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RESEARCH ARTICLE

Evaluation of Water Quality Index from 2008 to 2010 of Euphrates River : Case Study, Upstream of Al-Hindiya Barrage, Iraq

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ABSTRACT

The water shortage in current years due to claiming change and reduce of water share of Euphrates river from source. The changing caused to increase in elements, salts and acidity index (PH). This study aim to compare the water quality of 2008 with 2009 and 2010.This study is done in order to measure water quality by using water quality index (WQI). The WQI is a tool utilizing to calculate more than parameters to evaluate water quality and it works mathematically. WQI gives water validity to drinking. The study carries out in upstream of Al-Hindiya barrage on Euphrates River. The results in study show the WQI by utilizing Sumitomo and Nemerow model in 2008, 2009 and 2010 are acceptable as they < 1. The second tested model by using Weighted arithmetic index method from Brown RM et al. and Dhirendra MJ et,al indicates that all tested samples were valid. According to these results of the three models, it can be said that the overall water quality in 2008, 2009 and 2010 is valid; however; some parameter needed to be treated in the Sumitomo and Nemerow model. Sumitomo and Nemerow model indicate that the year of 2009 that is less discharge than 2008 and 2010 has more invalid elements.

Key words: water quality index, Al-Hindiya barrage, Sumitomo and Nemerow.

INTRODUCTION

The problems of water shortage in many countries lead to reduce agriculture, industry and many other activities. Water shortage and rising of temperature lead to degradation of water quality therefore; it is necessary putting tool to test and monitoring the Euphrates river water in upstream of Al-Hindiya barrage. Fadhil and Abdulkider, 2013 used water quality index (WQI) to evaluate the ground water quality of Dibdiba aquifer for drinking purpose. They tested twenty wells to calculate multi parameters. The results showed that the values of WQI ranged between 432.6 and 184.5. They proved that water for Dibdiba aquifer is not suitable for drinking of human use. Roşu Cristina et al., 2014 carried out the study of WQI in Mediaş town in faculity of environmental Sciences and Engineering Cluj-Napoca of Romania. The WQI utilizes the analyzing water quality of multi parameter. The WQI ranged between 76 was very poor to 375 was doing not suitable. Rafah Rasheed Ismail et al., 2018 used the remote sensing technology in verification of the pollution region in Diyala River, Tigris River, and study the influence of wastewater treatment station in AL-Rustamiyah in Baghdad capital that is site on Diyala River. From obtained results on four classes of WQI that are successful in evaluating and mapping water was polluted that confirmed which the water of River of Tigris is subjected to pollution by Diyala River that agree with the ecological tested of water samples took from five locations in the search region. Shahad and Khalid, 2018 studied development WQI method of drinking water of Iraq (IQS 417, 2009) to predict the validation in Euphrates River to drinking via classify the quality of the Euphrates water at variation stations.

To evaluate the water, the concentration of eight parameters were examined Cl, TDS, pH, Ca, Mg, Na, SO^{-4}, and NO^{-3}. The good water quality and decrease after it receives pollution from sources for example domestic sewage the water becomes Poor. The WQI utilizes the parameters witch weight value from one to five as to the significance of parameter. The equation which given was generated to estimate the end index that gathers the influence of all the (8) parameters. The area used of Al-Shanafiyah station until Al-Haritha station unfit as a source to drink water due to classificatory of the drink water at the stretch of the river classifying as Poor by WQI. Abbood et al., 2014 evaluated the WQI in Main Drain River of Iraq via Application the Canadian Council of Ministers of the Environment Water Quality Index. They studied fifteen water quality parameters measured for 10 stations through the length of main drain river from Baghdad to Babylon after that Qadiysiah then ThiQar and Al-Basrah. The work carried out through 2004 to 2011. The results got from WQI water river was between 26.6- 35.5 that show worst water quality because of influence of different pollutants sources. Adel Mashaan Rabee et al., 2011 utilized nine parameters in predicting the quality of Tigris River for public usage via taking five locations of sampling along the river in Baghdad region. The parameters that were tested are temperature, pH, BOD, NO_3, PO_4, fecal coliform, TU, and TDS. The results showed that the WQI in water of Tigris River was at medium class. Muthanna et al. 2018 studied the groundwater quality for dibdaba formation and to determining its water quality index and evaluating its use for irrigation. This study aims to assess the water quality in the Euphrates River at Al-Hindiya barrage from 2008 to 2010 for drinking validity by using WQI concept using Sumitomo- Nemerow and Weighted arithmetic index methods.

