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# Assessing the Effects of Al- Rasheed Electrical Power Plant on the Quality of Tigris River, Southern of Baghdad by Canadian Water Quality Index (CCME WQI)

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**Abstract**

This study was conducted to investigate the effects of Al-Rasheed power plant (RPP) effluents at Al-Zafaraniya city on the physical – chemical of the Tigris River by using Canadian Water Quality Index(CCME WQI).Water samples were taken monthly at four positions and 11parameters were analyzed . The results of this study conducted that there was a significant impact of the RPP effluents on increase of water temperature, turbidity and electrical conductivity, and there was an increase in the phosphate concentration and water hardness at station 2 and the model classified water of Tigris river as poor in winter and fair to marginal in rest season for drinking and aquatic life

**Keywords**: Tigris river, power plant, water index.

# تقدير تاثير محطة كهرباء الرشيد على نوعية مياه نهر دجلة (جنوب محافظة بغداد ) باستخدام الدليل الكندي لنوعية المياه

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**الخلاصه**

اجريت الدراسه لتقدير تاثير مياه الدفق لمحطة كهرباء الرشيد في منطقة الزعفرانيه على الخصائص الفيزيائيه والكيميائيه لمياه نهر دجله باستخدام الدليل الكندي لنوعيه المياه حيث جمعت عينات المياه بشكل شهري وبواقع اربع محطات وتم قياس ١١ خاصيه من الخصائص الفيزيائيه والكيميائيه للمياه وقد اظهرت النتائج بان هنالك تاثير معنوي لمياه دفق محطة كهرباء الرشيد على عكورة و درجة حرارة المياه والتوصيليه الكهربائيه لمياه نهر دجله في منطقة الدراسه وهنالك ارتفاع ملحوظ في تركيز الفوسفات ومعدلات العسره الكليه في موقع الدراسه رقم ٢ التي تعتبر المحطه الاقرب لمياه دفق محطة كهرباء الرشيد كما واعتمادا على الدليل الكندي تصنف مياه نهر دجله على انها رديئه خلال فصل الشتاء الى منصفه في بقيه فصول السنه لمعيشه الكائنات المائيه.

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**Introduction**

Actually Iraq faces earnest water troubles; not only over-exploitation and irregular in the locative apportionment resources of water, but also heavy water pollution in Iraqi main rivers, which give contribution for the scarcity of water in sufficient quantity and quality [1]. In Iraq, all wastewater discharged into rivers, and most of that is untreated [2]. Large amounts of waste from industries, domestic sanitation and agricultural practices find their way into rivers, leading to widespread degradation of water quality [3]. Increasing water pollution not only lead to deterioration of water quality, but also threatens validity of human and equipoise of aquatic Eco- systems, Economic growth and social opulence [4]. Availability of water and its biological, chemical and physical parameters affected on ability of aquatic ecosystem to sustain the health , moreover, the decline of water quality and quantity lead to increasing of the organisms suffer and services of social ecosystem may be gone [5].

Currently, water quality oversight has become significant subject in stream and river system that's influenced from neglected disposal of pollutants [6] and the state of pollution in our river [7].

The CCME WQI was developed to use as an instrument for facilitating and focusing on the information's of water quality. Three measures were selected to calculate the CWQI [8].

$F_1$ (Scope)

$$F_1 = \left[\frac{Number\ of\ Failed\ Variables}{Total\ Number\ of\ Variables}\right] \times 100$$

$F_2$ (Frequency)

$$F_2 = \left[\frac{Number\ of\ Failed\ \ Testes}{Total\ Numbers\ of\ Testes}\right] \times 100$$

$F_3$ (Amplitude)

When the test value must not exceed the objective:

$$Excursion = \left[\frac{failef\ test\ value}{Objective}\right] - 1$$

When the test value must not fall below the objective:

$$Excursion = \left[\frac{Objective}{failef\ test\ value}\right] - 1$$

$$nse = \frac{\sum_{i=1}^{n} excursion}{number\ of\ tests}$$

$$F_3 = \left[\frac{nse}{0.01\ nse + 0.01}\right]$$

$$CWQI = 100 - \left[\frac{\sqrt{F1^2 + F2^2 + F3^2}}{1.732}\right]$$

The last mathematical equation gives s a value between 0 and 100 and numerical value to the state of water quality. Observing that zero (0) value marks to a very poor water quality, whereas a value close to 100 marks to excellent water quality

**Table 1-**The water quality is grouped in the under 5 categories:

| Group | CCME WQI values |
|---|---|
| Excellent | 95- 100 |
| Good | 80- 94 |
| Fair | 60- 79 |
| Marginal | 45- 59 |
| Poor | 0- 44 |

According on visual basic the CCME has designed in software, which is performed in Microsoft Excel for calculating the CWQI, CCME-WQI model has been used due to its facility and durable nature in reporting water quality issues.

