Seasonal Variations in the Physico-chemical and Biological Characteristics of Al-Gharraf River within Al-Haay City Southern of Iraq.

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Abstract

The study reports the seasonal changes in water quality of Al-Gharraf, one of the main tributaries of the Tigris river. Monthly sampling was carried out from December 2015 till November 2016 for a year. The study location situated in the south-eastern sector of Iraq and surrounded by wide and fertile agricultural lands. Three stations were selected to. The former is located at 5 km before entrance of AL-Hayy City as control. The second is situated at distance 5 km away from the former (mid of AL-Hayy City) represented study area and the latter station is located at 15 km apart from the second one (end of AL-Hayy City). collecting samples monthly ,two samples were taken each month.

In the present study Fourteen physical and chemical parameters were analyzed based on the importance of these parameters. These Fourteen parameters are ranged as following: air temperature (16 to 32) ºC, water temperature (11 to 26) ºC, pH (7.05to 8.35), E.C. (827 to1558) µS/cm, salinity (0.54 to 0.99) ppt, DO (7.04 to 10.38) mg/L , BOD (0.90 to 7.01) mg/L ,turbidity (31.0 to 177.0) NTU, TDS (550.78 to 1108) mg/L , TSS (38 to 636.5) mg/L , T.H (275 to 520) mg/L , Cl^- (95.9 to 213.7) mg/L, NO_3 (15.4 to 25.0) mg/L and PO_4 (0.15 to 0.59) mg/L. The results showed that most parameters are exceeding permissible limits for Iraqi standard specifications and WHO standard for drinking.

The study results also showed that the heavy metals concentrations (cadmium and lead) were 0.002-0.089 ppm and 0.031- 0.21 ppm respectively. Concentrations of these metals of Al-Gharraf River showed seasonal variations during the study period and they are exceeding permissible limits for Iraqi standard specifications and WHO standard for drinking.

The highest bacterial count was recorded at sit.2 the during winter 2016, 2800 cell /1 ml , whereas the lowest value was found during summer 2016, 320 cell /100ml. whereas numbers of *E.coli* were (230-1700) cell/10ml.

Key Words: physic – chemical and biological parameters, water quality, Al-Gharraf river.

دراسة التغيرات الفصلية في الخصائص الفيزيائية والكيميائية والبيولوجية لمياه نهر الغراف ضمن مدينة الحي جنوب العراق.

الخلاصة:

درست التغيرات الفصلية في الخصائص الفيزيائية والكيميائية والبيولوجية للمياه لتقييم نوعية مياه نهر الغراف بيئياً للمدة من تشرين الثاني ٢٠١٥ إلى كانون الأول ٢٠١٦ لمدة عام. يقع نهر الغراف في الجزء الجنوبي الشرقي من العراق و تحيط فيه مساحات شاسعة وخصبة من الأراضي الزراعية. يَستلمُ النهرُ أغلب مياه الفضلاتِ مِنْ العديد مِنْ المُدنِ بضمنها مياه الفضلاتِ المحليةِ والزراعيةِ والصناعيةِ. وارتباطا بتطورِ المنطقة فأن زيادة تسرب الملوثات إلى النهر كَانتْ سببا للقلق في الفترة الأخيرة.

تم اختيار ثلاثة محطات للدراسة ، تقع المحطة الأولى على بعد ٥ كم من مدينة الحي لتكون محطة السيطرة. وتقع المحطة الثانية على بعد ٥ كم من المحطة الأولى حيث تمثل منطقة الدراسة .أما المحطة الثالثة فتقع على بعد ١٥ كم من المحطة الثانية بعد اجتياز النهر لمدينة الحي. تم أخذ العينات شهريا وبواقع نموذجين لكل شهر.

