Plant Archives Vol. 19, Supplement 1, 2019 pp. 260-267 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

WATER QUALITY MONITORING OF AL-GHARRAF RIVER SOUTHERN OF IRAQ BY USING GIS MAPPING BASED WATER QUALITY PARAMETERS

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Abstract

The research deals with assessment of water quality of Al-Gharraf River Southern of Iraq. Samples were taken monthly from December 2016 till November 2017 for a year, from twenty one sites along of the river. The study indicates that analysis of water quality parameters (WQPs) with the help of geographic information system (GIS), would prove a viable method of characterizing the water quality of the river. The analytical results show high concentration of turbidity (NTU), electrical connectivity (EC), total dissolved solid (TDS), total suspended solid (TSS),biological oxygen demand (BOD5), total hardness (TH), sulfate (SO_4), chloride (Cl), phosphate (PO_4), lead (pb), chlorophyll-a (CHL-a) and fecal coliform (FC), which indicates signs of deterioration along Al-Gharraf River.

Keywords: Al-Gharraf River, Water quality parameters, Water Quality, GIS.

Introduction

Water, a prime natural resource and precious national asset, forms the chief constituent of ecosystem. Water sources may be mainly in the form of rivers, lakes, rain water, ground water etc. Besides the need of water for drinking, water resources play a vital role in various sectors of economy such as industrial activities, agriculture, livestock production, fisheries and other activities. The availability and quality of water either surface or ground, have been deteriorated due to some important factors like increasing population, industrialization, urbanization etc (Shweta *et al.,* 2013).

The Geographic Information System (GIS) are used to facilitate collecting, storing, and analysis the databases for the water quality parameters (Shamsi, 2005). The GIS also enables the team to display the data on different scales and views to be understandable by the environment and water responsible figures to support the project continuity, especially the use of GIS that is new technology in Iraq.

The Al-Gharraf River is one of the largest branches from Tigris near Al-Kut city and flows through Wasit and Dhi-Qar provinces south of Iraq. And is considered the main source for agriculture and public water supply and has impacts on the socio-economic aspects of the area. The main objective of this study is used a GIS to compare water quality data and related information collected for water quality in Al-Gharraf River, and display the distribution of pollution in the river in easily viewed maps that can be used by the public and decision makers.

Material and Methods

Study Area

The Al-Gharraf River is one of main branches of the Tigris River at Kutt City, 225 km south of Baghdad City. After branching from the Tigris, the Al-Gharaff flows southeast toward Dhi-Qar Province. The River is 230 km in length with a variable depth of 75 m at its branching point from the Tigris to 15.0 m at its junction with the Euphrates River at the Al-Hammar marsh north of Nassyria City as presented in Figure (1).

Water samples collection and analysis.

Water samples for physical, chemical, and microbiological variables were performed from twenty one sites during period extended from the December 2016 till November 2017. Water samples were collected for physiochemical analysis using pre-washed polyethylene bottle by water sample twice before filling.

The studied physical, chemical, and microbiological parameters: water temperature (by using precise mercury thermometer), hydrogen ion concentration (by using pH-meter), electrical conductivity (by using EC-meter), turbidity level (by using turbidity-meter), dissolved oxygen, biological oxygen demand (Winkler methods), sulfate, nitrate, reactive phosphate, chlorophyll-a (by using spectrophotometric methods), total hardness and chloride (by using titrimetric methods), heavy metals (by using flame atomic absorption spectrophotometer), and fecal coliform (by using most probable number (MPN) technique), were measured according to APHA (2005).

Geographica Information System (GIS) Analyses.

For a better understanding and interpretation of the analyzed results, the concentrations of various parameters at various locations were integrated with GIS (Sharma *et al.,* 2017). The present study used the kriging interpolation method for generate the thematic water quality variation maps and water quality index to see the spatial distribution of water quality over river Al-Gharraf. Finally maps showing spatial distribution were prepared to easily identify the variation in concentrations of the different parameters in the surface water of study area (Katyal *et al.,* 2012).

