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

Applying Water Quality Index Technique to Estimate Tigris Rivers Stability for Drinking in Saouira North Wasit Government, Iraq

Dr. Raad Mahmoad Nasif Al-Khafaji

College of Education for Pure Science (Ibn Al-Haitham), University of Baghdad, Iraq

Abstract: ***In the present study water Quality Index has been used to assess suitability of serves water quality for drinking purpose in Saouira area. Service water samples were collected in September (2015) and April (2016) from nineteen samples have been modeling analysis in General Commission for Ground Water the analyzed for their physicochemical characteristics such as pH, total dissolved solids, Electrical Conductivity, sodium, calcium, magnesium, potassium, bicarbonate, sulphate, chloride, total hardness and nitrate. Each parameter was compared with its standard permissible limit as prescribed by Iraqi drinking water standards. The results showed that WQI values for the serivec water of the study area ranged from 47.36 to 52.63.Based on the WQI classification majority of the samples are falling under excellent to good water category and suitable for drinking water purpose.***

Keywords: Water quality index; WQI; Saouira; physical –chemical analysis; quality rating

1. Introduction

Tigris River Saouira reach in recent years exposed to industrial waste disposal, agricultural and urbanization affecting the quality of water. The increase in population and expansion of economic activities undoubtedly leads to increasing demand of water use for various purposes. Drinking water should be aesthetically pleasant, ideally looking clear, colorless and well aerated with no unpalatable taste and odor. However, suitability in terms of public health is determined by microbiological, physical, chemical and radiological characteristics. Also a number of chemical contaminants (both organic and inorganic) are found in water. These cause health problems in the long run and, therefore, detailed analyses are warranted [1]. Water Quality Index (WQI) is an important technique for demarcating service water quality and its suitability for drinking purposes. It is defined as a technique of rating that provides the composite influence of individual water quality parameters on the overall quality of water for human consumption.

Study area consist of recent and quaternary sediments of Pleistocene – Holocene of the alluvium Mesopotamian plain [2], the area is characterized by flood plains deposits which consist of thin layers of fine sand , silt and clay and some gravel within deeper layers [3]. The area characterized by an arid climate of hot dry summer.

The objective of this work is the determine the suitability of the Tigris River Saouira research for human consumption based on computed water quality index. The study values area is located between latitudes (38 27 18 – 33 04 45) N and longitude (44 21 29 – 45 17 22) E .

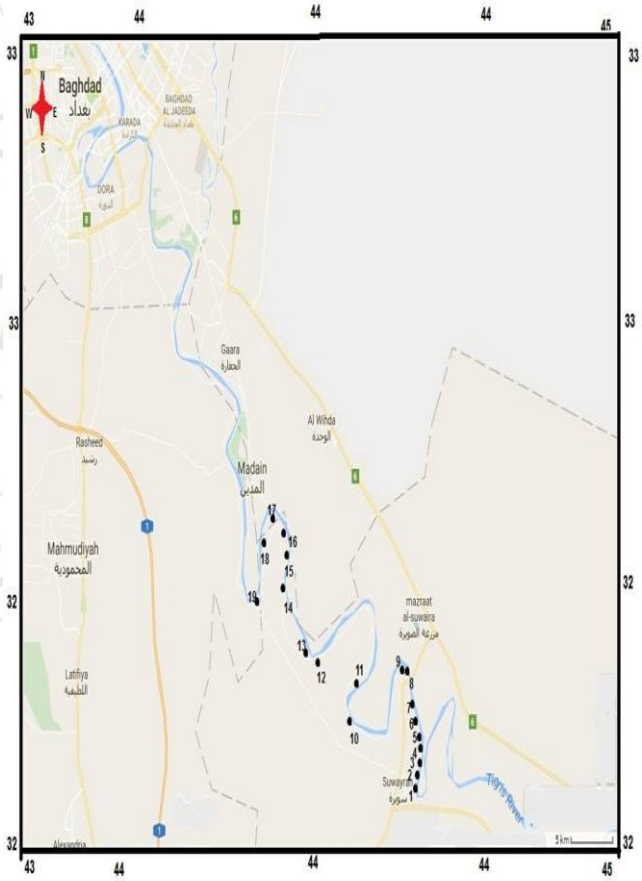

Figure 1: Study area with samples locations

2. Materials and Methods

Serve water samples were collected from nineteen samples from the study area for two periods during September (2015)

