Journal of Education for Pure Science- University of Thi-Qar
Vol.9, No.2 (June, 2019)
Website: jceps.utq.edu.iq Email: jceps@eps.utq.edu.iq

DOI: http://doi.org/10.32792/utq.jceps.09.02.08

Evaluating of The Gharraf River Water Thi Qar Southern Irarq Using The Water Quality Index (WQI)

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Received 19/09/2018, Accepted 31/12/2018, Published 02/06/2019

Abstract:

The Water Quality Index was developed mathematically to evaluate the water quality of Al-Gharraf River The Qar , the main branch of the Tigris River in the south of Iraq. Water samples were collected twice monthly from tow stations during 2017, and 10 parameters analyzed: Total dissolved solids(TDS), the concentration of hydrogen ions(PH), dissolved oxygen(DO), turbidity(TUR), phosphates (SO_4), nitrates (NO_3), chlorides (Cl), total hardness, electrical conductivity(EC) and alkalinity (ALK). The index classified the river water , excluding turbidity, is poor for drinking at both stations, when turbidity was included, the index classified the river water is very poor in station GT2 and poor in station GT3 for drinking purpos. The results showed thae seasonal variations are negligible in both stations .The study highlights the importance of applying the water quality index which indicate the total effect of the ecological factors on surface water quality and which give a simple interpretation of the monitoring data to help local people improving water quality improving .

Keywords: Al-Gharraf River, Physical and chemical variables ,Water Quality Index(WQI).

1- Research problem

The assessment of the quality of water still complex in our departments concerned with this matter. Also of the Gharraf river has a reduction in its virtual and environmental specifications year after year.

2-Research Objective

Assessment of the water quality of the River Gharraf through a simple indicator and values describing the complex condition of water quality for drinking purposes as well as measuring the seasonal changes in the quality of water throughout 2017 and measuring the decline or improvement of the water quality of the river Gharraf from the beginning of its entry into the first city in the province of Dhi Qar to the city of A-Refaee.

3-Research Hypothesis

1- The quality of river water in the study area is weak for drinking purposes due to sewage and sewage pollution and needs high quality treatment.

2- There are seasonal variations in the water quality of the Gharraf river depending on changing climatic conditions.

3-The quality of water is high and low dowenstream.

4- Research Methodology

1-Demonstrate the importance of using the water quality index in the assessment of water quality and facilitate understanding and dissemination among the different filed interested in this area.

2-Identify the types of water quality indicators and then adopt one of them and measure the quality index of the Gharraf river in the two sampling stations in the city of AI- Fajr and AL- Rifai.

5- Drinking water quality

Surface water is an essential natural source of water that available all over the world. The fresh water is one of the must issue for humanity since it has a divec association with the human survival and its use in domestic, industrial and irrigation usage. Water quality indices include information from several water quality parameters to puting a mathematical equation that estimates the suitability of water for human survival with a number [Yogendra, K., & Puttaiah, E. T 2008]. Based on some water quality parameters, Water quality index (WQI) offers a single number that shows overall water quality in a certain at time location. A single number is not adequate to identify the water quality, there are many various other water quality parameters that must be included in the index. Nevertheless, a water quality index depending on some essential parameters can provide a very easy indicator of water in general, water quality refers to the description of physical, chemical, and biological characteristics of water associated with intended uses and a collection of standards [Khalil et al.(2011)]. A WQI is one of the greatest effective tools used to ascertain the quality of water for different purposes. Various water quality indices have been formulated to summarize water quality information in an easily expressible and simply recognized the insufficiency of surface water is a result of point source and non-point source pollution jeopardize the water supply and aquatic ecosystems [Darradi et al.(2012)]. The pollution of point source mostly contains discharges of municipal wastewater and the loads of industrial wastewater. Whereas the pollution of non-point source occurs when irrigation water or rainfall, snow melt water run over the land. Thus, water hauling and transferring pollutants to rivers, coastal waters, and lakes. There is an issue of the pollution of non-point source of agriculture because it is regarded as the major result of the surface water quality degradation [Tang, J. et al.(2011)]. WQI reflects the influence that is composite of water quality parameters and it is determined through the perspective for the suitability of human consumption [I.S.Akoteyon et al.(2011)]. WQI is extremely efficient method for evaluating the suitability of water quality. also It is invaluable for interacting the information on overall quality of water to the citizen and policy makers. Hence, WQI becomes a significant parameter this is certainly essential in the evaluation and management of water quality Assessment of surface water quality and its suitability for human consumption and this the aim of the present research by comparing the results against drinking water quality standards laid down by the World Health Organization (WHO). The suitability of surface water for drinking use has been assessed based on computed WQI values. WQI defines the overall scenario of water bodies by changing the levels of water quality variables into a rating score by making use of mathematical tools for the investigation of the water pollution condition of the surface water the following water quality parameters were analysed: (1) pH, (2) Electric Conductivity, (3) Total Dissolved Solids, (4) Total Hardness, (5) Calcium, (6) Magnesium, (7) Sulphate and (8) Chlorides. The determined WQI value ranges between 0 to 300, and categorizes water bodies as excellent (0–50), good (50–100), poor (100–200), very poor (200–300) or unsuitable (more than 300).