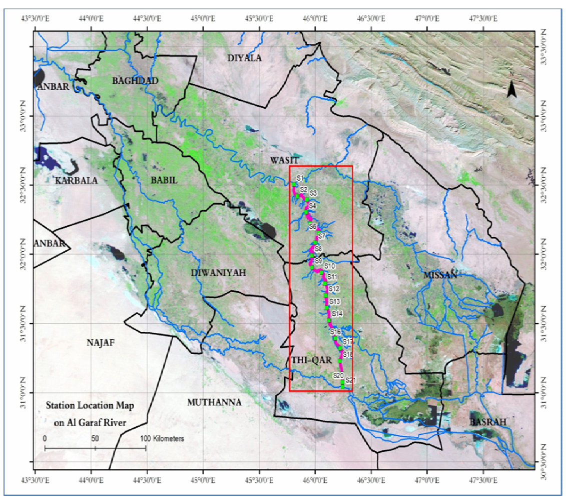

Fig. 1 : Digital map of Al-Gharraf River showing the stations of the case study.

Result and Discussion

Table (1): illustrates the annual mean values of 18 water quality parameters which compared with three standard of Iraqi Criteria & Standards of water's chemical limits (ICS), number 417/2001, first update 2001, World Health Organization (WHO) (2006), and Canadian Council of Minis-tries of the Environment (CCME) (2012).

Water Temperature (WT)

The water temperature is an important factor in any aquatic environments affecting on chemical and biological processes (Simon *et al.,* 2011), in this study it was ranged between 9 to 33ºC, as shown in Figure (2), and statistical analysis showed that water temperature was significantly differences ($P<0.05$) among seasons, while no significant differences between stations.

Power Hydrogen (pH)

The pH value of aquatic system is indicates the strength of the water to react with the acidic or alkaline material present in the water (Yousry *et al.,* 2009). The pH in this study ranged 6.51 to 8.25, as presented in Figure (3), and statistically the regional and seasonal showed significant differences ($p< 0.05$). The pH values were within the permissible level set by Iraqi standards for drinking water, 2001, No. 417, and CCME in 2001 for aquatic life which were between 6.5-8.5, as shown in Table (1).

Electrical Conductivity (EC) and TDS

The EC is a measure of water capacity to carry the electrical current, it used as an indicator of water quality based on total dissolved salts (Ezzat *et al.,* 2012). The results were revealed that the EC was ranged between 700 to 1652 μS/cm, while TDS was ranged between 448 to 1057.23 mg/l, as indicated in Figure (4).

The data of EC and TDS indicated significant differences ($p< 0.05$), among studied stations and seasons. However, the concentrations of TDS were found to be above the highest allowable levels of Iraqi standards for drinking water, 2001, No. 417, and CCME in 2001 for aquatic life, while the concentrations of EC was found to be below the highest allowable levels of the mentioned guide line, as presented in Table (1).

Turbidity and Total Suspended Solid (TSS)

Turbidity is refers water clarity, it is a measure of the total suspended matter in water, caused by clay, silt, organic and inorganic matters, plankton and other microscopic organisms (Fulazzaky, 2010). In this study turbidity values ranged from minimum of 11 to maximum of 176 NTU, while the lowest TSS value was 23 mg/l and the highest value was about 194 mg/l, as presented in Figure (5).

The statistically results the showed significant differences ($p< 0.05$) among studies stations and seasons. The observed turbidity and TSS values of the river were above the permissible level recommended by Iraqi standards for drinking water No. 417 in 2001 and CCME for aquatic life, as indicate in Table (1).

Dissolved Oxygen (DO) and BOD_5

DO is one of the important factors, and it is very necessary for all living organism (EPA, 2013). The results in this study were revealed that the DO level was ranged from 3.42 to 10.8 mg/l, as shown in Figure (6), while BOD_5 value was ranged among 0.79 to 9.07 mg/l, as indicated in Figure (7).

The statistical analysis showed that there was significant differences ($p< 0.05$), were observed among studied stations and seasons. However the concentrations of DO and BOD_5 were found to be above the highest allowable levels of Iraqi standards for drinking water, 2001, No. 417 and CCME in 2001 for aquatic life.

On other hand, high levels of BOD_5 and low levels of DO, in paricular for the stations in Dhi-Qar Governorate, were observed during the warm summer months (June, August and September) which coincided with a high water temperature and low DO. additionally to decomposition of organic matters run directly to the river with domestic sewage.

