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Evaluation of Water Quality Parameters in the Euphrates River within Ramadi City and Al-Dhiban Canal

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ABSTRACT

The main objective of this study is to evaluate the Euphrates river at Ramadi city and Al-Dhiban canal for different purposes, and to study the variation of cations, anions, electrical conductivity, total dissolved solids, total hardness, sodium adsorption ratio and percentage of sodium for the period (1992-1998). The results indicate that water in Euphrates river at Ramadi city and Al-Dhiban canal is suitable for drinking, irrigation and for different industrial purposes according to the world and Iraqi standard except the total hardness. This exceeded the permissible limits for some months during the study interval which causes additional limitation for domestic and industrial purposes. The results also revealed an increase in parameter values in Al-Dhiban canal in contrast to Al-Ramadi location due to the effect of Al-Warrar canal and Al-Habbaniyah lake. The study concluded that calcium is the cations which are the most available elements in both locations, followed by sodium, magnesium, and potassium. As for anions it was observed that sulfate concentrations are higher than chloride concentrations.

Introduction

The Euphrates River is one of the major water resources in Iraq. Its water is used for all purposes mainly for drinking, irrigation and industrial purposes. Increasing industrial and agricultural development accompanied by population growth has introduced a lot of pollutants to the Euphrates River. Any change in the quality of the river will affect these purposes.

Al-Anbar is one of the largest provinces located at the upstream of the Euphrates River. The river crosses the western border of Iraq at Husiba town. Al-Ramadi barrage across the Euphrates River was constructed in 1955 to pass part of the flood water down to Al-Habbaniyah lake through the Warrar canal (8.5) km long with a regulator of (24) openings.

The Dhiban outlet canal (9.5) km long, connecting Al-Habbaniyah lake with the river, a regulator of (5) opening was constructed to allow a discharge of (200) m3/sec back to the river.

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Concerning the Euphrates, this study is conducted to evaluate the concentrations of some water quality parameters in two sites: the upstream of Al-Ramadi barrage (site 1) and outlet of Al-Dhiban canal (site 2) with respect to time interval and to compare these parameters with the permissible limits of drinking, irrigation and industrial purposes.

Literature Review

Evaluation of water quality has been one of the important subjects in the field of management and control of environment. Many works have been conducted on water quality of the Euphrates River. Al-Faraj and Mansor [1] evaluated water quality in lower Euphrates at Nasiriyah and Sug Al-Shiukh by studying the variation of many parameters and Sodium Adsorption Ratio (SAR) with respect to time and distance. It has been observed that the salinity level ranges from high to very high and the sodium level ranges between low to medium according to U.S. salinity classifications.

Al-Mudaris [2] studied the effect of Al-Qadisyah Lake on the water quality of the Euphrates River. The

results have indicated that there is an increase in the concentrations of hardness and sulfate in the lake and river, however the water quality parameters stay below the maximum permissible limits for different uses. Moslem [5] concluded that the levels of chloride, sulfate, calcium and total hardness concentrations in the Euphrates River at Babylon town sometime exceed the permissible limits.

Water Quality Parameters Data

The present study is based on data that were collected by the Ministry of Irrigation during (1992, 1993, 1994, 1995, 1996, 1997, and 1998) for on the two sites of upstream of Al-Ramadi barrage on the Euphrates River (i.e. site 1) and Al-Dhiban canal outlet (i.e. site 2). Fig. (1) shows the location under study.

The original data included the chemical analysis of major cations and anions for (2250) samples that were taken on monthly basis. A summary of annual data for the each year is given in Table (2).

The parameters included total dissolved solids, electrical conductivity, total hardness as (CaCO3), chloride, sulfate, calcium, magnesium, sodium and potassium. The sodium adsorption ratio (SAR) and percentage sodium (Na%) were calculated according to USDA [7]. In addition, the correlation coefficients between water quality parameters were determined (Table 3 and 4). However, Murdoch and Barnes [4] concluded that the correlation coefficients values seem to be important if the values are greater than (+0.30).