تراوحت قيم و تراكيز مؤشرات الماء الشهرية كالاتي: درجة حرارة الهواء (١٦ الى ٣٢) م٠ و الماء (١١ الى ٢٦) م٠ و الاس الهيدروجيني (٧.٠٥ الى ٨.٣٥) و عكوره المياه (٣١.٠ الى ١٧٧.٠) وحدة عكورة والتوصيلية الكهربائية (٨٢٧ الى١٥٥٨) مايكرو سيمنز والملوحة (٠.٥٤ الى٠.٩٩) جزء بالألف والمواد الصلبة الذائبة (٥٥٠.٧٨ الى ١١٠٨) ملغم/ لتر والمواد الصلبة العالقة (٣٨ الى (٦٣٦.٥ ملغم/ لتر والاوكسجين الذائب (٧.٠٤ الى ١٠.٣٨) ملغم/ لتر والمتطلب البيولوجي للأوكسجين (٠.٩٠ الى٧.٠١) ملغم/ لتر والعسرة الكلية (٢٧٥ الى ٥٢٠) ملغم/ لتر والكلوريد (٩٥.٩ الى ٢١٣.٧) ملغم/ لتر والنترات (١٥.٤ الى ٢٥.٠) ملغم/ لتر والفوسفات (٠.١٥ الى ٠.٥٩) ملغم/ لتر. اظهرت النتائج ان معظم مؤشرات الماء تجاوزت المحددات العراقية لمياه الانهار و منظمة الصحة العالمية لماء الشرب. أما بالنسبة لقيم المعادن الثقيلة فقد تراوحت قيم الكادميوم بين ٠.٠٠٢ – ٠.٠٨٩ جزء من المليون ، وقيم الرصاص ٠.٠٣١ – ٠.٢١ جزء من المليون. وأظهرت تراكيز المعادن المدروسة في مياه الغراف تغيرات فصلية خلال فترة الدراسة، وتجاوزت الحدود المسموح بها من قبل المحددات العراقية لنظام صيانة الأنهار.

أما بالنسبة لدراسة العوامل البايولوجية فقد ظهرت نتائج أعلى المعدلات للأعداد الكلية للبكتريا في المحطة الثانية خلال فصل الشتاء ٢٠١٥ حيث بلغت ٢٨٠٠ خلية / ١ مل ، وادنى المعدلات في المحطة الاولى خلال فصل الصيف ٢٠١٦ وكانت ٣٢٠ خلية/١٠٠ مل. بينما تراوحت أعداد بكتريا E.Coli بين ٢٢٠ – ١٧٠٠٠ خلية/ ١٠مل.

Introduction

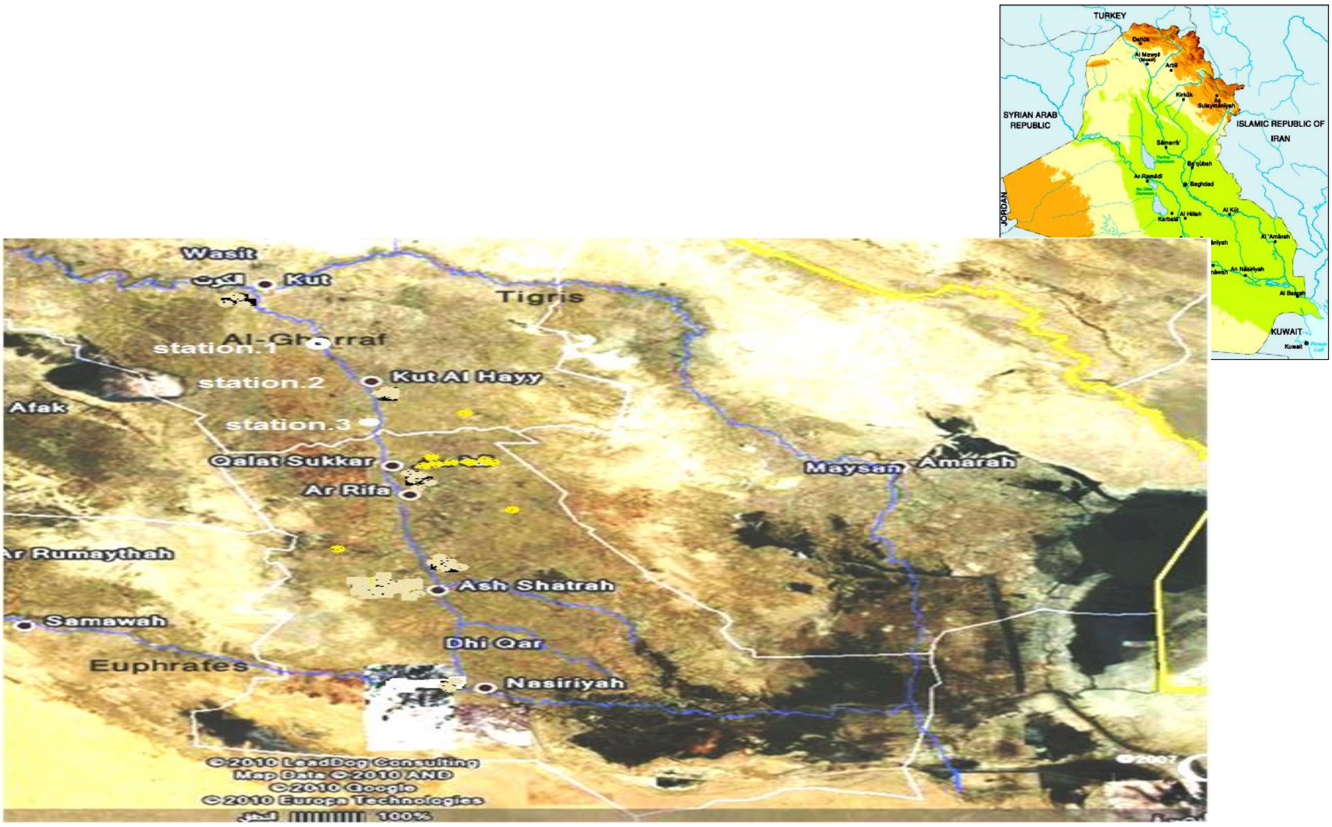
Rivers have always been the most important fresh water resources, and most developmental activities are still dependent upon them. Rivers play a major role in assimilating or carrying industrial and municipal waste water, manure discharge and runoff which are responsible for water river pollution[1] [2]. The degree of pollution is generally assessed by studying physical and chemical characteristics of the water bodies[3]. Iraqi inland waters witness tremendous impacts through discharges of manufacturers, agricultural and domestic sewage [4] [5]. Quite few studies were performed on Tigris River [6] [7] [8], but no work had considered Al-Gharraf canal in Al-Haay City. The present study has taken in consideration the investigation of abiotic conditions in this vital habitat on monthly basis.

