THE EFFECT OF AL-THARTHAR –EUPHRATES CANAL ON THE SOME ECOLOLOGICAL PROPERTIES OF EUPHRATES RIVER

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Abstract

The present study was designed for two targets , the first, to demonstrate the seasonal variations in physic-chemical parameters of Al-Tharthar-Euphrates canal and River Euphrates and the second is explain the possible effects of canal on some ecological properties in Euphrates river. Water samples were collected seasonally from both sides for a period of spring (April) 2009 to winter (February) 2010. Twenty two parameters were studied included temperature, pH, dissolved oxygen, biological oxygen demand, electrical conductivity , total dissolved solids, total hardness, alkalinity, total suspended solids, calcium, magnesium, potassium, sodium, chloride, nitrate, phosphate, lead, manganese, copper, nickel, iron and zinc. These parameters were compared with water quality standards to evaluate the quality of water in canal and river for public usage. The almost water quality parameters remained within the safe limits through the study period except total hardness, chloride, calcium manganese, copper, lead and nickel were recorded concentrations in some seasons higher than the permissible limits values for drinking water. The results also showed that the Al-Tharthar-Euphrates canal contributes in significant increase for the total hardness values and significant decrease of EC , TDS, TSS, K, Na, Cl and NO_3 in Euphrates river.

تأثير قناة الثرثار – الفرات على بعض الخصائص البيئية لنهر الفرات

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الخلاصة

صممت الدراسة الحالية من اجل هدفين: الاول، توضيح التغيرات الموسمية في مؤشرات الماء الفيزيائية والكيميائية لقناة الثرثار – الفرات فضلا عن نهر الفرات، والثاني تقييم مدى تأثير القناة على بعض الخصائص البيئية لنهر الفرات عند منطقة الدراسة . جمعت عينات الماء من كل المواقع موسمياً للفترة من شهر نيسان ٢٠٠٩ الى شباط ٢٠١٠. تم دراسة ٢٢ مؤشراً شملت درجة حرارة الماءِ والاس الهيدروجيني والاوكسجين المذاب والمتطلب الحيوي للاوكسجين والتوصيلية الكهربائية ومجموع المواد الصلبةَ الذائبة والعسرة الكلية وقاعدية المياه ومجموع المواد الصلبة العالقة والكالسيوم والمغنيسيوم والبوتاسيوم والصوديوم الكلورايد والنترات والفوسفات والرصاص والمنغنيز والنحاس والنيكل والحديد والخارصين. كما قورنت هذه المؤشرات بمعايير نوعية المياه من اجل تقييم مدى ملائمة المياه في القناة والنهر للاستخدامات العامة. بينت النتائج بان اغلب المؤشرات المدروسة كانت ضمن الحدود الامنة والمقبولة لمياه الشرب ما عدا قيم العسرة الكلية والكالسيومِ والكلورايد والمنغنيز والنحاس والرصاص والنيكل والتي سجلت تراكيز اعلى من الحدود المسموح بها في بعض الفصول. اظهرت النتائج ايضا ان قناة الثرثار – لفرات لها تأثير مهم في زيادة قيم العسرة الكلية وتقليل كل من

قيم التوصيلية الكهربائية ومجموع المواد الصلبة الذائبة والعالقة وايونات البوتاسيوم والصوديوم والكلورايد والنترات في مياه نهر الفرات عند منطقة الدراسة.

Introduction

Water quality monitoring is an essential tool used by environmental agencies to gauge the quality of surface water and to make management decisions for improving or protecting the intended uses [1,2]. A continuous monitoring of water quality is very essential to determine the state of pollution in our rivers [3]. This information is important to be communicated to the general public and the government in order to develop policies for the conservation of the precious fresh water resources [4]. In general, the water entering rivers coming from nearest lakes frequently differs from the water already present in respect of temperature, in content of dissolved oxygen, chemical substances and suspended solids [5,6]. Present study was designed firstly to monitor seasonal variation in water quality parameters in Euphrates river and Al-Tharthar-Euphrates canal and secondly to investigate the effect of Al-Tharthar-Euphrates canal on the ecological properties of Euphrates River.

Study area

The canal of Al-Tharthar - Euphrates is considered one of the important parts of Al-Tharthar lake project, it was established in 1976 to connect the lake (which receives its water from Tigris River) to Euphrates River, with total length reaches to 37 km , and maximum discharge (500 m^3/sec.), while the working discharge ranged between 10-200 m^3/sec. Four stations were selected to carry out the present study. Two stations were located at Al-Tharthar-Euphrates canal, and the other two were located at Euphrates River. First station was located in the area before the connection of this canal with Euphrates River as a control station, and the other one was located after the confluence of the canal to evaluate the ecological effects of this canal by comparison with the control station (Fig 1).