METHODOLOGY

New Al-Hindiya barrage is very important project in Iraq because of providing several rivers and canals from its upstream (Musib project, shat Al-Hila, Kifil project, Beni Hassan project, and Husinia project) that feed area of an approximately 500 hectar. It sited on Euphrates River, which located in Sadat Al-Hindiya town of Babylon governorate as shown in Fig.1. New Al-Hindiya barrage site in 44 43'41.82"N and 44 16'8.19"E. The length of the barrage was 115m and it has six arch gates in 16 m width in each. The barrage has a hydro power station with a length of 79.6m and lock of navigation 20 m length. The height of barrage was 10 m, bed level 24.90 m and top level 34.90 m.

The water samples for upstream of Al-Hindiya barrage was taking by Al-Hindiya barrage office (daily measurements note book of 2008, 2009 and 2010) . The tests consist of ten parameters: TDS (total dissolve solid), pH(acidity index), Calcium(Ca), Sodium(Na) , Magnesium(Mg), Sulfate(So_3), Electric conductivity of water (EC), Nitrate (No_3), Chloride (Cl), and total hardness (T.H.). Table.1 The Iraqi standard for drinking purpose as permitted value, 2009. Table.2. The status WQI on Mishra and Patel, 2001.

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WATER QUALITY INDEX MODELS

The water quality indexes are calculating and predicting of Al-Hindiya barrage in Babylon city at Sadat Al-Hindiya town ship by two methods:

1. Sumitomo and Nemerow model,
2. Weighted arithmetic index method.

Sumitomo and Nemerow model

The water pollution index using Sumitomo and Nemerow model by following equations:

$$Pij = f\left(\frac{Ci}{Lij}\right) \quad \ldots\ldots (1)$$

where:
Pij= the pollution index for the use j
Ci= multi item of water qualities.
Lij= permissible level for use (standard level).
i= number of the i-item of water quality.
j= number of the j-item of water utilize (use)

The pollution index for the use j if equal 1 was critical value but if pollution index for the use j was more than one therefore the water required some treatment

$$Pij = f(\text{ max of } \left(\frac{ci}{Lij}\right) \text{ and mean of } \left(\frac{ci}{Lij}\right) \quad \ldots\ldots (2)$$

$$Pij = m * \left(\max \left(\frac{ci}{Lij}\right)^2 + \text{mean} \left(\frac{Ci}{Lij}\right)^2 \right)^{0.5} \quad \ldots\ldots (3)$$

where:
m = the proportionality constant
If pij =1 and max (ci/Li)=1 and mean (ci/Lij) =1 substitute in eq.(3)
m=constant equal to $1/\sqrt{2}$

$$Pij = \frac{1}{\sqrt{2}} * \left(\max \left(\frac{ci}{Lij}\right)^2 + \text{mean} \left(\frac{Ci}{Lij}\right)^2 \right)^{0.5} \quad \ldots\ldots (4)$$

$$\frac{Ci}{Lij} \text{ of PH } = \frac{ci - Lij}{Lij\max - Lij} \quad \ldots\ldots (5)$$

$$Lij = \frac{Lij\max + Lij\min}{2} \quad \ldots\ldots (6)$$

The other test take Ci/Lij as show in Table (3)

Weighted arithmetic index method

From Brown RM et al., 1972 and Dhirendra MJ et,al., 2009. Using equation of constant of proportionality (K),

$$K = \frac{1}{\sum_{i=1}^{n} \frac{1}{si}} \quad \text{.....(7)}$$

where:
Si = permissible limit for i^{th} parameter
n = number of parameters

$$Wi = k/Si \quad \text{.....(8)}$$

where:
Wi= weightage of i^{th} parameter.

$$Qi = \frac{100Vi}{Si} \quad \text{.....(9)}$$

$$WQI = \frac{\sum_{i=1}^{n} Qi\, Wi}{\sum_{i=1}^{n} Wi} \quad \text{.....(10)}$$

where:
Vi= current reading for i^{th} parameter
WQI= water quality index.
Qi = sub index of i^{th} parameter Qi

RESULTS AND DISCUSSION

The physical and chemical parameter were concentrating on water sample of Euphrates River in Al-Hindiya barrage using three method to evaluate the water quality of river.

