Lead

Table (4): person coefficient

Lead	Cobalt	Cadmium	Iron	phosohate	Sulphate	lithium	Sodium	Potassium	Nitratre	Chloride	factors / factors
							**0.924				Chloride
								**0.811			Nitrate
**0.808									**0.811		potassium
										**0.924	Sodium
					*0.679						lithium
						*0.679					sulphate
											phosphate
											Iron
											cadmium
											cobalt
											Lead

CONCLUSIONS

1. The results of current study were similar to international and Iraqi standards.
2. There is variation in physical and chemical variables between the studied wells; significant spatial difference at the different wells and temporal difference during the study period.
3. None of the wells is valid for drinking, however, some of them are valid to animal drink and irrigation.
4. Make the process of treatment and purification for water wells to be valid for all uses.
5. Maintenance of the wells and rehabilitation by the bureau competent with a focus on wells in rural areas.

Ethical Clearance: Permissions for carrying out the study were obtained from the authorities at University of Karbala and University of Tikrit, Iraq.
Financial Disclosure: There is no financial disclosure.
Conflict of Interest: None to declare.

REFERENCE

1. AL- Hadithi M. Use of water quality index technique to assess groundwater quality for drinking purposes in Saqlawiah. Tikrit Journal of pure science. 2013; 19(1): 89-95.
2. Reports from Ministry of water resources, 2018.
3. Shane and Jerzy J. "Hydrochemistry and isotopic composition of Na-HCO3-rich ground waters from the Ballimore Region", Central New South Wales, Australia. Chem. Geol. 2003; 211(1-2): 111-134.
4. Cronin AA, Barth JAC, Elliot T and Kalin RM. "Recharge velocity and geochemical evolution for the Permo-Triassic Sherwood Sandstone, Northern Ireland. J of Hydrology. 2005; 315(1-4): 308-324.
5. Todd DK. "Groundwater hydrology, Ch.7: Quality of Groundwater", 2nd edition, pp.267315, John Wiley and Sons, Haryana, India; 2006.
6. Al-Mussawi WH. "Kriging of Groundwater Level - A Case Study of Dibdiba aquifer in Area of Karbala-Najaf", Scientific Journal of Karbala University. 2008; 6(1): 170-182.
7. Shyam R and Kalwania GS. "Groundwater Chemistry: A case study of eastern part of Sikar city(Rajasthan), India", International Journal of Applied Engineering Research. 2011; 2(2): 367-378.
8. AL- Saadi RJM. Contour Maps and Evaluation of Groundwater Quality in Karbala Region. Journal of Karbala University. 2013; 11(1): 204-222.
9. Spellman FR. The science of water Concepts and Applications (2nd edition). CRC Press Taylor and Francis Group, NY. 2007; 213.
10. Berkowitz B, Dror I and Yaron,B. Contaminant Geochemistry, Springer-Verlag Berlin Heidelberg. 2008; 412.
11. Bradl HB. Heavy Metals in the Environment Vol 6, 1st ed, Netherlands. 2005; 269.
12. Leung C and Jiao JJ. Heavy metal and trace element distributions in groundwater in natural slopes and highly urbanized spaces in Mid-Levels area. Hong Kong water research. 2006; 40: 753–767.
13. Manhi, H. "Groundwater contamination study of the upper part of the dibdibba aquifer in safwan area (southern iraq)", M.S. Thesis,

University of Baghdad, College of Science, Department of Geology, 2012.
14. Foa'd MA and Ali AG. Concentration of Some trace elements in ground Water for four Wells in Al- Khider /Al-MothannaGovernoment / Iraq. Al QadIsiyah Journal of pure science. 2011; 16(3): 51-61.
15. Wikipedia, the free encyclopedia, (2012),"Karbala province-Iraq", website: http://en.wikipedia.org/wiki/Karbala.
16. APHA (American Public Health Association).(2003). Standard Methods for the examination of water and wastewater 20th Edition. A.P.H.A.,1015 fifteenth street, NW. Washington. Dc,USA.
17 APHA, American Public Health Association . (1998). Standard methods for the examination of water and waste water. 20 th edition. Washington.
18. AL-Afangideh GN, Ewa EE, Eli HD and Iwara AL. Assessment of water quality status of borehole in calabar south local governorate area, Cross River State, International Journal of Biosciences. 2011; 1(5): 71-76.
19. Adamu GK and Adekiya OA. An Assessment of Water Quality of Boreholes around selected Landfills in Kano Metropolis. Afrecan scientist. 2010; 11: 2155-6881.
20. Miroslav R and Bashkin and Vladimir N. Practical environmental Analysis, the Royal society of chemistry. 2006; 469.
21. Imoke D, Lekam I and Opaminola DN. Vulnerability of Groundwater quality to Septic Systems in Calabar Municipality, Nigeria, International. Jornal of Social Science. 2016; 10(2): 74-88.
22. Hassan AM. Hydrogeochemical of groundwater for Mandli Fan aquifers and hydrochemical model Ph.D Thesis submitted to Department of Ggeology, College of Sciences, Baghdad university, Iraq. 2007 (in Arabic).
23. AL- Kilabi JA. Hydrogeochemistry of groundwater and the probable effect of Kirkuk irrigation project on its quality in Al-Hawija area, Iraq, M.Sc, College of Sciences, University of Baghdad. 2013.
24. AL- Qaraghuli NA. Contents of nutrient elements (Total, water soluble and available) in the fertilizers (TSP, MAP, NP & NPK) produced from AL-Qaim plant, Iraq, Iraqi Journal of Agricultural Sciences. 2005; 36(5): 35-41.
25. Chandra PS and Babu GN. Lithium in drinking water and food, and risk of suicide (correspondence). Br J Psychiatry. 2009; 195: 271-272.
26. Obiefuna GI and Sheriff A. Assessment of Shallw groundwater quality of Pindiga Gombe Area, Yola Area, NE, Nigeria for Irrigation and Domestic Purposes, Research Journal of Environmental and Earth Science. 2011; 3(2): 131- 141.
27. Boyd CE. Water quality an introduction, Kluwer Acad publisher, USA. 2000; 330.
28. Alloway BJ. Heavy metals in soils, trace metals and Metalloids in soil and their Bioavailability, 3rd edition, springer dordacht Heidelberg and New york and London. 2012; 613.
29. Jeje JO and Oladepo KT. Assessment of Heavy Metals of Boreholes and Hand Dug Wells in Ife North local Governorate area of Osun state, Nigeria, international journal of science and technology. 2014; 3(4): 209-214.
30. Prasad MNV. Trace Elements as Contaminants and Nutrients: Consequences in Ecosystems and Human Health, Published by John Wiley & Sons, New Jersey. 2008; 777.