Ann. For. Res. 65(1): 1123-1136, 2022
ISSN: 18448135, 20652445
ANNALS OF FOREST RESEARCH
https://www.e-afr.org/

MEASURING THE WATER QUALITY OF THE TIGRIS RIVER BY APPLYING GEOGRAPHIC INFORMATION SYSTEMS (GIS) IN SOME REGION OF IRAQ

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Abstract

Concern for natural resources and their sustainability this time period represents the current study of the Tigris River for three provinces that start included, Salah al-Din north Baghdad province one station (sammara), Baghdad province, represented by (Al-Muthanna bridage, Al-Utifiya, Al-Jadiriyah) and then Al-Kut Province in the south Baghdad, which includes (Azizia, Zubaydia, Numaniyah, Al-Muftah). Water samples were collected for three months (February, March, June) of the current year 2022. The tests were done conducted physical and chemical detectors for water quality that included five factors: potential hydrogen (pH) value range (6.5-7.9) in St.7 of month February and March respectively, Total Disolved Solid (TDS) ranged (147 -486)mg/L in St.2 and St.6 of both the month of June and February, Total Nitrogen (TN) value ranged (0.1-0.74) mg/ L in March and Jun in St.4 and St.1, Total phosphorous (TP) levels ranged (0.027- 0.26) in St.1 during the month of June and St.8 during the month of February , Turbidity ranged (5 - 18)NTU at St.6 , St.8 in June and March). The results of water quality showed variations between station and months of the study. The spatial distribution of five water quality parameters within the studied area was also performed by applying (QGIS) technology to a quantum geography information system that was generated on the distance-inverse IDW method to produce the expected interpolation maps for the stations along with the study studies. The results showed a deterioration in water quality and an increase in some concentrations of variables observed for the current study stations along the course of the river, due to various human activities.

Keywords: Water quality, Tigris River, GIS, Spatial mapping and Predicted maps.

Introduction

Water is the most abundant ecological resource on the planet. It is a crucial factor for conserving all living forms in nearly all human activities for drinking, irrigation, and municipal use to meet industry demands, growing food, recreational activities, and power production (Al-Ansari, 2019). Nonetheless, anthropogenic activity has significantly worsened water quality in many large rivers around the world in the last two to three decades (Kibaroglu, 2019). More than 20% of the world's population does not have access to safe drinking water, and nearly half of the population does not

have enough clean water. In certain third-world nations, where an estimated 95 percent of untreated urban garbage is released straight into rivers, this problem is particularly problematic. Iraq is one of nine Middle Eastern countries with insufficient freshwater (Abed, et al.,2021, Ghalib, 2017). Water resource contamination is a big issue all around the world. The assess the level of contamination in the river, ongoing water quality monitoring is necessary. Pollution of lakes and rivers is becoming increasingly fashionable in many regions of the world (Hadeel et, al., 2022) .
The Tigris River, the second longest river in Western Asia and one of Iraq's greatest rivers, from a length 1,800 km2 ,originates Armenian Highlands in Turkey, source of water for supplies drinking water, agriculture, industry, domestic water supply and for disposal of waste water, the flow of the Tigris River is affected over time by the construction of dams and climate change (Rasheed et, al., 2021).
Also, the makers of decisions use the quantum GIS created on the Inverse Distance Weighted IDW approach to present and compare water quality data and related information, as well as the spread of river contamination in simple predicted maps (Fouad and Zina, 2020). Color maps of stations along the river based on water quality metrics were forecasted using IDW interpolation (Ahmed and Mashee, 2022).
The aim of this research is to determine the water quality specifications in the Tigris River from Salah al-Din, north of Baghdad to Kut, using GIS technology.

Description of the study area

The study area lies between latitude 31-55'N, 33˚28'N and longitude 44˚30'E, 46˚35'. The field work in this study was carried out in eight locations representing three provinces in the central part of Iraq. The station were chosen randomly to collect study samples from the river water, starting from Salah al-Din Province, north of Baghdad, in one location in the city of Samarra, passing through the city of Baghdad. Three were chosen. The station in Baghdad Province (Al-Muthanna Bridge, Al-Utaifi, Al-Jadiriya), to the Kut Province, four sites were selected (Al-Aziziyah, Al-Zubaydah, Al-Numaniyah, Al-Kut). Table (1) represents the determination of the distance between each site and the other and the length of the study area, as shown in Figure (1) . The first Province station is Wasit, located 180 km south of Baghdad and located at latitude 31.474 31.955 N and longitude E 536. 46.54244, the station of Al-Aziziyah desicrbtion is about 80 km to the south of Baghdad. Samples were taken on the east bank of the river only, while the opposite bank was occupied by agricultural land, the seconed station, Al- Zubaidiyah It is located southward from the first site above 20 km by the river, the thired location, Al- Numaniyah This station is about 55km from st.2 This station is characterized by agriculture with a wide irrigation network on both sides of the Tigris River , The fourth location, Kut (Al-Meftah) It is located beginning the river enters Kut city, and 45 km away from station 3. The seconed Province Salah al-Din located at latitude N 35.653 33.625 and longitude E 42.445 44.851 represented fifth location Samarra dam is one of the important dams on the Tigris River, which was built to prevent floods from Baghdad, as the distance from Baghdad is about 130 km Near by is a sewage circuit that dumps sewage waste. The third Province is Baghdad city is located at latitude N 33.748 32.831 and longitude E 43.771 44.912 Considered as sixth location, Al- Muthanna Bridge is station at the entry of Tigris River to the north of Baghdad City, The banks of the river are covered by rocks and are characterized by enhanced development of reed and papyrus vascular plants. The seventh station, Al-Jadriya Contains important facilities in Baghdad, the campus of the University of Baghdad is located at the end of the Jadriyah which is also one of the residential station and is famous for the existence of orchards. Also, is far from Al- Muthanna bridge (23 km). The eight location, Al- Utifi is located in the center of Baghdad and is far from Al-Jadriya site is about 14 km. The region enjoys a hot and semi-arid general climate, spanning about eight months, and short, cold winters about three months. The climates of Iraq are affected by the subtropical regions' high levels of humidity and drought, with wintertime highs of 12°C and wintertime lows of 4°C, and summertime highs of 50°C with frequently very brilliant sun (Fouad and Zina, 2017). Due to its influence beneath the southern coastal regions of the Arabian Gulf, rivers, streams, and North and south of the research area, the region is primarily agricultural in nature, densely populated around the Tigris River, and dependent on chemical fertilizers. (Ali et al., 2019). It is interspersed with some factories, laboratories, commercial activities, hospitals and recreational centers whose wastes are discharged into the Tigris River, as well as human and residential complexes that drain heavy water waste into the Tigris River as well. And without scientific treatment, which exposes the water to pollution (Ali,2018).