By using Sumitomo and Nemerow model

In this method using Sumitomo and Nemerow model from eq.1 to eq.6 to obtain on The pollution index for the use j was less than 1 (the water do not need treatment) or equal 1 was critical value but if pollution index for the use j was more than one therefore the water required some treatment. Table (3) shows water quality index by using Sumitomo and Nemerow model.

pH= MIN+MAX/2=8.5+6.5/2=7.5
Lij=(ci-Lij)/(Lmax-Lij)=(ci-7.5)/(8.5-7.5)

$$SAR = \frac{Na}{\sqrt{\frac{Ca+Mg}{2}}} \quad \text{.....(11)}$$

Sodium adsorption ratio (SAR)= Max. value of sodium dividing on root square of Max. value of calcium and magnesium(Larry W. Mays,2005). The result from table.3 and Eq.11 obtain on SAR = 23.5

$PIj = Sqr\left(\frac{aver+max}{2}\right) = 0.934 < 1\ ok$ but Max value of SO4=1.25>1 need treatment.

Tables (4) to (7) show the discharge (Q) and upstream water level (U/S W.L) of Al-Hindiya barrage during 2008, 2009 and 2010 to compare the discharge and U/S W.L with Max WQI.

Sodium adsorption ratio (SAR)= Max. value of sodium dividing on root square of Max. value of calcium and magnesium(Larry W. Mays,2005). The result from table.3 and Eq.11 obtain on SAR = 12.6

$$PIj = Sqr\left(\frac{aver+max}{2}\right) = 0.993 < 1\ ok$$

The Maximum values of WQI of T.H,Ca,SO4 and TDS equal to 1.3,1.17,1.14 and 1.2, respectively. these indices point to the water need to treatment because of WQI more than one.

Sodium adsorption ratio (SAR)= Max. value of sodium dividing on root square of Max. value of calcium and magnesium(Larry W. Mays,2005). The result from table.3 and Eq.11 obtain on SAR = 23.5

$PIj = Sqr\left(\frac{average+max}{2}\right) = 0.995 < 1\ ok$ but Max value of T.H=1.3>1 need treatment.

When Ci/Lij>1 use equation, Ci/Lij= 1+k * log(Ci/Lij) the K=5 from Sumitomo and Nemerow. Figures (2) to (4) show average and maximum WQI for (U/S W.L) of Al-Hindiya barrage during 2008, 2009 and 2010.

Weighted arithmetic index method from Brown RM et al., 1972 and Dhirendra MJ et,al., 2009. In 2008 depending on eq.(7), eq.(8) and (9). This method was utilized by Brown RM et al., 1972 and Dhirendra MJ et,al., 2009 which Using equation of constant of proportionality (K) as shown of equation 7 to 10. They used permissible limit for i^{th} parameter with weightage of i^{th} parameter. They using Vi= current reading for i^{th} parameter as shown in eq.9 and obtained on WQI= water quality index as explaind equation 10.

Table (9) to (11) show WQI by using weighted arithmetic index method from 2008 to 2010. The WQI average equal to 41.5 the index is good as shown in table (8) because of the good pointing was between 26-50.

The WQI average equal to 40.7 the index is good as shown in table (9) because of the good pointing was between 26-50. The WQI average equal to 31.7 the index is good as shown in table (10) because of the good pointing was between 26-50

CONCLUSIONS

The concluding which obtains from result will be as following: using the water quality index (WQI) by Sumitomo and Nemerow model,1970 will obtain on WQI of 2008 is 0.934 < 1 ok. But in maximum value of SO4 is 1.25. this value more than 1 therefore the increasing of parameter SO4 explains the water need to treatment to reduce the sulfate value. WQI of 2009 is 0.993 < 1 ok. But in maximum values of T.H, Ca, SO4 and TDS is1.3, 1.17,1.14 and 1.2, respectively. this index of four parameters points to the water need to treatment of T.H, Ca, SO4 and TDS more than 2008. WQI of 2010 is 0.995 <1 0k But in maximum values of T.H is 1.3. this value more than 1 therefore the increasing of parameter T.H explains the water need to treatment to reduce the total hardness. using the water quality index (WQI) by Weighted arithmetic index method from Brown RM et al., 1972 and Dhirendra MJ et,al., 2009. WQI of 2008, 2009 and 2010 is 41.5, 40.7 and 31.7, respectively. These indices are good because of they was between 26-50. From conclusion shows the water need treatment to total hardness from 2008 to 2010 while in 2008 also need treatment to sulfate calcium, total dissolved solid. The Sumitomo and Nemerow model show that the year of 2009 which is less discharge than two are 2008 and 2010 has WQI more than 1 and the water needs to treatment. The decreasing of discharge at 2009 caused increasing of polluting parameters.