Major Cations (Total Hardness and Na^+)

Hardness is one of the important chemical properties to determine the suitability of water for domestic drinking and industrial purposes, it is depends mainly on the presence of dissolved calcium and magnesium salts (Cheepi, 2012). The observed values of TH for water samples of the Al-Gharraf River was ranged from minimum of 218 to maximum of 689 mg/l, as shown in Figure (8). On other hand, the concentration of Na^+ is varied from 29 to 173.6 mg/l, as display in Figure (9).

Based the permissible limit of Iraqi standards for drinking water No.417 in 2001, WHO water quality standards in 2010 for irrigation, and CCME in 2001 for aquatic life, that most sites in Al-Gharraf River is very hard and exceeding allowable levels as presented in Table (1). The data of TH and Na, indicated significant differences ($p > 0.05$), among studied sites and seasons.

Major Anions (Cl^-, SO_4-, NO_3-, and PO_4-).

Most stations of Al-Gharraf River for Cl^-, SO4-, NO_3-, and PO_4- were exceeding the allowable levels of Iraqi standards for drinking water No. 417 in 2001, WHO water quality standards in 2010 for irrigation, and CCME in 2001 for aquatic life as shown in Table (1). The range of chloride (Cl^-) is found to vary between 10 mg/l and 381.3 mg/l for water samples, while sulfates (SO_4^-) was ranged from minimum of 111.8 to maximum of 469, as presented in Figure (10).

However, the NO_3 in river water is observed between 3.01 mg/l and 33 mg/l, and concentration of the PO_4 is varied from 0.107 mg/l and 0.964 mg/l, as shown in Figure (11). From the statistical analysis observed significant differences ($p > 0.05$), among studies stations and seasons.

Furthermore, the high concentrations of Cl^-, SO_4^-, NO_3^-, and PO_4^-, may be a result direct domestic and industrial effluents. Additionally the bad fertilizing and irrigation management in surrounding agricultural areas Al-Gharraf River.

Heavy metals (Pb and Ni).

The occurrence of heavy metals in aquatic environments has led to serious concerns about their influence on plant and animal life (Leena *et al.,* 2012). The study results showed that the heavy metals concentrations (Pb and Ni), were varied between 0.007 – 0.242 ppm and 0.0021 – 0.039 ppm, respectively, as presented in Figure (12and 13).

The concentrations of Pb and Ni were found to be above the highest allowable levels of Iraqi standards for drinking water, 2001, No.417, and CCME in 2001 for aquatic life, as shown in Table (1). However, metals contents revealed that they were obviously significant differences ($p < 0.05$), among studies stations and seasons.

Chlorophyll-a (CHL-a).

High concentration of the chlorophyll-*a* can reflect an increase of nutrient levels in river and can indicate of phytoplankton abundance and primary productivity in aquatic ecosystems (Swain, 2013). In this study CHL-a was ranged between 0.033 to 9.534 mg/l, as indicated in Figure (14), and statistically the results showed significantly difference ($P < 0.05$) among studies sites and seasons. The highest CHL-a values in April and October would be related to phytoplankton blooms, this indicates the high of eutrophication phenomenon in the Al-Gharraf River during the investigated period.

Fecal Coliform (FC).

All sites of Al-Gharraf River for the biological factors were exceeding the allowable limits of Iraqi standards for drinking water No. 417 in 2001, WHO water quality standards in 2010 for irrigation, and CCME in 2001 for aquatic life as presented in Table (1). The results were revealed that the Faecal coliform was fluctuated between 180 to 97000 CFU/100 ml, as shown in Figure (15). From the statistical analysis observed significant differences ($p > 0.05$), among studies stations and seasons.

Conclusions

From the obtained results for physicochemical and biological parameters, it can be concluded that th no Site in Al-Gharraf River meets the drinking water standard; therefore it is not safe for human consumption without elaborate treatment. On other side, GIS can be directly used to analyse and compare conditions across river area and to detect trends over time. Thus, we recommend usage of GIS for improving comprehension of general water quality issues, communicating water quality status and illustrating the need for protective practices.

Table 1: Physico-chemical and biological properties of Al-Gharraf River, data represented as annual mean concentration with Iraqi and international standards.

