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RESEARCH ARTICLE

A Study of Some Physico-Chemical Parameter and Heavy Metal on Water of Tigris River within Baghdad/Iraq

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Abstract

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In the present paper an attempt has been made to study water quality parameters and pollution status of Tigris River (Baghdad). The water samples were collected from preselected sampling stations from September 2013 to August 2014 at three different sites, important physico-chemical parameters such as temperature, turbidity, conductivity, pH, salinity, TDS, DO, BOD, phosphate, Iron and Zinc were analyzed. Present study revealed that temperature, turbidity, salinity, PO₄, DO, BOD₅ and Zn are all within permissible limits except pH, EC, TDS, salinity and Fe exceeded the permissible limits. On the basis of this study it was concluded that water of Tigris River is moderately polluted due to discharges of industrial waste, domestic sewage and agricultural runoff in river water, which require more efficient management to conserve this river.

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INTRODUCTION

Tigris River consider one of the most important twin rivers in Iraq, Tigris is nearly 2000 km long, of which 1360 km runs through Iraq, rising in the Taurus mountains of eastern Turkey and flowing in a generally south easterly direction until it joins the Euphrates near in southern Iraq (Rabeeet *et al.*, 2011). Several cities have been built on the banks of the Tigris since the dawn of civilization. Among these is Baghdad, the capital city of Iraq.

Water is vital to the existence of all living organisms, but this valued resource is increasingly being threatened as human populations grow and demand more water of high quality for domestic purposes and economic activities. Water abstraction for domestic use, agricultural production, industrial production, power generation, mining, and forestry practices can lead to deterioration in water quality and quantity that impact not only the aquatic ecosystem (i.e., the assemblage of organisms living and interacting together within an aquatic environment), but also the availability of safe water for human consumption (Al-Janabiet *et al.*, 2012).

Typically, water quality is determined by comparing the physical and chemical characteristics of a water sample with water quality guidelines or standards to enable the provision of clean and safe water for human consumption, thereby protecting human health. These are usually based on scientifically assessed acceptable levels of toxicity to either humans or aquatic organisms (Abdul-Kareem *et al.*, 2011).

Water resources in Iraq, especially in the last two decades have suffered of remarkable stress in terms of water quantity due to different reasons such as the dams built on Tigris and Euphrates in the riparian countries, the global climatic changes and the local severe decrease of the annual precipitation rates and improper planning of water uses inside Iraq (Al-Obaidyet *et al.*, 2010). Water quality is certainly affected by the quantity and quality of supplies coming from different sources. Therefore, the aim of this research studying water quality through analyzing some physicochemical parameter located on Tigris River within Baghdad province in order to keep our awareness and understanding of our environment.

2. Materials and Methods

2.1. Study area

The study area included three stations on Tigris River Within Baghdad city, the first was located at North of Baghdad in the northern area of Ghera'att City(S1), and the second at middle part in the area Baghdad medical city(S2), whereas the third station located at South part in the area near Al-Jadiriya Bridge(S3)(fig2).

2.2. Sample collection

Sample were collected from three station located on Tigris river, duplicated samples were taken monthly in the morning hours from November 2013 to October 2014, to collection the samples were used sterilized glass bottle of 1 L capacity except for dissolved oxygen (DO) test and biological oxygen demand (BOD₅) were used opaque bottle of 300 L capacity, the bottles were put in cork box contain ice and transport to the laboratory then the physical and chemical tests had been done with 24 hrs from samples collection.

2.3. Physico-Chemical Parameters tests

Water temperature was measured directly using graduated thermometer (0C° -100 C°) SHANGHAI(China). PH was measured by pH meter type WTW(Germany) after calibration by standard solutions. Turbidity measured by turbidometer type HACH(U.S.A). Total dissolved solids (TDS) Measured by conductivity meter type WTW Germany. Electrical Conductivity (EC) measured by conductivity meter type WTW Germany. The heavy metals(Iron and Zinc) were measured by Atomic absorption type Analytikjena novaa300(Germany). PO₄ were determined by spectrophotometer type Shimadzu(Japan). Dissolved oxygen meter Aphlo(U.S.A) manufacturing was used to determine the concentration of dissolved oxygen (DO) (mg/L %). While BOD₅ was calculated after incubation at 20 for 5 days (APHA, 2012). Salinity was calculated depending on (EC) values and according to method described in (Golterman *et al.*, 1978).

