International Journal of Aquatic Science
ISSN: 2008-8019
Vol 13, Issue 01, 2022

Effect of Tharthar Canal on Nutrients and Chlorophyll values of Tigris River, North Baghdad City Iraq

Eman D. Al-Amiedy[1], Ahmed J.M. Al-Azawi[2]

[1,2]Biology Department -College of Sciences, University of Baghdad, Baghdad, Iraq

Emails: [1]amiedy1981@gmail.com, [2]ahmedalazz@yahoo.com

ABSTRACT: This study investigated the effect Tharthar Canal on values of Nutrients and Chlorphyll of the waters of the Tigris River; the measurements were conducted for 12 months, starting from January to December 2020, five sites were selected. Results showed that after the confluence of the Tharthar Canal with the Tigris River, a change happens in values of the nutrients and chlorophyll properties increased in the Tigris River after the junction with the Tharthar Canal. In contrast, the low values of these characteristics decreased in the Tigris River directly below the confluence area. Therefore, it concludes that the Tigris River chlorophyll properties are affected by the Tharthar canal in the values of the river within the study area. It is worthwhile to mtioned that all the figured the Y-axis calculated in logarithm values due to very low of the measured values of the parameters.

Keywords: chlorophyll-a, chlorophyll-b, chlorophyll-total properties, Nutrients, Tgris River, Tharthar Canal.

1. INTRODUCTION

Rivers have been the most important freshwater resources, along the banks of which ancient civilizations have flourished, and most developmental activities are still dpendent upon them [1]. Rivers have multiple uses in every development sector, agrculture, industry, transportation, etc. A considerable quantity of waste from inutries, domestic sewage, and agricultural activity find their way into rivers, resulting from large-scale deterioration of the water quality [2]. Tigris River is one of the Iraqi most crucial surface waters; Baghdad city uses water supplies for drinking and industrial. Therefore, when the Tigris River passes through Baghdad city, it receives discharges of many pollutants, which require continuous monitoring [3].

2. Materials and Methods

2.1 Study area

Tharthar-Tigris Canal was construct in 1988. It diverted from the left side of the diviion regulator, located on the Tharthar-Euphrates Canal. It continues to the east for 65 Km until the confluence with Tigris River north of Baghdad City. Then, it directly discharges up to 600 m^3/s to the Tigris River [4].
Five sites were selected, two on Tharthar Canal and three along Tigris River (Fig.1). The first of the Tigris River is about 2.4 km before the confluence Tharthar Canal with Tigris River at

33°29'04.5"N latitude and 44°18'06.3"E longitude. The second site was on Tharthar at 33°28'27.2"N, 44°07'49.6"E. Third site was on Tharthar Canal before the entrance to the main street (33°28'43.0" 44°14'06.9" E) before the confluence of the canal with Tigris. The fourth site was on Tigris River, the joining point of Tharthar Canal with Tigris River, at 33°27'46.4"N and 44°18'10.3"E. Fifth site lies in Tigris River near Al-Muthana Bridge area at 33°25'43.0"N, 44°20'39.4"E below the joining point of Tharthar Canal with Tigris River, as shown in Figure 1

2.2 Sample collection

Samples were collected monthly from January to December 2020. Water samples were in a well-stopped polyethylene bottle 1000 ml in a 4°C refrigerator. In addition, some properties were conducted on the site directly.

3. MEASUREMENTS

3.1 Chlorophyll-(a, b, Total)

The procedure used to filter one liter of the sample using 0.45 µm filter paper size type GF/F [5]. Before ending the filtration procedure, add 2 ml of Magnesium carbonate to prevent Dye decomposition, then transfer to a crushing bowl and melt by using 203 ml of Acetone of concentration of 90%. Then clean the crushing bowl and the glass rod with the Acetone and complete the volume to 10 ml. afterward left in the dark with a temperature of 4 ºC for two hours, then transferred to Centrifuge with the velocity of 500 cycles per minute of 20 minutes. Absorbance measured apparatus (665 and 750 nm). The Dyes measurement was done by using the following equations:
Mg concentration of Chlorophyll per sample=11.9 x 2.43 (Db-Da)(V/l)
Were
Da represents the optical density of the Chlorophyll extract after adding the acid.
Db represents the optical density of the Chlorophyll extract before adding the acid.
V represents the Acetone used to extract the dye measured by (ml).
L is the wavelength of the Optical Photometer measured by (nm).
Measuring the concentration of Chlorophyll was by Microgram/cm^2.

4. Nutrients

The samples of nutrients were collected and filtrated on the same day. First, one liter filtered from each site using filter papers type GF/C 0.45 µm, using Millipore Filtration Apparatus. (250 ml) collected from the filtered sample in a glass container for Nitrogen Dioxide NO_2^-, Nitrate nitrogen NO_3^- and Silicate SiO_4^{-3} analysis. Then, keep the containers in the refrigerator until starting study in the laboratory.

4.1 Reactive Nitrate NO_3

Nitrates measured according to the Ultraviolet method described in [6], take 25 ml of the sample and 1 ml of hydrochloric acid added, and the concentration measured by Cecil-Model 7200 UV spectrophotometer at a wavelength of 220 nm. Then, these measurements are repeated at a wavelength of (275 nm), depending on the difference between the two readings. Finally, the results are expressed in units of (micrograms, nitrogen atoms/liter) as shown in the following equation:
Dilution × F × A-B)) = µg / L NO3
Were
A = Read sample at 220 nm wavelength.

B = Sample reading at 275 nm wavelength.
F = Factor = 4.43

4.2 Reactive Nitrite NO_2

Nitrites were determined using the method described by [6] as, and after two minutes (1ml), the second solution N-1-Naphthyl ethylene diamine was added. Afterward, dihydrochloride and the sample are shaken well and left for (15 minutes). The intensity of the resulting pink color is proportional to the nitrite ion concentration, using a Visible Spectrophotometer at a wavelength of (543) nm. Expressed the final product was in a unit of micrograms of nitrogen/liter.