2.Material and Methods

2.1.Study area

Al- Gharraf River is one of two branches of the Tigris River at Kut City, 225 km south of Baghdad City (Fig. 1). After branching from the Tigris, the Garaff flows southeast toward Al-Haay City (study area) within Wasit Province, 220 km southwest of Baghdad City. The river is 230 km in length with a variable depth of 18 m at its branching point from the Tigris to 10 m at its junction with the Euphrates River at the marsh area near Thi Qar Province .

Figure (1) showing map of sampling location in the study area



2.2.Sampling

Samples for physical and chemical variables were performed from three sites during period extended from the December 2015 till November 2016. Water samples were collected for physiochemical analysis using pre-washed polyethylene bottle by water sample twice before filling.

The studied physic-chemical parameters include 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 (titrimetric methods), biological oxygen demand (Winkler methods), nitrate, reactive phosphate (by using spectrophotometric methods), total hardness and chloride (by using titrimetric methods), were measured according to APHA[9] [10].

Heavy metals in water samples are measured using flame atomic absorption spectrophotometer (Model Pyeunicam SP9) [9].

Water sample for biological analysis *E. Coli* used multiple fermentation tubes or most probable number (MPN) technique are commonly used for enumeration of the bacteria [9], while total bacterial count (TBC) was carried out using the pour plate technique according to described by APHA [10].

3.Results

Figure (2) and Table (1), shows seasonal changes in air temperature for the three selected stations. Values ranged between 16ºC in a station-1 during winter (2016) to 38º C in station-3 during summer (2016).

Figure (3) and Table (1), however, indicates seasonal variations in water temperature. The lowest value was 11ºC in station-2 during winter (2016) and the highest 31ºC in station-1 during summer (2016). Figure (4) and Table (1), shows seasonal changes in pH. The lowest (7.05) was encountered in autumn (2015) from station-2 and the highest (8.09) was recorded in winter (2016) from station-1, but values in general were slightly alkaline direction.

Figure (5) and Table (1), Shows seasonal changes in values of Electrical conductivity. The lowest (827 µs/cm) was measured from station-3 in spring (2016) and the highest (1558 µs/cm) was observed in autumn (2015) from station-2.

Figure (6) and Table (1), shows seasonal changes in values of water salinity. The lowest (0.54 ppt) was observed in station-3 during spring (2016) and the highest (0.99 ppt) measured from station-2 in autumn (2015).

Figure (7) and Table (1), Shows seasonal changes in values of Turbidity. The lowest (31.0 NTU) was observed in station-1 in summer (2016) and the highest (177.0 NTU) was observed in winter (2016) from station-2.