**Materials and Methods**

**Description of the Study Area**

Al- Rasheed power plant were designed up on the principle of generating steam as an operating power consist of six units at the east side of Tigris river southern of Baghdad province Figure-1 which supplied the power plant with water these were necessary as operating and cooling water and each unit need for 500m$^3$\ h of water from Tigris river, the present study designed to assess the impacts of Al- Rasheed thermal power plant on the physical and chemical properties of the Tigris river in Baghdad province by choosing four stations .

- Station No.1 was located at 500 meters before Al-Rashed power plant.
- Station No.2 was near the west place of Al- Rasheed power plant
- Station No. 3 was at 500 meters after the waste place of Al- Rasheed power plant.
- Station No.4 was at 1000 meters of Al-Rasheed power plant.

Water samples were collected monthly from January to December of 2012, at each sampling stations. Samples were kept then tested according to American Public Health Association (APHA)[9]. Physical and chemical characteristics involving water temperature (T), electrical conductivity (EC),pH, were computed in field by using a "HANA multi- model HI9811". Turbidity (Tur) was determined in laboratory by using "Jenwaw company prtable turbidity meter model – 6035". Alkalinity (Alk) as $CaCO_3$ measured by titration method, $Ca^{+2}$**,** $Mg^{+}$were measured by EDTA complex metric titration [10]. Sulphat ($SO_4$) concentration was determined spectrophotometrically using barium sulphat turbidity method[11]. Nitrate ($NO_3$) and phosphate ($PO_4$) concentration were measured by cadmium reduction and molybdate ascorbic acid methods respectively.Dissolved oxygen(DO) concentration were measured according to[12].