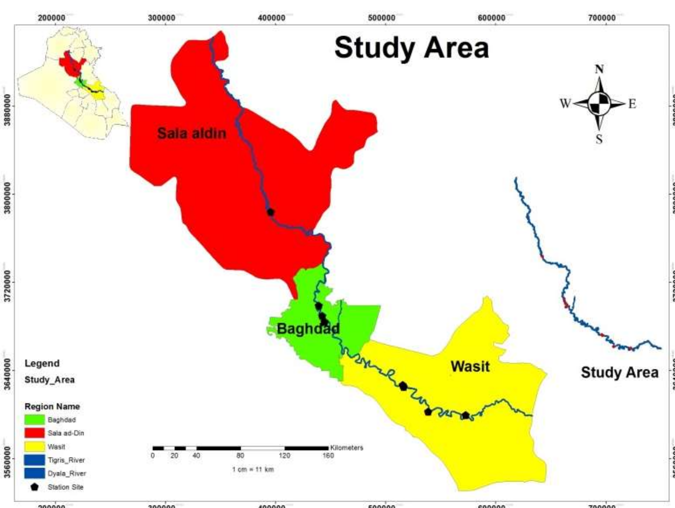

Figure (1). Map of Study area of Tigris river pass throw three cities in Iraq.

Table (1). Distance between each site from the other and the length of the study area.

Area 1	Lentht1	Lentht-nam

782685	922812	Al-Kut to Omara boundary
782685	1660210	Samarra to Al-Muthanna Bridge
782685	2035370	Samarra to Karkuk boundary
782685	138869	Al-Muthanna Bridge to Al-Utifia
782685	937161.1	Al-Atifia to Al-Jadria
782685	1794340	Al-Jadria to Al-Azizia
782685	19695.3	Al-Azizia to Al-Zubadia
782685	523673	Al-Zubadia to Al-Numania
782685	638161	Al-Numania to Al- Kut

Material and Methods

The locations of the station were collected by using a mobile GPS, shown in Table (2).Physical and chemical water quality parameters divided two type parameter (Fieled Measurements) which include pH, TDS by using multimeter. and Laboratory Measurements, which include Total Nitrogen (APHA ,2005),Total Phosphorus (APHA ,2005) and turbidity by using Turbidity meter different water quality characteristics were tested and analyzed in the samples.

Table(2). Sample sites and their GPS values.

Station	Station Name	Longitude (ϕ)	Latitude (λ)	X-Coordinate (UTM)	Y-Coordinate (UTM)
1	**Al- Azizia**	45.162487	32.778982	3626796.983	515216.599
2	**Al-Zubaidi**	45.173651	32.762858	3625011.197	516265.02
3	**Al-Numani**	45.409655	32.559483	3602526.899	538457.348
4	**Al-Kuit**	45.789193	32.545552	3599349.888	572649.1666
5	**Al-muthanna Bridge**	44.343277	33.426066	3698715.025	438947.703
6	**Al-Utifi**	44.543277	33.326066	3690673.67	442219.4363
7	**Al-Jadriya**	44.401702	33.294768	3684125.385	444295.676
8	**Salah al-Din**	3783877.163	395414.866	3783877.163	395414.866

Spatial mapping using interpolation technology by applying GIS softwareand field data measurements are two methodologies used in the study's methodology Fig.(2). The results of the water quality analysis were then utilized to populate the average concentration per station point in the GIS 10.4 software. The water quality measurements were merged with the sample site stations to generate anticipated interpolation geographic maps. The IDW technique was used in this study to create a spatial interpolation map of water quality distributions to anticipate unexplained values at a specific location as an average distance value known to the surrounding areas of unidentified points. The nearest points in the prediction position will effect the predicted values more than the farther away points in the IDW approach (Fouad, 2020).

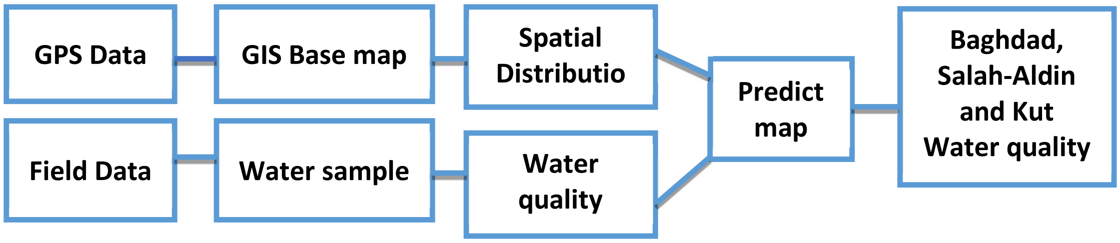

Figure (2). Show of the methodology used to analyze the water quality in study area.