Materials and methods

Samples collection

Sampling was performed 4 times, started in spring (April) 2009, and continued up to summer (July), autumn (October) and winter (February) 2010, The samples were taken from surface water in plastic bottles of 1.5L capacity.

Procedures

Water temperature was measured in the filed with a thermometer, while Electrical conductivity, TDS and pH were also recorded in the filed using portable Multimeter HANNA Model (HI 9811-5). Dissolved Oxygen and BOD_0 were determined using Winkler's method. Other parameters like total hardness, bicarbonate (HCO^-_3), total suspended solids (TSS), calcium (Ca^+), magnesium(Mg^{2+}), potassium (K^+), sodium (Na^+), chlorides (Cl^-), Nitrate (NO^{3-}), Phosphate (PO_4^{3-}), Lead (Pb), Manganese (Mn), copper (Cu), Nickel (Ni), Iron (Fe), Zinc (Zn), were determined following standard methods [7]. Heavy metals were determined by using an Atomic absorption Spectrophotometer (Perkin - Elemer model 5000). Calcium and magnesium were estimated using EDTA titrimetry, sodium and potassium by flame photometry, phosphates by molybdenum – blue complex formation using (UV-VIS Spectro-photometer Varian-Cary model 100), and nitrate was estimated by acid treatment followed by spectrophotometry.

Results and discussion

Physic-chemical characteristics

Temperature

Temperature during the sampling of different seasons was found to vary from 12 to 27 °C in canal, while ranged between 12 – 26 °C in Euphrates River. The overall range in water temperature was minimum in winter and maximum in summer (Table I) and (Fig 2). which are these values followed almost identical seasonal cycles. However, the variations in water temperature may be due to different timings of collection, influence of the season and the effect of atmospheric temperature. Temperature is known to influence the pH, alkalinity and DO concentration in the water [8].

Table 1: Means and ± standard deviation of the tested parameters in water samples

Parameters	Al-Tharthar-Euphrates canal		Euphrates River	
	Station 1	**Station 2**	**Station 3**	**Station 4**
Temperature (°C)	21.1 , ±5	21.4 , ±6	21.9 , ±6.9	22.3 , ±6.2
pH	7.3 , ±0.9	7.3 , ±0.9	7.3 , ±0.85	7.4 , ±0.84
Dissolved oxygen(mg/L)	8.6 , ±1.1	8.8 , ±1	9.1 , ±1.3	9.2 , ±1.2
BOD_5 (mg/L)	3.7 , ±0.9	2. 6 , ±0.7	2.1 , ±1	2.2 , ±1
EC (µS/cm)	1088 , ±564	1080, ±544	1605 , ±579	1232 , ± 361
TDS (mg/L)	582 , ±307	605 , ±272	807 , ±280	678 , ±191
Total hardness (mg/L)	556 , ±273	567 , ±243	450 , ±71	472 , ±86
HCO^-_3(mg/L)	216 , ±70	211 , ±82	257 , ±97	253 , ±87
TSS (mg/L)	1069 , ±503	1038 , ± 416	1148 , ±374	976 , ±266
Ca^{2+} (mg/L)	196 , ±١05	216 , ±201	210 , ±87	176 , ±85
Mg^{+2}(mg/L)	265 , ±204	255 , ±170	262 , ±106	273 , ±81
K^+ (mg/L)	1.2 , ±0.9	2.2 , ±1.5	3.5 , ±2.6	1.7 , ±0.25
Na^+ (mg/L)	94 , ±56	98 , ±59	144 , ±85	108 , ±55
Cl^-(mg/L)	110 , ±35	109, ±29	185 , ±137	103 , ±93
NO^-_3(mg/L)	2.2 , ±1.1	1.8 , ±0.9	3.4 , ±0.8	2.7 , ±0.8
PO_4^{-3}(mg/L)	0.32 , ±0.3	0.20 , ±0.19	0.4, ±0.37	0.30 , ±0.3
Pb (mg/L)	0.32 , ±0.3	0.20 , ±0.1	0.37 , ±0.22	0.30 , ±0.2
Mn (mg/L)	0.34 , ±0.2	0.16 , ±0.10	0.10 , ±0.09	0.10 , ±0.08
Cu (mg/L)	0.05 , ±0.04	0.04 , ±0.03	0.06 , ±0.05	0.03 , ±0.03
Ni (mg/L)	0.05 , ±0.04	0.09 , ± 0.07	0.06 , ± 0.04	0.04 , ±0.03
Fe(mg/L)	0.10 , ±0.٠9	0.18 , ±0.12	0.18, ±0.023	0.13 , ±0.018
Zn (mg/L)	0.20 , ±0.٠3	0.35 , ±0.3	0.04 , ±0.03	0.09 , ±0.013