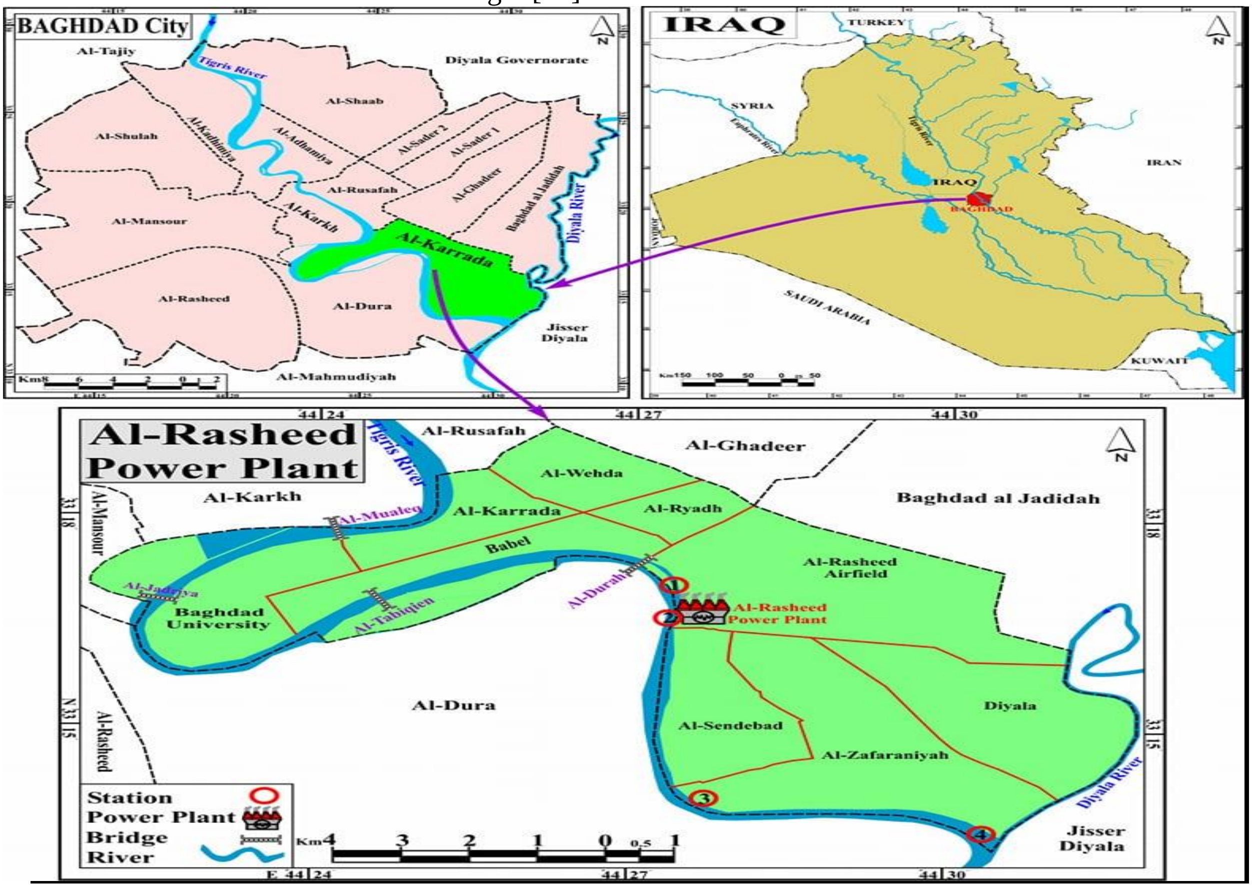


**Figure 1**-Map of Iraq and Baghdad city showing stations of present study Source: Ministry of water resources 2012\ map scale 1\100000

**Results and Discussion**

Water Quality Index for the four stations along the river was determined monthly during a year using physiochemical parameters listed in Table-2.

According to physical parameters the water temperature values were higher at station 2 about 10-38.8 which located under the effects of heating water discharged from Al- Rasheed power plants that have great effects on aquatic animals and plankton community depending on relation between water temperature and aquatic community [13] as well as the rest stations showed simple variations in water temperature according to the air temperature of seasons and these results were conformed with other studies[14], so increasing in turbidity values 2.85- 68.6 which had great effects on light reflection inside water column depending on increasing of suspended particles of salts and organic matter that may be affected by the discharged water from Al- Rasheed power plants furthermore their effects on TDS , EC values and concentrations of phosphates compounds as a result of discharging $P_2O_5$ compounds from plants . There were moderated values of $NO_3$ 0.03- 2.5mg\l of all stations.

In other hands there were decreasing in pH and DO values at station 2 compared to rest stations , pH values affected by the chemical and biological activities in aquatic environment [14,15]besides to inverse relationship between DO value and water temperature which increased rate of metabolic activities of aquatic organisms[16].

The present study showed increasing in total hardness, $Ca^{+2}$ and $Mg^{+}$ hardness in summer season especially at station 2 according to high level of water evaporation [14, 17]

**Table 2-**Annual simple analysis of water quality parameters at the study stations on Tigris River \ south of Baghdad province

| Parameters | 1 st Station | | | 2 nd Station | | | 3 rd Station | | | 4th Station | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Min | Max | Mean | Min | Max | Mean | Min | Max | Mean | Min | Max | Mean |
| T C° | 10 | 27.5 | 20.34 | 18 | 38.8 | 29.26 | 12 | 30.1 | 21.85 | 10 | 27.7 | 20.15 |
| pH | 7.5 | 8.9 | 8.14 | 3.5 | 8.2 | 7.6 | 7.7 | 9 | 8.19 | 7.5 | 9 | 8.14 |
| ECµs\cm | 580 | 1000 | 773.3 | 590 | 1090 | 829.16 | 550 | 1130 | 797.5 | 610 | 1140 | 840.83 |
| DO mg\L | 6.5 | 10.7 | 8.14 | 3.5 | 8.2 | 7.6 | 7.7 | 9 | 8.19 | 7.5 | 9 | 8.14 |
| Tur NTU | 1.9 | 17.3 | 8.67 | 2.85 | 68.6 | 15.42 | 4.73 | 61 | 14.05 | 3.4 | 22.8 | 8.96 |
| $CO_3$ mg\L | 10 | 160 | 101.4 | 30 | 190 | 139.5 | 18 | 189 | 130.5 | 12 | 161 | 118.1 |
| $Ca^{+2}$ mg\L | 0.25 | 135 | 61.52 | 12 | 214 | 84.75 | 23 | 255 | 81.25 | 13 | 228 | 85.08 |
| $Mg^{+}$mg\L | 0.19 | 0.69 | 0.39 | 0.21 | 2.45 | 0.71 | 0.31 | 5.58 | 1.07 | 0.208 | 5.4 | 1.165 |
| $SO_4$mg\L | 15 | 85 | 38.2 | 50 | 275 | 109.1 | 25 | 158 | 71.5 | 20 | 155 | 65.87 |
| $PO_4^{-2}$mg\L | 0.018 | 1.15 | 0.241 | 0.019 | 3 | 0.55 | 0.02 | 1.15 | 0.24 | 0.028 | 1.17 | 0.22 |
| $NO_3^{-2}$ mg\L | 0.03 | 0.8 | 1.42 | 0.058 | 2.5 | 0.91 | 0.09 | 2.5 | 0.91 | 0.99 | 2.59 | 0.69 |