Figure (8) and Table (1), Reveals seasonal variations in dissolved oxygen in selected stations Values declined during autumn (2015). The lowest (7.04 mg/L) was in summer (2016) from station-2 and the highest (10.38 mg/L) was, in general, in winter (2016) from station-1

Figure (9) and Table (1), shows seasonal variations in values of biological oxygen demands (BOD_5). The lowest (0.90 mg/L) was recorded in spring (2016) from station-1 and the highest (7.0 mg/L) was in autumn (2015) from station-2.

Figure (10) and Table (1), shows seasonal changes in total dissolved solid. The lowest (550.78 mg/L) was encountered in summer (2016) from station-3 and the highest (1108 mg/L) was recorded in autum (2015) from station-2.

Figure (11) and Table (2), shows seasonal variations in total suspended solid. The lowest (56 mg/L) was observed in summer (2016) from station-1 and the highest (938 mg/L) was observed in winter (2016) from station-2.

Figure (12) and Table (2), Revealed seasonal variations in values of total hardness in the selected locations. Highest value (520 mg/L) was in autumn (2015) and encountered from station-2. The lowest (275 mg/L), however, was in summer (2016) from station-1.

Figure (13) and Table (2), Shows seasonal changes in values of Chloride. The lowest (95.9 mg/L) was measured from station-1 in spring (2016) and the highest (213.7 mg/L) was observed in autumn (2015) from station-2.

Figure (14) and Table (2), Reveals seasonal variations in Nitrate. The lowest (15.4 mg/L) was in summer (2016) from station-1 and the highest (45.00 mg/L) was observed in autumn (2015) from station-2.

Figure (15) and Table (2), Shows seasonal changes in values of Reactive phosphate. The lowest (0.15 mg/L) was observed in autumn (2015) from station-1 and the highest (0.59 mg/L) was observed in autumn (2015) from station-2.

Figure (16) and Table (2), Reveals seasonal changes in values of Cadmium . The lowest (0.002 ppm) was observed in summer (2016) from station-1 and the highest (0.089 mg/L) was observed in autumn (2015) from station-2. Figure (17) and Table (2), Shows seasonal changes in values of Lead. The lowest (0.031 ppm) was observed in summer (2016) from station-1 and the highest (0.21 ppm) was observed in autumn (2015) from station-2.

Figure (18) and Table (2), Reveals seasonal variations in Total Bacterial Count. The lowest 320 cell /100ml was in summer (2016) from station-1 and the highest 7800 cell /100ml was observed in winter (2016) from station-2.

Figure (19) and Table (2), Shows seasonal changes in values of . *E.coli* were. The lowest 480 cell/10ml was observed in summer (2016) from station-1 and the highest 5200 cell/10ml was observed in winter (2016) from station-2 .

Table (1): seasonal variation of physic-chemical characters of Al-Gharraf river through period study 2015 – 2016

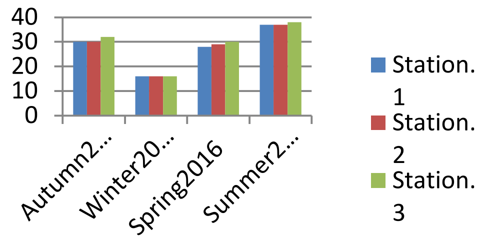
Time	Station	Air T. C°	Water T.C °	PH	E.C µs/cm	Sali. ppt.	Turb. NTU	DO mg/l	DOB5 mg/l	TDS mg/l
Autumn 2015	S.1	30	24	7.38	1335	0.87	78	8.22	1.89	946
	S.2	30	26	7.05	1558	0.99	121	7.04	7.0	1108
	S.3	32	25	7.34	1339	0.87	74	7.61	4.01	928
Winter 2016	S.1	16	11.5	8.09	1075	0.69	161.0	10.38	2.0	715.9
	S.2	16	11	7.98	1078	0.70	177.0	8.36	5.5	717.9
	S.3	16	12.5	7.77	1062.5	0.69	163.5	9.57	2.5	707.7
Spring 2016	S.1	28	24	7.8	855	0.56	35	8.0	0.90	569.43
	S.2	29	23	7.5	888	0.58	67	7.5	4.5	591.40
	S.3	30	23	7.8	827	0.54	43	8.1	2.1	550.78
Summer 2016	S.1	37	31	7.8	1018	0.65	33	8.1	1.9	677.99
	S.2	37	29	7.3	1029	0.66	52	7.2	5.2	685.32
	S.3	38	30	7.2	1014	0.65	37	7.9	2.9	675.32