Results and Discussion

Table 3 shows the findings of the physical and chemical parameters (pH, TDS,~~TN~~ ,TP and Turbidity) that were tested in all sampler stations. In this study spatial five physical and chemical water measured to make a distribution map. Random, irregularly spaced stations were selected, representing all human activities along the river, which represents the study area, for a period of three months (February, March, and June) in 2022, beginning in Salah al-Din Province, moving through Baghdad, and completing in Kut Province. Expectation (predictive) maps produced using GIS computer application were produced using IDW interpolation technique (Jasim and Mashee, 2020). provides spatial distribution maps to measure the quality of the water as well as information on the parameters' concentrations in chemical and physical elements, For all parts of the study area.

Table (3). Physico-chemical concentrations along of the Tigris River's results for three Province Salah al-Din, Baghdad and Al-Kut**.**

Parameters	*ST1	**ST2**	**ST3**	**ST4**	**ST5**	**ST6**	**ST7**	**ST8**
	Parameters for February							
pH	6.73	6.6	6.57	7.7	6.6	7.8	6.5	6.7
TDS mg/L	225	421	430	239	480	486	485	480
TN.mg/L	0.23	0.45	0.33	0.1	0.23	0.25	0.71	0.54
T P. mg/L	0.13	0.12	0.17	0.17	0.17	0.09	0.26	0.22
Tur. NTU	10	12	13	15	14	17	14	15
Parameter for March								
pH	7.5	7.7	7.6	7.7	7.8	7.8	7.9	7.9
TDS mg/L	334	324	350	239	437	486	480	468
TN.mg/L	0.3	0.14	0.13	0.1	0.24	0.25	0.22	0.2
T P. mg/L	0.17	0.05	0.064	0.17	0.1	0.09	0.077	0.1
Tur. NTU	11	13	15	15	16	17	17	18
	Parameter for Jun							
pH	7.2	7.5	7.6	7.3	7.7	7.8	7.5	7.6

TDS mg/L	173	147	149	200	310	274	234	260
TN.mg/L	0.74	0.4	0.5	0.6	0.55	0.6	0.6	0.65
T P. mg/L	0.027	0.047	0.063	0.062	0.06	0.068	0.075	0.08
Tur. NTU	5	8	10	12	13	15	14	16
Iraq limits	**P1=6.5-8.5**		**P2=1000**		**P3 , p4 = -**		**P5 =5**	
WHO	**P1=6.5-8.5**		**P2=500**		**P3 , p4 = -**		**P5 = 5**	

ST1(Salah al-Din), ST2(Al-Muthanna Bridge), ST3(Al-Utifia), ST4 (Al-jadria), ST5 (Al-Azizia), ST6 (Al-zubadia), ST7 (Al-Numania) and ST8 (Al-Kut). P (parameter)

1-Potential Hydrogen (pH)

Concentration of hydrogen ions pH, which is used to establish whether water is acidic or alkaline, is a major indicator of the quality of the water and the extent of pollution in river and basin areas. The results indicate minor variations over the course of the study, and for the locations chosen, the lowest value (6.5) was recorded at ST7 for the month of February (7.9) and the highest value was ST7 for the month of March, as shown as Figure (3) and Table (3).In general, the pH concentrations are in the narrow range and slightly alkaline, the pH value is directly related to the bicarbonate current and carbonate ion in the water according to the decomposition of organic matter and the release of organic acids into the river's sewage water, as well as the presence of other factors that affect pH values, including temperature variations and organism respiration (Ameen et al.,2019). It was within WHO standards and Iraqi standards of the allowable limit of pH. The spatial distribution map depicts the pH distribution in the water selected samples in the study area. These values are thought to be within the netural range, however a decline in the level of high water and an increase in the rate of emission as well as rain may cause pH values to slip (Zerveas et al.,2021). The outcomes were compared to those given in and actually better than those mentioned (Ilayaraja, and Ambica, 2015, Obaid, 2021) .

