International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Based on Water Quality Index, An Assessment of the Water Quality at Some Areas of Anbar City, West Iraq

Maher Ahmed Abed[1], Jalal N. Jeber[2], Ausama Abbas Faisal[3], Abdulhakem D. Hussien[4]

[1] University of Anbar, College of Agriculture, Department of Food Sciences, Anbar City

[2]Universities of Baghdad, College of Science, Department of Chemistry, Baghdad City, Al-Jaderiya Street

[3]University of Anbar, College of medicine, Department of biochemistry, Anbar City

[4]University of Anbar, College of Agriculture

Abstract: ***The chemical characteristics of water quality index for water which were supplied from some areas of Anbar city were carried out in order to determine the quality of the water for the drink and domestic purposes. Based on several chemical parameters, the water quality index can provide a number which expresses the overall quality of the water in any sample. In this paper, 9 wells water samples and 8 raw waters were collected between January and April 2017 and analyzed for the following ions: pH, turbidity (Tur), electrical conductivity (EC), total hardness (TH), alkalinity suspended solids (SSs), total suspended solids (TSS) and total dissolved solids (TDSs) by standard methods. According to the McCarty and Sawyer total hardness classification, all samples (wells and raw water) were very hard waters (TH>180 mg/L). The normal range of pH values for raw water is ranged from 6.5-8.5, while for the wells water is ranged from 6-8.5. In general, the pH value which is less than 6.5 refers to acidity of water. While, the value that is above 8.5 refer to basicity of the water. The results of pH values have ranged between 7.1-8.4 and registered good water quality. Also, from the electrical conductivity (EC) values it was observed that all the water samples (raw and wells) registered very high values reached to 11000 µs/cm^{-1} which means that the study areas are of high mineralization because the electrical conductivity indicates mineralization level. The high degree of mineralization suggests long contact time of water with geological formation and soil of the study areas. The chloride concentration registered a varied value between 2178-57 (mg/L). The total hardness values ranged from 320 to 2948 (mg/L) Based on total hardness classification of Sawyer and McCarty, all the water samples classified as very hard water (total hardness values >300 mg/L) (Table 2). In Table 4 all the water quality index values were included. It was observed that none of all water samples registered water quality index=100. The raw waters which obtained from the river registered a fair water quality with average rating (WQI= 35.9) indicating polluted water and unacceptable for potable which implied unsuitable water for direct consumption without pretreatment. While the water of the wells registered a medium to good quality which implied simple treatment is necessary to the water before human consumptions regardless the good rating while the medium quality required to conventional and advance treatment before consumption.***

Keywords: Water quality index, Water quality rating

1. Introduction

The definition of water quality assessment is that evaluation of chemical, physical and biological nature of water which has relation to the intended uses and human effects. One of the most powerful tools which allowing to ascertain the quality of water for the domestic purpose is the water quality index. In order to summarize the water quality data, several of water quality indices have developed in easy and understandable format. One of these indices is the water quality index which is a summative index to the collected data that is come from multiple water quality parameters. These parameters can reflect combined influence on the overall quality [1]. Each parameter is weighted based on its perceived importance to overall water quality. Calculating the weighted average of all observed parameters provides the water quality index value [2-5]. The computed water quality index provides an understandable ranking of water quality which possesses a rating scale from 0 to 100. Therefore, the sample of water that possesses a high value of water quality index has better quality water while lower water quality index value shows poor quality water. So, a single numerical value of water quality index interprets the quality of water sample [6-8]. The water quality index can indicate not only for the quality of water but also can provide information about the degree of anthropogenic activity which affects the water quality. Until this moment, a millions of people around the world depend on the groundwater as the main source for the drink and domestic purpose [9]. Before 1970, the common belief was the groundwater doesn't contain any contaminations because the soil works as a filter to remove and prevent all contaminants from reaching to the groundwater. However, a great deal of research proved that the contaminants can easily reach to the groundwater [10]. The present study aims to evaluate the water quality for various uses like the drink and domestic purpose for water supplied from some areas of Anbar city. This study is very important because of a half of people who live in the studied area are depending on the groundwater as their main water source for the drink and domestic purpose.