RECOMMENDATIONS

1. We recommended study of WQI of Al-Hindiya barrage water from 2011 to 2019.
2. Studying of biological, chemical and physical of Euphrates river through shortage time and summer season.

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Table.1 The Iraqi standard for drinking purpose as permitted value (Ministry of Environment, 2009)

parameters	PH	TDS	Ca^{+2}	Mg^{+2}	Na^{+1}	Cl^{-1}	EC	NO_3	$So4^{-2}$	T.H
Iraqi standards	6.5-8.5	1000	150	100	200	350	1563	50	400	500

Table 2. The status WQI on Mishra and Patel, 2001

WQI value	Water Quality
0-25	Excellent
26-50	Good
51-75	poor
76-100	Very poor
>100	Unfit for drinking purpose

Table 3. Water quality index by using Sumitomo and Nemerow model of 2008.

Date 2009		Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Average	Max
EC	Av.	1133	1169	1155	1125	1150	1262	1430	1203	1430
	limit	1563	1563	1563	1563	1563	1563	1563	1563	1563
	Ci/Lij	0.725	0.748	0.739	0.72	0.736	0.807	0.915	0.77	0.915
TDS	Av.	842	812	844	772	818.7	994	996	868.4	996
	limit	1000	1000	1000	1000	1000	1000	1000	1000	1000
	Ci/Lij	0.842	0.812	0.844	0.772	0.819	0.994	0.996	0.868	0.996
Ca (mg/L)	Av.	12.9	0.45	7	15.37	7.067	9.3	26.85	11.28	26.85
	limit	150	150	150	150	150	150	150	150	150
	Ci/Lij	0.09	0.003	0.05	0.07	0.05	0.06	0.18	0.07	0.18
Mg(mg/L)	Av.	46.5	44.6	48.7	15.4	49.3	58.5	72.7	47.2	72.7
	limit	100	100	100	100	100	100	100	100	100
	Ci/Lij	0.47	0.45	0.49	0.1	0.49	0.59	0.74	0.47	0.73
Na(mg/L)	Av.	-	-	-	151	95.3	157	166	128	166
	limit	200	200	200	200	200	200	200	200	200
	Ci/Lij	-	-	-	0.75	0.45	0.53	0.83	0.64	0.83
CL (mg/L)	Av.	101	117	117	117	120	132	174	136	174
	limit		350	350	350	350	350	350	350	350
	Ci/Lij	0.29	0.33	0.33	0.33	0.34	0.38	0.5	0.36	0.5
So4 (mg/L)	Av.	499	278	257	266	325	313	420	331	499
	limit		400	400	400	400	400	400	400	400

	Ci/Lij	1.25	0.7	0.64	0.67	0.81	0.78	1.05	0.84	1.25
NO3 (mg/L)	Av.	-	-	-	6.35	0.83	0.75	1.35	0.82	1.35
	limit	50	50	50	50	50	50	50	50	50
	Ci/Lij	-	-	-	0.01	0.02	0.02	0.03	0.02	0.03
T.H	Av.	223	184	182	188	210	250	365	229	365
	limit	500	500	500	500	500	500	500	500	500
	Ci/Lij	0.45	0.37	0.36	0.38	0.42	0.5	0.73	0.46	0.73
pH	Av.	8.1	7.7	7.8	7.9	8.1	8.1	8.2	7.99	8.2
	limit	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
	Ci/Lij	0.6	0.2	0.34	0.35	0.63	0.64	0.65	0.49	0.65

pH= MIN+MAX/2=8.5+6.5/2=7.5
Lij=(ci-Lij)/(Lmax-Lij)=(ci-7.5)/(8.5-7.5)

Table 4. Discharge and upstream water level of Al Hindiya barrage from 2008 to 2010