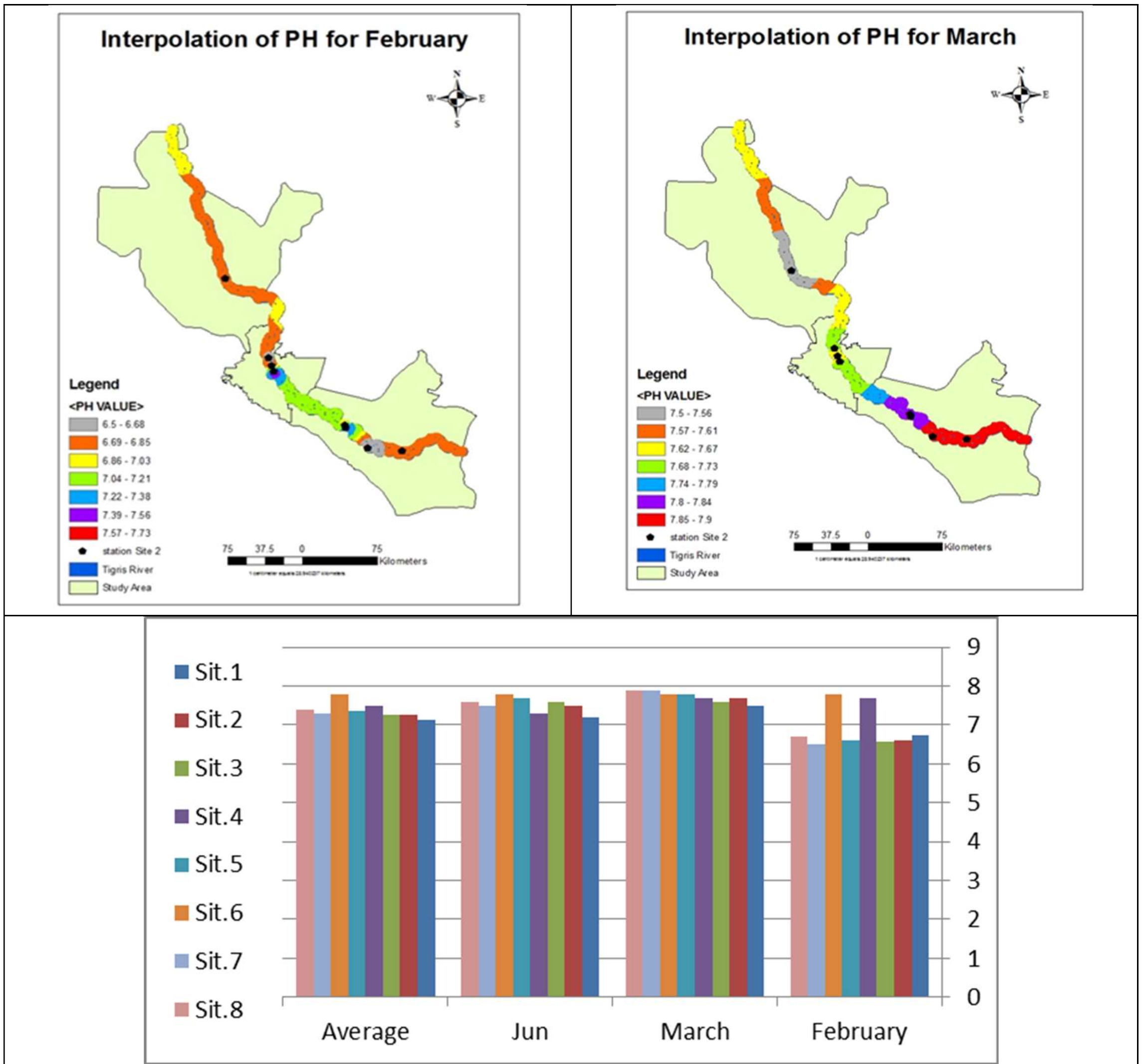

Figure (3). The monthly variations potential hydrogen (pH) in study sites during the study period.

2-Total Dissolved Solids (TDS)

TDS is the total amount of dissolved solids in a water sample. As a result, the TDS concentration is the study's key pollution. As shown in Table 3, the TDS values in the research area ranged from the lowest of 147 mg/L for site ST2 in the month of June to the highest of 486 mg/L for site ST6 in the months of February and June.The cause is the combining of polluted water from the surrounding residential and agricultural areas with the river, given that they possess more than 1000 mg/L of brackish water, these water samples are regarded as such, these values can be found in suspended matter, including lipids, dirt, and animal excrement (Khalaf et al., 2019). On the other hand, when the river's water level is low, the concentration rises, which causes an increase in muck and turbidity. The outcomes were the worse than what was projected, (Al Naqeeb et al., 2020 and Jabbar, 2021). Geographic distribution of dissolved solids concentration along the river for the research region, as shown in Fig (4). Total dissolved solids can be contrasted between regions and months.).

In general, TDS the concentrations are within the WHO standards and Iraqi standards of the allowable limit of TDS .

