Assessment of Water Quality of Tigris River at El- Kut Dam, Iraq

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المستخلص:

نهر دجلة في العراق له دور أساسي في المجتمع المحلي كمصدر للمياه للأستخدامات المنزلية , الزراعية هذا بالأضافة يستلم مياه الصرف الزراعي والصحي . تقدير نوعية المياه لنهر دجلة قبل وبعد سدة الكوت تم تقديره بواسطة معامل نوعية المياه WQI الخاص بالمجلس الكندي لوزارة البيئة CCME مما يوضح بأن نوعية المياه هي بين الهامشي والجيد لمرتبة المياه . متغيرات النوعية تم تحديدها لمساحة المصدر أوضحت بأن مياه نهر دجلة هي بصورة جيدة ضمن معدلات القبول ويشير الى أجمالي نوعية المياه هي ملائمة وآمنة للأستخدامات المنزلية وري الأراضي الزراعية . معامل المياه هو ضروري جدا ومفيد كأداة لأتخاذ القرار في التخطيط البيئي وأتخاذ القرارات ذات العلاقة لحماية مصادر المياه , وتطوير وأستخدامات تجاه الأدارة المستديمة لمصادر المياه في محافظة واسط .

Abstract:

The Tigris River in Iraq has fundamental roles in local society as a source of water for recreation; domestic use; irrigation; as well as receives of agricultural and municipals wastewater. The Canadian Council of Ministries of the Environment (CCME) Water quality Index (WQI) used for rating of water quality in Tigris River before and after El-Kut Dam indicates that the quality of water is in between marginal and fair water rank. The quality parameters determined for sources of the area showed that the water of Tigris River at all the sites was quite within the acceptable range and shows that the overall quality of water is suitable and safe for domestic and irrigation purposes. The water quality index is potentially useful as a decision tool in environmental planning and decision-making activities related to water resource protection, improvement and utilization towards a sustainable water resource management in the province of Wasit.

Keywords: WQI, Water Quality Assessment, Tigris River, El-Kut Dam

Introduction

Water treatment should be carefully performed. Because it is essential product for drinking and irrigation . life on all craters can not go on without of purified water without water. In some countries water is not adequate resource therefore a competition among agriculture, industry and domestic will be taken place , therefore a restriction will be imposed on different aspects of country development [1,2] .

Water pollution is a big critical problem and treatment should be taken place in order to protect the environment. There are many signs of warning come from the drying depletion of water levels of rivers in the worlds, affecting the life on the planet [3,4] . All kind of water resources are subjected critically to pollution issue [5,6] . The major reason of water pollution in the world [7,8] is the rapid growth in population societies and the development different industry with high demand for demineralized water, losing high of water through disposing in sewages, and polluted with nutrients from fertilizer, pesticide, disposal of different industrial activities, and petroleum refineries [9,10] .

WQI consist of many data of water quality information. The overall quality of water is stated by WQI and guide us towards all kinds of polluted matter that water can be subjected through different uses. Also this standard allows to make a comparison between different water sources. Analyses as a general also performed by this index for water at different levels of quality. Models which are suggested by many workers are reported to give a clear picture of all kinds of water. To reduce and control the water quality in the nature is to use the general index that meets all water qualities and provide a quick response for understanding water content and description. Therefore the index represents as a tool to make assessment of the quality of water in order to make it useful to different uses especially it affects the humans [11,12]

To make a good and clear description for water quality, there should be a tool , this tool should give a full description of water state in order to be suitable for diverse life. The output index is the quality level of water and this index should posses quality data for water and easily employed to different uses . This index is very useful in follow up water specification and quality variants at specific time, however this data can be used in a comparison at different locations for the same specification parameters of water. Many investigators [13,14,15] developed WQI based on different water quality parameters. Basically a WQI provides a mechanism for presenting numerical formula defining a specific level of water quality.

Studying of surface water with its inclusion depends on many criteria of high knowledge and employing a wide scientifically principles to put a solution to its ecology problems, in other word its chemical and biological and other quality issue. The particularity and complexity of the surface water chemical (organic and inorganic) composition and of quality indicators (such as mineral, organic matter, gases, colloids, suspended particles, and microorganisms) effect seriously to use quality index methods for assessment [16].