6-Materials and methods

This section includes an explanation of the method of work of the operational tests and a description of the area study of study and sampling location Sampling, and the variables that have been standardized and abstract in the calculation of the water quality index, and then to present the laboratory tests, sample loading and results extraction with a brief explanation of the variable size, and others(WQI). The mathematical equation was used to calculate the water quality index for the water samples from the monitoring which station were collected monthly started from 2017. The collected samples were analysed to determint 8 physical and chemical parameters by following the standard procedures. These parameters are pH, total dissolved solids(TDS), and electrical conductivity(EC) were monitored at the sampling station and the other parameters were tested and analysed in the laboratory according to techniques as outlined in the standard procedure of APHA The WQI has been determined using the standards of drinking water quality advised by the (WHO).

7-Study Area

AL- Gharf river is one of the main branches of Tiegris River, divided branches in city of Kut, passing through the government of Wasit and Dhi Qar, , The length of the river is about 230 km, 50- 80 m in width and 3-7 m depth. Its basin populated by more than million people using about 432000 m³/year of refined water and passing through an agricultural area of about 2150.19 Km^2 in the southwest of Iraq within the sedimentary plain GT2 models were taken from the two sites of the first site 2 in the Gharraf river in the two sampling stations in the city of AI- Fajr which is the first city in the government of Dhi Qar. and AL- Rifai. Area Shows the sampling location in the study are figure 1 .

Figure 1:Google maps Shows the sampling location in the study area.