Parameters	Unit	Mean	Drinking	Irrigation	Living Aquatic
Temperature	◦C	19.8	25*	-	15***
pH		7.36	6.5 - 8.5*	6.5 - 8.4**	6.5 – 9.0***
Turbidity	NTU	1216.02	5*	-	25*
EC	µS/cm	812.6	1500*	2250*	-
TDS	mg/l	52.4	1000*	1500**	500***
TSS	mg/l	72.8	25*	-	50**
DO	mg/l	8.13	>5*	-	5.5-9.0**
BOD_5	mg/l	4.59	<5*	-	-
Hardness	mg/l	402.1	500*	-	500**
Na^+	mg/l	95.29	200*		-
CL^-	mg/l	184.2	250*	100***	250***
SO_4^-	mg/l	282.3	250*	400*	250**
NO_3^-	mg/l	10.14	45*	15**	13***
PO_4^-	mg/l	0.37	0.4*	0.4*	0.1**
Pb	ppm	0.073	0.01*	0.2**	0.007**
Ni	ppm	0.019	0.02*	0.2***	0.15**
CHL-a	mg/l		0	-	0.04**
FC	CFU/1m	25053.8	0*	-	-

- Unknown Criteria; *Iraqi Criteria, (2001) ; **WHO, (2006); ***CCME, (2012).