The aims of study

The present wok aims to evaluate the Tigris River water quality before and after El-Kute Dam, using Canadian Water Quality Index (CCME). The main reasons to choose CCME index among others area, it is flexible with respect to the type and number of water quality variables to be tested, the period of application and the type of water body tested. The index depends on three factors which help to communicate in a better way. Objective (limit) of parameters can be selected as per requirement. This helps the index to apply anywhere in the world.

Materials and methods

Samples of water were taken from five different sites before and after the Dam, the collected samples submitted to laboratory for water analysis.

Figure (1): Sampling sites before and after El-Kut Dam, Iraq

Analytical methods

Analysis of pH, BOD, TSS, Turbidity, COD, DO, TH, Calcium, Magnesium, TDS, K, Chloride, Sodium, Sulphate, Lithium, Nitrate and Alkalinity for five sampling sites before and after the Dam, the samples were conducted using the procedures described in standard methods. These parameters were monitored and recorded continuously, all tests methods were conducted according to APHA, 2012 for water and wastewater examination [1].

Canadian Council Water Quality Index (CCME)

The index was set by a technical committee formed by Canadian Council of Ministers of Environment in 1997 to create a CCME Water Quality Index (CCME WQI) that may be used by all parts of Canada. Values range between 0 and 100 with higher values indicating water to be considered to be of higher quality [16].

The index is based on (1) The number of variables whose objectives are not met, (Scope). (2) The frequency with which the objectives are not met, (Frequency) (3) The amount by which the objectives are not met, (Amplitude) Range of CCME WQI is 0 to 100. A value of 100 is the best possible index score and a value of 0 is the worst possible. Once the value has been determined, water quality is ranked in different categories as described below:

Table (1): CCME water quality ranks [16]

S/N	Rating	WQI	Categorization
1	Excellent	95-100	Water quality is protected with a virtual absence of threat or impairment; conditions very close to natural or pristine levels.
2	Good	80-94	Water quality is protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels.
3	Fair	65-79	Water quality is usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.
4	Marginal	45-64	Water quality is frequently threatened or impaired; conditions often depart from natural or desirable levels.
5	Poor	0-44	Water quality is almost always threatened or impaired

First variables and objectives should be defined. Variables selections are site specific or user defined. Objectives are limited which set by authorities. The index has three factors and each one should be estimated. Estimation of F1 and F2 is relatively straight forward; while F3 requires some additional steps. F1(Scope) represents the percentage of variables that doesn't agree with objectives at least only once through the time period under consideration (failed variables), relative to the total number of variables measured. F1 (Scope) can be determined with the application of equation1

$$F_1 = \left(\frac{Number\ of\ failed\ variables}{Total\ number\ of\ variables}\right) \times 100 \ \dots\dots\dots\dots (1)$$

F2 (Frequency) is a percentage of individual tests that do not agree with objectives (failed tests) which is determined with the application of equation 2,

$$F_2 = \left(\frac{Number\ of\ failed\ tests}{Total\ number\ of\ tests}\right) \times 100 \ \dots\dots\dots (2)$$

F3 (Amplitude) is the amount by which failed test values do not agree with their objectives. *F3* is determined in three steps. i) The number of times by which an individual concentration is greater than (or less than, when the objective is a minimum) the objective is termed an excursion and is expressed in equation 3a and 3b. When the test value must not exceed the objective.

$$excurison_i = \left(\frac{Failed\ Test\ Value_i}{Objective_j}\right) - 1 \ \dots\dots\dots (3a)$$

for the cases at which the test value must not decline below the objective

$$excursion_i = \left(\frac{Objective_j}{Failed\ Test\ Value_i}\right) - 1 \ \dots\dots\dots (3b)$$