3. Results and discussion

The physico-chemical parameters of the station were given in (Table1) had been analyzed by using IBM SPSS ver.20 program

The climate of Iraq recognize with seasonal fluctuation from one side and day and night fluctuation from other side, and through current study temperature varied between 8 C° to 32 C°. The highest temperature was recorded during August (32C°) at station 2 and the lowest value was recorded during January (8C°) at station1(fig1). The results were showed significant difference ($p < 0.01$, $p < 0.05$) between months and seasons, and show positive and negative correlation between temperature and other parameters. these results was similar with the same conclusion of many studies in Tigris river (Al-Tameemi, 2004; Al-kinani, 2010). The present study also showed obvious change water temperature during the seasons, while the highest values of temperature were recorded during summer and the lowest were recorded during winter, this variation was occurred because the seasonal and geographical change.

Potential of hydrogen (pH) is negative logarithm of the hydrogen ion concentration and shows the intensity of acidity or alkalinity of water (Dubey and Ujjania, 2013). During the investigation water of Tigris river was observed the maximum value (8.7) in May at station1 and station3 and minimum value (6) in June month at station2 which slightly acidic as show in figure with average value of all seasons in three station. It was obvious that the pH was relatively stable within station during the year. With slightly acidic at station2 and this may be due to the effect of medical city discharge that indicate presences of pollution. the present study showed pH values a slightly above of pH values of surface water which lie within the range (6.5-9.0) that permit all natural processes of aquatic life (USEPA, 2006). However, the values come also in accordance with the known values of Iraqi inland waters (Rozoska, 1980). The statistical analysis showed that there was a high significant differences at $p \leq (0.05)$ in water pH among month and season, The correlation test showed positive and negative correlation between pH and other parameters.

The Turbidity reflects the transparency in water and it is caused by the presence of substances in water. The results recorded the highest value of turbidity was 104 NTU in April at station1 while the lowest value was 9.9 NTU in June at station3. The statistical analysis detected high significant differences at $p \leq (0.01)$ in water turbidity among month and season while no any significant differences at $p \leq (0.05)$ among station. The correlation test showed high significant correlation at $p \leq (0.01)$ between turbidity and pH while inverse correlation with number of studied parameter as show in table The results showed increase the average of turbidity value during winter and spring and decrease the average of turbidity during summer and autumn, this may be due to the turbidity increased during rainy season was attributed to soil erosion in the nearby catchment and massive contribution of suspended solids from hospitals or factory sewage (Al-Obaidy, 2009). This result have been agreed with what was reported by Al-Nuaemy (2011) and Ma'alah (2013).

Conductivity is a measure of the ability of water to pass an electrical current and depends on mineral contents present in water. The results recorded the highest average of EC value reach to 1024 $\mu\text{s}/\text{cm}$ at summer season while the lowest average of EC value was 946 $\mu\text{s}/\text{cm}$ during winter and this due to evaporation process occur in summer season result from high temperature which lead to increase of salt concentration and increase electric conductivity, also high conductivity may arise through natural weathering of certain sedimentary rocks or may have an anthropogenic source, e.g. industrial and sewage effluent (WHO, 2004). The statistical analysis indicated a high significant differences at $p \leq (0.01)$ in EC among month while no any significant differences among season and station. The correlation test showed high significant correlation at $p \leq (0.01)$ between EC and other parameter.

The results indicate that the highest TDS value was 752 mg/l in June at station3 while the lowest TDS value was 400 mg/l in September at station1, also the results showed the highest average value of TDS was 657 mg/l recorded during summer season while the lowest average value of TDS was 538 mg/l during winter season. Usually TDS level between 500-1500 mg/l, depending on geology of rejoin, climate and weathering, the results showed that the highest value during summer season and this may be due to the increasing of dust storm and the increase rates of dry fallout into resources of surface water (Jain, 2001). The statistical analysis revealed that there was a high significant differences at $p \leq (0.01)$ in water TDS among month and season while no any significant differences among station. The correlation test showed high significant correlation at $p \leq (0.01)$ between TDS and other studied parameter.