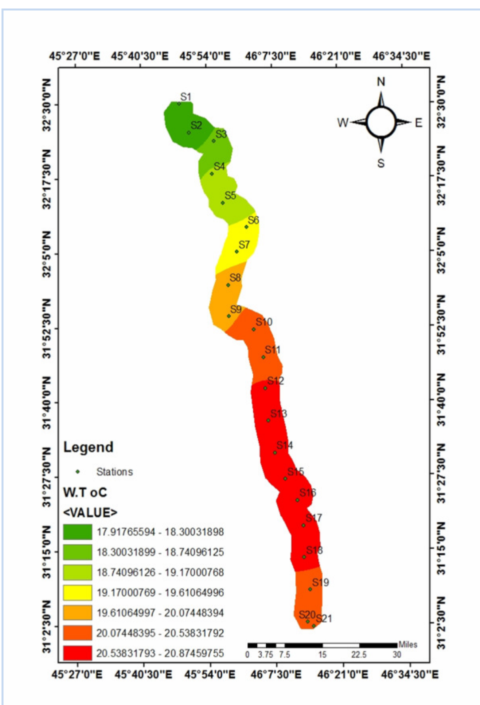

Fig. 2 : Map of water temperature

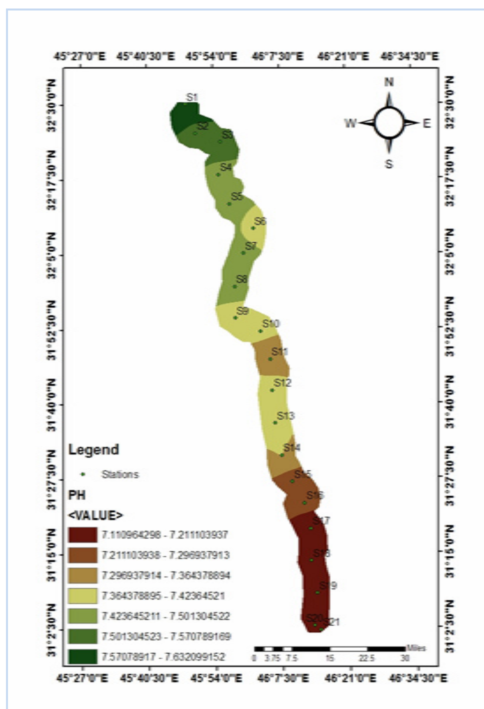

Fig. 3 : Map of pH

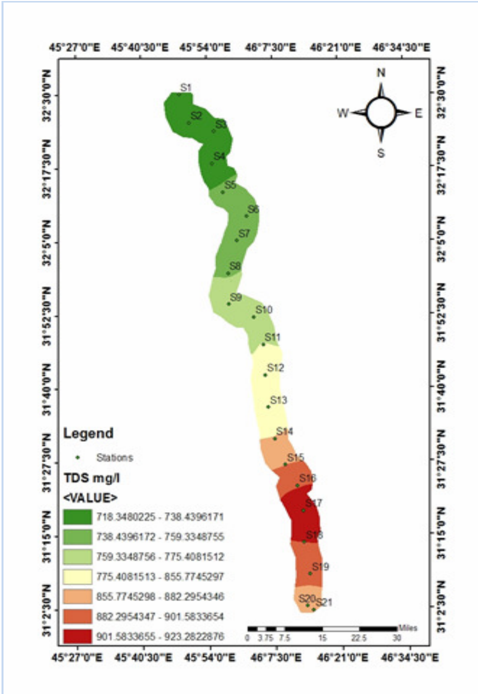

Fig. 4 : Map of TDS

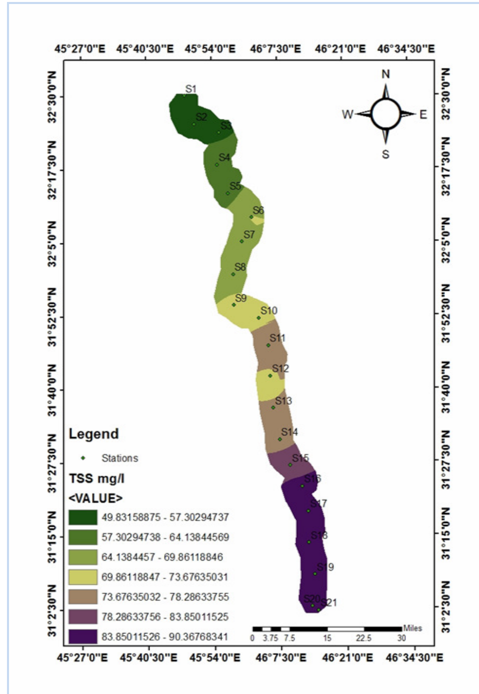

Fig.5 : Map of TSS

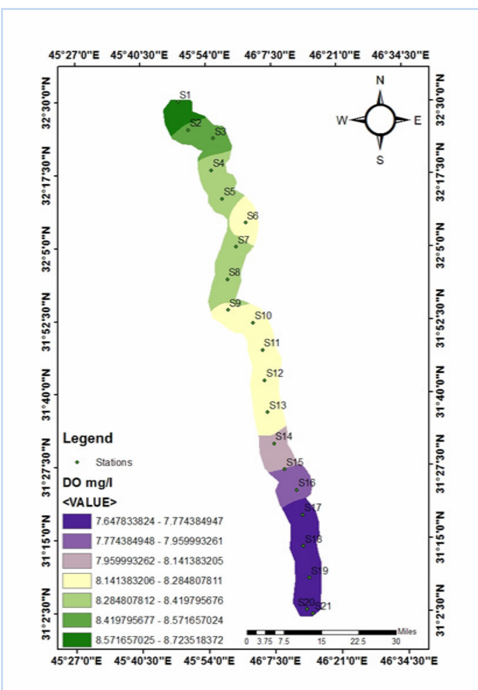

Fig. 6 : Map of turbidity

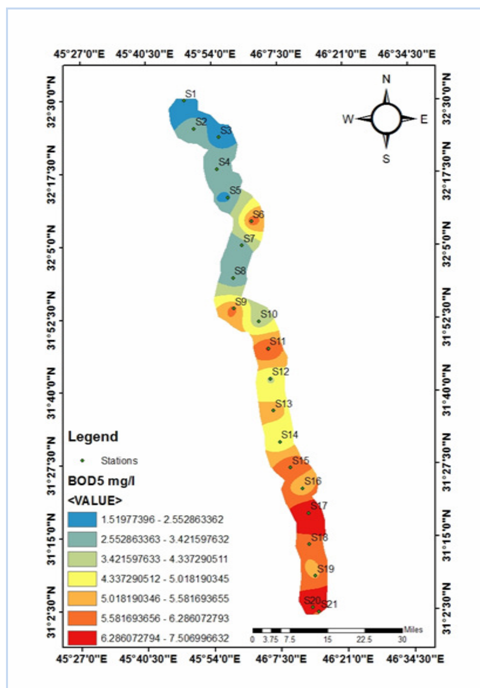

Fig. : 7 Map of BOD5

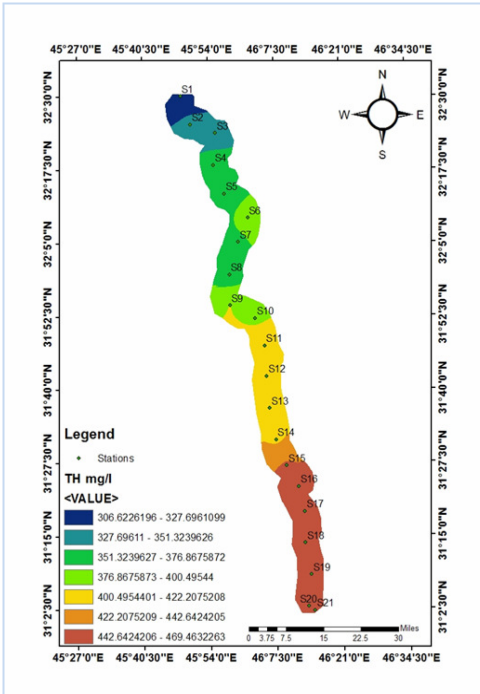

Fig. 8 : Map of total hardness

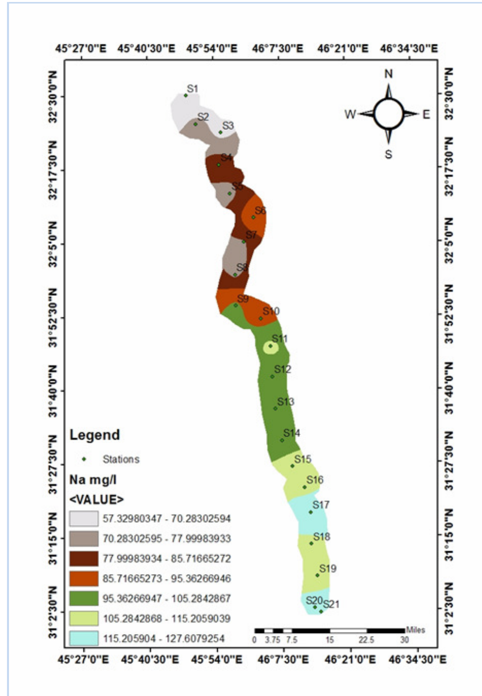

Fig. 9 : Map of Na^{+}

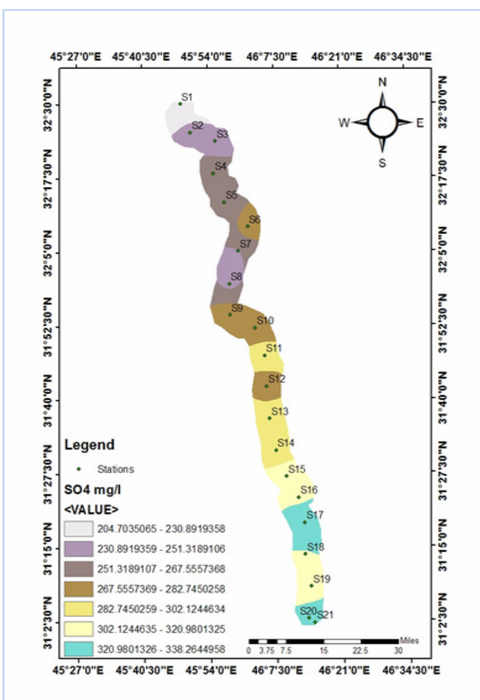

Fig. 10 : Map of SO_4^{-}

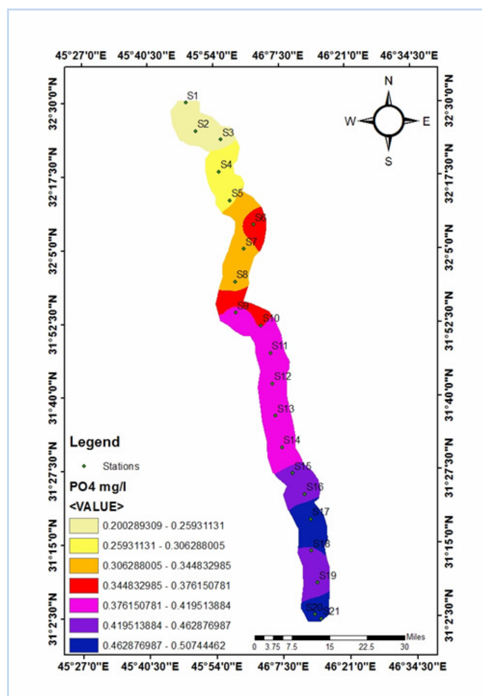

Fig. 11 : Map of PO_4^{-}

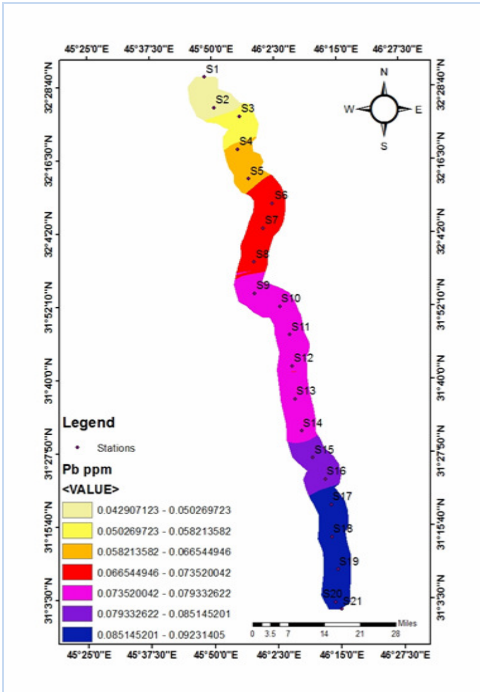

Fig. 12 : Map of pb

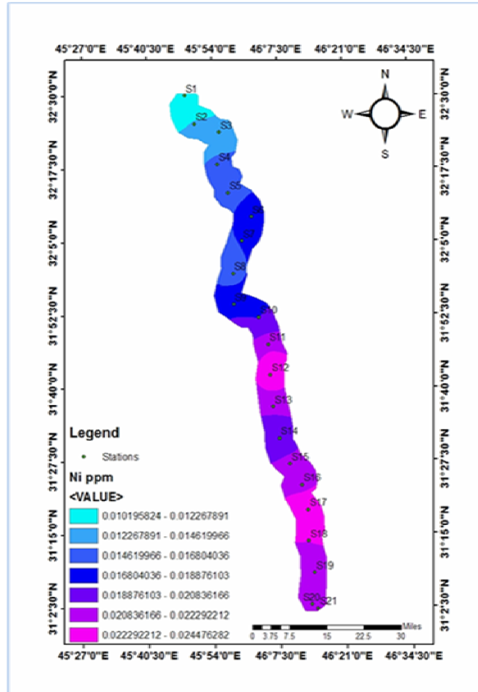

Fig. 13 : Map of Ni

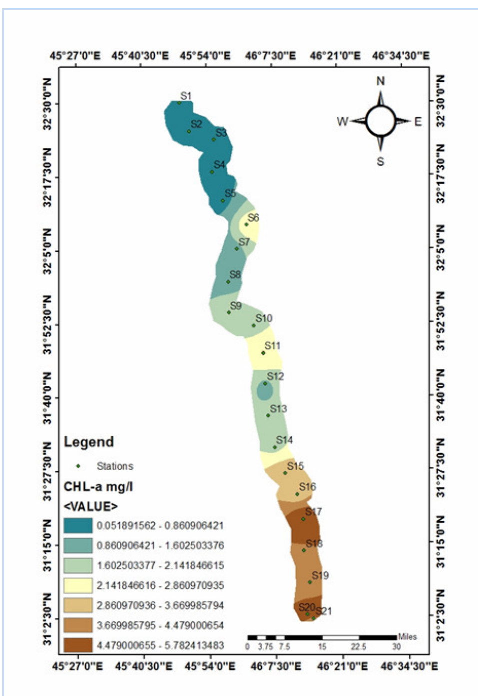

Fig. 14 : Map of chlorophyll-a

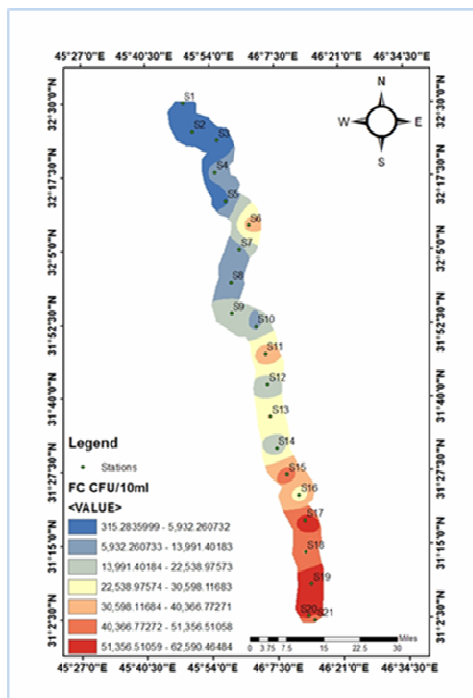

Fig. 15 : Map of fecal coliform