, ii) The collective amount by which individual tests are out of compliance is determined by summation the excursions of individual tests from their objectives and dividing by the total number of tests (both those meeting objectives and those not meeting objectives). This variable, referred to as the normalized sum of excursions, or *nse*, is calculated as per equation 4,

$$nse = \frac{\sum_{i=1}^{n} excursion_i}{\#\ of\ tests} \dots\dots\dots (4)$$

iii) F3 is then calculated by an asymptotic function that scales the normalized sum of the excursions from objectives (nse) to yield a range between 0 and 100. F_3 (Amplitude) was determined as per equation 5 ,

$$F_3 = \left(\frac{nse}{0.01nse + 0.01}\right) \dots\dots\dots (5)$$

Once the factors have been obtained, the index itself can be calculated by summing the three factors as if they were vectors. The sum of the squares of each factor is therefore equal to the square of the index. The CCME Water Quality Index (CCME WQI) was determined as per equation 6,

$$CCMEWQI = 100 - \left(\frac{\sqrt{F_1^2 + F_2^2 + F_3^2}}{1.732}\right) \dots\dots\dots (6)$$

the divisor 1.732 normalizes the resultant values to a range between 0 and 100, where 0 represents the worst water quality and 100 represents the best water quality

Results and discussion

During Jan. 2017

The samples of raw surface were collected from the river before and after El-Kut Dam and analyzed in the Laboratory. The main properties of water are analyzed and tabulated in **Table (2).** The water pH values of the sampling sites ranged from 7.43 to 7.54, the results shows that the pH values were higher after the El Kut Dam than before the Dam, that could be due to the algal photosynthesis. The same trend found in most parameters TSS, turbidity, COD, BOD, TH, conductivity, TDS, K, chloride, calcium, magnesium, sodium, sulphate, lithium, nitrate and alkalinity as shown in Table (2) and Figures (2, 3, and 4). The obtained results shows that the Tigris river suffer from discharge of un-pointed sources of partially treated wastewater which causes deterioration of the water quality specially after the El-Kut Dam.

Table (2): Results of water quality of Tigris River during January 2017

Parameter	Unit	Sampling Site				
		1	2	3	4	5
pH	-	7.44	7.43	7.52	7.54	7.53
D.O	mg/l	8.1	8.2	8.1	7.92	7.94
TSS	mg/l	7.6	7.6	9.2	9.4	9.1
Turbidity	NTU	9.8	9.7	13.4	14.1	13.9
COD	mg/l	16.8	17.1	19.3	19.8	19.4
BOD	mg/l	2.1	2.2	3.4	4.1	4.4
TH	mg/l	282	282	310	318	322
Conductivity	uS/cm	1124	1131	1203	1210	1213
TDS	mg/l	674	679	722	726	728
K	mg/l	2.4	2.5	3.1	3.2	3.4
Chloride	mg/l	118	120	122	124	126
Calcium	mg/l	64	64.8	66.4	68	68.8
Magnesium	mg/l	29.7	29.2	35.0	36.0	36.5
Sodium	mg/l	102	103	111	109	112
Sulphate	mg/l	202	203	213	212	216
Lithium	mg/l	1.1	1.1	1.3	1.26	1.33
Nitrate	mg/l	3.4	3.5	4.6	4.4	4.8
Alkalinity	mg/l	152	151	162	161	164

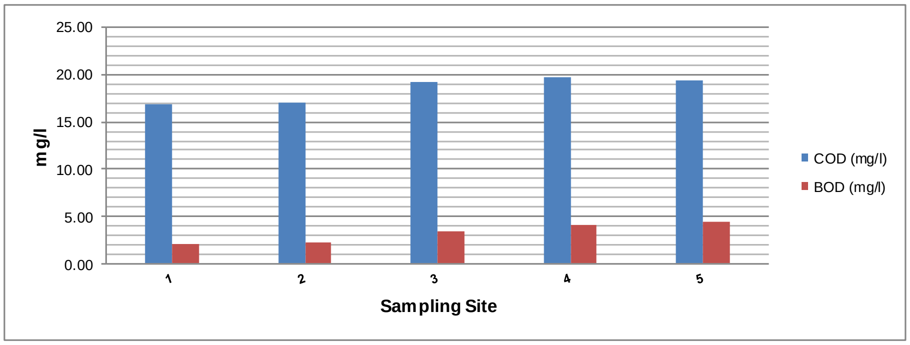

Figure (2): Tigris water quality before and after the Al-Kut Dam during Jan. 2017 (COD & BOD)