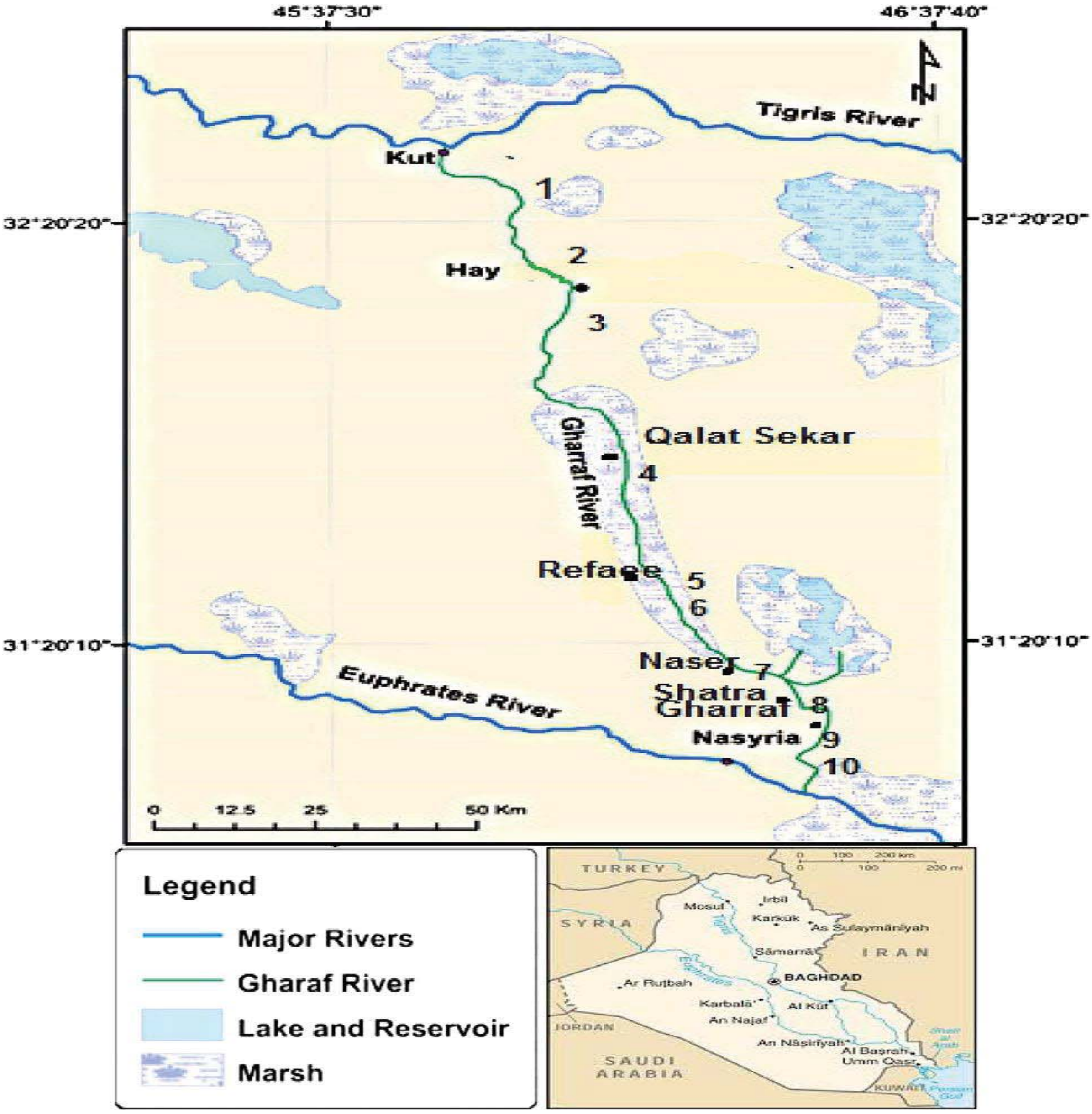

Figure 2: Google maps Shows the sampling location in the study area.

Station name	langtude	latitude	Note
GT2	31.917864°	45.962888	AL –Fajr
GT3	31.714718°	46.104902˚	AL-Rifai

9-Physical and chemical parameters used in research (WQI)

The purpose of studying and calculating the water quality index for the periodic sampling of samples at the beginning of the shire and for the average and the rate of the one-year per year 2017and then calculate the values of the physical and chemical variables and compare with drinking water specifications of the Health Organization (WHO), (WHO) Common variables in the examination of drinking water, which are the research, the following water quality parameters were analysed: (1) pH, (2) EC, (3) T D S, (4) TH, (5) C, (6) Mg, (7) SO_4 and (8) Cl. The determined WQI value ranges between 0 to 300, and categorizes water bodies as excellent (0–50), good (50–100), poor (100–200), very poor (200–300) or unsuitable (more than 300) (WQI) can be defined as a method of rating that offers the composite effect of individual water quality parameters on the total quality of water. It lowers the large quantity of water data into a single value, this is certainly numerical [Lohani, B. N., & Todino, G. 1984]. It is calculated through the true viewpoint of human consumption. For calculation of WQI, water quality and its viability for drinking purposes have been viewed. The higher values of the WQI suggest better quality of water and the lower values reveal poor quality of water. The parameters tend to be weighted according to their considered importance of total water quality. The weightage for assorted water quality parameters is assigned proportionally to the recommended requirements for the matching parameter in method of computing the WQI [Vasanthavigar, M. et al . 2010]. in the gained single number symbolizes the status of the overall drinking water quality. Frequently, the calculation of (WQIs) are done in two steps. the first step is using the sub-index functions, whereas, the second step is using some aggregation function forms.The sub-index formation is one of the greatest significant step in the calculation of WQI. The sub-index is a value function which is usually used to convert the various dimensions and units of the water parameters into typical scale. In sub-index formation, each parameter is given a rating value based on its acceptable limits of guideline values prescribed by WHO (2006) (Table 1). First, the temporary weight (w) was given to each parameter from the water quality parameters according to its benefits to drinking water quality assessment. Afterward, relative weight factor (Wi) can be determined by dividing the specific temporary weight of each parameter by the sum of temporary weight [Gupta et al., 2003; Debels et al., 2005; Boyacioglu, 2007] (as shown in Eq. (1).