Dissolved oxygen may play a very crucial role for the survival of aquatic organism (Yakub and Ugwvmba, 2009), and represent a barometer of the ecological health of the river. The results showed that the highest average value of DO was recorded during winter and autumn while the lowest average value of DO was recorded during spring and summer which lie between (6.9-8.9) mg/l respectively. The statistical analysis revealed that there was a high significant differences at $p \leq (0.01)$ in water DO among month and season. The correlation test showed high significant relationship at $p \leq (0.01)$ with different parameter specially with temperature that show highly significant negative relationship this may be due to warm water holds less oxygen than cold water. Usually high BOD level might indicate the presence of pollution or sewage (Penn *et al.*, 2003). Seasonal BOD₅ results recorded highest value during summer season (3.6) while the rest season usually appeared convergent to each other and rang between (0.9-3.6) mg/l. BOD₅ values indicate a possibility of organic pollution effect on water in this area. Therefore, a continuous monitoring is needed. The statistical analysis showed that there was a high significant differences at $p \leq (0.01)$ in water BOD₅ among month and season. The correlation coefficient test showed high significant correlation at $p \leq (0.01)$ between BOD₅ and other studied parameter. Surface water quality index is proposed in the study of Ismail for the year 2013 were showed that BOD result was in the rang excellent to slightly polluted and this agreed with our results while the same trend were notice on Tigris river in the study of Al-Obaidy *et al.*, (2010a).

Salinity is a measure of the total salt concentration, comprising mostly of Na⁺ and Cl⁻ ions as well as small quantities of other ions. The salinity results rang between (0.72-0.39) ppm. The statistical analysis showed that there was a high significant differences at $p \leq (0.01)$ in water salinity among month. The correlation test showed high significant correlation at $p \leq (0.01)$. This result was slightly above the rang of fresh water salinity that less than 0.5. Most phosphorous in surface water is in the form of phosphates. Wang *et al.* (2001) concluded that 90% of phosphorus entering the waters is related to human activity. Domestic sewage discharge, the quantity of synthetic detergent usage and industrial capacity all increase with increased population density, so the phosphorus discharge also increases with increased population density.

The results showed that the highest average value of phosphate was (0.23) recorded during winter while the lowest average value of phosphate was (0.14) recorded during summer. The statistical analysis revealed that there was a high significant differences at $p \leq (0.01)$ in water phosphate among month and season. The correlation test showed high significant correlation at $p \leq (0.01)$ between phosphate and other parameter. Al-Azawy, 2012 in her study on soap factory found the phosphate value of draining waste was rang between (0.2-0.06) and this result allowable, so our result on Tigris river which consider the large acceptable for draining waste was (0.4) that permissible value reported by Iraqi and WHO standard.

Natural water contamination with zinc and iron turned out as a problem due to various factors: industry, transport, agriculture, lack of sewage systems in heavily populated areas, or from point sources as sewage waterleakage (Georgieva *et al.*, 2010). The results showed that the highest value of Fe was 0.6 during March and April at station3 and Zn was 0.2 during February at station2 while the lowest value of Fe was 0.001 during June at all station and Zn was not detected during May in all station. The observed values of Fe and Zn in the study sites have been within the allowable limits recommended by Iraq drinking water standard and recommended value for rivers maintaining system and general water from pollution. Excepted during spring season the Fe recorded high value and Zn during

February also showed higher value Iraqi and American river standard. However the statistical analysis showed that there was a high significant differences at $p.v \leq (0.05)$ for iron among month and season while no any significant differences among station. The correlation test showed high significant correlation at $p.v \leq (0.01)$. while the zinc results showed a high significant differences at $p.v \leq (0.05)$ in zinc level among month while no any significant differences among season and station. Also similar results were obtained by Abdul-Kareem *et al.*, 2011 and his researcher in study on Tigris river at Baghdad region that found the range of Fe (0.01-1.06) and Zn (0.1-0.4).

Table1: phsico-chemical parameter of water in three station along Tigris river within Baghdad City (mean, standard deviation, Pearson Correlations coefficient)