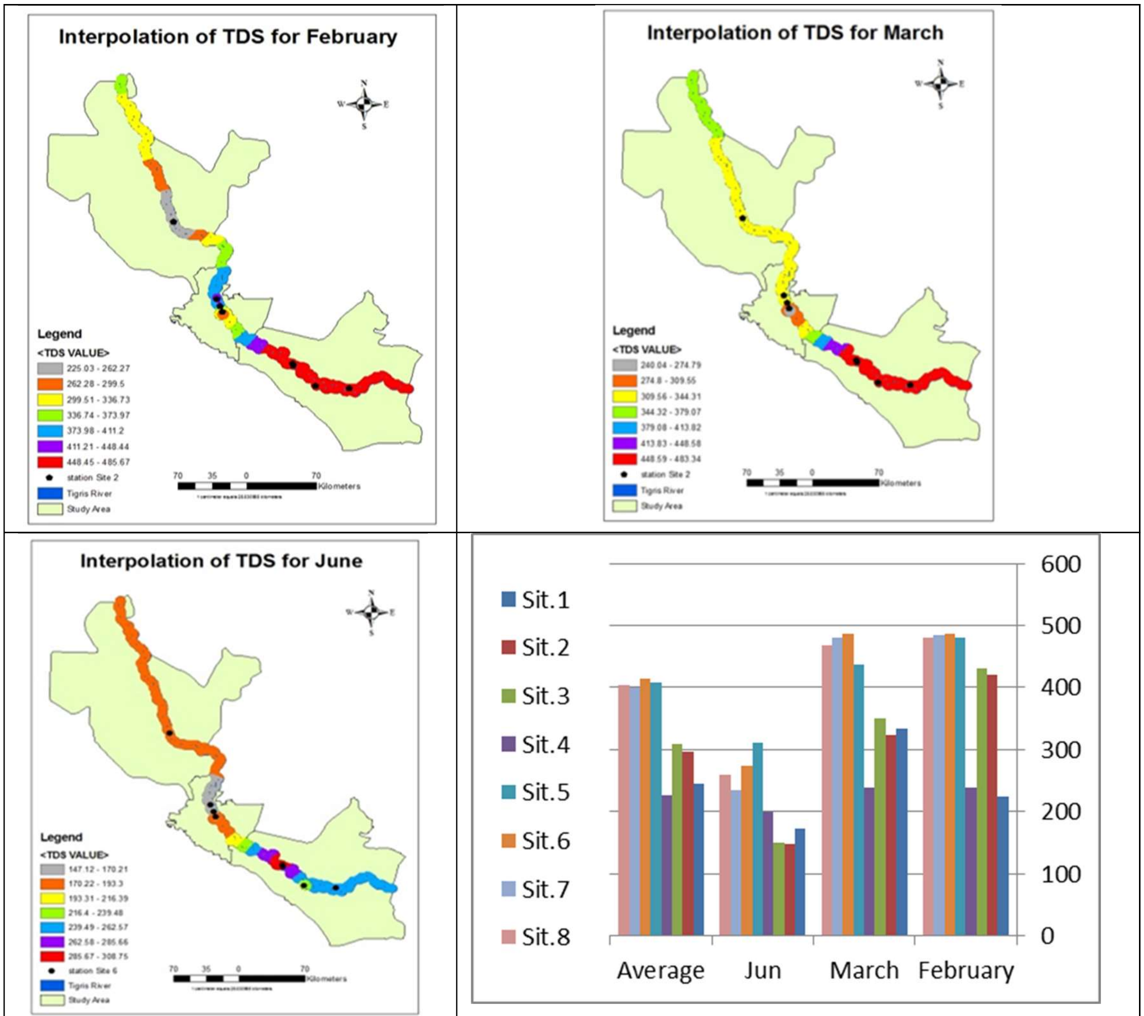

Figure (4). The Monthly Variations Total dissolved solids in Study Sites during the Study Period.

3-Total Nitrogen (TN.)

One of the most significant elements in the river environment is nitrogen, which limits nutrient availability and essential for the development of algae, especially diatoms. a vital element in numerous metabolic activities, including the generation of fatty acids and proteins in diatom cells. It is also essential for epiphyseal diatoms and acts as an economic agent (Berkessa et al.,2019) . The spatial distribution appear, the values of total nitrogen in this investigation ranged from the lowest of 0.1 mg/L in March at ST4 to the maximum of 0.74 mg/L. The research findings could have an impact on how organic matter decomposes, how detergents are used, and how agricultural land is used. Decomposition of organic materials and deceased organisms (and Al Naqeeb et al., 2020). As shown in Figure (5) and Table (3).

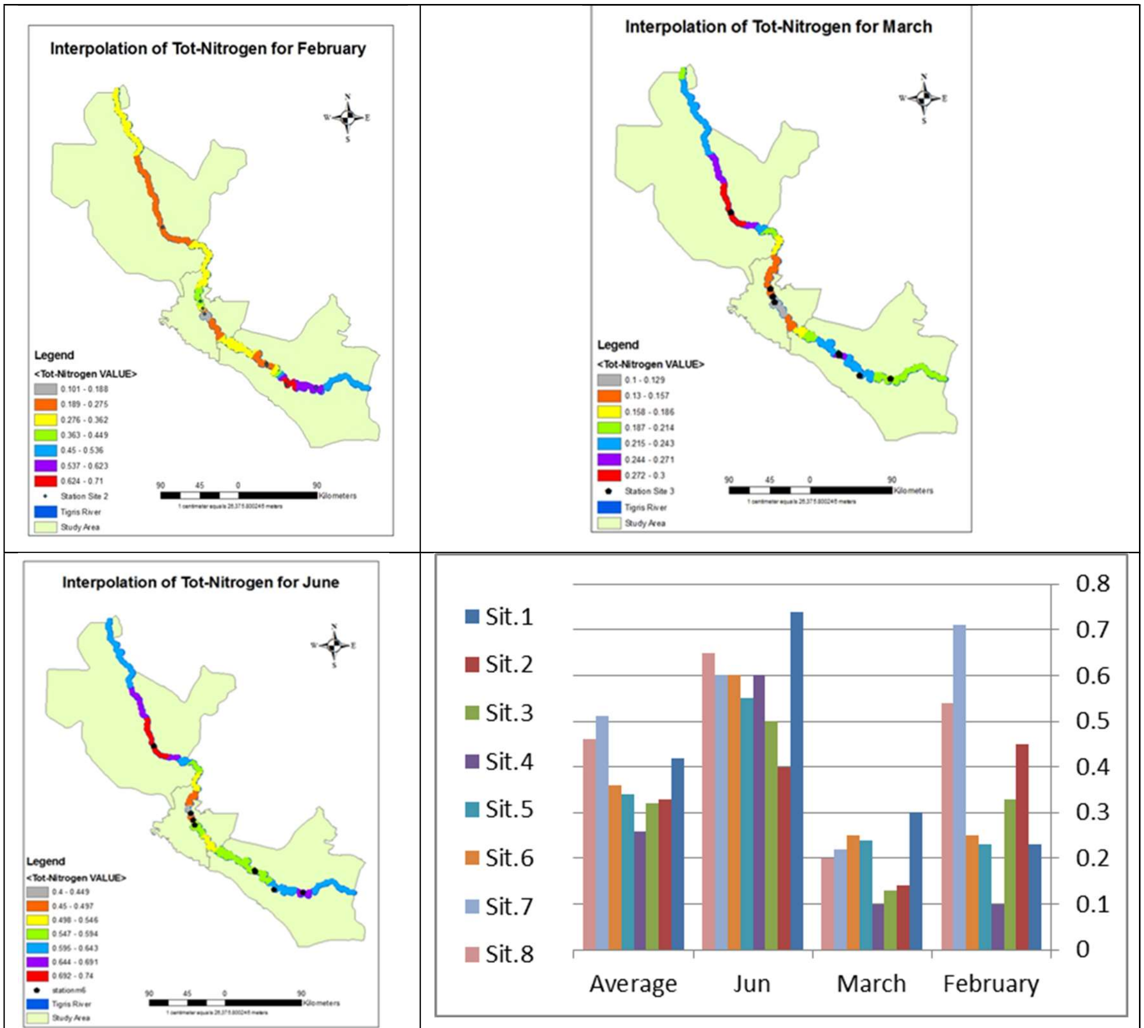

Figure (5). The Monthly Variations Total Nitrogen in Study Sites during the Study Period.