and April (2016) (Figure 1). Each of the water samples was analyzed for twelve parameters which are pH, total dissolved solids (TDS), Electrical Conductivity (EC), sodium, calcium, magnesium, potassium, bicarbonate, sulphate, chloride, total hardness and nitrate using standard procedures recommended by APHA, 1998 [4].The mean concentrations of parameters of the two periods are shown in Table -1-.

Table 1: The mean values of physical and chemical parameters of water samples

Well No.	PH	TDS mg/l	EC (µS/cm)	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	HCO_3 mg/l	SO_4 mg/l	Cl mg/l	NO_3 mg/l	TH
1	7.14	970	1262	88	61	143	5	68	334	337.3	0.4	390
2	7.2	889	1228	82	54	132	4.1	64	245	326.5	1.2	370
3	7.13	1009	1270	90	63	145	5.2	69	390	314	0.44	375
4	7.3	890	1237	85	56	137	4.5	66	252.	130	1.3	372.
5	7.25	1010	1277	90	63	147	5,2	69	363	200.5	0,44	375.
6	7.2	900	1252	87	60	149	4.7	67	331	196	0,4	370
7	7.14	965	1257	87	69	142	4,5	67	332	187.5	0.4	371
8	7.4	885	962	113	72	91	6	51	431	87	0,2	340
9	7.35	890	970	60	40	110	2	31	200	74.3	0.5	343
10	7.4	661	884	61	38	75	2	23	181	210	2.1	280
11	7.12	670	892	61	39	76	2	23	183	231	2	283
12	7.18	649	867	52	28	84	1.2	22	138	96.5	1,2	240
13	7.14	650	850	54	30	85	1.2	22	140	463	2	244
14	7.13	570	851	42	25	539	1,1	88	118	98	o.48	230
15	7.12	560	949	51	27	137	1,1	66	206	380	1.1	232
16	7.12	569	842	51	27	139	1.1	66	208	195.5	1.2	210
17	7.12	630	949	61	38	75	2	23	181	139.7	1.4	214
18	7.2	550	842	37	20	51	0.9	18	114	144	1.1	240
19	7.13	560	850	51	27	137	1.1	66	206	210.5	1.1	242

Water Quality Index (WQI) is used in this research, which is defined as the rating that reflects the composite influence of the different parameters. Water Quality Index (WQI) is a mathematical tool to integrate the complex water quality data into anumerical score that describes the overall water quality status [5]. Quality index is an important tool for getting an idea about the quality of water for drinking purpose. One of the most effective ways to communicate information regarding water quality trends to policy makers and the general public or citizens is with indices [6]. The quality index does not show exact degree of pollution, rather it is used to assess water quality trends for the management purpose [7].The twelve parameters which were pH, total dissolved solids, Electrical Conductivity, sodium, calcium, magnesium potassium, bicarbonate, sulphate, chloride and nitrate were used for the calculation of WQI. To calculate the WQI, the weight has been assigned for the parameters according to the parameters relative importance in the overall quality of water for drinking water purposes. The assigned weight ranges from 1 to 5 as shown in Table 2. The maximum weight of 5 has been assigned for nitrate and TDS, 4 for pH, EC, SO4, 3 for HCO_3, Cl, 2 for Ca, Na, K and weight 1 assigned for magnesium [8] (Vasanthavigar *et al.*, 2010). The relative weight is computed from the following equation:

$$Wi = \frac{wi}{\sum_{i=1}^{n} wi} \quad \text{..... 1}$$

Where:
*Wi*is the relative weight
Wi is the weight of each parameter
n is the number of parameters