		Station1										
Month		Temp	pH	Turbidity	EC	TDS	DO	BOD5	Salinity	PO4	Fe	Zn
Jan	Mean	9.0000	7.1500	47.3000	831.0000	550.0000	8.7500	.9000	.5100	.2400	.0650	.0155
	Std. Deviation	1.41421	.07071	0.00000	1.41421	0.00000	.35355	0.00000	0.00000	.01414	.00707	.00071
Feb	Mean	11.5000	7.3500	95.0000	1065.0000	495.0000	8.4000	1.0500	.6550	.2100	.2050	.0335
	Std. Deviation	.70711	.07071	7.07107	35.35534	7.07107	.14142	.07071	.02121	0.00000	.00707	.00212
Mar	Mean	18.5000	8.1500	95.0000	1031.0000	681.0000	7.8000	.9500	.6350	.2200	.6150	.0470
	Std. Deviation	.70711	.07071	1.41421	1.41421	1.41421	.28284	.07071	.00707	.01414	.02121	.00141
Apr	Mean	22.0000	7.9500	102.0000	1105.0000	534.0000	7.4000	1.0000	.6800	.1800	.2500	.0225
	Std. Deviation	1.41421	.07071	2.82843	7.07107	1.41421	.14142	0.00000	0.00000	0.00000	.07071	.00354
May	Mean	24.0000	8.4500	36.0000	905.0000	553.0000	7.3000	2.0000	.5550	.3750	.0110	0.0000
	Std. Deviation	1.41421	.07071	1.41421	5.65685	4.24264	.42426	0.00000	.00707	.02121	.00141	0.00000
Jun	Mean	29.0000	7.0500	18.5000	1082.0000	651.0000	7.0500	1.9500	.6600	.1450	0.0000	.0110
	Std. Deviation	1.41421	.07071	.70711	2.82843	1.41421	.07071	.07071	.01414	.00707	0.00000	.00141
Jul	Mean	31.0000	7.5000	41.6000	981.0000	599.0000	7.0000	2.6500	.6050	.1500	.0350	.0125
	Std. Deviation	0.00000	0.00000	2.26274	1.41421	1.41421	.14142	.21213	.00707	.02828	.00707	.00071
Aug	Mean	30.5000	7.7500	30.5000	1005.0000	620.0000	7.0500	2.9500	.6150	.1800	.0900	.0215
	Std. Deviation	.70711	.07071	.70711	7.07107	1.41421	.07071	.07071	.00707	.02828	.01414	.00212
Sep	Mean	29.0000	7.1000	42.6500	651.0000	406.0000	7.3000	1.4000	.3950	.1500	.1300	.0160
	Std. Deviation	0.00000	.14142	1.34350	1.41421	8.48528	.14142	.00707	0.00000	.00707	.01414	0.00000
Oct	Mean	25.0000	7.9500	17.0000	1160.0000	684.0000	10.0500	1.0000	.7200	.2900	.2000	.0140
	Std. Deviation	1.41421	.07071	1.41421	1.41421	8.48528	.07071	0.00000	0.00000	.02828	.01414	.00141
Nov	Mean	19.0000	7.4500	19.0000	855.0000	473.0000	9.1000	1.2000	.5250	.2150	.0450	.0105
	Std. Deviation	1.41421	.07071	0.00000	7.07107	1.41421	.14142	0.00000	.00707	.00707	.00707	.00071
Des	Mean	12.0000	6.9500	44.3000	990.0000	573.0000	9.7500	1.0500	.6100	.2500	.0400	.0250
	Std. Deviation	1.41421	.07071	.42426	0.00000	4.24264	.35355	.07071	0.00000	.01414	0.00000	.00707
Total	Mean	21.7083	7.5667	49.0708	971.7500	568.2500	8.0792	1.5083	.5971	.2171	.1405	.0191
	Std. Deviation	7.64130	.47427	30.30648	138.49541	83.00196	1.08827	.69715	.08705	.06636	.16764	.01206