4-Total-phosphorus (TP)

The Tigris River's waters contain soluble and insoluble complexes of phosphorus in both inorganic and organic forms. The orthophosphate ions PO_4-^{3}, HPO^4, and H_2PO^{-4} are examples of inorganic forms (Faulkner & Richardson , 2020). The geographic variation according to the study's findings of , total phosphorus levels were lowest in Station1 during the month of June and greatest in Station 8 during the month of February , As shown in Figure (6) and Table (3).

Phosphorus in river water may have a greater value as a result of sewage water discharge since it may include significant volumes of rich phosphate) . Liu et al., 2017).

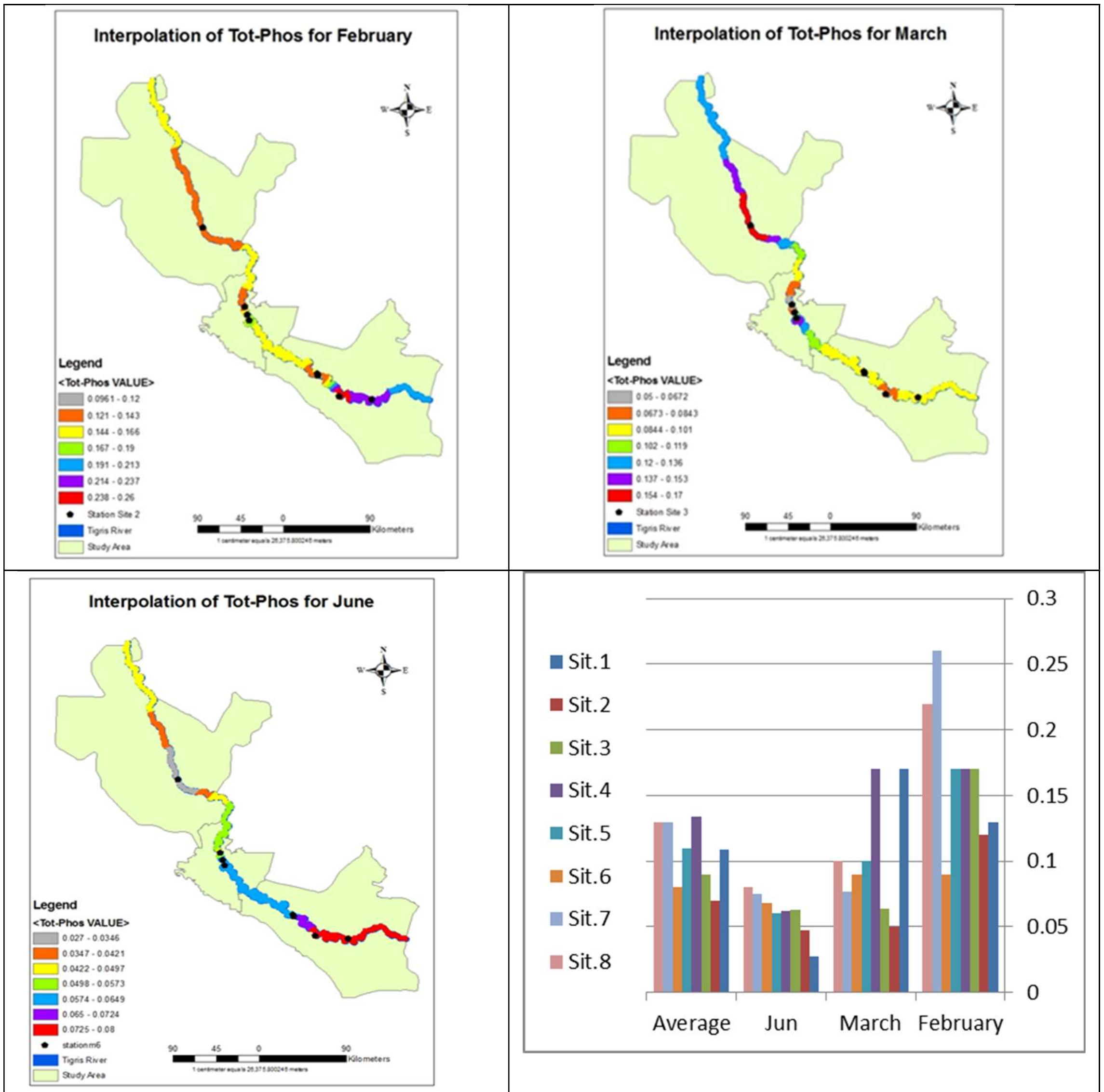

Figure (6). The monthly variations total phosphorus in study sites during the study Period

5-Turbidity

Water quality is determined by turbidity. Microorganisms like silt may organically generate turbidity. This in turn blocks out the light, causing huge cells of algae to produce less primary material (Tiwari, 2015). The spatial variation, finding showed off that the turbidity values varied between the lowest value of 5 NTU in June at Station 6 and the highest value of 18 NTU in March at ST8, shown as Figure (7) and Table (3). According to, increased water flow and water level result in the transfer of benthic effluents to the water column and the erosion of soil and other floodplain debris, while low water flow resulted in ordinances, (Obaid, 2021). Typically, turbidity concentrations are higher than both the WHO and Iraqi criteria for acceptable turbidity levels.