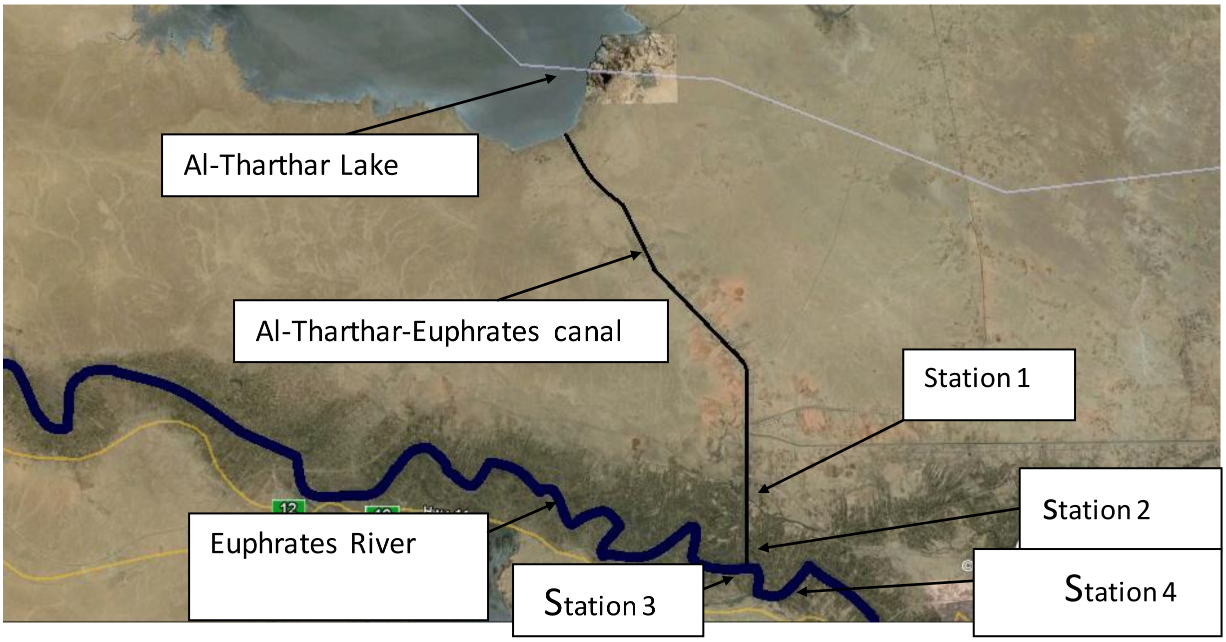

Fig 1: Image of study area showing the locations of the studied stations

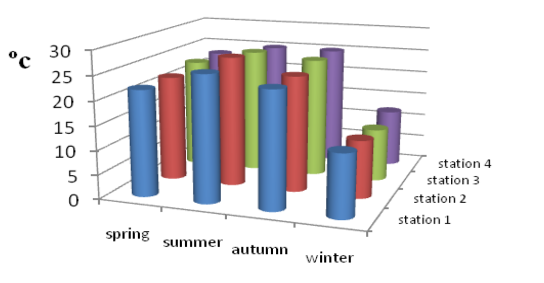

Fig.2 The variation of temprature in study stations

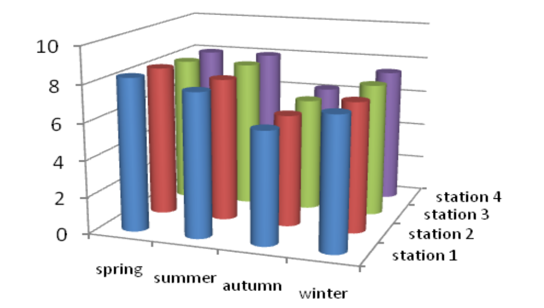

Fig.3 The variation of pH in study stations

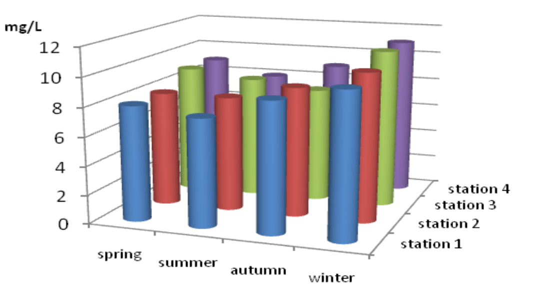

Fig. 4 The variation of DO in study stations

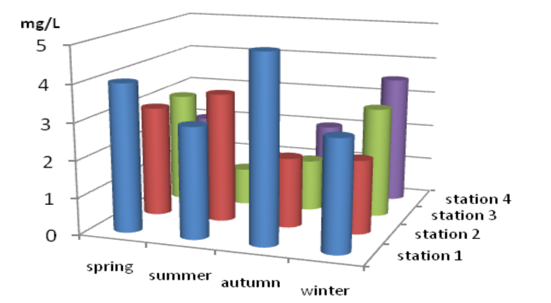

Fig. 5 The variation of BOD5 in study stations

pH

In the canal water the pH range was found from 6.1-8.3, whereas in Euphrates River samples it varied from 6.2 to 8, and there was no significant difference found among study stations. Therefore, no pronounced effect for Al-Tharthar- Euphrates canal on Euphrates River. The pH of the River water and canal tended to be higher in spring (Fig 3). Alkaline pH is considered to be good for promoting high primary productivity. According to Fakayode

[9]. The pH of a water body is very important in determination of water quality since it affects other chemical reactions such as solubility and metal toxicity. The pH of the water under study in both seasons are within the WHO standard of 6.50-8.50[10], while optimal pH range for sustainable aquatic life is pH 6.5 - 8.2 [11].

Dissolved Oxygen and BOD_5

Dissolved oxygen in the River and canal water showed slightly variation at different seasons . In the canal it ranged from 7.5 mg/L in summer and went up to 10.3 mg/L in winter, while ranged between 8-11mg/L in River stations, this indicated that the study area is highly oxygenated. In the present findings, the DO is higher in winter season (Fig.4) could be due to increased aeration because of rainfall and decreases of water temperature [12]. No significant difference among study stations according to analysis of variance results, and the slightly increased for concentrations of DO in Euphrates stations returned to currents factor in this river. BOD_5 varied between 1.9 – 5 mg/L in canal and ranged from 1 - 3.5 mg/L in River (Fig 5), with significant difference among stations. It is obvious that the BOD_5 concentrations decreases in the River stations. This phenomenon can be attributed to the natural self-purification of the river and the lack of outfalls along this stretch. The availability of oxygen