2. Materials and Methods

2.1 Sampling and preparation the samples

A total of 17 water samples were monthly collected from January to April 2017 and randomly selected from Euphrates River and wells which located different suburbs within the

Anbar city (Figure 1). 2 L polyethylene bottles were used to collect the water samples and were labelled accordingly to their locations. All the sampling bottles were pre-washed with 10% nitric acid and rinsed four times with the water sample at the same time of sampling. For the cation analysis, the collected samples were filtered and acidified using 0.45 um filter paper and diluted nitric acid respectively to prevent all the unstable metals from precipitation during exposure to the new environmental conditions. While the anion analysis, all the samples were stored below 5 C° before analysis at the laboratory. The standard methods Association of Official Analytical Chemists (AOAC), 1990) [11] and (American Public Health Association (APHA), 1992 [12] were applied.

2.2 Sample analysis

In order to prevent the inter-sampling contamination, all the collected samples were immediately analysed for the pH, total dissolved solids (TDSs) and electrical conductivity (EC) by Hanna pH-EC-TDS meter (Model HI-9812). The concentrations of the following ions Ca^{+}, K^{+}, Na^{+} and Mg^{+2} were determined using Flame Atomic Absorption Spectrometer (FAAS) at followings: calcium (Ca^{+2}) (422.7 nm), potassium (K^{+}),(769.9 nm), (Mg^{+2}) (285.2 nm), magnesium and sodium (Na^{+}) (589.0 nm). The concentrations of chloride ion, TH, carbonate ion CO_3^{-2} and bicarbonate ion HCO_3^{-} were determined using titrimetric methods. Finally, the concentration of SO_4^{-2} ion was determined using UV-VIS spectrophotometer (Shimadzu) at 420.

Figure 1: The locations of studied areas

2.3 Data Analysis

The followings classifications Sawyer and McCarty (1967) [13] (Table 2) for total hardness and Fetter (1990) [14] (Table 3) total dissolved solids were used to determine the chemical parameters of water in the study area. The rating quality of water was obtained based on the following equation:

$$q_i=100(v_i/s_i) \quad (1)$$

Whereas the v_i is the value of each parameter at sampled site and the s_i is the standard allowable value of the parameter. The above equation ensured the followings:

q_i =0 when the pollutant equal to 0 in water sample

q_i =100 when parameter equal to the allowable value in the water sample. Therefore, the lower value of q_i, the lower polluted was water with pollutant and vice versa. However, special handling is required for calculating the quality rating for pH parameter of samples water. The allowable range of pH for the drink is ranged from 6.0-8.5. The following equation was used to determine the quality rating of pH:

$$q_{pH}= 100[v_{pH}-6.0)/(8.5-6.0)] \quad (2)$$

Where the v_{pH} is the value of pH of sampled site.

The weight of each water quality parameter was assumed to be inverse to the recommended value and the following equation was used:

$$W_i= K/S_i \quad (3)$$

where W_i is the weight of the parameter (i=1,2,3,4,5,6,.....,13), and the K is the propitiation constant which determined to be equal to 1 for sake of simplicity.

$$\sum_{i=1}^{13} K = 1 \quad (4)$$

Table 1: The scale of water quality index rating [6]

WQI %	The category and interpretation of water quality rating
95–100	Excellent water quality (does not require treatment before human consumption)
91-94	Very good water quality (does not require treatment before human consumption)
71-90	Good water quality (require minor treatment works before human consumption)
51-70	Medium or average water quality (reasonable potable water which require advance and conventional treatment before human consumption)
26-50	Fair water quality (polluted water that has doubtful potable use)
0-25	Poor water quality (highly polluted water that is unacceptable for human consumption)

Finally, the overall water quality index was calculated and computed into simple and usable value to assess the overall quality of water by the following equation:

$$WQI = \frac{1}{100}\left(\sum_{i=1}^{13} qiwi\right) \quad (5)$$

Where the qi= registered value, w_i = the rank of the implication of the parameter and i= the quality parameter. The water quality was classified into six types depending on the value of water quality index [15] (Table 1).

Table 2: Classification of total hardness for water based on Sawyer and McCarty [13]

T.H. concentration (mg/L)	Category	% Samples
150	Soft water	100
150-300	Hard water	0
> 300	Very hard water	0

Table 3: The classification of total dissolved solid for water based on Fetter [14]

TDS concentration (mg/L)	Category	% Samples
< 1000	Freshwater	100
> 1000	Brackish	0

The water quality rating started from to be poor, fair, average, good, very good and ended up with excellent. The rating lies in the range 0-25, 26-50, 51-70, 71-90, 91-94 and 95-100 respectively (Oram, 2012) (Table 1). Therefore, the water sample which possesses quality rating: 0-25 considered as unacceptable for human consumption, 26-50 considered as polluted water and unacceptable for potable use, 51-70 was required to conventional and advance treatment before consumption from the human (was considered as reasonable portable use), 71-90 considered suitable for human consumptions and required simple treatment before use it. Finally, 91-100 which didn't require any treatment before the consumption (very good potable).