Table 1:Weight facters assigned to individual parameters.

no	Parameter	Temporary Weight(w)	Relative weigh Factors (wi) DWQI
1	PH	3	0.1250
2	Ca	2	0.0833
3	Mg	2	0.0833
4	Total hardness	3	0.1250
5	SO4	3	0.1250
6	CL	3	0.1250
7	TDS	5	0.2083
8	EC	3	0.1250

$$wi = \frac{w}{\sum_{i=1}^{n} w} \qquad (1)$$

Where: Wi is the relative weight factor of the water parameter
w is the temporary weight of that water parameter
(n is the total number of water parameters (i.e. n=8)
The sub-index is calculated according to following equation

$$Si = Qi.Wi \qquad (2)$$

Where: Si is the sub-index value of selected parameter
Qi is the quality rating, which can be computed from the following formul

$$Qi=(\frac{m}{\cdots})*100 \qquad (3)$$

Where, mi is the measured value for the selected parameter, ci is the maximum. WHO standard value of selected parameter (table2)Subsequently, to compute the WQI, the following equation used was

$$QWI=\frac{\hat{}\ 8\ -}{\hat{}\ 8\ -\ Œ} \qquad (4)$$

The aggregation function is another criteria being essential in the strategy of WQI. To calculate the WQI, the weight factors and sub-indices of all used parameters are aggregated making use of aggregation function. The well-known aggregation methods in the WQI technique are additive and multiplicative aggregation functions.

WQI is determined due to the weighted average of all the observations of importance [Tsegaye, Sargaonkar, Pesce, Liou, and Ŝtambuk-Giljanović2006.] . The computed WQI is supposed to produce an easy way to understand ranking of water quality on a score scale ranged between 0 and 300 (as shown in Table2).

Table 2: water quality classification based on WQI value(Bhavet et.al.2011)

Water quality status	WQI value
Excellent	<50
Good water	50-100
Poor water	100-200
Very poor water	200-300
Water unsuitable for drinking	>300

The subjective water quality index (WQIsub) is another equation used for the calculating of WQI as proposed by Rodriguez de Bassoon [Pesce and Wunderlin ,2000] and can calculated using:

$$WQI_{sub}= K\frac{\hat{}\ 8\ -\ \cdots}{\hat{}\ -8\ -} \qquad (5)$$

Where, n is the total number of water quality parameters

Ci is the value given to parameter i following normalization process.

Pi is the relative weight given to each parameter (the value range from 1 to4) The objective water quality index (WQIobj) is the final equation of the subjective water quality index that was determined using (k=1) in the equation above (equation 5) and it can be simplified and written as:

$$WQI_{obj}=\frac{\hat{}\ 8\ -\ \cdots}{\hat{}\ -8\ -} \qquad (6)$$

10-Results and Discussions

After taking the samples monthly at the beginning and the end of the month during 2017, the Table (3) the tables 3 and 4 for the stationGT2 and station GT3 respectially.

Table 3: shows the the measured parameters for station GT2 for 2017.

Parameter	Unit	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Averag GT2
PH	unitless	7.55	8.05	7.75	7.45	7.4	7.35	7.3	7.2	7.8	7.35	7.85	7.65	7.55833
DO	ppm	7.25	7.5	6.15	5.8	5.3	5.25	5.1	5.3	6.1	6	6.4	6.5	6.05417
PO_4	ppm	0.07	0.09	0.04	0.1	0.15	0.14	0.16	0.14	0.18	0.11	0.21	0.11	0.12375
NO_3	ppm	1.9	2.7	1.25	2	2	1.3	1.15	1.7	1.95	0.95	4.85	1.8	1.9625
TH	ppm	560	520	560	380	370	360	386	410	440	460	430	470	445.5
Cl	ppm	225	245	240	200	140	135	154	230	250	195	165	205	198.625
TDS	ppm	929	945	960	825	635	594	706	885	915	798	750	824	813.75
EC	µs	1628	1660	1678	1434	1070	995	1200	1505	1559	1385	1313	1378	1400.33
Alk	ppm	168	170	180	210	220	180	220	196	210	190	210	188	195.167
TUR	NTU	10	2.3	1.65	0.25	3.8	12	3.15	4.15	5.65	8.25	20.8	1.95	6.1625