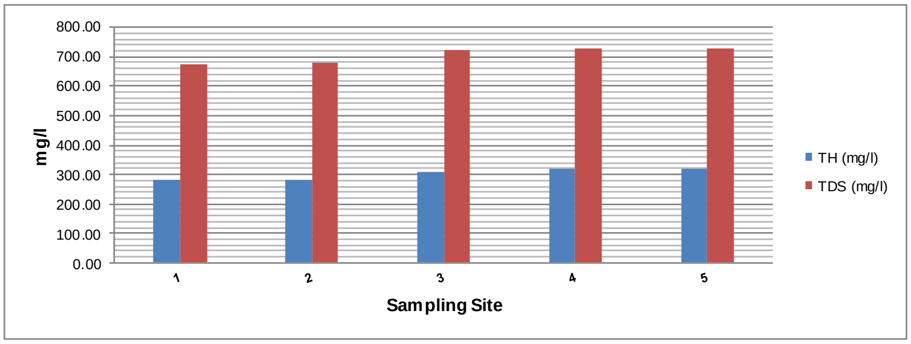

Figure (3): Tigris water quality before and after theAl- Kut Dam during Jan. 2017 (TH & TDS)

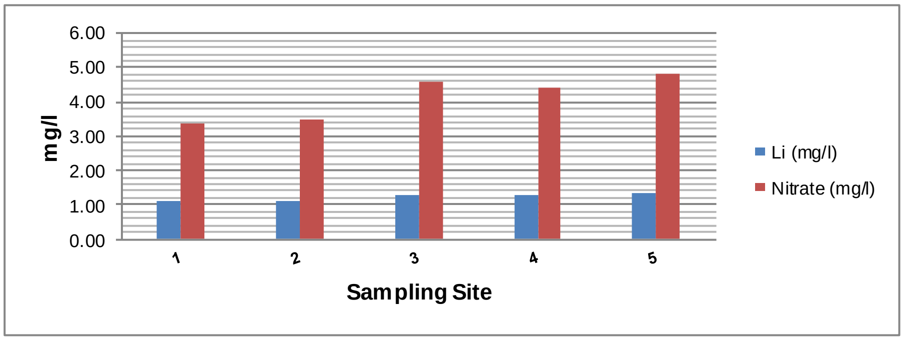

Figure (4): Degla water quality before and after the Kute Dam during Jan. 2017 (Lithium & Nitrate)

During Feb. 2017

The main properties of water are analyzed and tabulated in **Table (3).** The water pH values of the sampling sites ranged from 7.45 to 7.63, the results show that the pH values were higher after the El- Kut Dam than before the Dam, that could be due to the algal photosynthesis. The same trend found in most parameters TSS, turbidity, COD, BOD, TH, conductivity, TDS, K, chloride, calcium, magnesium, sodium, sulphate, lithium, nitrate and alkalinity as shown at Table (3) and Figures (5, 6, and 7).

Table (3): Results of water quality of Tigris River during February 2017

Parameter	Unit	Sampling Site				
		1	2	3	4	5
Ph	-	7.46	7.45	7.6	7.61	7.63
D.O	mg/l	7.91	7.89	7.76	7.81	7.7
TSS	mg/l	7.9	7.8	9.9	10.4	10.8
Turbidity	NTU	9.6	9.4	14.2	16.1	16.6
COD	mg/l	13.4	13.1	15.4	16.2	17.2
BOD	mg/l	1.8	1.9	2.3	2.8	3.1
TH	mg/l	272	272	282	288	286
Conductivity	uS/cm	1090	1088	1108	1110	1118
TDS	mg/l	654	653	665	666	671
K	mg/l	2.2	2.3	2.8	2.9	3.1
Chloride	mg/l	108	110	112	118	118
Calcium	mg/l	63.2	63.2	64.8	64.8	65.6
Magnesium	mg/l	27.7	27.7	29.2	30.6	29.7
Sodium	mg/l	97	97.2	99.2	102.1	104.3
Sulphate	mg/l	198	197	203	208	210
Lithium	mg/l	0.94	0.98	1.1	1.1	1.12
Nitrate	mg/l	2.91	2.93	3.2	3.3	3.5
Alkalinity	mg/l	148	150	155	158	160