to living organisms decreases with increase of BOD in water [13]. The lower concentration of BOD in the winter season was probably due to higher value of DO as low temperature. DO in good quality streams is usually more than 6 ppm to promote proper growth of fish and other aquatic organisms. Thus, all study stations the DO levels indicate good quality water while, the BOD’s were within the WHO standards limits.

Electrical conductivity and TDS

EC of the canal water ranged from 380-1620 µS/cm, while this EC increased to a range of 800-2360 µS/cm in Euphrates sites (Fig 6). The total dissolved solids (TDS) concentrations varied between 210- 859 in canal , while varied between 500 -1180 in River (Fig 7). The EC and TDS recorded higher values in autumn at lower discharge, which may be attributable to greater solubility of ions at higher temperature in late summer. Several factors influence the conductivity including temperature, ionic mobility and ionic valences. In turn, conductivity provides a rapid mean of obtaining approximate knowledge of total dissolved solids concentration and salinity of water sample [14]. In general, these results agreed with other studies on the same river [15,16]. The analysis of variance showed significant difference among stations especially between station 3 and station 4 in Euphrates River. The decreased values were recorded in station 4 indication to impacts of canal water on Euphrates river in study area.

Total hardness

Total hardness of the canal water fluctuated from 222-800 mg/L in canal, while fluctuated from 350-550 mg/L in Euphrates River (Fig. 8). Water with 50 mg/L of hardness is considered to be soft. Hardness of 300 mg/L is however, permissible for domestic use and for agriculture, an upper limit of 150 mg/L is usually recommended [3]. A significant difference was recorded among study stations especially between station 3 and station 4. This difference returned to effect of Al-Tharthar - Euphrates canal on station 4 in Euphrates river. According to Lind classification based on total hardness, Euphrates river and canal water is described as very hard, this results agreed with other studies on the same river[15,16].

Bicarbonate

In the canal the bicarbonate ranged from 131-286 mg/L, while that in River varied from