The quality rating scale for each parameter is calculatedby dividing its concentration in each water sample by its respective standards [9] as shown in Table -2- and multiplied the results by 100.

$$qi = \frac{Ci}{Si} \times 100 \quad \text{.....2}$$

Where:
qi is the quality rating
Ci is the concentration of each parameter in each water sample
Si is the Iraqi drinking water standards for each parameter
For computing the final stage of WQI, the SI is first determined for each parameter. The sum of SI values gives the water quality index for each sample.

$$SIi = Wi \times qi \quad \text{..... 3}$$

$$WQI = \sum_{i=1}^{n} SIi \quad \text{.....4}$$

Where:
SIi is the sub-index of i^{th} parameter
Qi is the rating based on concentration of i^{th} parameter
n is the number of parameters

On the basis of the WQI, the quality of the water is categorized into fivestatuses from unfit for drinking purpose to excellent [3], [8] (Table 3).

Table 2: Relative weight for each parameter (14)

Chemical parameters	Iraqi Standard 2009	Weight (wi)	Relative weight (Wr)
pH	8.5	4	0.114
TDS	1000	5	0.142
EC	1500	4	0.114
Ca	150	2	0.057
Mg	100	1	0.028
Na	200	2	0.057
K	12	2	0.057
HCO_3	200	3	0.085
SO_4	400	4	0.114
Cl	350	3	0.085
NO_3	50	5	0.142
		$\sum 35$	

Table 3: Water quality classification based on WQI values

WQI range	Type of water
< 50	Excellent water
50–100	Good water
100-200	Poor water
200-300	Very poor water
>300	Unfit for drinking

3. Results and Discussion

In order to determine the water quality index (WQI), physical and chemical properties for nineteen samples from the study area were analyzed for different parameters (Table -1-).The statistical parameters like minimum, maximum and mean concentration of physico-chemical parameters and their comparison with Iraqi drinking water standards are tabulated in Table -4-.

The pH values of the study area service water ranged from (7.12 to 7.4) (Figure 2), indicating the low alkaline nature of the serves water .The pH values are found to be within the permissible limit. The TDS and EC values are ranged from (550 to 1010 mg/l) and (842 to 1277 µs/cm) respectively, (Figs. 3 and 4).The mean concentrations of TDS and EC exceeded the permissible limits for drinking water.

Increasing in TDS and EC concentrations may be attributed to the gypsum and anhydrite rocks dissolution from Formation during the passage of Tigris River for them during the runoff from upstream to downstream.

The ranges of Ca^{+2}, Mg^{+2}, Na^{+} and K^{+} were (37 to 113 mg/l), (20 to 72 mg/l), (51 to 149 mg/l) and (0.9 to 6 mg/l) respectively (Figs. 5, 6, 7, and 8). High concentrations of Calcium, Magnesium and Sodium ions are observed for serves water samples that exceeded the permissible limits for drinking water, while the potassium concentration was within the permissible limits too. The ranges of (HCO_3^{-}), (SO_4^{-2}) and (Cl^{-}) were (18 to 88 mg/l), (114 to 431mg/l) and (98 to 266 mg/l) respectively (Figures 9-11). HCO_3SO_4 and Cl water samples have concentrations that exceeded the permissible limits for drinking water. The Total hardness and nitrate values ranged from (210 to 390 mg/l) and (0.2 to 2.1 mg/l) respectively (Figures 12, 13), the total hardness exceeded the permissible limits for drinking water, while the nitrate concentration was within the permissible limits.

The calculation of water quality index WQI results for individual groundwater samples shows that the WQI values ranged from (37.36 to 70.12) (Table -4- and Figure 14). About 52.61% of water supply can be classified as excellent water, while 47.36 % of water supply are classified as good water.