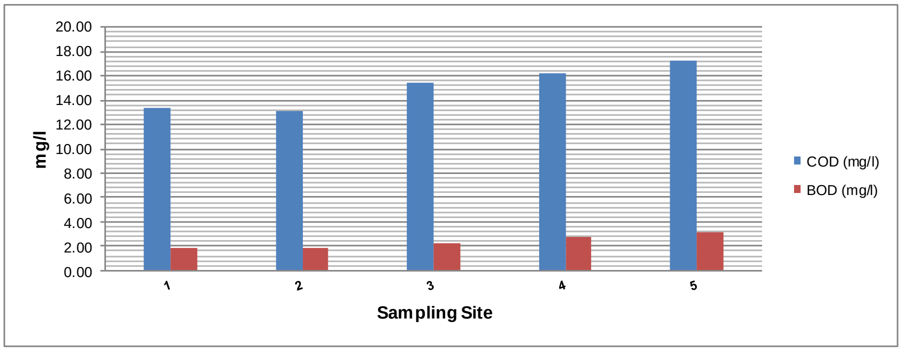

Figure (5): Tigris water quality before and after the Al-Kut Dam during Feb. 2017 (COD & BOD)

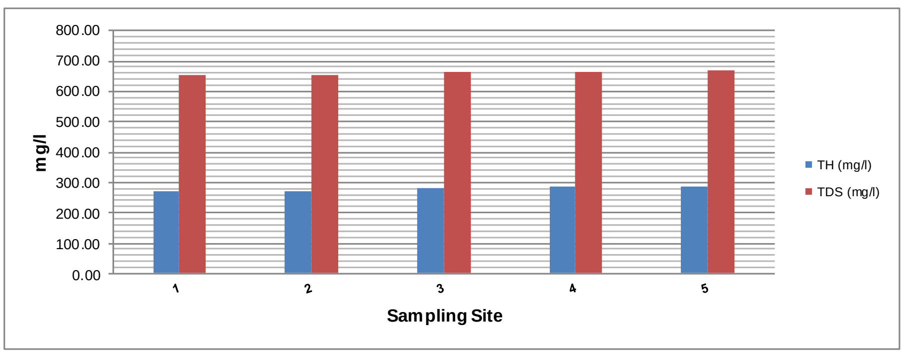

Figure (6): Tigris water quality before and after the Al- Kut Dam during Feb. 2017 (TH & TDS)

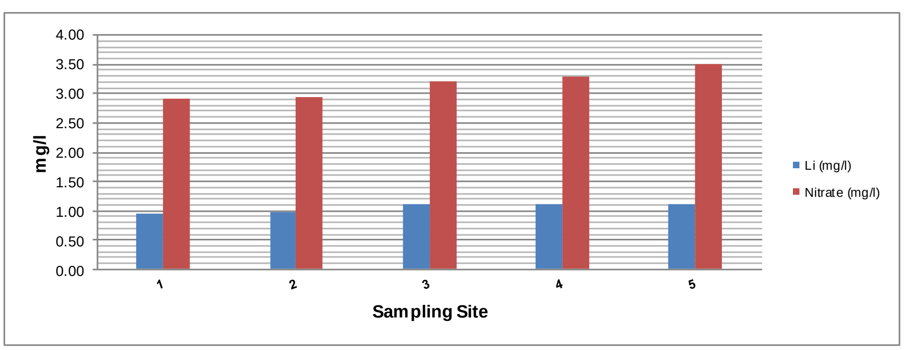

Figure (7): Tigris water quality before and after the Al-Kut Dam during Feb. 2017 (Lithium & Nitrate)

During Mar. 2017

The main properties of water are analyzed and tabulated in **Table (4).** The water pH values of the sampling sites ranged from 7.41 to 7.48, the results shows that the pH values were higher after the El- Kut Dam than before the Dam, that could be due to the algal photosynthesis. The same trend found in most parameters TSS, turbidity, COD, BOD, TH, conductivity, TDS, K, chloride, calcium, magnesium, sodium, sulphate, lithium, nitrate and alkalinity as shown in Table (4) and Figures (8, 9, and 10).