Month	Average Q (m^3/s)2008	U/S W.L	Average Q (m^3/s)2009	U/S W.L	Average Q (m^3/s)2010	U/S W.L
January	344	31.7	258	31.6	246	31.8
February	361	31.7	216	31.5	331	31.9
March	422	31.7	247	31.6	302	31.8
April	383	31.7	226	31.6	281	31.8
May	336	31.6	213	31.8	236	31.7
June	476	31.9	309	31.9	384	31.8
July	586	31.9	370	31.8	487	31.7
August	491	31.9	329	31.8	429	31.7
September	503	31.9	312	31.7	417	31.8
October	459	31.9	270	31.6	386	31.7
November	347	31.8	289	31.6	273	31.6
December	283	31.8	259	31.7	278	31.6
Average	416	31.8	275	31.7	337.5	31.7

Table 5.Water quality index by using Sumitomo and Nemerow model of 2009.

Date 2009		Jan.	Feb.	Mar..	Apr..	Mayy	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Average
EC	Av.	1405	1320	1304	1179	1405	1375	1570	1520	1593	1603	1426	1319	1418
	limit	1563	1563	1563	1563	1563	1563	1563	1563	1563	1563	1563	1563	1563
	Ci/Lij	0.9	0.84	0.83	0.75	0.9	0.88	1	0.97	1.02	1.03	0.91	0.84	0.91
TDS	Av.	900	918	894	867	1024	1200	1156	1146	1122	632	1048	1002	992.4
	limit	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
	Ci/Lij	0.9	0.92	0.89	0.86	1.02	1.2	1.16	1.15	1.12	0.63	1.05	1.00	0.992
Ca mg/L	Av.	22.39	13.81	14.51	8.3	145.3	147.3	150	176	156	115	113.3	147	100.7
	limit	150	150	150	150	150	150	150	150	150	150	150	150	150
	Ci/Lij	0.15	0.09	0.1	0.06	0.97	0.98	1	1.17	1.04	0.77	0.76	0.98	0.67
Mg mg/L	Av.	68.3	59.6	63.1	49.7	54.6	48.8	65.6	50.3	65.9	40.6	57.3	62.5	57.2
	limit	100	100	100	100	100	100	100	100	100	100	100	100	100
	Ci/Lij	0.68	0.6	0.63	0.5	0.55	0.49	0.66	0.5	0.66	0.41	0.57	0.62	0.57
Na	Av.	134	123	122	103	114	93	131	121	-	-	-	-	112

mg/L	limit	200	200	200	200	200	200	200	200	200	200	200	200	200
	Ci/Lij	0.67	0.61	0.61	0.52	0.57	0.47	0.65	0.61	-	-	-	-	0.59
CL mg/L	Av.	152	147	334	142	155	153	165	138	145	159	144	138	164
	limit	350	350	350	350	350	350	350	350	350	350	350	350	350
	Ci/Lij	0.43	0.42	0.95	0.41	0.44	0.44	0.47	0.39	0.41	0.45	0.41	0.39	0.47
So4 mg/L	Av.	340	313	334	334	372	439	431	447	456	426	342	365	375
	limit	400	400	400	400	400	400	400	400	400	400	400	400	400
	Ci/Lij	0.85	0.78	0.84	0.59	0.93	1.1	1.08	1.12	1.14	1.07	0.86	0.91	0.94
NO3 mg/L	Av.	1.15	1.25	0.8	0.9	0.25	1.5	2.5	2.4	0.05	0.6	1.03	0.7	1.09
	limit	50	50	50	50	50	50	50	50	50	50	50	50	50
	Ci/Lij	0.02	0.03	0.02	0.02	0.01	0.03	0.05	0.05	0.001	0.01	0.02	0.01	0.02
T.H	Av.	336	279	295	210	587	569	624	647	662	456	519	625	484
	limit	500	500	500	500	500	500	500	500	500	500	500	500	500
	Ci/Lij	0.7	0.6	0.6	0.4	1.2	1.1	1.2	1.3	1.3	0.9	1	1.3	1
pH	Av.	8.1	8	7.9	8	8	7.9	7.5	7.8	8	7.6	7.9	7.9	7.9
	limit	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
	Ci/Lij	0.56	0.46	0.45	0.48	0.54	0.39	0.04	0.3	0.46	0.06	0.4	0.4	0.38

Table 6. Water quality index by using Sumitomo and Nemerow model of 2010.