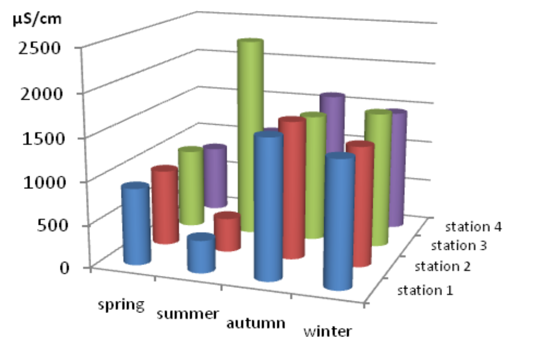

Fig. 6 The variation of EC in study stations

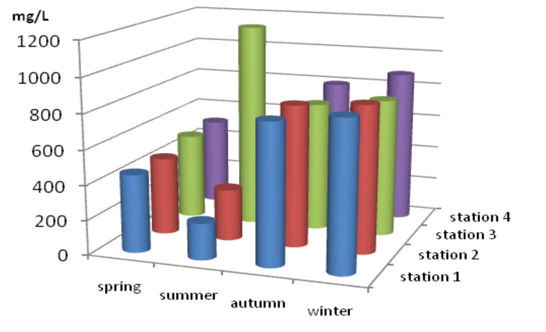

Fig. 7 The variation of TDS in study stations

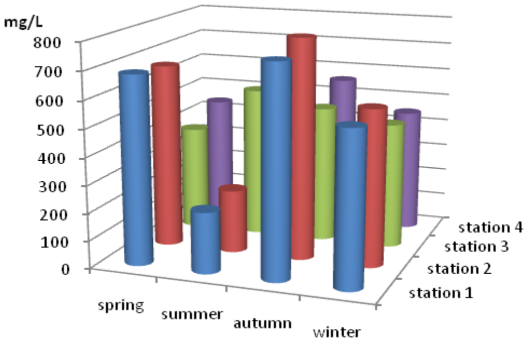

Fig. 8 The variation of total hardness in study stations

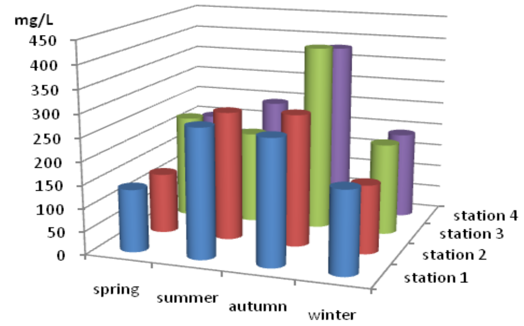

Fig. 9 The variation of HCO3 in study stations

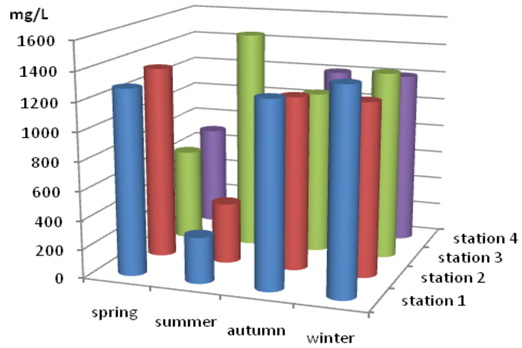

Fig.10 The variation of TSS in study stations

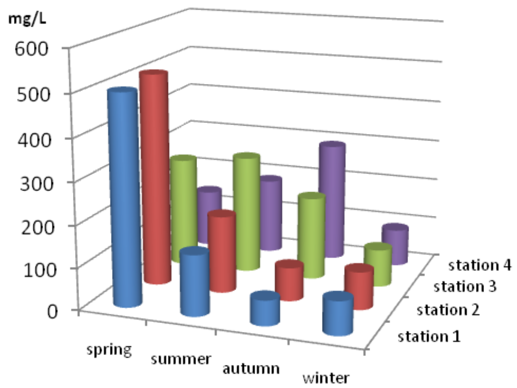

Fig. 11 The variation of Ca in study stations

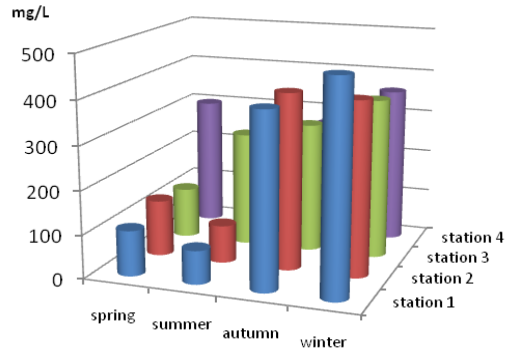

Fig.12 The variation of Mg in study stations

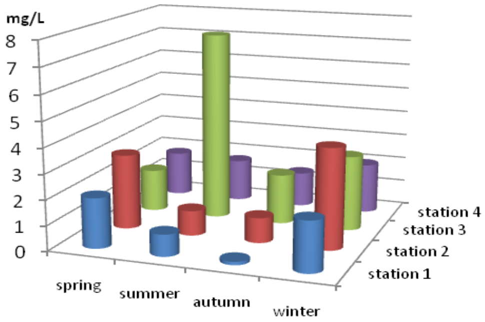

Fig. 13 The variation of K in study stations

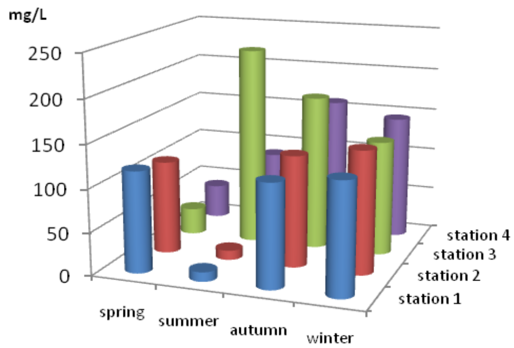

Fig.14 The variation of Na in study stations

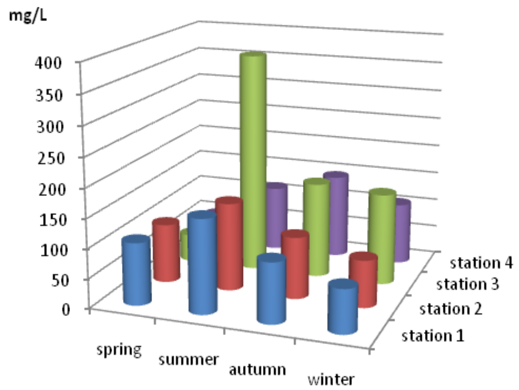

Fig. 15 The variation of Cl in study stations

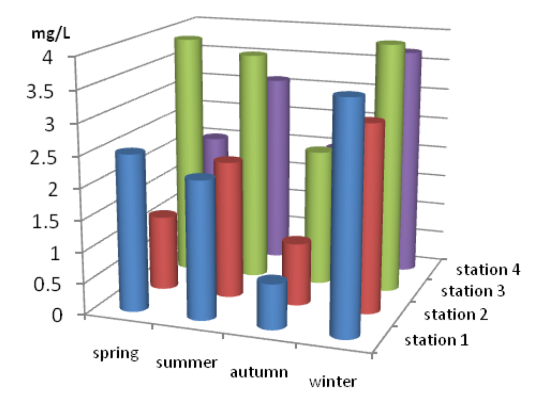

Fig. 16 The variation of NO3 in study stations

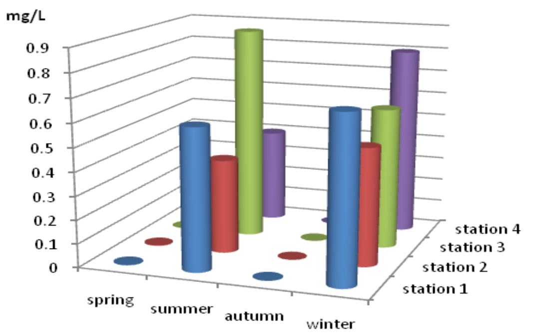

Fig. 17 The variation of PO4 in study stations

200-402 mg/L (Fig 9). Alkalinity serves as a pH reservoir for inorganic carbon. The higher values of alkalinity during autumn indicate greater ability of the river water to support algal growth and other aquatic life in this season [17] . The results of statistical analysis showed significant difference between canal and river samples with higher values were recorded in Euphrates stations.

Total suspended solids