Table (4): Results of water quality of Tigris River during March 2017

Parameter	Unit	Sampling Site				
		1	2	3	4	5
pH	-	7.41	7.42	7.34	7.42	7.48
D.O	mg/l	7.95	7.92	7.89	7.84	7.82
TSS	mg/l	6.3	6.2	8.1	9.2	9.6
Turbidity	NTU	8.1	7.8	11.8	11.9	15.2
COD	mg/l	10.8	11.2	12.5	12.7	13.8
BOD	mg/l	1.6	1.8	2.2	2.4	2.7
TH	mg/l	266	268	271	272	278
Conductivity	uS/cm	990	998	1060	1080	1093
TDS	mg/l	594	599	636	648	656
K	mg/l	2.1	1.98	2.34	2.45	2.71
Chloride	mg/l	102	101	106	108	110
Calcium	mg/l	62	62	63.2	63.2	64
Magnesium	mg/l	27.0	27.5	27.5	27.7	28.7
Sodium	mg/l	92	92.3	97.4	98.1	99.8

Sulphate	mg/l	188	189	192.6	194.1	194.6	
Lithium	mg/l	0.86	0.88	1.02	1.11	1.08	
Nitrate	mg/l	2.64	2.66	2.81	2.88	2.93	
Alkalinity	mg/l	144	146	151	152	152	

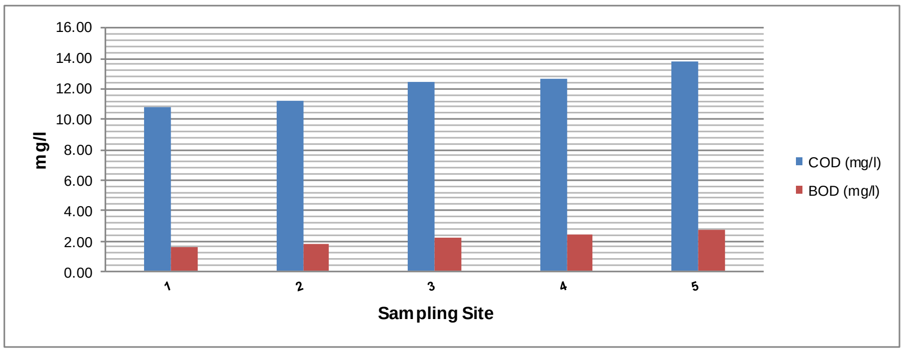

Figure (8): Tigris water quality before and after the Al- Kut Dam during Mar. 2017 (COD & BOD)

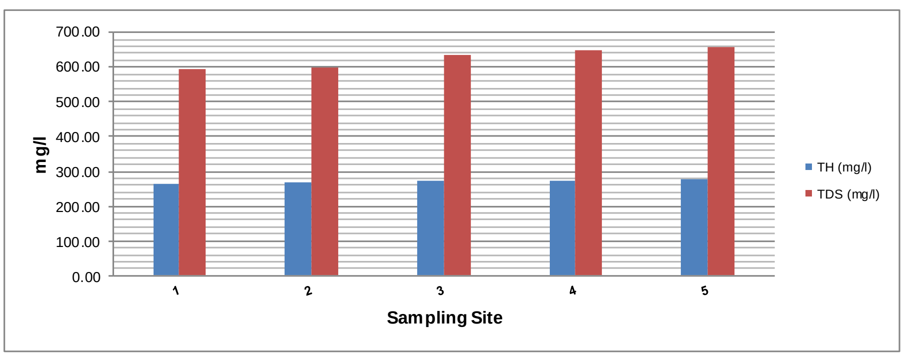

Figure (9): Tigris water quality before and after the Kut Dam during Mar. 2017 (TH & TDS)