Table (2): seasonal variation of physic-chemical and biological characters of Al-Gharraf river through
period study 2015 – 2016

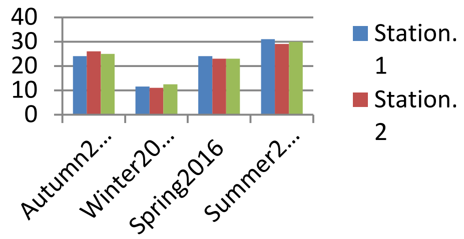
Time	Station	TSS mg/l	T.H mg/l	Cl^- mg/l	$NO3^=$ mg/l	$PO4^-_3$ mg/l	Cd ppm	Pb ppm	T.B.C Cell/100ml	*E.coli* Cell/10ml
Autumn 2015	S.1	738	430	159.4	31.09	0.15	0.023	0.09	1400	2900
	S.2	890	520	213.7	45.00	0.59	0.089	0.21	2150	3600
	S.3	820	437.5	193.6	35.69	0.31	0.081	0.19	3200	2500
Winter 2016	S.1	887	314	154.9	20.12	0.19	0.009	0.073	2700	3400
	S.2	938	412	198.5	32.45	0.23	0.013	0.096	7800	5200
	S.3	908	392	180.7	25.62	0.2	0.011	0.089	1350	3800
Spring 2016	S.1	165	310.4	89.02	16.1	0.32	0.004	0.033	1500	2300
	S.2	196	388	153	20.0	0.43	0.007	0.041	3900	4200
	S.3	185	329.8	111.5	16.0	0.38	0.005	0.039	2800	2100
Summer 2016	S.1	56	275	95.9	15.4	0.33	0.002	0.031	320	480
	S.2	86	335	138	28.2	0.45	0.006	0.037	1500	2600
	S.3	87	360	105	21.7	0.38	0.005	0.035	980	1400

Table (3): Comparison between some water quality parameters of Al-Gharraf river with the Iraqi and International standards.

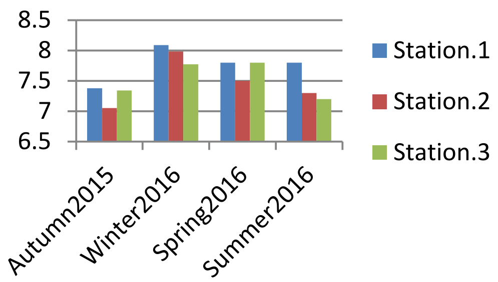
Parameter	WHO (2004)	EEC 464/76 (Tebbutt, 1998)	Iraqi standards (٢٠٠١)
pH	6.5- 8.5	6.5- 8.5	6.5- 8.5
TDS mg/L	500-1500	500-1500	1000
Turbidity NTU	0-50	0-25	25
DO mg/L	> 5	> 5	> 5
BOD5 mg/L	> 3	> 5	> 3
T.H mg/L	100 – 500	100-500	-
Cl^- mg/L	200	200 – 600	200
NO_3^- mg/L	0 – 45	0 – 40	25 –50
Cd ppm	٠.٠٠٣	٠.٠٠٥	٠.٠٠٥
Pb ppm	٠.٠١	٠.٠٥	٠.٠١



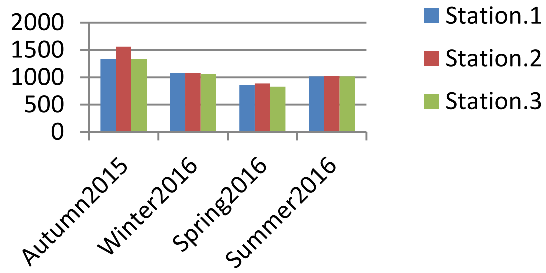
(Fig.2)Seseanal changes in Air Temperture ºC in three selected...



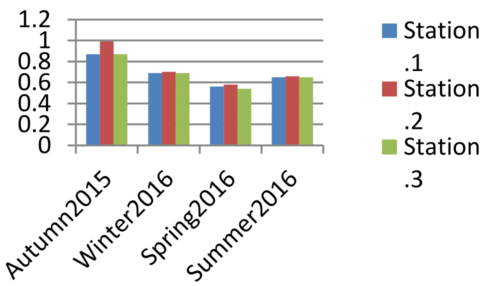
(Fig.3)Seseanal changes in Water Temperture ºC in three selected...