The values of TSS ranged from 319-1280 mg/L in canal while ranged from 639-1205 mg/L in Euphrates River(Fig 10), with recorded high values in winter in all studied stations indicating high discharge in this season. In winter showing rains at various places from where River and canal passes, which brings clay, sand and organic matter from adjoining areas of the river. According to analysis of variance there was significant difference between station 4 and station 3, this may be due to effect of canal water which contribute to decrease of TSS concentrations in station 4 . The values are also within the WHO permissible limits.

Ionic composition

Calcium

The variation in Cations and Anions composition of the river water viz. Ca^{+}, Mg^{2+}, Na^{+} , K^{+}, Cl^{-} , NO^{-}_{3} and PO_4^{-3} are shown in table (I). Ca^{+}, which is a major component of natural waters, comes mainly from the rocks, seepage, drainage, wastewater etc.[18]. Ca^{+} generally varied from 60 to 500 mg/L in canal (Fig 11), but noticeably decrease at River stations (90-290 mg/L) especially in station 4. This indication of greater precipitation of Ca^{+} in this zone in the form of $CaCO_3$.

Magnesium

Magnesium is required as an essential nutrient for plants as well as for animals and the concentration of 30 ppm is recommended for drinking waters [19]. The concentration of Mg^{2+} ions varied from 77 to 480 mg/L in canal (Fig 12), this concentrations was much higher than Mg concentrations in Euphrates (117 to 300 mg/L). The concentrations of magnesium in all study period were irregular in seasonal variation. However, the concentration of Mg^{2+} was high in both seasons and exceeded the maximum permissible limit.