Table 4: shows the the measured parameters for station GT3 for 2017.

Parameter	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average GT3
PH	unit less	7.45	7.7	7.7	7.3	7.3	7.9	7.5	7.6	7.95	7.5	7.85	7.7	7.62083
DO	ppm	7.2	6.85	6.3	5.85	5.2	5.65	5.25	6.25	5.4	6	6.4	6.55	6.075
PO_4	ppm	0.08	0.09	0.09	0.09	0.12	0.17	0.12	0.13	0.19	0.13	0.13	0.1	0.1175
NO_3	ppm	2.05	2.6	1.6	2.05	1.9	1.5	1.2	1.65	1.75	1.1	4.65	1.65	1.975
TH	ppm	590	540	540	420	370	340	380	390	460	500	440	470	453.333
CL	ppm	229	244	220	210	150	125	162	185	210	205	153	210	191.833
TDS	ppm	975	937	945	818	655	585	720	792	831	810	690	855	801.042
EC	µs	1654	1649	1637	1422	1096	983	1210	1322	1413	1395	1159	1460	1366.54
Alk	ppm	204	166	200	196	170	190	235	184	210	186	200	196	194.75
TUR	NTU	4.55	1.7	2.25	0.75	2.95	10.8	4.65	6.3	6.6	6.3	5.7	3.9	4.70417

Using the mean values for the whole year and their mathematical analysis by Brown's water quality index equation using the WHO drinking water determinants WQI for the first station GT2 without using the turbidity and using the turbidity factor as shown in Table 5 As well as the values of WQI for the second station (GT3) without using the turbidity factor, as well as using the turbidity factor as shown in Table 6 Where the symbols in the tables mean MI measured value, SI limit, LI the ideal value of the variable, QI variable sub-indicator, Wi relative weight of the variable

Table (3-4) WOI Values of the station (GT2).

Table 5 : WOI Values of the station (GT2).

Parameter	Unit	Concentration of the measured variable in the sample MI	Standard Permissible Value (SI)	The ideal focus of the variable (LI)	Quality rating scale (QI)	Relative Weight factors (Wi)	Wi*Qi
P.H	unit less	7.56	7.5	7	111.667	0.133333	14.88889
D.O	ppm	6.05	5	14.6	89.02	0.2	17.80382
PO4	pmm	0.12	5	0	2.475	0.2	0.495
NO3	ppm	1.96	50	0	3.925	0.02	0.0785
T.H	ppm	445.50	500	0	89.1	0.002	0.1782
CL	PPM	198.63	350	0	56.75	0.002857	0.162143
T.D.S	ppm	813.75	1000	0	81.375	0.001	0.081375
COND.	µs	1400.33	250	0	560.133	0.004	2.240533
ALK	pmm	195.17	200	0	97.5833	0.005	0.487917
TURBIDITY	NTU	6.16	5	0	123.25	0.2	24.65
Summation with turbidity Σ With TUR						0.76819	61.06638
Summation without turbidity Σ Without TUR						0.56819	36.41638
WQI with turbidity				very poor			79.49379
WQI without turbidity				poor			64.09185

Table 6: Values (WOI) of the station (GT3)