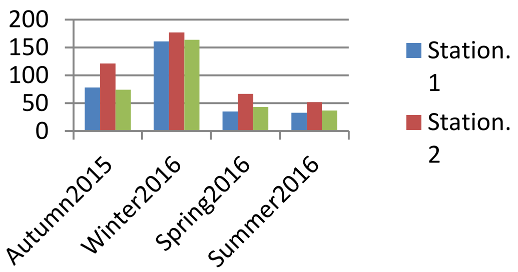
(Fig.4)Seseanal changes in pH in three selected stations



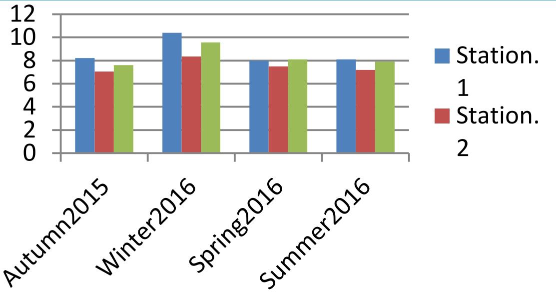
(Fig.5)Seseanal changes in EC ms/cm in three selected stations



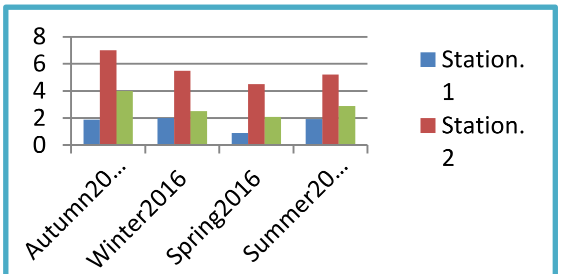
(Fig.6)Seseanal changes in Salinity ppt in three selected stations



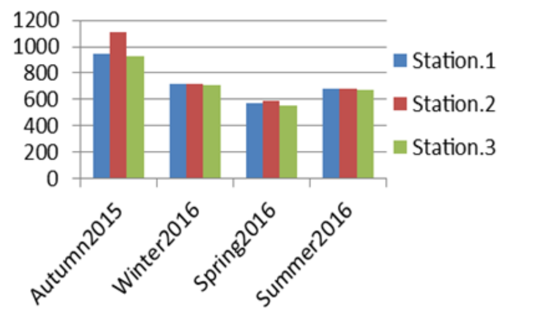
(Fig.7)Seseanal changes in Turbidity NTU in three selected stations



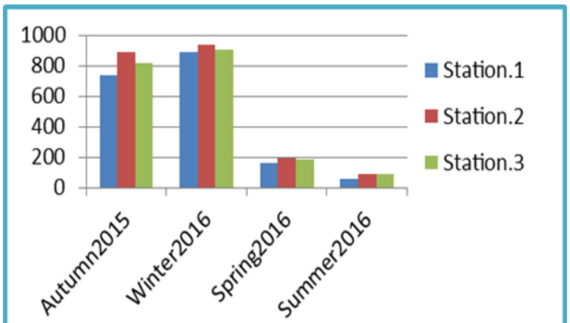
(Fig.8)Seseanal changes in DO mg/l in three selected stations



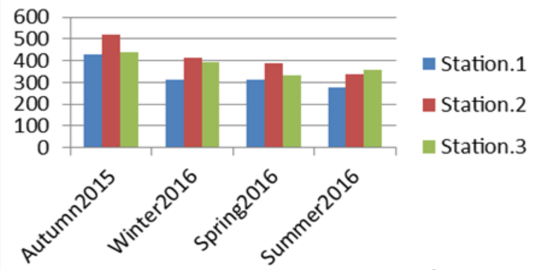
(Fig.9)Seseanal changes in BOD5 mg/l in three selected stations



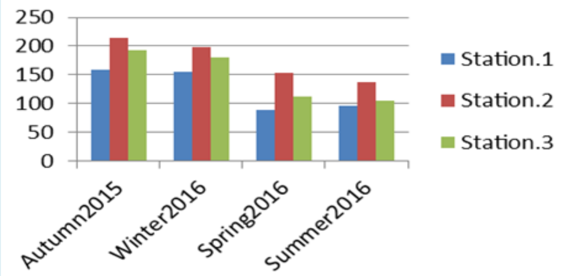
(Fig.10)Seseanal changes in TDS mg/l in three selected stations