4.3 Reactive Phosphate PO_4

The method described [7] uses diluted to 50 mL of digested sample into an acid-cleaned, dry 125 mL Erlenmeyer flask. Then add one drop of phenolphthalein indicator. If a red color develops, add 5 N sulfuric acids until the color disappears. Then add 8.0 ml of combined reagent and mix thoroughly. Then allow at least 10 minutes (but not more than 30 minutes) for color development. Next, measure the absorbance at 880 nm using a reagent blank to zero the spectrophotometer and make reagent blank by using 50 ml of distilled water carried through the digestion and ascorbic acid procedures. In highly colored or turbid samples, prepare a blank sample by adding all the reagents except the ascorbic acid and potassium antimonyl tartrate. Next, subtract the absorbance of this blank from the absorbance of the sample. Finally, the absorbance was checked against the calibration curve and determined the concentration. Correct for dilution, the unit of the reactive phosphate is represented by (mg/l).

4.4 Reactive Silicate Si

Silicates are measured using the method modified by [8]. Molybdate complex is proportional to the silicate concentration intensity using a Visible Spectrophotometer. Spectrophotometer at a wavelength of 810 nm, the intensity of which is measured expressed in units of micrograms silica atom/liter.

5. RESULTS

5.1 Chlorophyll-a

The results showed that Chlorophyll-a values during the study period ranged 0.00059–0.005 mg/l, the lowest value 0.00059 mg/l was during summer 2020 in site-5, while the highest value 0.005 mg/l recorded during spring 2020 in site-1 (Table-1; Figure-2).

The increase in chlorophyll-a- values in the spring season is due to increased nutrients. And, the relative increase in temperature and the increase in light intensity stimulate the growth of green algae and blue-green algae rich in high chlorophyll-a content [9].

Decreases in their values in summer resulted from reductions in phytoplankton and macroalgae, which decreases with high temperatures. The concentrations of Chlorophyll-a in phytoplankton may change according to environmental changes [10].

Chlorophyll-a is the most critical environmental indicator for estimating primary productivity in any water body. In other studies, on Iraqi waters, concentrations ranged between (0.29-8.7) g/liter due to environmental effects of the Tharthar canal or arm on the Tigris River before entering Baghdad [11].

The correlation of chlorophyll-a between site-1 (Tigris River before joining point of Tharthar

canal), site-2 (Tharthar canal), site-3 (Tharthar canal), and site-4 (which was the joining point between Tigris River and Tharthar canal) were, r=1, 1, 0.9993 and 0.9942 respectively (Table-1).
Also, the study showed a positive correlation between the chlorophyll-a with Total Alkalinity, Mg^+, pH, and PO4, at $p \leq 0.01$, r =0.45235, 0.32149, 0.39495, and 0.7585. On the other hand, a significant negative correlation relationship whereas observed with, Air temperature, Water Temperature, Electrical conductivity, SO_4, NO_3, and Si at $p \leq 0.05$, r =-0.534, -0.37358, -0.55052, -0.36544, -0.13067, and -0.31069,
respectively (Table-1).

6. Chlorophyll-b

The results showed that Chlorophyll-b values during the study period ranged 0.000438 mg/l–0.005 mg/l, the lowest value 0.000438 mg/l was during November-winter 2020 in site-2, while the highest value 0.005 mg/l recorded during February-winter 2020 in site-3. (Table-1; Figure-3).
The correlation of chlorophyll-b between site-1 (Tigris River before joining point of Tharthar canal), site-2 (Tharthar canal), site-3 (Tharthar canal), and site-4 (which was the joining point between Tigris River and Tharthar canal) were, r=1, 1, 1 and 1
respectively.
Also, the study showed a positive correlation between the chlorophyll-b with pH, Total Alkalinity, Mg^+, NO_3, PO_4, and at $p \leq 0.01$, r = 0.32732, 0.43658, 0.36287, 0.9923, and 0.4383. On the other hand, recorded a significant negative correlation was with Air temperature, Salinity, Ca, and SO_4 at $p \leq 0.05$, r = -0.4892, -0.53085, -0.50616,
and -0.3228, respectively (Table -1).
Significant differences were recorded in chlorophyll-b between months through the study period at all sites.
The chlorophyll-b values reached maximum values of 70.9 mg/l at effluent water in the spring season, while noticed minimum value of 2.9 mg/l was at primary
sedimentation tanks during the winter season. Significant differences were recorded in Chlorophyll-b between months through the study period at all sites [12].

7. Chlorophyll-Total

For photosynthesis, a study along with the soil [13] of the bank of the lower Diep River, Cape Town, South Africa. The chlorophyll content of leaves by extracting the pigments using dimethyl sulphoxide (DMSO). Chlorophyll was quantified from the extract using a spectrophotometer (645 and 665 nm).
The concentration of heavy metals investigated [14] in plant tissue can be an essential indicator of the potential for bioaccumulation in aquatic systems. Collected samples were from three sites along the Euphrates River for one year, from October 2009 to September 2010.
This study was carried out [15] during 2012 utilizing selected four swim areas on the Tigris River in Baghdad city. Collected twenty water samples from four swim areas during swim season were for quality analyses using chemical, physical and bacterial parameters. Significant differences were recorded in Chlorophyll-Total between months through the study period at all sites.
The results showed that Chlorophyll-Total values during the study period ranged 0.00079 mg/l–0.009 mg/l, the lowest value 0.00079 mg/l was during April-winter 2020 in site-5, while the highest value 0.009 mg/l recorded during February 2020 in site-2 (Figure-4; Table-2)
The correlation of Chlorophyll-Total between site-1 (Tigris River before joining point of

Tharthar canal), site-2 (Tharthar canal), site-3 (Tharthar canal), and site-4 (which was the joining point between Tigris River and Tharthar canal) were, r=1, 1, 1and 1 respectively (Table-2).
Significant differences were recorded in Chlorophyll-Total between months through the study period at all sites.
Also, the study showed a positive correlation between the chlorophyll-Total with pH, and Total Alkalinity, NO_3, at $p \leq 0.01$, r = 0.32794, 0.43666, and 0.9948. On the other hand, observed a significant negative correlation was with salinity, Ca^+, TDS, and NO_2 at $p \leq 0.05$, r =-0.53081, -0.53081, -0.54399, -0.17898, respectively. (Table 2).