2010							positive Ion					
	Average	limit	ci/Lij	Average	limit	Ci/Lij	Average	limit	Ci/Lij	Average	limit	Ci/Lij
Date	EC			TDS			Ca(mg/l)			Mg(mg/l)		
Jan.	1224	1563	0.783	892	1000	0.892	144	150	0.96	45.4	100	0.45
Feb.	1259	1563	0.806	1004	1000	1.004	148	150	0.99	70.4	100	0.7
Average	1242	1563	0.794	948	1000	0.948	146	150	0.97	57.9	100	0.58
Max	1259	1563	0.806	1004	1000	1.004	148	150	0.99	70.4	100	0.7

Table 7.Water quality index by using Sumitomo and Nemerow model of 2010

Negative Ion														
Average	limit	Ci/Li	Average	limit	Ci/Li	Average	limit	Ci/Li	Average	limit	Ci/Li	Average	limit	Ci/Li
CL(mg/l)			So4(mg/l)			NO3(mg/l)			T.H			pH		
126	350	0.36	324	400	0.81	0.55	50	0.01	548	500	1.1	7.8	6.5-8.5	0.3
111	350	0.32	392	400	0.98	0.7	50	0.01	659	500	1.3	7.6	6.5-8.5	0.1
119	350	0.34	358	400	0.9	0.63	50	0.01	604	500	1.2	7.7	6.5-8.5	0.2
126	350	0.36	392	400	0.98	0.7	50	0.01	659	500	1.3	7.8	6.5-8.5	0.3

Table 8. Chemical parameters, highest permitted value for water(Si), 1/Si,k and Wi

chemical parameters	highest permitted value for water(Si)	1/Si	k	Wi
Ec	1563	6E-04	5.941	0.004
TDS	1000	0.001		0.006
Ca	150	0.007		0.04
mg	100	0.01		0.059
Na	200	0.005		0.03
Cl	350	0.003		0.017
So4	400	0.003		0.015
No3	50	0.02		0.119
T.H	500	0.002		0.012
PH	8.5	0.118		0.699
Sum		0.168		1

Table (9) .Q of parameters Qi==100vi/Si during 2008

2008 Date	EC Q1	TDS Q2	Ca Q3	Mg Q4	Na Q5	Cl Q6	So4 Q7	No3 Q8	T.H Q9	pH Q10	Q1* W1	Q2* W2	Q3* W3	Q4* W4	Q5* W5	Q6* W6	Q7* W7	Q8* W8	Q9* W9	Q10* W10	WQI
June	72	84	9	47	-	30	120	-	44.6	60	0.29	0.5	0.36	2.77	-	0.5	1.8	-	0.5	41.94	48.7
July	75	81	0	45	-	30	70	-	36.8	20	0.3	0.49	0	2.66	-	0.5	1.1	-	0.4	13.98	19.4
Aug.	74	84	5	49	-	30	60	-	36.4	34	0.3	0.5	0.2	2.89	-	0.5	0.9	-	0.4	23.77	29.5
Sept.	72	77	7	10	75	30	70	0.7	37.6	35	0.29	0.46	0.28	0.59	2.25	0.5	1.1	0.1	0.5	24.47	30.4
Oct.	74	82	5	49	45	30	80	1.67	42	63	0.3	0.49	0.2	2.89	1.35	0.5	1.2	0.2	0.5	44.04	51.7
Nov.	81	99	6	59	53	40	80	1.5	50	64	0.32	0.59	0.24	3.48	1.59	0.7	1.2	0.2	0.6	44.74	53.6
Dec.	91	1	18	73	83	50	110	2.7	73	65	0.36	0.01	0.72	4.31	2.49	0.9	1.7	0.3	0.9	45.43	57
											if depending max 57 poor			Good 26-50				Average WQI			41.5