Table 4: Minimum, maximum and mean concentration of parameters and their comparison with Iraqi drinking water standards

Parameters	Minimum	Maximum	Mean	Iraqi Standard 2009
pH	7.12	7.4	7.20	6.5-8.5
TDS	550	1010.5	761.47	1000
EC	8425	1277	1047.05	1500
Ca	37	113.5	68.57	150
Mg	20	72	44.05	100
Na	51	149.5	110.94	200
K	0.9	6	2.88	12
HCO_3	18	88	51	200
SO_4	114.6	431	239.63	400
Cl	98	266	197.63	350
TH	210	390	301.10	500
NO_3	0.2	2.1	0.99	50

Table 5: Water quality index (WQI) classification for individual water samples

Well No.	WQI	Water Classification	Well No.	WQI	Water classification
1	99.39	Good water	11	90.4	Good water
2	95.23	Good water	12	36.55	Excellent water
3	131.97	Poor water	13	139.81	Poor water
4	49.25	Excellent water	14	67.15	Good water
5	87.26	Good water	15	137.74	Poor water
6	81.79	Good water	16	77.21	Good water
7	79.79	Good water	17	41.14	Excellent water
8	29.65	Excellent water	18	46.9	Excellent water
9	27.25	Excellent water	19	78.41	Good water
10	77.81	Good water	20	35.42	Excellent water