8. Reactive Nitrite NO_2

Nitrate NO_2 mg/1 values for the present study ranged between 0.07 - 1.09 mg/l, the lowest value 0.07 mg/l was in site-4 in winter 2020, while the highest value 1.09 mg/l was in site-1 during summer 2020 (Table2, Figure-5).
The increase in nitrate values in the summer may be due to the high-water temperature, which reduces nitrates to nitrites, which agrees with the study [16]. On the other hand, it may be due to Lower values, the increase in water levels due to rain, which brings more nutrients.
The correlation of NO_2 between site-1 (Tigris River before joining point of Tharthar canal), site-2 (Tharthar canal), site-3 (Tharthar canal), and site-4 (which was the joining point between Tigris River and Tharthar canal) were, r=0.05883, -0.0037, -0.02884 and -0.1059 respectively.
The correlation of NO_2 between site-1 (Tigris River before joining point of Tharthar canal), site-2 (Tharthar canal), site-3 (Tharthar canal), and site-4 (which was the joining point between Tigris River and Tharthar canal) were, r=0.05883, -0.0037, -0.02884 and -0.1059 respectively (Table-2).

9. Reactive Nitrate NO_3

Nitrate NO_3 values for the present study ranged between 0.6135 - 5.336 mg/l. The lowest value 0.6135 mg/l was in site-4 in autumn 2020, while the highest value 5.336 mg/l was in site-5 during winter 2020 (Table-2, Figure-5).
The high concentrations of nitrates in winter are due to the decrease in phytoplankton that consumes nutrients. In contrast, the reduction in their concentrations in the autumn season is due to algae and aquatic plants [17].
Significant differences were recorded in Nitrate nitrogen between months through the study period at all sites, as shown in (Table-2).
The correlation of NO_3 between site-1 (Tigris River before joining point of Tharthar canal), site-2 (Tharthar canal), site-3 (Tharthar canal), and site-4 (which was the joining point between Tigris River and Tharthar canal) were r= 0.272, 0.2045, 0.281 and 0.4479 respectively (Table-2).
There was a significant positive correlation between nitrate NO_3 with Si at $p \leq 0.01$, r = 0.50704. There was also a negative correlation between nitrate with SO_4 at $p \leq 0.05$, r = -0.3689. The statistical analysis results showed no significant P> 0.05 among sites (Table-2).

Reactive Phosphate (PO_4^{-3}) mg/l

Reactive phosphate values found during the study period ranged between (0.0019 mg/l - 0.0237 mg/l), the lowest values (0.0019 mg/l) were in site-2 and site3- during autumn 2020, while the highest value (0.0237 mg/l) was found during winter 2020 in site-1. (Figure 6,Table 1).

The decrease in phosphate values in the autumn season may be due to the adsorption of phosphate by clay granules and the consumption of quantities of phosphate by some types of aquatic plants and algae.
The high values in this winter season are due to the fall of large amounts of rain, which leads to the washing away of large quantities of phosphorous from neighboring regions. Many researchers have noticed in the different areas of the world [18].
The correlation of Phosphate PO_4 between site-1 (Tigris River before estuary of Tharthar canal), site-2 (Tharthar canal), site-3 (Tharthar canal), and site-4 (which was the joining point between Tigris River and Tharthar canal) were, r=-0.1859, -0.1098, -0.2436 and -0.406 respectively (Table 2).
A significant positive correlation was found between phosphates with TDS at $p \leq 0.01$, r = 0.395. Also, a negative correlation was found between phosphates with PO_4 at $p \leq 0.01$, r =-0.205. (Table 2).
Significant differences were recorded in reactive phosphate between months through the study period at all sites. However, values of reactive phosphate not exceeded the WHO standards for rivers' water quality during the study period.

10. Reactive Silicate Si

Si values for the present study ranged between 323 - 1210 µg/l, the lowest value 323 ppb was in site-2 in winter 2020, while the highest value 1210 µg/l was in site-5 during spring 2020. (Table-1; Figure-8).
The high concentrations of silica in the winter season may be due to the erosion of large quantities of silica from neighboring lands with rainfall, as well as the domestic wastewater dumped directly into the water without treatment [19]
concentrations decrease in in spring was due to an increase in the number of diatoms that consume large amounts of silicates in building their structures, or due to the presence of some types of aquatic plants that consume quantities of silica in making their bodies [18]
The correlation of Si between site-1 (Tigris River before joining point of Tharthar canal), site-2 (Tharthar canal), site-3 (Tharthar canal), and site-4 (which was the joining point between Tigris River and Tharthar canal) were, r=0.8469, 0.6521, 0.7273, and 0.6343 respectively (Table-1).
Significant differences were recorded in Si between months through the study period at all sites.

11. CONCLUSIONS

1. Tharthar canal affected many properties of water Tigris River on such as Chlorophyll (a-b-total) where Chlorophyll-a values increased after joining point in sites-5 except in January 2020, whereas for Chlorophyll-b in all sites, while for Chlorophyll-Total increased the values of Chlorophyll-a after joining point in sites-5 except in January 2020.
2. The Tharthar canal affected the Nutrients values after joining point of Tigris River. It decreased for NO_2 values, while increased for NO_3 except in April and May in site-5, whereas, for SO_4 values decreased except for January, June, July, September, and October in site-5. And finally, for Si values decreased except February, March, November, and December.

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Figure (1): A map showing the Tigris River and Tharthar-Tigris Canal study sites.

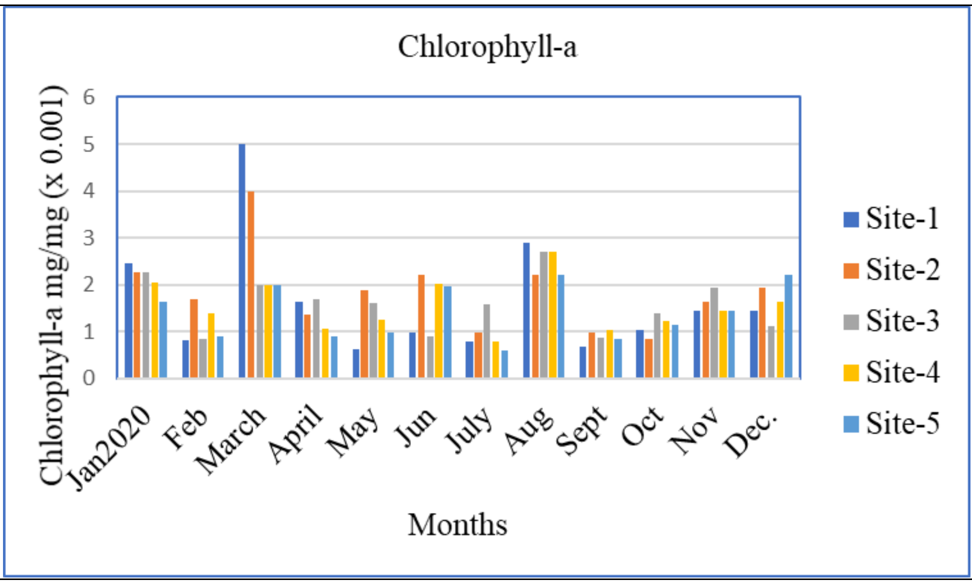

Figure 2- Monthly Chlorophyll-a mg/gm values for the study periods in the Tharthar canal and Tigris River