Table 10. Q of parameters during 2009

2009 Date	EC Q1	TDS Q2	Ca Q3	Mg Q4	Na Q5	Cl Q6	So4 Q7	No3 Q8	T.H Q9	PH Q10	Q1* W1	Q2* W2	Q3* W3	Q4* W4	Q5* W5	Q6* W6	Q7* W7	Q8* W8	Q9* W9	Q10* W10	WQI
Jan.	90	90	15	68	67	43	85	2	67	56	0.36	0.54	0.6	4.01	2.01	0.7	1.3	0.2	0.8	39.14	49.7
Feb.	84	92	9	60	61	42	78	3	56	46	0.34	0.55	0.36	3.54	1.83	0.7	1.2	0.4	0.7	32.15	41.7
Mar.	83	89	10	63	61	95	84	2	59	45	0.33	0.53	0.4	3.72	1.83	1.6	1.3	0.2	0.7	31.45	42.1
Apr.	75	87	6	50	52	41	59	2	42	48	0.3	0.52	0.24	2.95	1.56	0.7	0.9	0.2	0.5	33.55	41.4
May	90	102	97	55	57	44	93	1	117	54	0.36	0.61	3.88	3.25	1.71	0.7	1.4	0.1	1.4	37.75	51.2
Jun.	88	120	98	49	47	44	110	3	114	39	0.35	0.72	3.92	2.89	1.41	0.7	1.7	0.4	1.4	27.26	40.7
July	100	116	100	66	65	47	108	5	125	4	0.4	0.7	4	3.89	1.95	0.8	1.6	0.6	1.5	2.80	18.3
Aug.	97	115	117	50	61	39	112	5	129	30	0.39	0.69	4.68	2.95	1.83	0.7	1.7	0.6	1.5	20.97	36
Sept.	102	112	104	66	-	41	114	0	132	46	0.41	0.67	4.16	3.89	-	0.7	1.7	0	1.6	32.15	45.3
Oct.	103	63	77	41	-	45	107	1	91	6	0.41	0.38	3.08	2.42	-	0.8	1.6	0.1	1.1	4.19	14.1
Nov.	91	105	76	57	-	41	86	2	104	40	0.36	0.63	3.04	3.36	-	0.7	1.3	0.2	1.2	27.96	38.8
Dec.	84	100	98	62	-	39	91	1	125	40	0.34	0.6	3.92	3.66	-	0.7	1.4	0.1	1.5	27.96	40.1
																Average WQI = 40.7					

Table 11. Q of parameters during 2010

2008	EC	TDS	Ca	Mg	Na	Cl	So4	No3	T.H	pH	Q1*	Q2*	Q3*	Q4*	Q5*	Q6*	Q7*	Q8*	Q9*	Q10*	WQI
Date	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	
Jan.	78	89	96	45	-	36	81	1	110	56	0.31	0.53	3.84	2.66	-	0.6	1.2	0.1	1.3	30	40.6
Feb.	81	100	99	70	-	32	98	1	130	10	0.32	0.6	3.96	4.13	-	0.5	1.5	0.1	1.6	10	22.7
											if depending max 40.6poor							Good 26-50		Av. WQI	31.7