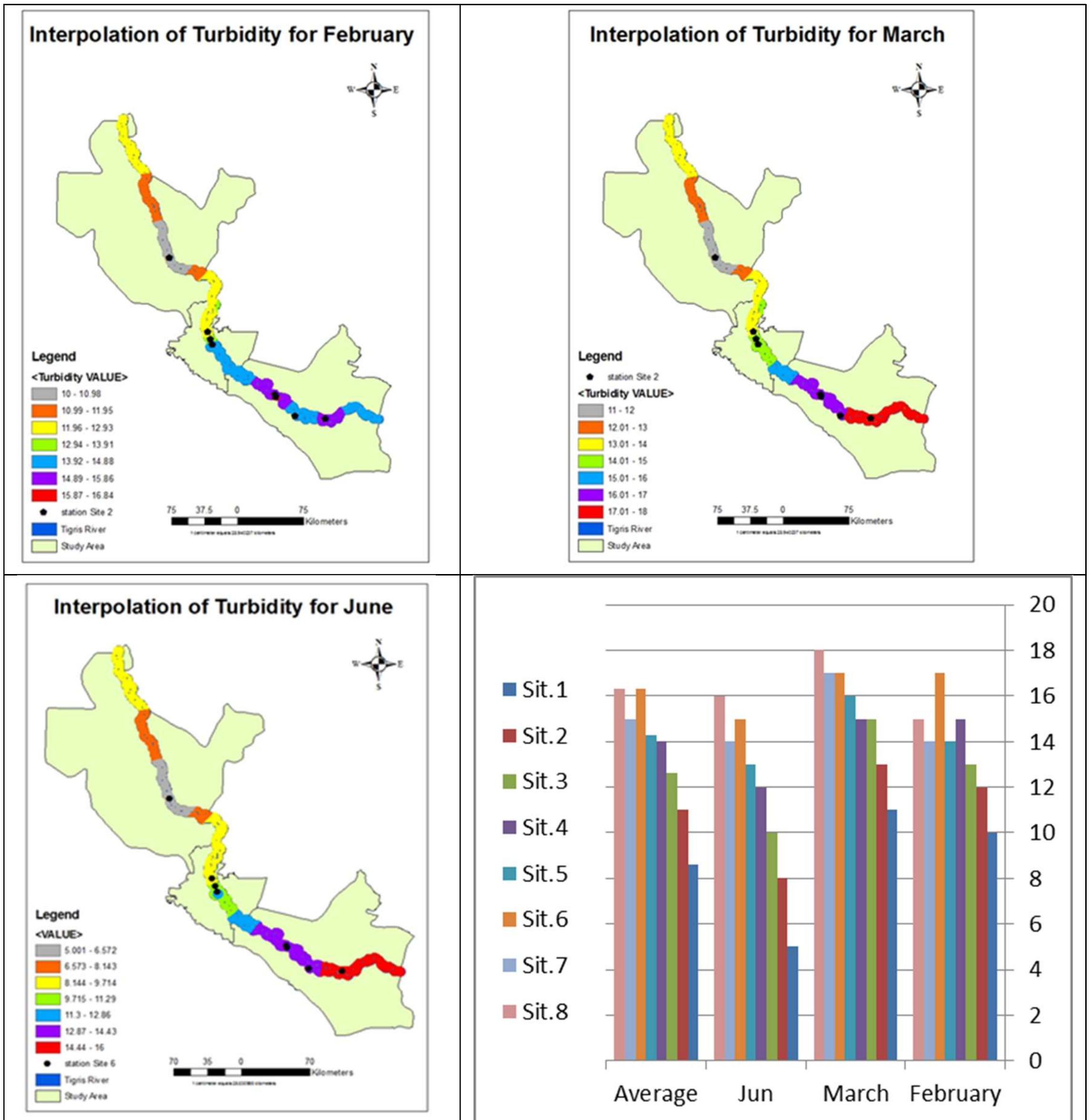

Figure (7). The monthly variations turbidity in study sites during the study period.

Conclusions

The Tigris River is the main source in the study area sites. It was tested in 2022 and examined five components of its water. Water quality indicators include pH, total dissolved solids, total phosphorous, total nitrogen, and turbidity. The results showed that there were differences between the study sites from site 1 to site 8 and between the duration of the current study (February - March

- June) in addition to the choices made for the parameters in the current investigation. The values of pH and values of dissolved solids within the permissible Iraqi and World Health Organization standards ranged between (6.5-7.9), while the values of total nitrogen, total phosphorous and turbidity were above the Iraqi standards and the World Health Organization permitted, as it was (0.1-0.74) mg/ Liter, (0.027 -0.22) mg/L (5-18)NTU respectively , Since about 60% of the standards are outside the limits of the permissible (Iraqi and WHO) standards, therefore, they are considered unfit for uses and which confirms the presence of environmental pollution within the study area .

References

1- Al-Ansari N. (2019). Hydro Geopolitics of the Tigris and Euphrates. In Recent Researches in Earth and Environmental Sciences. *Springer, Cham*, 35-70.

2- Kibaroglu, A. (2019.). State-of-the-art review of transboundary water governance in the Euphrates– Tigris river basin. International Journal of Water Resources Development, 4-29.

3- Abed, B. D. (2021). Water quality modelling and management of Diyala river and its impact on Tigris River. Journal of Engineering Science and Technology, 122-135.

4- Ghalib, H. (2017). Groundwater chemistry evaluation for drinking and irrigation utilities in east Wasit province, Central Iraq. Applied Water Science, 3447-3467.