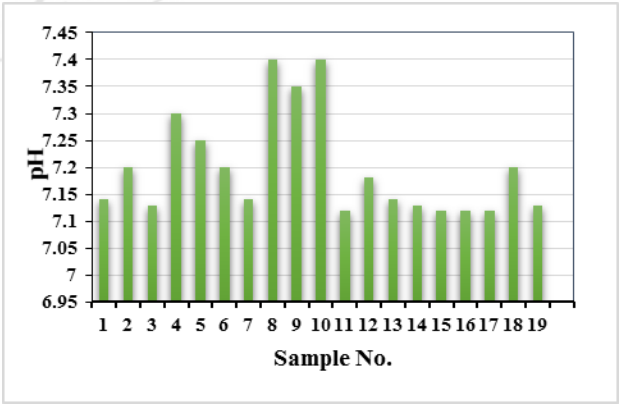

Figure 2: pH values for all samples

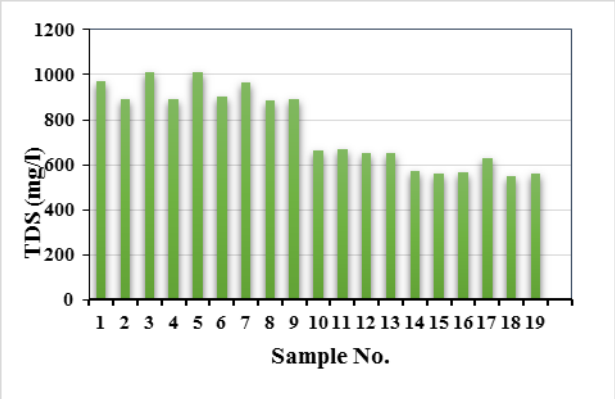

Figure 3: TDS values for all samples

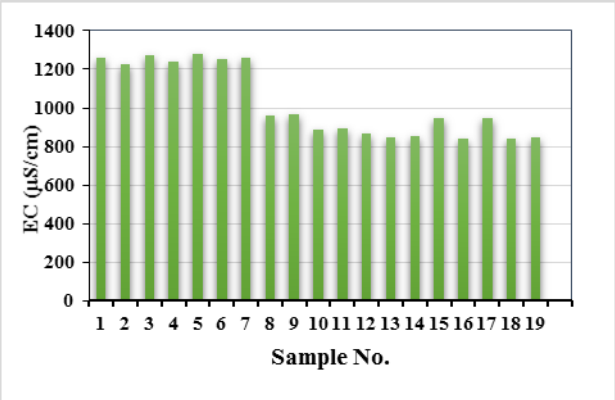

Figure 4: EC values for all samples

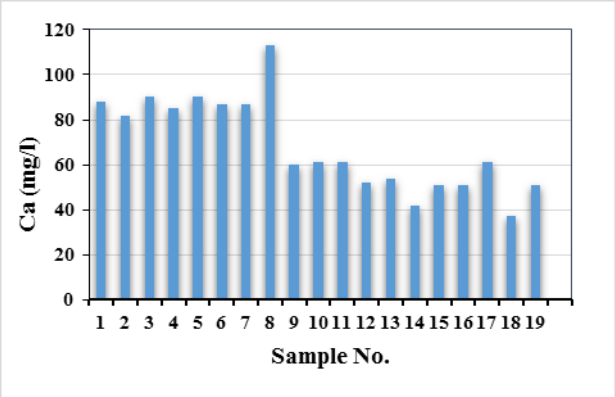

Figure 5: The values of Calcium ions for all samples

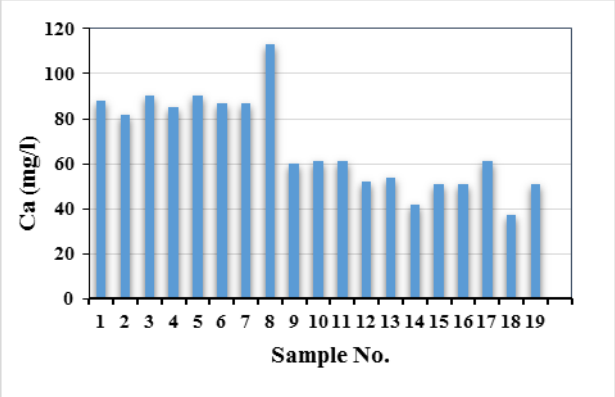

Figure 6: The values of Magnesium ions for all samples

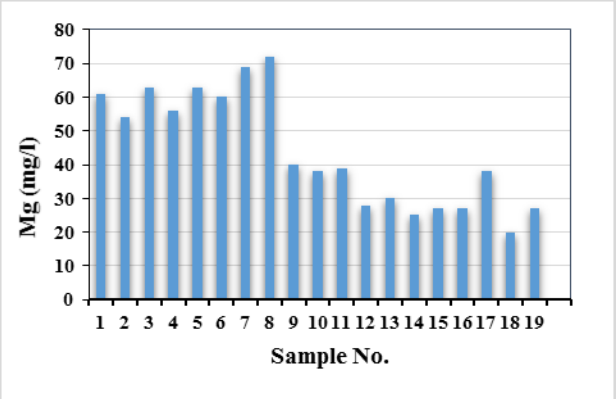

Figure 7: The values of Sodium ions for all samples

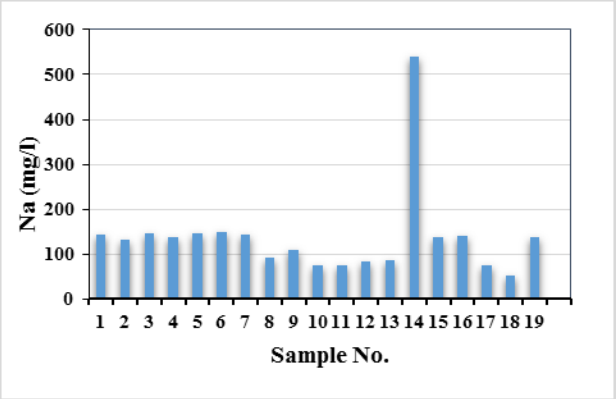

Figure 8: The values of Potassium ions for all samples

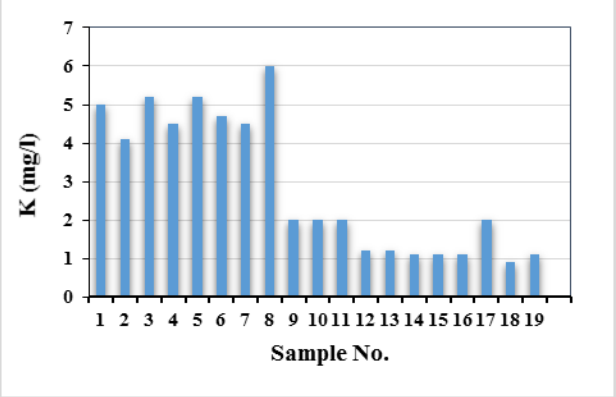

Figure 9: The values of Bicarbonate ions for all samples

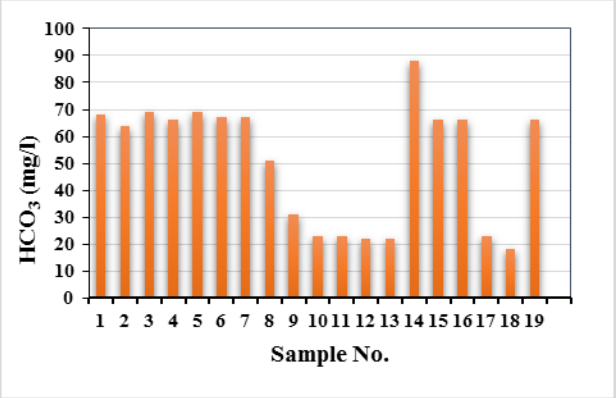

Figure 10: The values of Sulphate ions for all samples

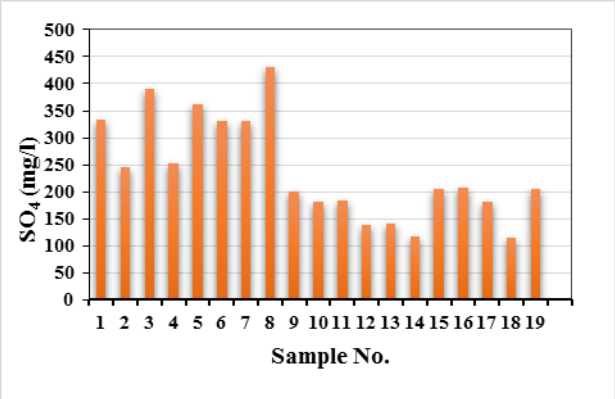

Figure 11: The values of Chloride ions for all samples

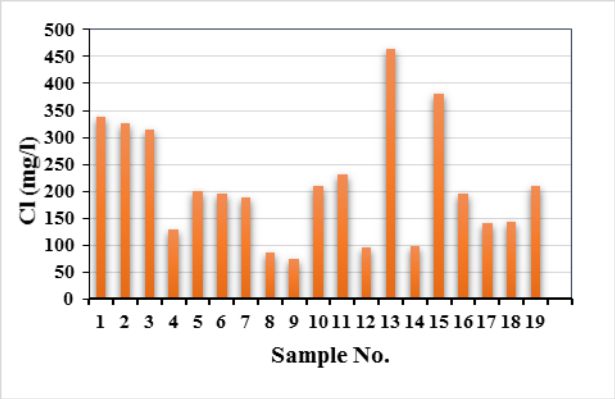

Figure 12: The values of Nitrate ions for all samples

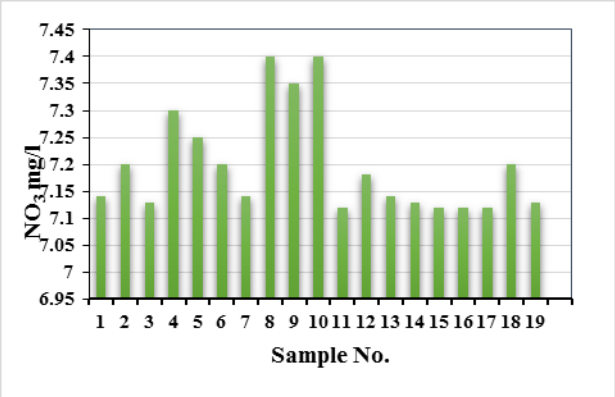

Figure 13: The values of TH for all samples

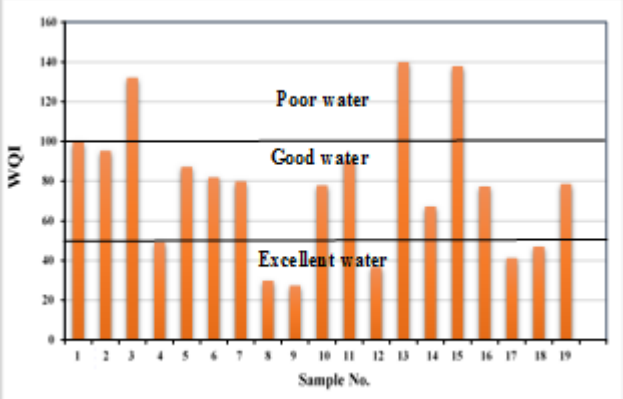

Figure 14: The WQI values for all samples