Parameter	Unit	Concentration of the measured variable in the sample MI	Standard Permissible Value (SI)	The ideal focus of the variable (LI)	Quality rating scale (QI)	Relative Weight factors (Wi)	Wi*Qi
Parameter	Unit	MI	SI	LI	QI	Wi	Wi*Qi
P.H	unit less	7.620833	7.5	7	124.1667	0.133333	16.55556
D.O	ppm	6.075	5	14.6	88.80	0.2	17.76042
PO4	ppm	0.1175	5	0	2.35	0.2	0.47
NO3	ppm	1.975	50	0	3.95	0.02	0.079
T.H	ppm	453.3333	500	0	90.66667	0.002	0.181333
CL	ppm	191.8333	350	0	54.81	0.002857	0.156599
T.D.S	ppm	801.0417	1000	0	80.10417	0.001	0.080104
COND.	µs	1366.542	250	0	546.6167	0.004	2.186467
ALK	ppm	194.75	200	0	97.375	0.005	0.486875
TURBIDITY	NTU	4.704167	5	0	94.08333	0.2	18.81667
Summation with turbidity Σ With TUR						0.76819	56.77302
Summation without turbidity Σ Without TUR						0.56819	37.95635
WQI with turbidity				poor			73.90487
WQI without turbidity				poor			66.80216

The results of the water quality index show that the Ghrraf river water in the two stations and throughout the year almost show apoor quality water in general (Poor), and when incalcude the turbidity facter in the WQI calculation that will increase the quality of water and show at the first station average quality of water is very poor (Very poor) The results of the first station (GT2) show a low concentration of dissolved oxygen, exceeding the minimum limit by a very small and far from the ideal concentration that gives the water self-purification ability, and show the Concentrations of (NO_3) and (PO_4) it is compatible with the specifications and much lower than indicating On the lack of pollution of sewage water because their main source comes from wastewater and increase their concentrations are indicative of the presence of pollution Concentrations of total hardness, dissolved solids and alkalinity show high concentrations barely below the allowable limits.

The values EC electrical conductivity exceeds the allowable limit, which means increasing the salinity, which is likely to have a sewage, increase the washing of the agricultural land and discharge the washing water in the river, and the turbidity exceeds the permissible limit, which led to the deterioration of the WQI when calculated.

The results of the second station (GT3) show a low concentration of D.O, exceeding the minimum limit by a very small and far from the typical concentration that gives the water self-purification ability, and show the concentrations of (NO_3) and (PO_4) are compatible with the specifications and far below the minimum, on the lack of pollution of sewage and wate Whisperer because their main source comes from wastewater and increase their concentrations are indicative of the presence of pollution.

Concentrations of TDS and alkalinity show high concentrations barely below the allowable limit. The EC exceed the allowable limit, which means increasing the salinity, which is likely to have a The Whisperer and sewage, or increasing the washing of the agricultural land and the drainage of the washing water in the river, and the turbidity is close to the permissible limit, which led to the decline of the water quality index when calculated but less than The first stop.