5- Hadeel Kh. Hammood, F. K. (2022). Measurement and Analysis of the Distribution of Pb-214 Lead Isotope in Baghdad Soil using Remote Sensing Techniques. Iraqi Journal of Science, 897-907. DOI: 10.24996/ijs.2022.63.2.41.

6- Muaid Jassim Rasheed and Fouad K. Mashee Al-Ramahi. (2021). Detection of the Impact of Climate Change on Desertification and Sand Dunes Formation East of the Tigris River in Salah Al-Din Province Using Remote Sensing Techniques. Iraqi Geological Journal, 13-23.

7- Fouad K. Mashee Al Ramahi, Z. K. (2020). The Spatial Analysis for Bassia eriophora (Schrad.) Asch. Plant Distributed in all IRAQ by Using RS & GIS Techniques. . Baghdad Science Journal, 126-135.

8- Ahmed S. M., M. F. (2022). Evaluate the Effect of Relative Humidityin the Atmosphere of Baghdad City urban expansion Using Remote Sensing Data. Iraqi Journal of Science, 1848-1859. DOI: 10.24996/ijs.2022.63.4.41.

9- Fouad K. M. A., Z. K. (2017). Estimation of Suaeda aegyptiaca Plant distribution regions at Iraq using RS & GIS Applications”. Iraqi Journal of Science, 767-777, DOI:10.24996.ijs.2017.58.2A.20

10- Ali K. Mohammed Ali, F. K.-R. (2019). Evaluation of impact of vegetation decrease on precipitation rates in Baghdad City using remote sensing technique. *Eco. Env. & Cons*, S48-S54.

11- Ali K. M. A., F. K. (2020). A study of the Effect of Urbanization on Annual Evaporation Rates in Baghdad City Using Remote Sensing. *Iraqi Journal of Science*, 2142-2149.

12- Ramahi F. K. M. (2020). "Spatial Analysis of Radon Gas Concentration Distrbuted at Baghdad City Using Remote Sensing and Geographic Information System Techniquesd". *Iraqi Journal of Agricultural Sciences* , 21-32.

13-Standerd Methods for the Examination of Water and Wastewater:APHA, AWWA and WFF,21 st Eduction,2005.

14- Jasim M. S., M. F. (2020.). Monitoring and calculating the carbon dioxide emissions in Baghdad and its effect on increasing temperatures from 2003-2018 using remote sensing techniques data. *Periódico Tchê Química*, 117-128.

15- Ameen F, Almaarofi S, Talib A, Almansob A, Al-homaidan AA. Phytoplankton diversity recovers slowly and cyanobacterial abundance remains high after the reflooding of drained marshes. Hydrobiologia. 2019; 843(1): 79-92

16- Zerveas S, Mente MS, Tsakiri D, Kotzabasis K. Microalgal photosynthesis induces alkalization of aquatic environment as a result of H+ uptake independently from CO2 concentration–New perspectives for environmental applications. J Environ Manage. 112 2021;289:112546

17- Ilayaraja K. and Ambica A. (2015). Spatial distribution of groundwater quality between injambakkamthiruvanmyiur areas, south east coast of India. *Nature Environment and Pollution Technology*, 771-776.

18- Obaid M. A. (2021). Using Geographic Information Systems (GIS) and Epiphytic Diatoms for Monitoring Water Quality of Tigris River-Baghdad City/Iraq. *A Thesis submitted of College of Science for Women-University of Baghdad*, 1-119.

19- Neran A. AL Naqeeb, J. S. (2020). Assessment of the water quality of Um El-Naaj Marshes by Diatoms. *Eco. Env. & Cons*, 449-464.

20- Jabbar, K. (2021). Assessment of Water Quality in Tigris River of AL-Kut City, Iraq by Using GIS. *E3S Web of Conferences • January*, https://doi.org/10.1051/e3sconf/202131804001.

21- Berkessa YW, M. S. (2019). Simultaneous removal of nitrate and phosphate from wastewater using solid waste from factory. *Appl Water Sci*, 1–10.

22- Al Naqeeb N. A., M. F. (2020). Estimation the Factors Affecting on Growth of Algae in Um El-NAAJ Lake By Using Remote Sensing Techniques. . *Periódico Tchê Química*, 227-238.

23- Faulkner S. P. and Richardson C. J. (2020). Physical and chemical characteristics of freshwater wetland soils. *Constr Wetl wastewater Treat*, 41–72.

24- Tiwari S. (2015). Water quality parameters–A review. *Int J Eng Sci Invent Res Dev*, 319–324 .

25- Raikar R. V. and Sneha M. K. (2012). Water quality analysis of Bhadrav athi taluk using GIS – a case study. *INTERNATIONAL JOURNAL OF ENVIRONMENTAL SCIENCES*, 2243-2253.

26-Standard Specification (2001). Drinking Water, Iraq. First modernization,no.417,the council of Ministers Central Apparatus for Assessment And Quality Control, 5pp.

27-WHO, World Health organization (2004). ,, International Standards of Drinking Water,,
3 rd Edition, Volume 1, Recommendations ,Geneva 515pp.

28-Ali SK. Assessment of the Tigris River water quality in selected Iraqi governments. Int J Sci Res. 2018;7:500–4.

29-Khalaf SM, Hassan FM, Al-Obaidy AHJ. Detection of polycyclic 111 aromatic hydrocarbons compounds concentrations and their fate in Tigris River within Baghdad City Iraq. Iraqi J Agric Sci. 2019;50:231–44.

30. Liu Y, Dedieu K, Sánchez-Pérez J-M, Montuelle B, Buffan-Dubau E, Julien F, et al. Role of biodiversity in the biogeochemical processes at the water-sediment interface of macroporous river bed: an experimental approach. Ecol Eng. 2017;103:385–93