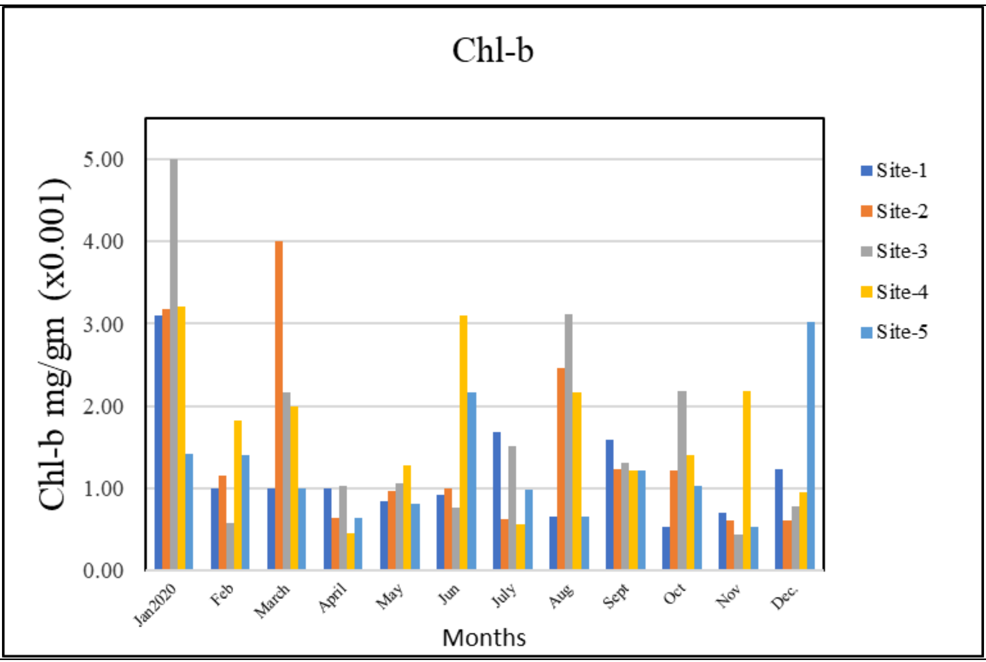

Figure 3- Monthly Chlorophyll-b mg/gm values for the Tharthar canal and Tigris River study periods.

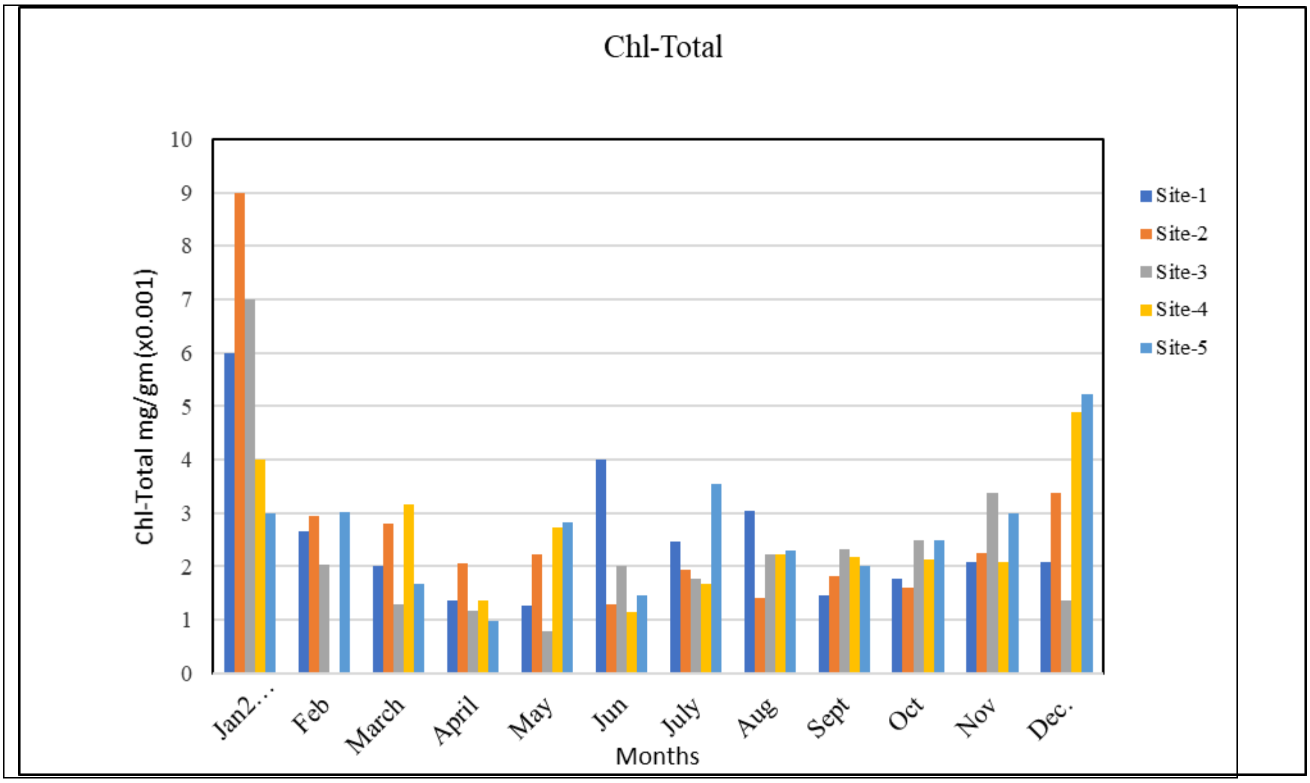

Figure 4- Monthly Chlorophyll-Total (mg/gm) values for the study periods in the Tharthar canal and Tigris River