11- Quarterly variations in the water quality index

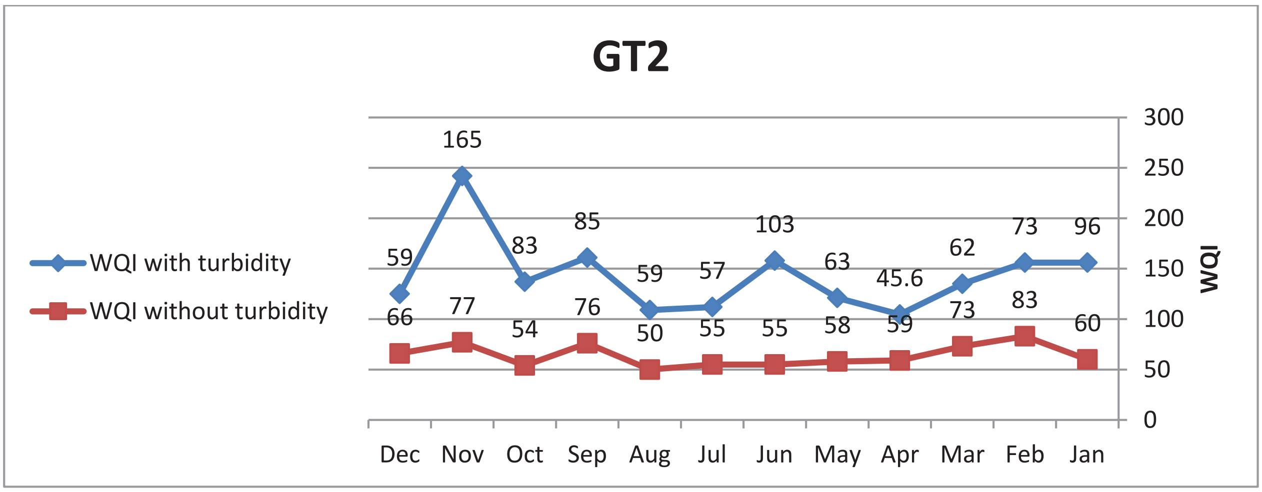

Figure3: Monthly variations of the (WQI) at GT2 Station

The GT2 water quality index does not show significant variation throughout the year, except a sudden increase in turbidity in November. The reason is that the Gharaf water depends on the storage water in the Tharathar lakes, the presence of regulations and the lack of rain which was very rare. In 2017 .

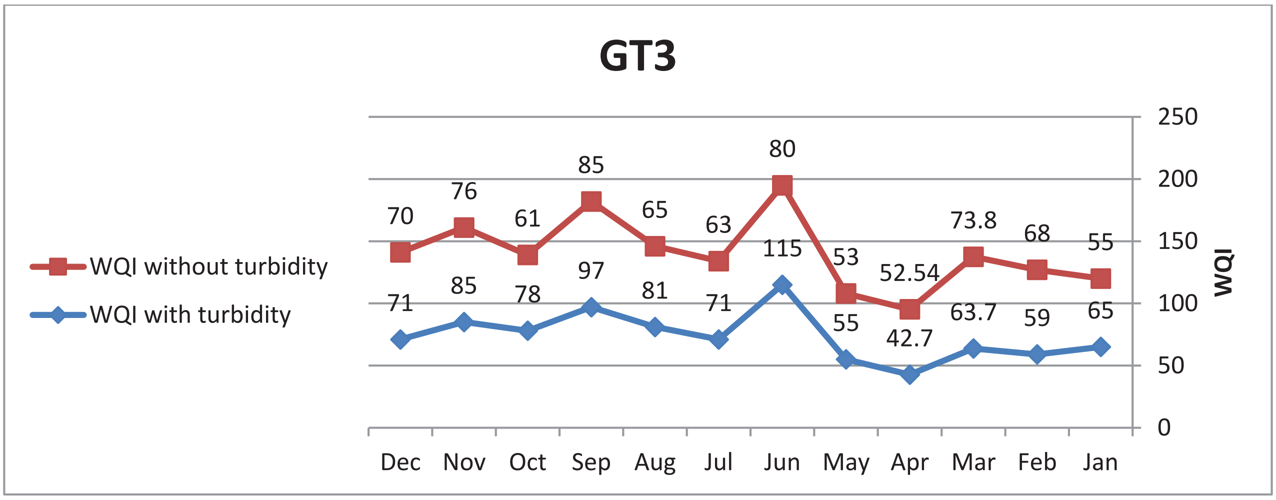

Figure (4) Monthly variations of the (WQI) at GT3 Station

Results showed that the WQI value for the year 2017at GT3 increase in turbidity in June. The reason is that the Gharaf water depends on the storage water in the Tharathar lakes, the presence of regulations and the lack of rain, which was very rare in the year 2017.