The CWQI value was 33 to 65 and the lowest value at station 3 which indicated that water quality is poor for drinking purposes at stations1, 3, and 4 which ranged from fair to marginal for aquatic life in all stations. The annual amounts the various scopes (F1), frequencies (F2) and amplitudes (F3) with their respective water quality index in all stations found in Table-3.

**Table 3-** Annual Variation of CWQI of Tigris River at each Station.

| Station | Data summary | Overall | Drinking | Aquatic |
|---|---|---|---|---|
| Station 1 | CWQI | 52 | 38 | 65 |
| | Categorization | Marginal | poor | Fair |
| | F1(scope) | 50 | 67 | 50 |
| | F2(Frequency) | 33 | 44 | 33 |
| | F3(Amplitude) | 57 | 72 | 10 |
| Station 2 | CWQI | 51 | 45 | 62 |
| | Categorization | Marginal | Marginal | Marginal |
| | F1(scope) | 33 | 33 | 50 |
| | F2(Frequency) | 31 | 33 | 42 |
| | F3(Amplitude) | 71 | 83 | 11 |
| Station 3 | CWQI | 44 | 33 | 64 |
| | Categorization | Poor | Poor | Marginal |
| | F1(scope) | 50 | 67 | 50 |
| | F2(Frequency) | 32 | 42 | 33 |
| | F3(Amplitude) | 76 | 86 | 14 |
| Station 4 | CWQI | 45 | 39 | 63 |
| | Categorization | Marginal | Poor | Marginal |
| | F1(scope) | 67 | 67 | 50 |
| | F2(Frequency) | 33 | 39 | 38 |
| | F3(Amplitude) | 58 | 73 | 17 |

The overall seasonal index values of Tigris River ranged from 33 to 68, the worst value was in winter which gives view that poor water for drinking and aquatic life in winter, fair in spring and marginal in summer and Autumn, the seasonal variation of CWQI is present in Table-4.

According to the same studies in Iraq showed that the water quality of Tigris and Euphrates River are fluctuated between poor and marginal categories [18, 19] this may be invert the drainage of pollutants from domestic sewers and warmed industrial wastes discharges to water resource, all of which may be untreated that leads to considerable actions on quality of river [20] as well as the dryness in the area might be behind the depletion of WQI [21].

**Table 4-** Seasonal variation of CWQI in Tigris River stations

| Season | Data summary | Overall | Drinking | Aquatic |
|---|---|---|---|---|
| Winter | CWQI | 45 | 33 | 66 |
| | Categorization | Marginal | Poor | Fair |
| | F1 | 50 | 67 | 50 |
| | F2 | 30 | 42 | 28 |
| | F3 | 74 | 85 | 12 |
| Spring | CWQI | 43 | 36 | 68 |
| | Categorization | Poor | Poor | Fair |
| | F1 | 67 | 67 | 50 |
| | F2 | 29 | 39 | 25 |
| | F3 | 66 | 80 | 5 |
| Summer | CWQI | 54 | 47 | 58 |
| | Categorization | Marginal | Marginal | Marginal |
| | F1 | 33 | 33 | 50 |
| | F2 | 33 | 33 | 50 |
| | F3 | 65 | 78 | 15 |
| Autumn | CWQI | 54 | 41 | 57 |
| | Categorization | Marginal | Poor | Marginal |
| | F1 | 50 | 67 | 50 |
| | F2 | 40 | 46 | 50 |
| | F3 | 47 | 62 | 21 |

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**Conclusion**

-Water quality indicators for private consumption is a simple method of initial recognition of river water quality and allow estimating the changes in water quality over time and space

- Assess the successes and weakness of domestic policies and international treaties aimed at protecting water resources

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