Potassium and Sodium

The percentage of K^{+} ions is often taken as important parameter deciding the suitability of water for irrigation[19]. The K^{+} levels were quite low (0.13 – 4 mg/L) in canal, while varied between 1.4-7.5 mg/L in River stations (Fig.13). Thus, the water is suitable for drinking or irrigation. The levels of Na^{+} were elevated in the range of 11-143 mg/L in canal, while varied between 30–231 mg/L in river(Fig 14). The higher values for K and Na were recorded in winter, these returned to rains flush out deposited these ions from near- surface soils. Station 4 in Euphrates River recorded low values for both of Na and K when it comparing with station 3 indication for effect of canal on Euphrates water in study area. In general, values of sodium recorded in this study were less than WHO standard limit for drinking purpose which reached to 200mg/L [10].

Chloride

Excess of Cl^{-} in inland water are usually taken as index of pollution. The sewage water and industrial effluents are rich in Cl^{-} and hence the discharge of these wastes result in high chloride levels in fresh waters[19]. The Cl^{-} concentrations varied between 102 - 159 mg/L and between 47-376 mg/L in canal and river respectively (Fig 15). The values recorded in this study were less than the acceptable values for drinking water (200 mg/L) in Iraq [20]. The significant difference showed between station 3 and station 4 according to statistical analysis may be due to affected station 4 by water quality of canal.

Nitrate

Nitrate levels were relatively low in canal, varying from 0.7 to 3.5 mg/L while, ranged from 2-4 mg/L River (Fig 16). Significant difference was showed between stations especially between station 3 and station 4 indication to affect on river by the canal water . The high level of nitrate observed in winter returned to be due to local run-off from the adjacent crop field in these areas where the farmers had used Nitrogen-fertilizers and it is in agreement with Wolfhard and Reinhard[22] who concluded that nitrates are usually built up during wet seasons and that high levels of nitrates are only observed during early rainy seasons. This is because initial rains flush out deposited nitrate from near-surface soils and nitrate level reduces drastically as rainy season progresses. In general, there was no indication of nitrate pollution in study area, and these values are within maximum permissible limit prescribed by WHO. The maximum permissible concentration of NO^-_3 in drinking water is 10 mg/L [21].

Phosphate

There are various sources of phosphate to rivers, such as firm rock deposit, runoff from surface catchments, and interaction between the water and sediment from dead plant and animal remains at the bottom of rivers[23]. Concentration of available phosphate in the canal water ranging from non detected to 0.7 mg/L. while varied between non detected to 0.9 mg/L in River (Fig 17). The phosphate levels increased during winter in the study stations . Agricultural runoff containing phosphate fertilizers increase phosphate concentrations in canal and river during winter. The phosphate concentration was showed relatively low and that was in agreement with other studies on the same river [15,16].

Heavy metals

All the studied heavy metals showed irregular change in its local and seasonal variation. The Pb concentrations varied from 0.06- 0.9 mg/L in the canal stations and 0.02-0.8 mg/L in Euphrates stations (Fig 18). Mn varied between 0.014 to 0.68 mg/L in canal and fluctuated between 0.004-0.22mg/L in River (Fig 19). Cu varied between 0.008-0.12 mg/Lin canal and 0.005-0.27mg/L in river (Fig 20). Ni ranged from 0.001- 0.2 mg/L and ranged from non detected to 0.17mg/L in River (Fig 21). Fe ranged from non detected to 0.5mg/L in canal and 0.01-0.4 in river (Fig 22). Zn varied between non detected – 0.8 mg/L in canal and 0.01-0.15 mg/L in river (Fig 23).The lowest concentrations of Mn , Ni and Zn were observed in winter, while those of Fe and Cu were observed in spring which may be due to dilution factor [24]. In wet period the intense rains cause an increase in the river flow, producing a dilution of the contaminants [25]. The spatial changes in the concentrations of Zn, Cu, pb, Fe, Ni and Pb were statistically non significant at confidence level reached to ($p<0.01$). Therefore no pronounced effect for canal water on Euphrates river respecting studied heavy metals. The concentrations of Fe and Zn were within the safe limit for both drinking as well as for crop production but the concentrations of Mn, Cu, Pb and Ni exceeded the safe limit for drinking water in some seasons (0.5 mg/L for Fe, 1mg/L for Zn, 0.1 mg/L for Mn, 0.05 mg/L for Cu , 0.2 for Ni and 0.05 for Pb) [19].