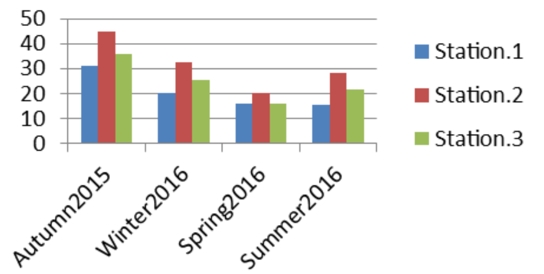
(Fig.11)Seseanal changes in TSS mg/l in three selected stations



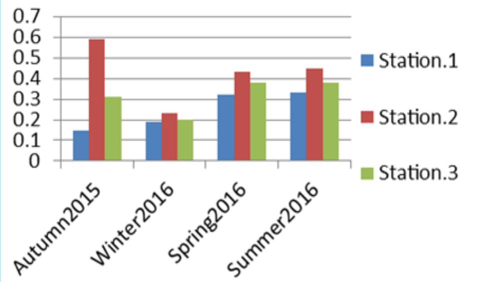
(Fig.12)Seseanal changes in total hardness mg/l in three selected stations



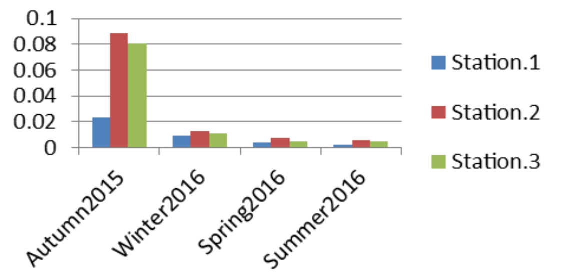
(Fig.13)Seseanal changes in Cl- mg/l in three selected stations



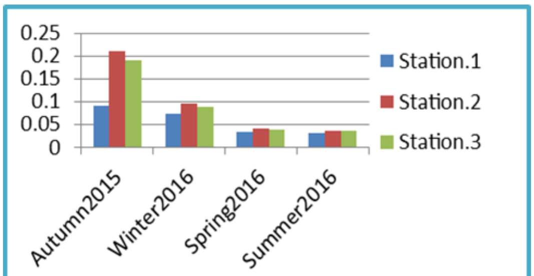
(Fig.14)Seseanal changes in NO3 mg/l in three selected stations



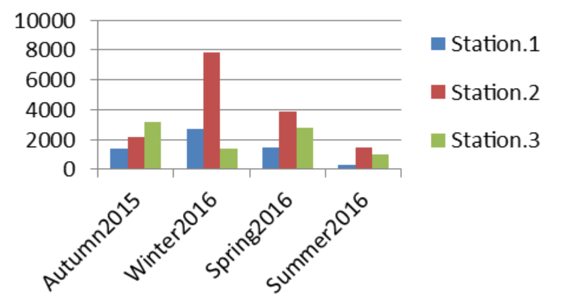
(Fig.15Seseanal changes in PO4mg/l in three selected stations



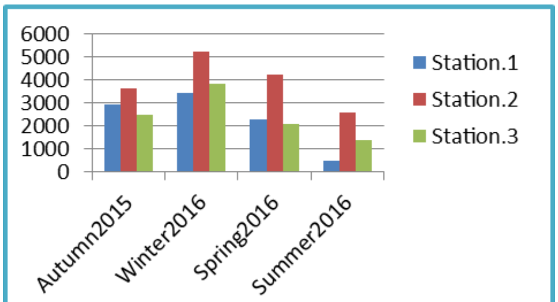
(Fig.16)Seseanal changes in Cd mg/l in three selected stations



(Fig.17)Seseanal changes in Pb mg/l in three selected stations



(Fig.18)Seseanal changes in T.B.C cell/100ml in three selected stations



(Fig.19)Seseanal changes in E.Coli cell/10ml in three selected stations

4.Discussion

Air and water temperature is an important factor in any aquatic environments affecting on biological processes, in this study it was ranged between 16 to 38 ◦C and 11 to 31 ◦C respectively. This result was similar to previous studies done by [11] [12].