Table 4: The water quality rating and the water quality index for the samples of study areas: R= River sample; W= Well sample.

Sample Location	pH	EC (µS cm -1)	TDS (mg/L)	Turb (mg/L)	TSS (mg/L)	$SO4^{-2}$ (mg/L)	Cl^{-} (mg/L)	TH (mg/L)	Mg^{+2} (mg/L)	Ca^{+2} (mg/L)	Na^{+} (mg/L)	K^{+} (mg/L)	Alkalinity	WQI %	WQI Rating
R1	8.3	875	553	9.3	30	240	158	336	39	70	81	4	132	37.7	Fair
Q value	73	2.9	20	77	85	30	63.2	67.2	78	93.3	16.2	2.7	66		
R2	8.4	878	505	3.6	83	248	170	340	38	73	77	3.8	140	32.9	Fair
Q value	70	2.9	20	89	14	31	68	68	76	97.3	15.4	2.5	70		
R3	8.2	470	390	12	86	124	57	262	23	67	24	1.7	160	37.6	Fair
Q value	77	1.6	48	72	40	15.5	22.8	52.4	46	89.3	4.8	1.1	80		
R4	7.6	1345	910	15	86	598	136	684	31	222	43	3.7	80	43.6	Fair
Q value	92	4.5	20	67	40	74.8	54.4	136.8	62	296	8.6	2.5	40		
R5	8.2	853	580	2.1	81	160	136	320	35	70	76	3.1	136	29	Fair
Q value	77	2.8	20	93	8	20	54.4	64	70	93.3	15.2	2.1	68		
R6	8.1	993	670	8.5	84	263	152	370	37	86	83	33	128	35.9	Fair
Q value	80	3.3	20	79	22	32.9	60.8	74	74	114.7	16.6	22	64		
R7	7.9	8572	8080	1.5	80	1898	1568	2838	386	501	1420	280	116	82.6	Good
Q value	87	28.6	20	95	4	237.3	627.2	567.6	772	668	284	186.7	58		
R8	7.9	1004	680	7	84	284	154	370	43	77	92	3.8	132	32.6	Fair
Q value	87	3.3	20	82	23	35.5	61.6	74	86	102.7	18.4	2.5	66		
W1	7.6	4754	4300	0.5	80	1918	928	2562	188	716	420	28	36	65.6	Medium
Q value	92	15.8	20	98	3	239.8	371.2	512.4	376	954.7	84	18.7	18		
W2	7.7	4303	4550	0.2	80	1905	586	2224	215	536	528	21	40	59.1	Medium
Q value	91	14.3	20	98	2	238.1	234.4	444.8	430	714.7	105.6	14	20		
W3	7.7	5432	5150	0.8	80	1928	936	2112	187	537	780	220	76	63.1	Medium
Q value	91	18.1	20	98	2	241	374.4	422.4	374	716	156	146.7	38		
W4	7.2	11000	10320	1.5	81	1885	2156	2948	397	528	2080	260	260	86.1	Good
Q value	92	36.7	20	95	5	235.6	862.4	589.6	794	704	416	173.3	130		
W5	7.6	4156	4068	6.7	84	1898	610	2112	220	484	600	80	72	63.4	Medium
Q value	92	13.9	20	83	20	237.3	244	422.4	440	645.3	120	53.3	36		
W6	7.5	8369	7388	4.7	5	2006	2178	2904	332	616	1100	215	44	84.6	Good
Q value	93	27.9	20	87	84	250.8	871.2	580.8	664	821.3	220	143.3	22		
W7	7.2	4006	4024	1.8	5	1954	740	2288	189	605	550	13	36	57.4	Medium
Q value	92	13.4	20	94	81	244.3	296	457.6	378	806.7	110	8.7	18		
W8	7.6	4363	4314	1.1	4	1945	653	1958	148	539	539	12	80	56.7	Medium
Q value	92	14.5	20	96	80	243.1	261.2	391.6	296	718.7	107.8	8	40		
W9	7.8	985	670	13.1	42	260	154	368	39	83	85	3.4	136	38	Fair
Q value	90	3.3	20	70	86	32.5	61.6	73.6	78	110.7	17	2.3	68		