12- Comparison of water quality between the two stations throughout the year

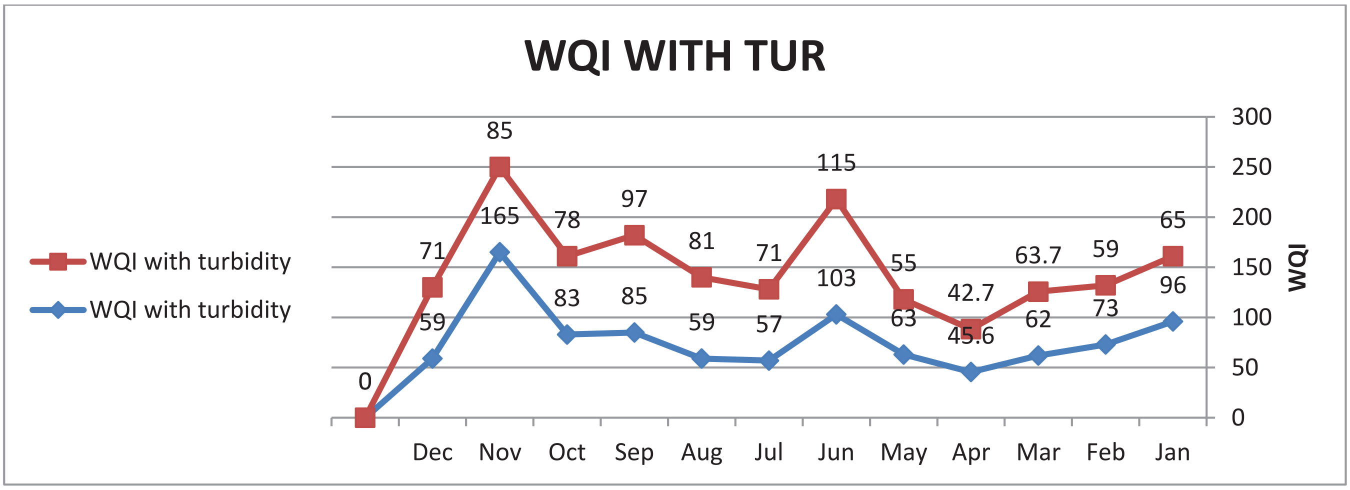

Figure (5) Comparison of the WQI with the turbidity between the two stations.

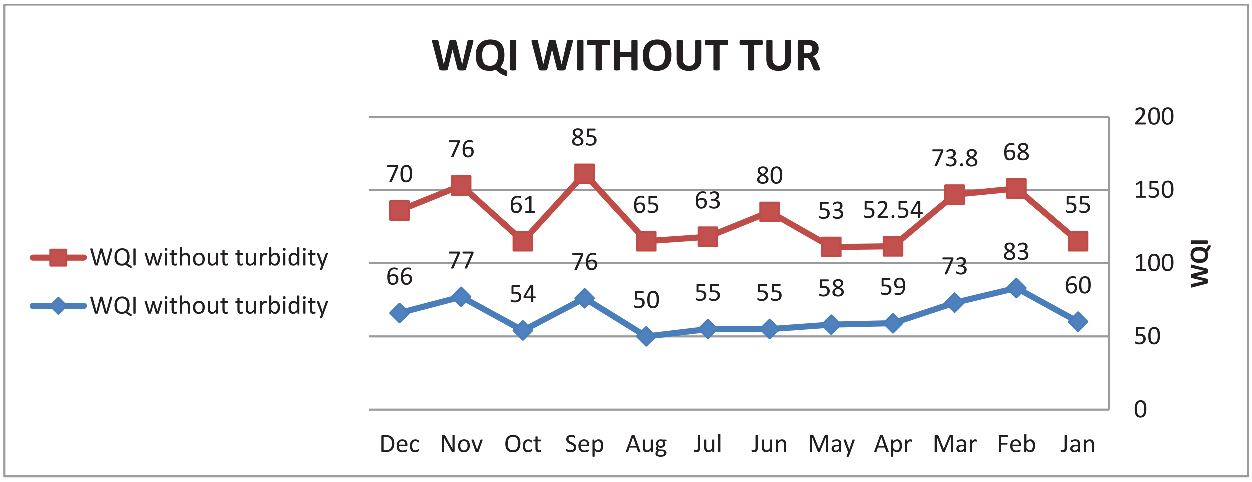

Figure (6) Comparison of WQI with at turbidity between the two stations

As shown in Figs. (4) , (5) above, there is no significant difference between the water quality of the two stations to support the water of the Gharraf River and the similar problems facing this watercourse in all districts.

13-Conclusions

After the studying AL- Gharraf River water quality of different water quality indices average quality of water is (Very poor), it may be inferred that the aim of WQI is to give a single value to water quality of a source along with reducing higher number of parameters into a simple expression resulting into easy interpretation of water quality monitoring data implies that the water quality is not good and unsuitable for drinking and other consuming purposes. The variations in seasonal of the water quality values are due to variation in physical and chemical characteristics of surface water. index does not show significant variation throughout the year, except a sudden increase in turbidity

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