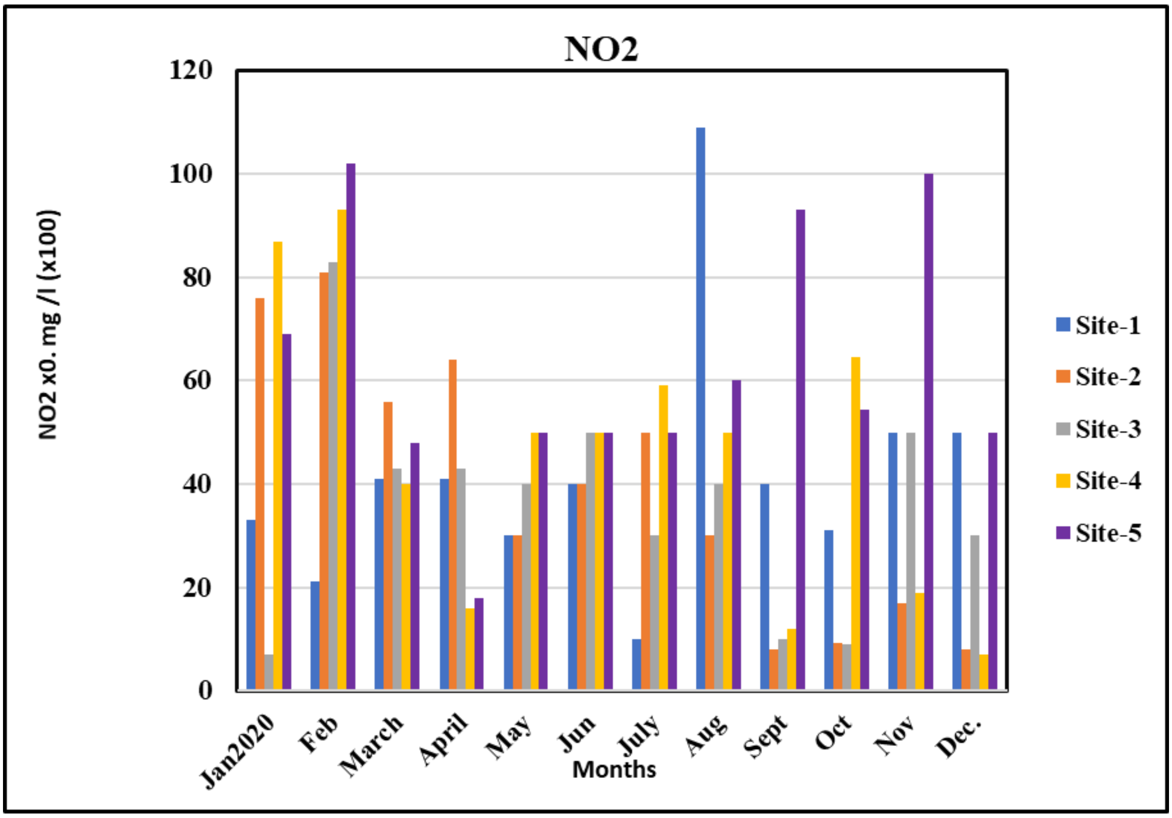

Figure-5 Monthly NO_2 mg/l values for the study periods.