3. Results and Discussion

Among all the chemical and physical parameters which were measured in the water samples, pH considers the most important because of it determines the suitability of water samples for various purposes. In this paper, pH values for raw water have ranged from 7.6 to 8.3 indicating the weakly basic character of the water. While the wells water has

registered also weakly basic character. 100% of the raw water classified as fresh water (TDS<1000mg/L) while 100% of wells water classified as brackish water(TDS>1000mg/L) based on Fetter (TDS) classification (Table 3). Also, from the electrical conductivity (EC) values it was observed that all the water samples (raw and wells) registered very high values reached to 11000 us/m which means that the study areas are of high mineralization because the electrical conductivity indicates mineralization level. The high degree of mineralization suggests long contact time of water with geological formation and soil of the study areas. The chloride concentration registered a varied value between 2178 to 57 (mg/L). The total hardness values ranged from 320 to 2948 (mg/L) Based on total hardness classification of Sawyer and McCarty, all the water samples classified as very hard water (total hardness values >300 mg/L) (Table 4). In Table 5 all the water quality index values were included. It was observed that none of all water samples registered water quality index=100. The raw waters which obtained from the river registered a fair water quality with average rating (WQI= 35.9) indicating polluted water and unacceptable for potable which implied unsuitable water for direct consumption without pretreatment. While the water of the wells registered a medium to good quality which implied simple treatment is necessary to the water before human consumptions regardless the good rating while the medium quality required to conventional and advance treatment before consumption.

4. Conclusion

Based on the results of water quality index in this paper, all the water samples registered as water require a pre-treatment before human consumptions. This paper discusses important problem because of people who live in the study areas are using the wells and river water for varies purposes such as drinking and domestic purpose. They believe that the water of the wells is suitable for the drink and don't require any treatment. This paper recommends that people should be made aware of the dangers of drink the wells water and its effects on human health. Also, it recommends the water quality index (WQI) should be adopted as a powerful tool for monitoring the water.

References

[1] Tiwari, T. and M. Mishra, *A preliminary assignment of water quality index of major Indian rivers.* Indian J Environ Prot, 1985. **5**(4): p. 276-279.
[2] Pesce, S.F. and D.A. Wunderlin, *Use of water quality indices to verify the impact of Córdoba City (Argentina) on Suquía River*. Water Research, 2000. **34**(11): p. 2915-2926.
[3] Ŝtambuk-Giljanović, N., *Comparison of Dalmatian water evaluation indices.* Water environment research, 2003. **75**(5): p. 388-405.
[4] Sargaonkar, A. and V. Deshpande, *Development of an overall index of pollution for surface water based on a general classification scheme in Indian context.* Environmental monitoring and assessment, 2003. **89**(1): p. 43-67.
[5] Liou, S.-M., S.-L. Lo, and S.-H. Wang, *A generalized water quality index for Taiwan.* Environmental Monitoring and Assessment, 2004. **96**(1): p. 35-52.
[6] Horton, R.K., *An index number system for rating water quality.* Journal of Water Pollution Control Federation, 1965. **37**(3): p. 300-306.
[7] Dinius, S., *Social accounting system for evaluating water resources.* Water Resources Research, 1972. **8**(5): p. 1159-1177.
[8] Lohani, B.N. and G. Todino, *Water quality index for Chao Phraya river.* Journal of Environmental Engineering, 1984. **110**(6): p. 1163-1176.
[9] Dagar, J., *Opportunities for alternate land uses in salty and water scarcity areas.* Int J Ecol Environ Sci, 2009. **35**(1): p. 53-66.
[10] Andrade, E.M.d., et al., *Land use and groundwater quality: the case of Baixo Acaraú Irrigated Perimeter, Brazil.* Revista Ciência Agronômica, 2010. **41**(2): p. 208-215.
[11] Kelrich, K., *ur.(1990) Official methods of analysis.* Arlington, VA: Association of Official Analytical Chemists/AOAC.
[12] Eaton, A.D., L.S. Clesceri, and A.E. Greenberg, *Standard methods for the examination of water and wastewater*, 1995, American Public Health Association, Washington, DC.
[13] Sawyer, C.N. and P.L. McCarty, *Chemistry for sanitary engineers*, in *Chemistry for sanitary engineers*1967, McGraw-Hill.
[14] Fetter, C.W. and C. Fetter, *Contaminant hydrogeology*. Vol. 500. 1999: Prentice hall New Jersey.
[15] Oram, B., P.G., *Water Quality Index Calculator. Field Manual for Water Quality Monitoring.*, 2012: Pennsylvania, USA.