		Station2										
Month		Temp	pH	Turbidity	EC	TDS	DO	BOD5	Salinity	PO4	Fe	Zn
Jan	Mean	10.0000	7.1000	81.5000	847.0000	535.0000	9.1000	1.0000	.5200	.2150	.0550	.0315
	Std. Deviation	1.41421	.14142	2.12132	1.41421	1.41421	.14142	0.00000	0.00000	.02121	.00707	.00071
Feb	Mean	13.0000	7.2000	89.0000	995.0000	494.0000	8.0000	.9000	.6100	.2100	.1150	.0260
	Std. Deviation	0.00000	.14142	1.41421	7.07107	2.82843	0.00000	.14142	0.00000	.02828	.02121	.00141
Mar	Mean	18.5000	8.0500	93.0000	1048.0000	690.0000	7.2500	1.0000	.6450	.1950	.2000	.0535
	Std. Deviation	.70711	.07071	1.41421	2.82843	2.82843	.07071	.14142	.00707	.02121	0.00000	.00071
Apr	Mean	21.0000	7.9500	101.0000	1045.0000	521.0000	8.2500	1.1500	.6400	.2150	.1250	.0130
	Std. Deviation	0.00000	.07071	1.41421	21.21320	1.41421	.35355	.07071	.01414	.02121	.03536	.00424
May	Mean	24.5000	8.6000	51.0000	857.0000	522.0000	7.1500	1.0000	.5250	.1950	.0200	0.0000
	Std. Deviation	.70711	.14142	1.41421	2.82843	2.82843	.21213	0.00000	.00707	.02121	0.00000	0.00000
Jun	Mean	27.0000	6.1000	17.0000	1146.0000	692.0000	7.2500	2.4500	.7100	.1150	0.0000	.0105
	Std. Deviation	0.00000	.14142	0.00000	1.41421	2.82843	.35355	.07071	0.00000	.00707	0.00000	.00071
Jul	Mean	31.0000	7.0000	43.0000	948.0000	604.0000	7.0000	2.9500	.5800	.1600	.0500	.0170
	Std. Deviation	1.41421	0.00000	1.41421	1.41421	4.24264	0.00000	.07071	0.00000	0.00000	0.00000	.00141
Aug	Mean	32.0000	7.9000	29.5000	973.0000	630.0000	6.7500	3.5000	.6000	.1450	.0650	.0140
	Std. Deviation	0.00000	.14142	.70711	4.24264	0.00000	.07071	.14142	0.00000	.02121	.02121	.00141
Sep	Mean	30.5000	7.4500	43.6000	795.0000	530.0000	7.5000	2.0000	.4850	.1450	.1150	.0140
	Std. Deviation	.70711	.07071	.56569	7.07107	2.82843	.28284	0.00000	.00707	.00707	.00707	.00141
Oct	Mean	23.0000	7.7000	16.3000	1150.0000	661.0000	9.8500	1.0500	.7100	.2550	.1850	.0145
	Std. Deviation	1.41421	.28284	.42426	1.41421	7.07107	.07071	.07071	0.00000	.02121	.00707	.00071
Nov	Mean	18.5000	7.2500	21.0000	820.0000	481.0000	9.9000	1.0500	.5000	.2550	.1700	.0200
	Std. Deviation	.70711	.07071	1.41421	0.00000	1.41421	.14142	.07071	0.00000	.00707	.01414	0.00000
Des	Mean	13.5000	7.0500	47.1500	969.0000	569.0000	9.9000	1.1000	.5950	.3250	.0400	.0240
	Std. Deviation	.70711	.07071	.21213	1.41421	1.41421	.14142	.14142	.00707	.03536	0.00000	.00141
Total	Mean	21.8750	7.4458	52.7542	966.0833	577.4167	8.1583	1.5958	.5933	.2025	.0950	.0198
	Std. Deviation	7.29689	.63996	30.16768	116.96894	73.98409	1.19779	.88440	.07417	.05863	.06587	.01309