References

APHA, A.W.W.A. and WF, F. (2005). Standard Methods for the Examination of Water and wastewater, 21th ed., edited by Eaton, A. D American Water Work Association and Water Environment Federation, USA.

Canadian Council of Ministries of the Environment (CCME), "Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life," 2012.

Cheepi, P. (2012). Musi River Pollution Its Impact on Health and Economic Conditions of Down Stream Villages-A Study. Journal of Environmental Science, Toxicology and Food Technology, 1(4): 40-51, ISSN: 2319-2402.

EPA (Environmental Protection Agency). (2013). Domestic waste water treatment systems, Ireland. www.epa.ie/whatwedo/advice/wastewater

Ezzat, S.M.; Mahdy, H.M.; Abo-State, M.A.; Abd El, S.E.H. and El-Bahnasawy, M.A. (2012). Water quality assessment of River Nile at rosetta branch: Impact of drains discharge. Middle-East J. Sci. Res., 12(4): 413-423.

Fulazzaky, M.A. (2010). Water quality evaluation system to assess the status and the suitability of the Citarum river water to different uses. Env. Monit Assess 168(1–4): 669–684.

Katyal, D.; Ahmed, Q.; Ali H. and Kiranmay, S. (2012). Water quality assessment of Yamuna River in Delhi region using index mapping. Inter. Environ. 13(2): 170-186.

Leena, S.; Choudhary, S.K. and Singh, P.K. (2012). Status of heavy metal concentration in water and sediment of River Ganga at selected sites in the Middle Ganga Plain. Int. J. Res. Chem. Environ., 2(4): 236-243.

Ministry of Environment. (2001). "System Maintenance of River and Public Water Pollution in Iraq," 2001. http://www.moen.gov.iq.

Shamsi, U.M. (2005). GIS Applications for Water, Wastewater, and Storm water Systems.1 ed. Boca Raton, London, New York, Washington, B.N.0-8493-2097-6.

Sharma, S.H.; Jha, P.K.; Ranjan, M.R.; Singh, U.K. and Jindal, T. (2017). Water Quality Monitoring of Yamuna River by Using GIS Based Water Quality Index in Delhi, India. Int. J. Curr. Microbiol. App. Sci., 6(2): 1249-1263.

Shweta, T.; Bhavtosh, S.; Prashant, S. and Rajendra, D. (2013). "Water Quality Assessment in Terms of Water Quality Index" American Journal of Water Resources, 1(3): 34-38.

Simon, F.X.; Penru, Y.; Guastalli, A.R.; Lorens, J. and Baig, S. (2011). Improvement of the analysis of the biochemical oxygen demand (BOD) of Mediterranean seawater by seeding control. Talanta 85(1): 527–532.

Swain, N. (2013). "Development of Sub-Seasonal Remote Sensing Chlorophyll-A Detection Models." American Journal of Plant Sciences, 4: 21.

WHO (World Health Organization) (2006). "Guidelines for Drinking Water Quality," 3rd Edition, WHO, Geneva, 2006.

Yousry, M.; El-Sherbini, A.; Heikal, M. and Salem, T. (2009). Suitability of water quality status of Rosetta branch for west Delta water conservation and irrigation rehabilitation project. Water Sci., 46: 47-60.