The pH value of AL-Gharraf River in study sites during of most studied period was alkaline side above 7, and this result agreed with [13], they reported that Iraqi inland water is regarded to be on the alkaline side of neutrality, reflecting geological formations of the area and the results are agree with the finding that recorded by [14] [15]. Electrical conductivity used as an indicator of water quality based on total dissolved salts [16]. The increase of EC values at station two reflects the strong effect of domestic sewage effluent discharge at this area. Also, EC values recorded in the present work is coincided with findings of [17] [18]. The study also revealed monthly changes in salinity, with notable increase during summer months due to evaporation [19]. The presence of agricultural drainage systems namely, Kut, Al-Muafakiah and AL-Haay may contribute in rising salinity as well[20]. Water turbidity is caused by suspended matter such as clay, silt and planktons also turbidity degree of River water is an approximate measure of the intensity of the pollution [20]. This result was similar to previous studies done by [21] [22]. Oxygen content of water is one of the important factors, and it is very necessary for all living organisms [23].The study finding coincided with other authors [24] [25] [26] on Iraqi inland waters mainly Tigris. Low concentration of DO recorded from station-2 may relate to organic wastes discharged from Al-Haay City. Generally, the DO at most stations of canal water was within normal guideline values cited by [27] for the protection of aquatic life.

The biological oxygen demand is defined as the quantity of DO which is able to oxidize the organic components in the water with the assistance of microorganisms under defined experimental conditions [28] . Generally, results indicate increasing levels of BOD, in particular at station-2 during the November and October , this may be due to decomposition of organic matters run directly to the river with domestic sewage. These results were slightly higher than that reported by [29] [30] at the same river. Values of total hardness in the selected stations exceeded 520 mg/L as $CaCO_3$. This indicates that waters are very hard according to [31]. Increase in hardness values was found to coincide with rise in salinity [32] [33].The results of total hardness are agreed with those of [34] [35]. Chloride is a natural substance present in all portable water as well as sewage effluents as metallic salt. Generally high concentration of chloride indicates to organic pollution in the water [36]. This result was similar to previous studies done by [37] [38]. Total dissolved solids (TDS) is the term used to describe the inorganic salts and small amounts of organic matter present in solution in water [39]. These results were slightly lower than that reported by [40] [41] at the same river. Total suspended solids are considered to be one of the major pollutants that contributes to the deterioration of water quality, contributing to higher costs for water treatment, decreases in fish resources, and the general aesthetics of the water [42], TSS values recorded in the present work is coincided with findings of [43] [44] Nitrate is the stable form of combined nitrogen and it is an important factor which might limit growth of phytoplankton [45]. The results of nitrate are agreed with those of [46] [47] Phosphorus is essential to the growth of algae and other biological organisms. The reactive phosphate concentration in studied river was ranged between 0.15 to 0.5 mg/l. The high concentration of phosphate may be due to sewage water effluent and fertilizer application in surrounding agricultural area. This result was close to that reported by [48]. Cd can enter the environment from various anthropogenic sources such as by-products from zinc refining, coal combustion, mine waste, electroplating processes, iron and steel production, and pesticides[49].The increase of the concentration of Cd during autumn season and decrease during summer due to increased discharge of domestic sewage especially at station 2 and using of fertilizer and pesticides that is added to agricultural lands [50]. Lead is one of the very toxic heavy metals that not only accumulate in individual but also have the ability to affect the entire food chain and disrupt the health system of human beings, animals and phytoplankton [51]. The recorded concentrations of Pb in Al-Gharraf River in all the stations as a result of the passage of the river through agricultural lands that used different chemicals that contains Pb [52]. The total bacterial includes all of the bacterial species that are capable of growing in or on a nutrient rich solid agar medium [53]. High numbers of bacterial level of the Al-Gharraf River due to receiving the large amounts of sewage especially in Al-Hayy city, as wall as increase the agricultural activities have led to increase bacteria number in the waters of the river [54]. The presence of *E.coli* bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of man or other animals[55]. In this study fecal indicator bacteria abundance were measured in samples collected in river located in Al-Haay city. Results showed that this river which flowing through urban areas was more contaminated than those rivers which flowing through agricultural areas [37].

5.Conclusions

The results of the study revealed that the river is not suitable for use as drinking water without elaborate treatment, poor for aquatic life protection and fair for irrigation. Also the results revealed that most water quality parameters were excess the Iraqi standards, and WHO standards for the raw water. The shortage of water in the river and runoff of the domestic sewage impacted negatively on the quality of water.

6.References

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