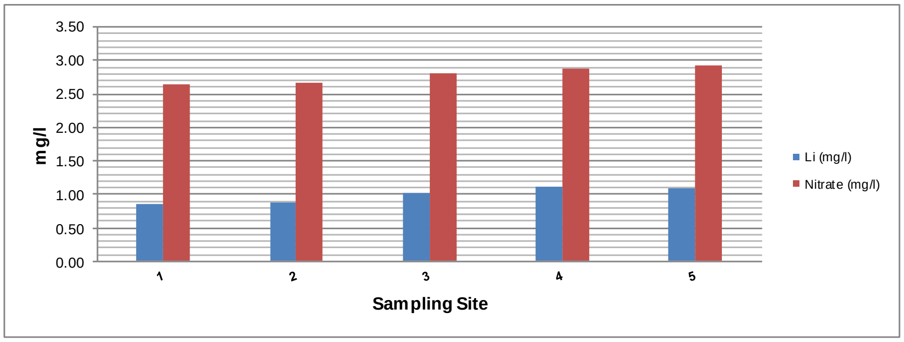

Figure (10): Tigris water quality before and after the Al-Kut Dam during Mar. 2017 (Lithium & Nitrate)

Evaluate the WQI

WQI is employed to express the purity of the water, which refers to essential data and formula correlation for water specification . Biocides to a practical study of water evaluation in t river of the Vistula basin at Poland are depicted [17]. Water quality index at Taiwan considered as a function of parameters temperature, pH, toxic content, organics (dissolved oxygen, BOD-5, ammonia), particulates (suspended matters, and turbidity) and microorganisms such as faucal coliforms [18]. Water pollution has an important public and environment issue , since the main resources of pollution developed very widely at industry . Employment of the water quality index for the evaluation of surface water specification gives excellent results [16].

The presented values of WQI in Table (5) and Figure (11) shows that, the values of WQI before the Dam were higher than after the Dam, as well as the values of WQI ranged from 62 (marginal) to 75.68 (fair) at **site 1**, the minimum and maximum values observed during Jan. and Mar. 2017, respectively, at **site 2**; the values of WQI ranged from 65.03 (fair) to 80.82 (good), the minimum and maximum values observed during Jan. and Mar. 2017, respectively, at **site 3**; the values of WQI ranged from 59.92 (marginal) to 76.72 (fair), the minimum and maximum values observed during Jan. and Mar. 2017, respectively, at **site 4**; the values of WQI ranged from 60.20 (marginal) to 75.60 (good), the minimum and maximum values observed during Jan. and Mar. 2017, respectively, and at **site 5**; the values of WQI ranged from 59.34 (marginal) to 73.17 (fair), the minimum and maximum values observed during Jan. and Mar. 2017, respectively, as shown in Table (5) and Figure (11).

Table (5) Evaluation of Tigris Water quality using WQI

Parameter	Unit	Sampling Site				
		1	2	3	4	5
Jan. 2017	-	62.00	65.03	59.92	60.20	59.34
Feb. 2017		68.69	73.81	68.92	67.40	65.37
Mar. 2017		75.68	80.82	76.72	75.60	73.17

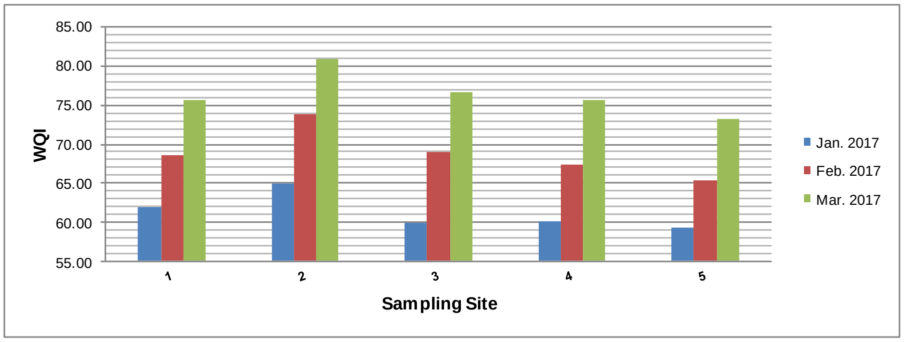

Figure (11): Evaluation of Tigris Water quality using WQI

Conclusion

The Canadian Council of Ministries of the Environment (CCME) Water quality Index (WQI) used for rating of water quality in Tigris River before and after El-Kut Dam indicates that the quality of water is poor. It is almost always endangered or deteriorated. The quality of parameters determined for sources of the area show that the water of Tigris River at all the locations was quite within the acceptable range and shows that the overall quality of water is suitable for domestic and irrigation process.