Inter-relationships

Most of the studied parameters were found to bear statistically significant correlation with each other indicating close association of these parameters with each other. The dissolved oxygen (DO) of the water however, showed a highly negative correlation ($r = -0.888$, $p<0.01$) with temperature. EC also had a strong correlation with a number of parameters like chloride ($r = 0.675$ $p<0.01$) and total hardness ($r = 0.777$ $p<0.01$). Potassium (K) showed positive correlation with sodium ($r = 0.597$ $p<0.01$) and chloride ($r =0.687$ $p<0.01$), while nitrate recorded negative correlation with temperature ($r = -0.510$ $p<0.01$) and positive correlation with phosphate($r = 0.660$ $p<0.01$).

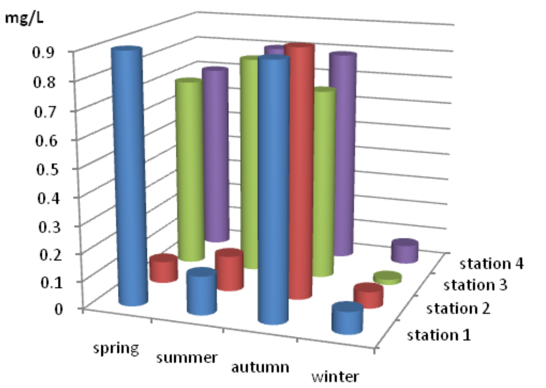

Fig. 18 The variation of Pb in study stations

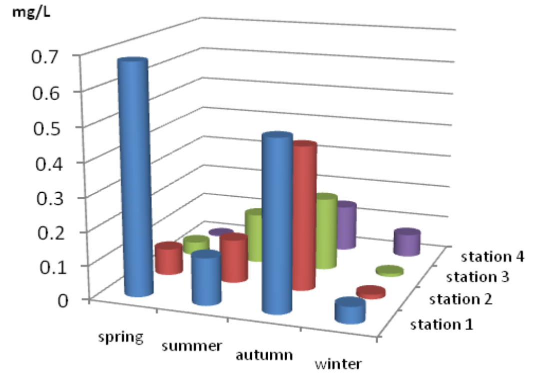

Fig. 19 The variation of Mn in study stations

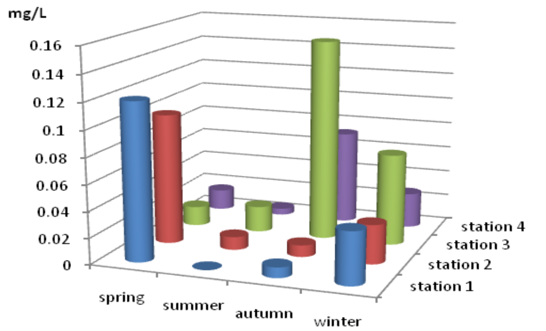

Fig. 20 The variation of Cu in study stations

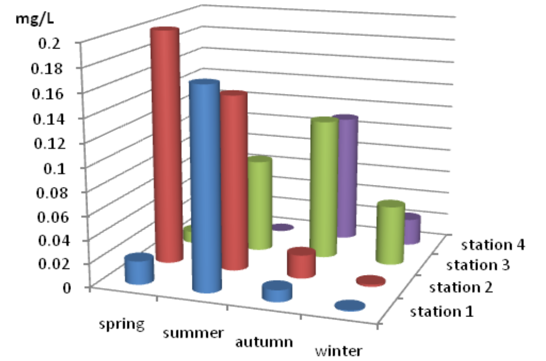

Fig.21 The variation of Ni in study stations

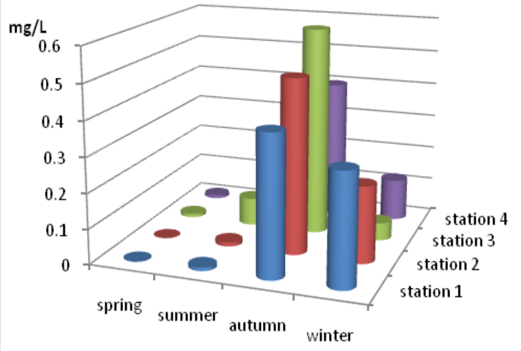

Fig.22 The variation of Fe in study stations

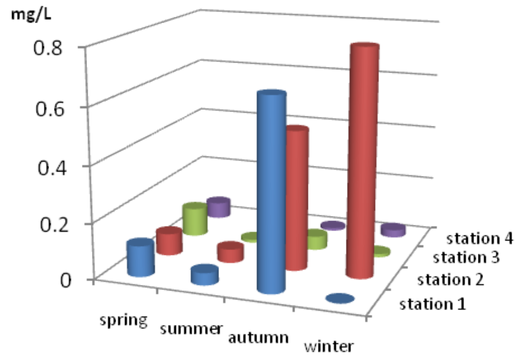

Fig. 23 The variation of Zn in study stations

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