Station3												
Month		Temp	pH	Turbidity	EC	TDS	DO	BOD5	Salinity	PO4	Fe	Zn
Jan	Mean	12.0000	7.1500	78.5000	825.0000	553.0000	8.5000	1.2500	.5050	.1900	.0550	.0195
	Std. Deviation	0.00000	.07071	2.12132	7.07107	4.24264	0.00000	.07071	.00707	.01414	.00707	.00071
Feb	Mean	14.0000	7.1000	90.0000	1000.0000	502.0000	8.1000	.9500	.6100	.1850	.1200	.0315
	Std. Deviation	1.41421	.14142	0.00000	0.00000	2.82843	.14142	.07071	0.00000	.00707	.02828	.00071
Mar	Mean	19.0000	8.0000	48.0000	1061.0000	697.0000	8.6000	.8500	.6500	.1550	.2850	.0515
	Std. Deviation	0.00000	0.00000	2.82843	1.41421	1.41421	.14142	.21213	0.00000	.00707	.02121	.00071
Apr	Mean	21.5000	8.2500	72.5000	1090.0000	560.0000	7.2500	.9500	.6700	.1700	.0900	.0315
	Std. Deviation	.70711	.07071	3.53553	0.00000	0.00000	.07071	.07071	0.00000	.01414	.01414	.00071
May	Mean	25.0000	8.7000	22.5000	858.0000	542.0000	7.2000	1.0000	.5250	.1600	.0200	0.0000
	Std. Deviation	0.00000	0.00000	.70711	2.82843	2.82843	.14142	0.00000	.00707	.01414	0.00000	0.00000
Jun	Mean	28.0000	6.9000	10.4500	1144.0000	751.0000	6.6500	2.1000	.7050	.1400	0.0000	.0150
	Std. Deviation	0.00000	.14142	.77782	1.41421	1.41421	.07071	.14142	.00707	.01414	0.00000	.00141
Jul	Mean	30.0000	7.0500	34.0000	960.0000	602.0000	6.9500	2.6500	.5900	.1500	.0250	.0205
	Std. Deviation	0.00000	.07071	1.41421	0.00000	1.41421	.07071	.21213	0.00000	.01414	.00707	.00071
Aug	Mean	31.0000	7.9500	28.0000	984.0000	619.0000	6.9000	2.6000	.6050	.1450	.0650	.0160
	Std. Deviation	1.41421	.07071	0.00000	4.24264	1.41421	.14142	.14142	.00707	.00707	.00707	.00141
Sep	Mean	28.0000	7.3500	28.5500	927.0000	564.0000	7.0000	2.3000	.5700	.1700	.0950	.0120
	Std. Deviation	1.41421	.21213	2.05061	1.41421	5.65685	.14142	.42426	0.00000	.01414	.00707	0.00000
Oct	Mean	24.0000	7.6500	17.3000	1170.0000	678.0000	9.9000	1.2500	.7200	.3000	.1900	.0110
	Std. Deviation	0.00000	.21213	.98995	1.41421	2.82843	.14142	.07071	0.00000	0.00000	.01414	0.00000
Nov	Mean	18.5000	7.4000	19.0000	850.0000	485.0000	9.9000	.9500	.5200	.2350	.0500	.0145
	Std. Deviation	.70711	0.00000	0.00000	12.72792	0.00000	.14142	.07071	.01414	.00707	0.00000	.00636
Des	Mean	14.0000	7.1500	45.1500	992.0000	576.0000	9.3000	1.1000	.6100	.2600	.0400	.0160
	Std. Deviation	1.41421	.07071	.07071	2.82843	1.41421	.42426	.14142	0.00000	0.00000	0.00000	.00141
Total	Mean	22.0833	7.5542	41.1625	988.4167	594.0833	8.0208	1.4958	.6067	.1883	.0863	.0199
	Std. Deviation	6.48689	.55323	25.66727	110.53700	78.10523	1.18063	.69625	.06901	.05001	.07961	.01290