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References

1. **APHA, Standard Methods for the Examinations of Water and Wastewater**, 22th ed., American Public Health Association, Washington, DC, 2012.
2. **Debels P., Figueroa R., Urrutia R., Barra R. and Niell X.,** Evaluation of water quality in the Chilla'n river (Central Chile) using physicochemical parameters and a modified water quality index, Environ. Monit. Assess.,110(1-3), 301–322, (2005).

3. **Kannel P. R., Lee S., Lee Y. S., Kanel S. R. and Khan S. P.,** Application of water quality indices and dissolved oxygen as indicators for river water classification and urban impact assessment, Environ. Monit. Assess. 132(1-3), 93–110, (2007).

4. **Abbasi S.A.,** Water quality indices, state of the art report, National Institute of Hydrology, Scientific contribution no. INCOH/SAR-25/2002, Roorkee, INCOH: 73, (2002).

5. **Khan A. A., Paterson R. and Khan H.,** Modification and application of the CCME WQI for the communication of drinking water quality data in newfoundland and Labrador, Pres. at 38th Cent. Sympo. Wat. Qual. Res., Canad. Associ. on Water Quality,10-11 February, Burlington, Canada, (2003).

6. **CCME, Water Quality Index 1.0 User's Manual,** Canadian Environmental Quality Guidelines Canadian Council of Ministers of the Environment, 2, (2001).

7. **Global Drinking, Water Quality Index,** Develop, and Sensi. Anal. Report, 100, (2007).

8. **Akobundu A. N.,** Quality assessment of Aba river using heavy metal pollution index, Am. J. Environ. Engin., 2(1), 45-49, (2012).

9. **Kim K.H., Hanson P. J., Barnett M. O. and Lindberg S. E.,** Biogeochemistry of mercury in the air-soil-plant system, Metal Ions in Biological Systems 34 (mercury and its effects on environ. and boil.Basel, Hong Kong), 185–212, (1997).

10. **Semiromi B., Hassani F., Torabian A. H., Karbassi A.R. and Lotfi H. F.,** Water quality index development using fuzzy logic : A case study of the Karoon River of Iran, Afri. J. Biotechnol.,10(50), 10125-10133, (2011).

11. **Khan A. A., Gawad S. A. and Khan H.,** Real time water quality monitoring network and water quality indices for river nile, 13th IWRA World Water Congress, 1-4 September, Montpellier, France, 15, (2008).

12. **Emad A. M., Heety A. L., Turki Ahmed M., Eethar M. A., and Al – Othman,** Assessment of the water quality index of euphrates river between heet and Ramadicities , Iraq, Int. J. Bas. App. Sci., 11(6), 450-455, (2011).

13. **Devi Prasad A., Kothathi S.,** Application of CCME Water Quality Index (CWQI) to the lakes of Mandya, Karnataka State, India, Onl. Int. Interdis. Res. J., 2(1), 108-114, (2012).

14. **Regulation on the Parameters of Ecological and Chemical Status of Surface Water and Parameters of the Chemical and Quantitative Status of Groundwater**, Offcial Gazette RS, No. 74/2011.

15. **N. Veljković,** Indicators of the Sustainable Development and the Water Resources Management, Andrejević Foundation, Belgrade, 2006.

16. **T. Banerjee, R.K. Srivastava,** Application of water quality index for assessment of surface water quality surrounding integrated industrial estate-Pantnagar, Water Sci. Tech, 60 (8) (2009) 2041-2053.

17. **J. Dojlido, J. Raniszewski, J. Woyciechowska,** Water quality index- application for rivers in Vistula river basin in Poland, Water Science and Tehnology, 30 (10) (1994) 57-64.

18. **S.M. Liou, S.L. Lo, S.H. Wang,** A generalised water quality index for Taiwan. Environmental Monitoring and Assessment 96 (2004) 35-32