Figure 1. The Google map of Al-Hindiya barrage

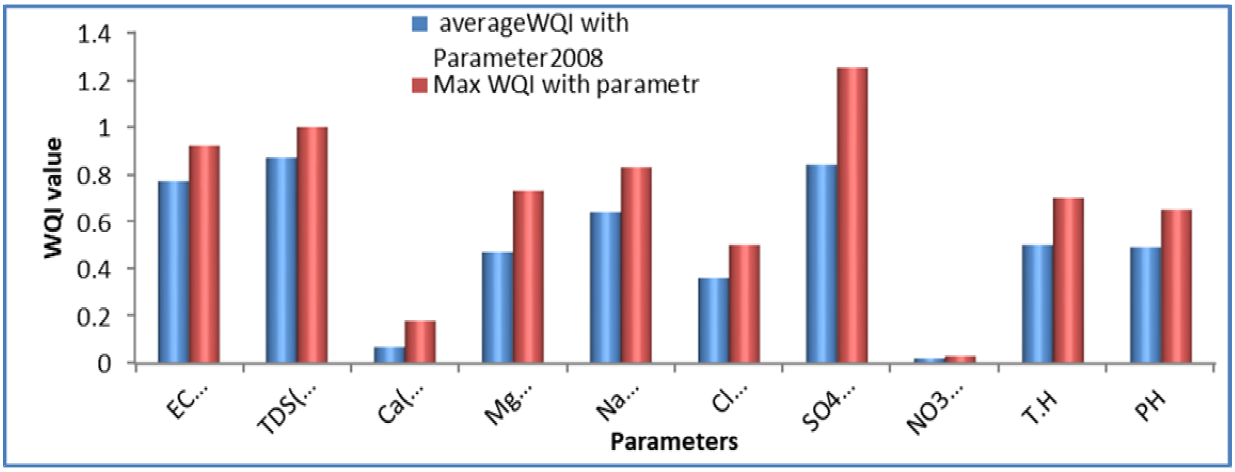

Figure 2. The average WQI and Max WQI in 2008

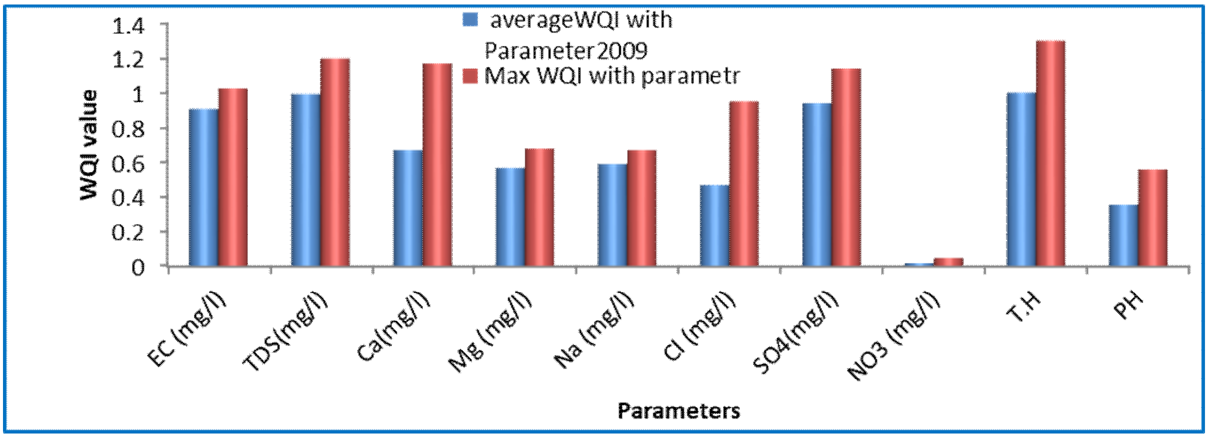

Figure 3. The average WQI and Max WQI in 2009

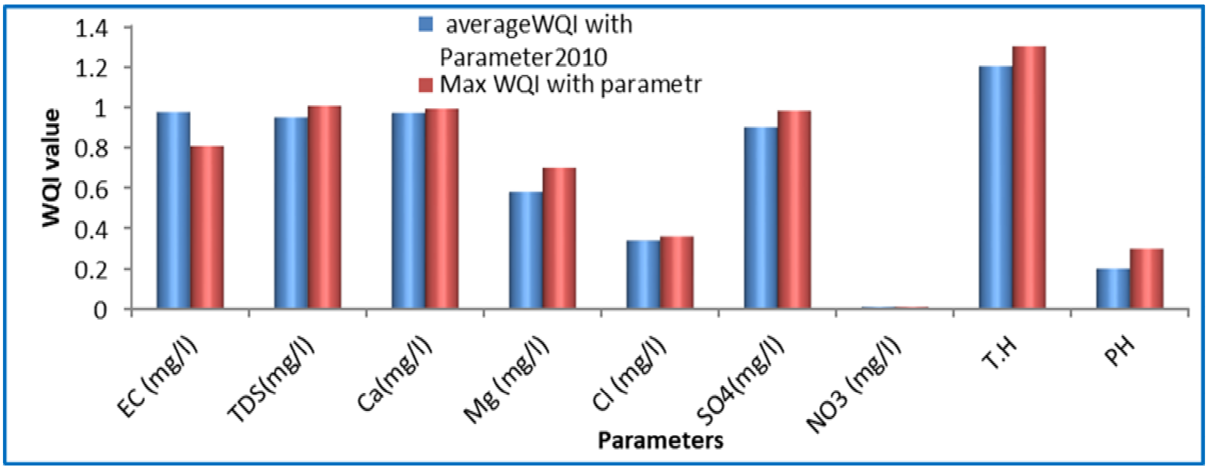

Figure 4. The average WQI and Max WQI in 2008