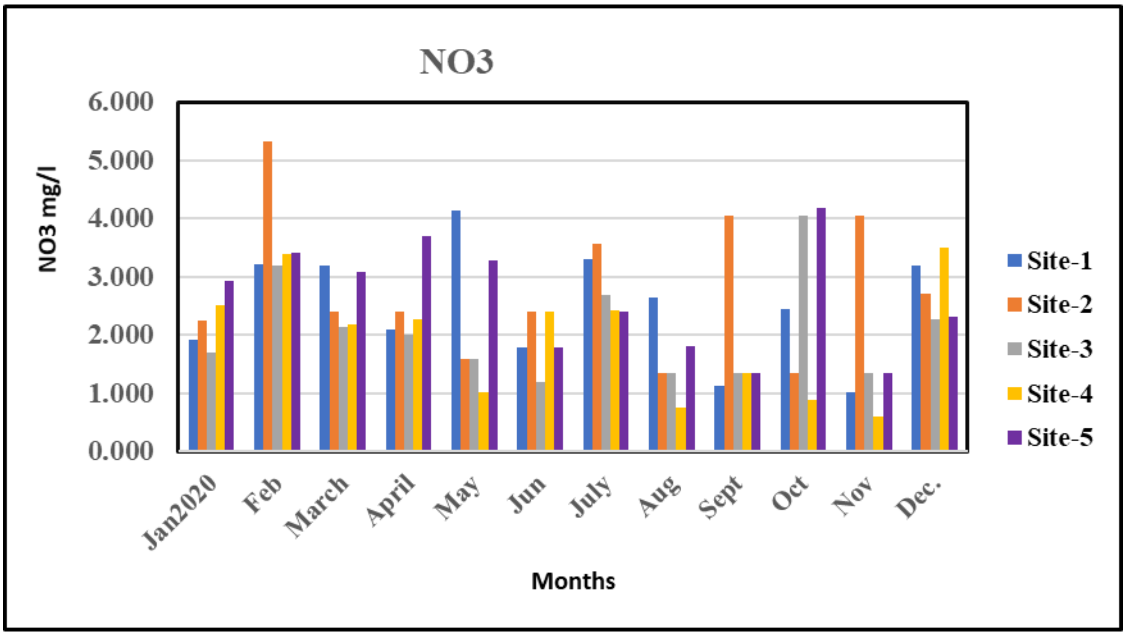

Figure-6: Monthly NO_3 mg/l values for the study periods

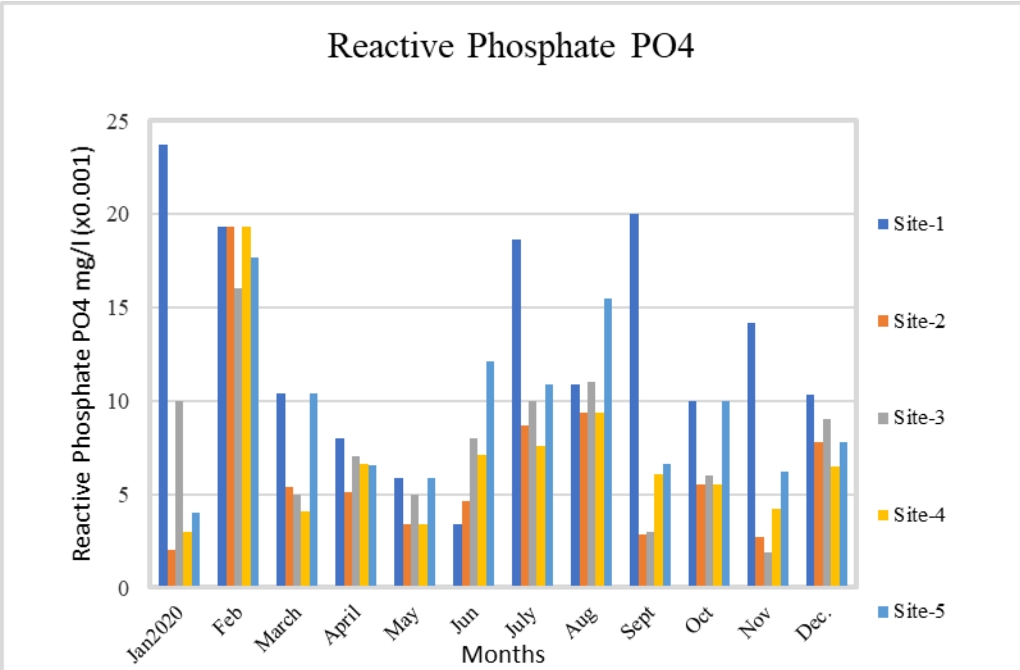

Figure (7): Monthly PO_4 mg/l values for the study periods.

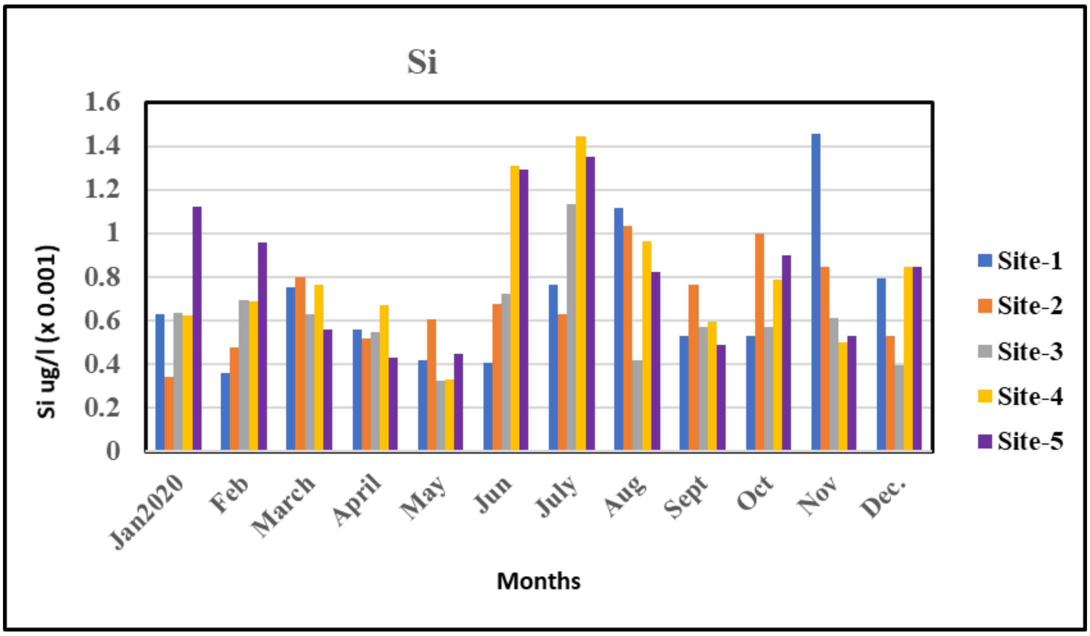

Figure-8 Monthly Si µg/l values for the study periods.

Table 3. Monthly values and LSD test for chlorophyll-a mg/gm through the study periods

Month	Tigris River	Tharthar Canal	Tharthar Canal	Tharthar Canal Joined Tigris River	Tigris River	LSD Value
	Site-1	Site-2	Site-3	Site-4	Site-5	
Jan.2020	0.002451	0.00225	0.002262	0.00204	0.00162	0.0016
Feb.	0.000819	0.001692	0.00084	0.001389	0.0009	0.0012
Mar.	0.005	0.004	0.002	0.002	0.002	0.003 NS
Apr.	0.001638	0.001362	0.00168	0.001062	0.0009	0.0014
May	0.000624	0.001874	0.001612	0.00125	0.000988	0.0017
Jun.	0.000988	0.002212	0.000886	0.00201	0.001968	0.0016
Jul.	0.000773	0.000988	0.001571	0.000786	0.00059	0.0014
Aug.	0.0029	0.0022	0.0027	0.0027	0.0022	0.0011
Sep.	0.000681	0.000988	0.000872	0.001022	0.000831	0.00102
Oct.	0.001032	0.000842	0.001374	0.001233	0.001143	0.0011
Nov.	0.001443	0.001634	0.001934	0.001443	0.001454	0.0010
Dec.	0.001443	0.001934	0.001103	0.001634	0.002196	0.0015
LSD	0.0019 NS	0.0017 NS	0.0020 NS	0.0017 NS	0.0015 NS	---

NS: Non-significant.

Table 4. Monthly values and LSD test for chlorophyll-b mg/gm through the study periods

Month	Tigris River	Tharthar Canal	Tharthar Canal	Tharthar Canal Joined Tigris River	Tigris River	LSD Value
	Site-1	Site-2	Site-3	Site-4	Site-5	
Jan.2020	0.0031	0.00317	0.005	0.003206	0.00141	0.0022 *

Feb.	0.001001	0.001144	0.000572	0.00182	0.001404	0.0015
Mar.	0.001	0.004	0.00217	0.002	0.001	0.0020 *
Apr.	0.001001	0.000631	0.001025	0.000451	0.000637	0.0011
May	0.0008323	0.00096	0.00105	0.00128	0.000802	0.0016
Jun.	0.000921	0.000997	0.000754	0.0031	0.00216	0.0020 *
Jul.	0.001686	0.000615	0.001502	0.000563	0.000983	0.0016
Aug.	0.0006501	0.002457	0.00312	0.002167	0.000655	0.0018
Sep.	0.0015842	0.001234	0.00131	0.001219	0.001219	0.0015
Oct.	0.0005256	0.001213	0.002181	0.0014	0.001032	0.0013
Nov.	0.000705	0.000606	0.000438	0.002181	0.000531	0.0016
Dec.	0.001227	0.000602	0.000777	0.000954	0.003025	0.0019
LSD	0.0020 *	0.0019 *	0.0027 *	0.0020 *	0.0018 NS	---

* (P<0.05), NS: Non-significant.