Pearson Correlations coefficient matrix for physicochemical parameter and heavy metal

Correlations											
	Temp	pH	Turbidity	EC	TDS	DO	BOD5	Salinity	PO4	Fe	Zn
pH	.154										
Turbidity	-.515**	.151									
EC	.090	.026	.022								
TDS	.308**	.021	-.277*	.720**							
DO	-.613**	-.156	-.080	.032	-.138						
BOD5	.760**	-.183	-.409**	.026	.292*	-.612**					
Salinity	.091	.025	.015	.999**	.724**	.036	.029				
PO4	-.461**	.162	-.008	.035	-.107	.670**	-.428**	.036			
Fe	-.173	.309**	.430**	.245*	.194	.164	-.357**	.244*	.115		
Zn	-.417**	-.014	.584**	.225	.208	.091	-.315**	.220	-.085	.621**	

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

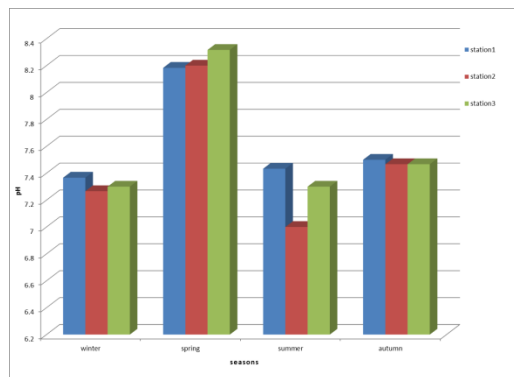
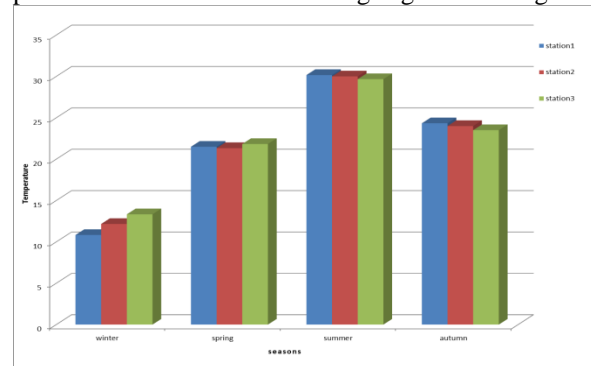
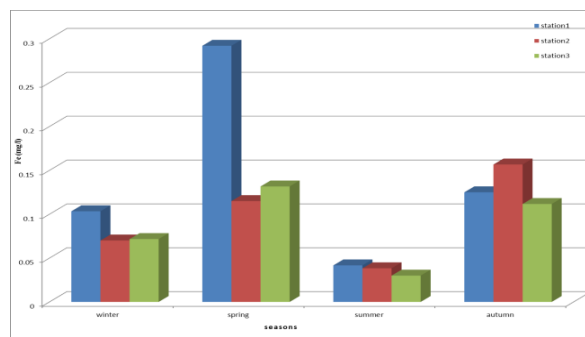
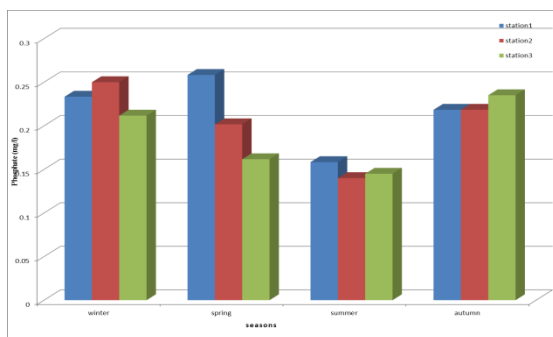
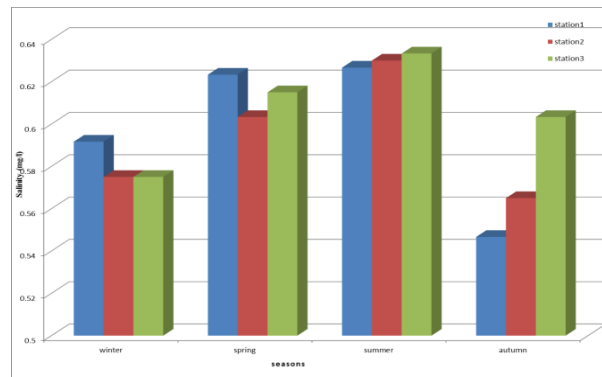
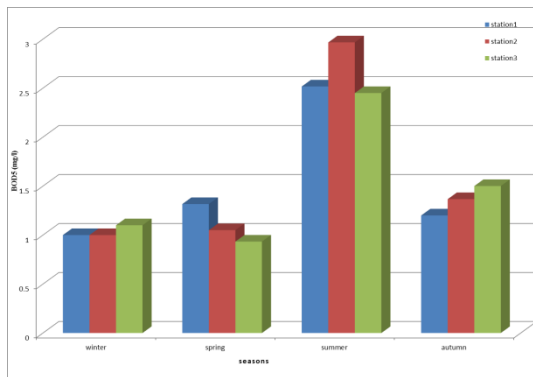
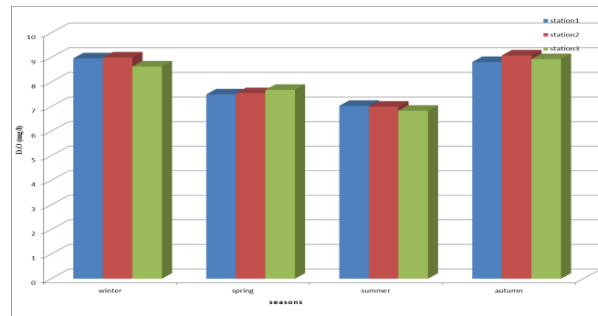
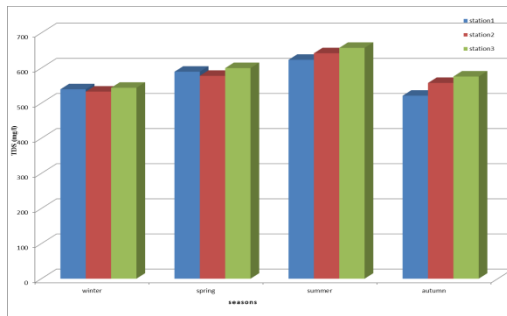
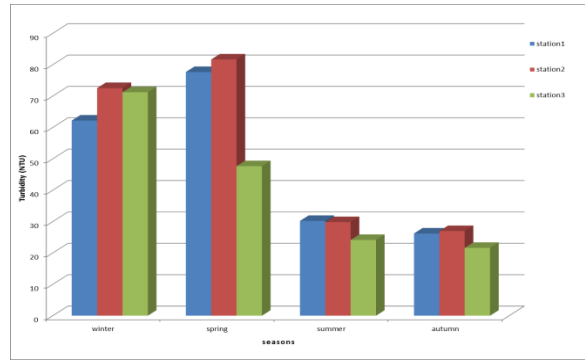
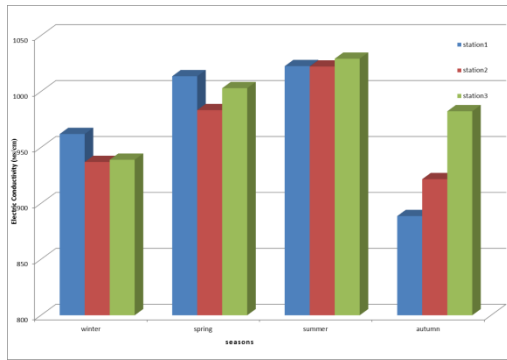