4. Conclusions

In this study, WQI has been computed to assess the suitability of serves water of eleven different parameters for drinking purposes in Saouria region. A total of nineteen samples were analyzed for WQI. Among these, 52.61% of the samples showed excellent water, 47.36 % of the samples fell under good water. Based on the WQI classification majority of the samples of study area are falling under excellent to good water category and suitable for drinking water purposes.

References

[1] Vigneswaran, C., Visvanathan, H.H., Ngo, M. and Sundaravadivel, M., Quantity and Quality of Drinking Water Supplies. Encyclopedia of Life Support Systems (EOLSS), Developed under the Auspices of the UNESCO, Eolss Publishers, Oxford, UK, 2004.

[2] Buddy, T. and Jassim, S., The regional geology of Iraq, Vol. 1, stratigraphy and Paleogeography. I.I.M. Kassab and S. Z. Jassim (Ed) SOM. Baghdad, 445p, 1980.

[3] Al-Dabbas, M., Al- Saadi, Q. and Baktash F., "Combating desertification in Iraq, the Iraq research and development initiative," IRDI Research Compendium, Rounds 1 and 2 - 1(1): 6-21, 2013.

[4] APHA, Standard methods for the examination of water and waste water. American Public Healthy Association (19th ed) Washington. 1980.