Table 5. Monthly values and LSD test for chlorophyll-Total mg/gm through the study periods

Month	Tigris River	Tharthar Canal	Tharthar Canal	Tharthar Canal Joined Tigris River	Tigris River	LSD Value
	Site-1	Site-2	Site-3	Site-4	Site-5	0.0038 *
Jan.2020	0.006	0.009	0.007	0.004	0.003	0.0016
Feb.	0.002665	0.002939	0.002041	0.0-1108	0.003029	0.0019
Mar.	0.002	0.0028	0.0013	0.003168	0.00168	0.0017
Apr.	0.001372	0.002059	0.00117	0.001372	0.0009684	0.0017
May	0.001258	0.002217	0.000787	0.002722	0.002823	0.0026 *
Jun.	0.004	0.001289	0.002	0.001151	0.00146744	0.0020
Jul.	0.002459	0.001936	0.001776	0.001662	0.003552	0.0016
Aug.	0.00303	0.0014	0.002218	0.002218	0.002304	0.0017
Sep.	0.00145	0.001813	0.002318	0.002174	0.002014	0.0019
Oct.	0.00177	0.001612	0.002496	0.002132	0.0025012	0.0016
Nov.	0.002091	0.002252	0.00338	0.002091	0.0029884	0.0031 *
Dec.	0.002091	0.00338	0.001366	0.004889	0.0052192	---
LSD	0.0031 *	0.0044 *	0.0035 *	0.0028 *	0.0033 *	0.0038 *

* (P<0.05), NS: Non-significant.

Table-6. Monthly values and LSD test for NO_2 mg/l through the study periods

Month	Tigris River	Tharthar Canal	Tharthar Canal	Tharthar Canal Joined Tigris River	Tigris River	LSD Value
	Site-1	Site-2	Site-3	Site-4	Site-5	
Jan.2020	0.33	0.76	0.07	0.87	0.69	0.157 *
Feb.	0.212	0.81	0.83	0.93	1.02	0.094
Mar.	0.41	0.56	0.43	0.4	0.48	0.144
Apr.	0.41	0.64	0.43	0.16	0.18	0.149 *
May	0.3	0.3	0.4	0.5	0.5	0.184 *
Jun.	0.4	0.4	0.5	0.5	0.5	0.113
Jul.	0.1	0.5	0.3	0.59	0.5	0.162 *

Aug.	1.09	0.3	0.4	0.5	0.6	0.244 *
Sep.	0.4	0.08	0.1	0.12	0.93	0.271 *
Oct.	0.31	0.093	0.09	0.645	0.545	0.209 *
Nov.	0.5	0.17	0.5	0.19	1	0.215 *
Dec.	0.5	0.08	0.3	0.07	0.5	0.229 *
LSD	0.336 *	0.319 *	0.373 *	0.298 *	0.384 *	---

* (P<0.05), NS: Non-significant.

Table 7. Monthly values and LSD test for Nitrate nitrogen NO_3 mg/l through the study periods

Month	Tigris River	Tharthar Canal	Tharthar Canal	Tharthar Canal Joined	Tigris River	LSD Value
	Site-1	Site-2	Site-3	Site-4	Site-5	
Jan.2020	1.91	2.24	1.71	2.51	2.93	0.446
Feb.	3.22	5.34	3.20	3.40	3.42	0.721
Mar.	3.19	2.41	2.14	2.19	3.09	0.705
Apr.	2.10	2.40	2.01	2.28	3.71	0.812
May	4.15	1.60	1.60	1.02	3.28	1.06 *
Jun.	1.80	2.40	1.20	2.40	1.80	0.883
Jul.	3.32	3.56	2.70	2.43	2.41	0.791
Aug.	2.64	1.35	1.35	0.76	1.80	0.804
Sep.	1.14	4.05	1.35	1.35	1.35	0.925
Oct.	2.44	1.35	4.05	0.90	4.18	1.08 *
Nov.	1.01	4.05	1.35	0.61	1.35	0.966
Dec.	3.19	2.72	2.28	3.51	2.32	0.793
LSD	0.882 *	0.907 *	0.841 *	0.835 *	0.861 *	---

* (P<0.05), NS: Non-significant.

Table 8. Monthly values and LSD test for Reactive Phosphate PO_4 mg/l through the study period.

Month	Tigris River	Tharthar Canal	Tharthar Canal	Tharthar Canal Joined Tigris River	Tigris River	LSD Value
	Site-1	Site-2	Site-3	Site-4	Site-5	
Jan.2020	0.02371	0.002	0.01	0.003	0.004	0.008 *
Feb.	0.01933	0.01933	0.016	0.0193	0.01766	0.016 NS
Mar.	0.0104	0.00538	0.005	0.0041	0.01038	0.0103 NS
Apr.	0.008	0.00514	0.007	0.0066	0.00657	0.004 NS
May	0.00588	0.00338	0.005	0.0034	0.00588	0.004 NS
Jun.	0.00338	0.00462	0.008	0.0071	0.01212	0.008 NS
Jul.	0.01866	0.00866	0.01	0.0076	0.01089	0.016 NS
Aug.	0.01085	0.0094	0.011	0.0094	0.0155	0.0102 NS
Sep.	0.02	0.00287	0.003	0.0061	0.00662	0.009 *
Oct.	0.01	0.0055	0.006	0.0055	0.01	0.011 NS
Nov.	0.0142	0.0027	0.0019	0.0042	0.0062	0.0044 NS
Dec.	0.0103	0.0078	0.009	0.0065	0.0078	0.0102 NS
LSD	0.009 *	0.007 NS	0.017 NS	0.016 NS	0.0147 NS	---

* (P<0.05), NS: Non-significant.

Table 9. Monthly values and LSD test for Si µ/l through the study periods.