Figure1: Average seasonal variation of phisico-chemical parameter for three stations along Tigris river/Baghdad city





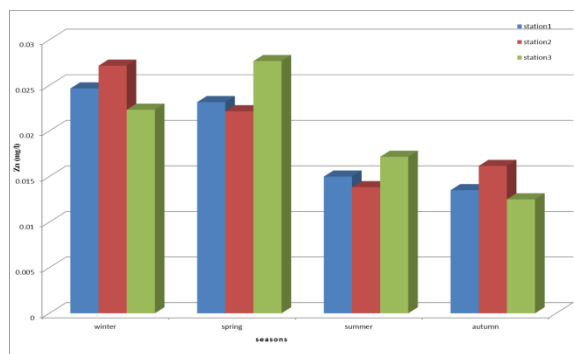
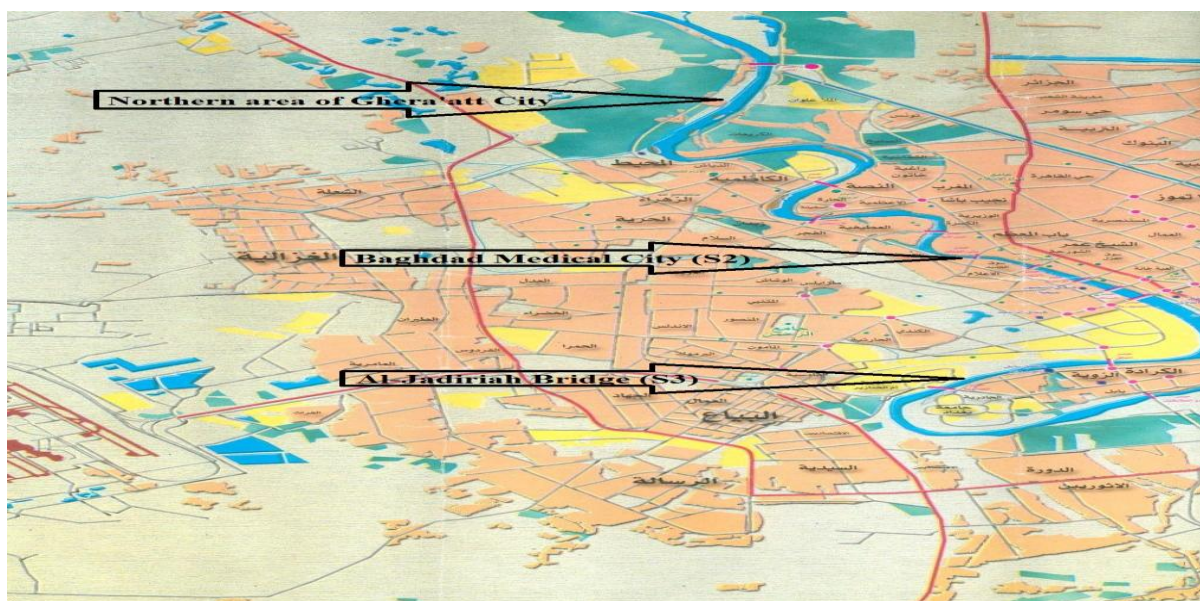


Figure2. Tigris River map and the location of sample station



4. Conclusions

According to the results obtained, we conclude Water quality in all water stations with respect to temperature, turbidity, salinity, PO_4 , DO, BOD_5 and Zn are all within the water quality standards recommended by Iraqi, WHO and American Standard For river water except pH, EC, TDS, salinity and Fe exceeded the Iraqi and International allowable levels. Finally, these results clearly indicate that the water of Tigris river need for additional efforts directed towards the protection of water resources. Therefore, strict measures should be taken in order to control the levels of pollutants discharged into Tigris River.

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