[5] Ramakrishnaiah, C.R., Sadashivaiah, C. and Ranganna G., "Assessment of Water Quality Index for the Ground water in Tumkur Taluk, Karnataka State, India.," E. Journal of Chemistery, 6(2), 523-530, 2009.

[6] Dwivedi, S. L. and Pathak, V., "A preliminary assignment of water quality index toMandakiniriver, Chitrakoot," Indian Journal Environmental Protection 27: 1036-1038, 2007.

[7] Mishra, B., Chaturvedi, G. and Tewari D. "Water quality index And suiability of water of Kohargaddi Dam at district Balarampur," India Environmental. 27: 497- 500, 2008.

[8] Vasanthavigar, M, Srinivasamoorthy, K, Vijayaragavan, K, Rajivganthi, R, Chidambaram, S, Anandhan, P, Manivannan, R. and Vasudevan S., "Application of water quality for groundwater quality assessment: Thirumanimuttar Sub basin, Tamil Nadu, India," Environmental Monitor Assessment, 171(1–4):595–609, 2010.

[9] IQS, Iraqi Standard of Drinking Water No. 417, Second modification, 2009.

Author Profile

Dr. Raad Mahmoad Nasif Al-Khafaji: Assistant Professor (PhD.) in College of Education for Pure Sciences (Ibn Al-Haitham), University of Baghdad, Baghdad, Iraq.