Month	Tigris River	Tharthar Canal	Tharthar Canal	Tharthar Canal Joined Tigris River	Tigris River	LSD Value
	Site-1	Site-2	Site-3	Site-4	Site-5	
Jan.2020	630	345	633	625	1120	203.71 *
Feb.	357	476	694	688	955	192.56 *
Mar.	751	800	628	762	562	142.07 *
Apr.	562	518	550	670	433	137.69 *
May	416	605	323	331	448	163.05 *
Jun.	405	679	721	1311	1291	223.58 *
Jul.	764	628	1134	1445	1350	281.01 *
Aug.	1118	1036	418	963	820	187.63 *
Sep.	530	764	570	594	490	164.25 *
Oct.	530	996	570	790	900	177.04 *
Nov.	1456	849	609	500	530	194.56 *
Dec.	791	527	395	847	847	182.03 *
LSD Value	217.5 *	184.2 *	169.3 *	207.8 *	191.3 *	---

* (P<0.05).

Table-**Error! No text of specified style in document.**The Range and Mean ± Standard Error of some physicochemical properties of water in the sites through the study period. (First line: Range): (Second line: Mean ± Standard Error)

Variables	Tigris River	Tharthar Canal	Tharthar Canal	Tharthar Canal Joined Tigris River	Tigris River	LSD Values
	Site-1	Site-2	Site-3	Site-4	Site-5	
Chlorophyll-a mg/gm	0.0006-0.005 0.0016±0.0012	0.0008-0.004 0.0018±0.0008	0.0008-0.0027 0.0016±0.0005	0.0008-0.0027 0.0015±0.0015	0.0006-0.0022 0.0014±0.0005	0.0011 NS
Chlorophyll-b mg/gm	0.0005-0.0031 0.0012±0.0006	0.0006-0.004 0.0015±0.001	0.0004-0.005 0.0017±0.0012	0.00045-0.0032 0.0017±0.0008	0.0005-0.003 0.0012±0.0007	0.0010 NS
Chlorophyll-Total mg/gm	0.0013-0.006 0.0025±0.0013	0.0013-0.009 0.0027±0.0019	0.0008-0.007 0.0023±0.0015	0.0012-0.005 0.0025±0.0011	0.001-0.005 0.0026±0.0011	0.0016 NS
NO_2 mg/l	0.1-1.18 0.421±0.25	0.08-0.81 0.39±0.24	0.09-0.83 0.36±0.20	0.07-0.93 0.45±0.26	0.18-1.02 0.62±0.23	0.307 NS
NO_3 mg/l	1.01-4.15 2.5±0.89	1.35-5.34 2.78±1.32	1.2-405 2.08±0.85	0.61-3.51 1.95±1.00	1.35-4.18 2.64±0.89	1.52 NS

Variables	Tigris River	Tharthar Canal	Tharthar Canal	Tharthar Canal Joined Tigris River	Tigris River	LSD Values
	Site-1	Site-2	Site-3	Site-4	Site-5	
Reactive Phosphate-PO_4^- mg/l	0.0034-0.0237 0.0129±0.0052	0.002-0.0193 0.0064±0.0044	0.0019-0.016 0.0077±0.0037	0.003-0.0193 0.0069±0.0041	0.004-0.0177 0.0095±0.0038	0.0117 NS
Si µg/l	356-1456 692±296	345-1036 685±198	323-1134 604±197	331-1445 794±294	432-1120 870±396	217.63 NS
Si µg/l	356-1456 692±296	345-1036 685±198	323-1134 604±197	331-1445 794±294	432-1120 870±396	217.63 NS
Means having with the different letters in same row differed significantly. * (P≤0.05), NS: Non-Significant.						

Table -2 Correlation between Chlorophyll and nutrients and the other paramters

		AT	WT	Turbi	EC	Sal	pH	Talk	DO	BOD	TPOS	TH	Ca	Mag	SO4	T.S.S.	NO3	Bic	PO4	TDS	Wav	Chla	Chb	ChT	NO2	NO3	SO4	Si
Chlorophyll-a (mg/gm)	r	-0.53	-0.37	-0.21	-0.55	-0.5	0.39	0.452	0.285	0.207	-0.09	-0.4	-0.48	0.321	-0.37	-0.28	0.028	0.32	-0.046	-0.6	0.4209		1					
Chlorophyll-b (mg/gm)	r	-0.49	-0.33	-0.19	-0.5	-0.5	0.33	0.437	0.263	0.188	-0.06	-0.4	-0.51	0.363	-0.32	-0.27	-0	0.34	-0.115	-0.5	0.4654	0.994	1	1				
Chlorophyll-Total	r	-0.49	-0.33	-0.19	-0.5	-0.5	0.33	0.437	0.264	0.188	-0.06	-0.4	-0.51	0.363	-0.32	-0.27	-0	0.34	-0.114	-0.5	0.4653	0.994	-0.18	1				
NO2 (ppm)	r	-0.25	-0.34	-0.27	0.1	0.48	0.31	-0.393	0.33	0.534	0.065	-0	-0.01	-0.09	0.32	-0.25	0.031	-0.4	0.2627	0.34	0.1029	-0.163	-0.1	-0.18	1			
NO3 (ppm)	r	-0.04	0.068	0.27	0.05	0.25	-0.46	0.564	0.138	0.064	0.523	-0.1	-0.45	0.59	0.26	0.31	0.75	0.56	-0.137	0.01	0.3753	-0.131	0.261	-0.1	-0.215			
Reactive Phosphate PO4	r	0.148	0.255	-0.17	-0.28	-0.2	0.29	-0.316	-0.36	-0.02	-0.55	0.52	0.348	-0.04	-0.2	-0.11	0.175	-0.4										
Si (ppb)	r	0.827	0.778	-0.14	0.24	-0.2	-0.05	-0.683	-0.77	-0.55	-0.42	0.53	0.509	-0.15	-0.05	-0.09	-0.69	-0.4	0.1234	0.1	-0.52	-0.311	-0.28	-0.21	-0.363	0.507	1	
		AT	WT	Turbi	EC	Sal	pH	Talk	DO	BOD	TPOS	TH	Ca	Mag	SO4	T.S.S.	NO3	Bic	PO4	TDS	Wav	Chla	Chb	ChT	NO2	NO3	SO4	Si