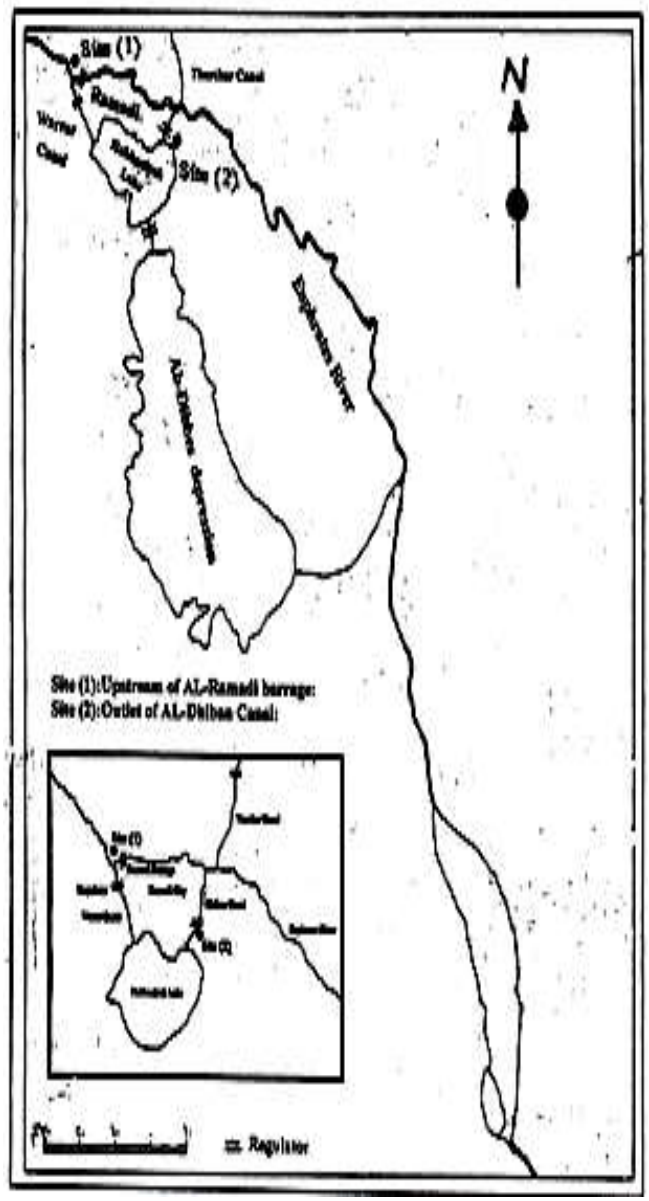

Fig. (1): Location map of the study area

Table (1): A Summary of the Water Quality Parameters of sites (1) & (2) for the years (1992-1998)

arame-ters	site	Site (1)*							Site (2)**						
	year	1992	1993	1994	1995	1996	1997	1998	1992	1993	1994	1995	1996	1997	1998
EC x 10^6 µ.mhos/cm		1000-1462	1200-1840	1063-1220	726-1000	782-1055	710-1072	673-861	1320-1780	1520-1710	1475-1700	1000-1620	910-1286	812-1200	866-1000

Na%	SAR	Total Hardness mg/l	TDS mg/l	SO_4^{-2} mg/l	Cl^{-1} mg/l	K^{+1} mg/l	Na^{+1} mg/l	Mg^{+2} mg/l	Ca^{+2} mg/l
35-36	2.11-2.63	435-563	890-1140	299-334	133-171	4-5	90-138	36-66	79-102
31-32	1.83-2.35	411-711	832-1650	272-402	176-242	3-5	86-135	41-70	96-130
34-40	2.17-2.22	245-408	730-900	238-297	151-192	4-5	78-107	24-46	58-96
-	-	158-275	554-718	174-233	92-157	-	-	17-23	26-68
-	-	186-288	642-774	210-258	118-152	-	-	20-25	42-78
-	-	-	488-648	151-223	61-116	-	-	21-36	42-78
42-43	1.92-2.31	168-231	438-600	132-166	45-74	3-5	55-81	19-28	32-46
26-29	1.99-2.23	588-750	920-1316	328-378	199-257	4-6	104-140	57-86	112-148
26-28	1.78-2.19	662-757	1250-1687	358-396	251-280	4-6	105-139	77-90	134-163
26	1.59-1.9	583-700	1236-1552	345-399	237-298	5-6	82-115	68-84	28-140
-	-	329-718	699-1356	267-385	157-273	-	-	49-86	72-144
-	-	258-466	717-1035	181-282	113-173	-	-	32-62	50-90
-	-	-	627-886	192-270	88-128	-	-	22-47	80-100
34-35	1.7-2.19	250-311	688-788	199-271	99-156	4-6	62-100	33-46	46-82

* = No. of samples 1142
** = No. of samples 1108

Table (2): Minimum, Maximum and Mean values of Water Quality Parameters of sites (1) & (2) over period (1992-1998)

Parameters		EC x 10^6 µ.mhos/cm	Na %	SAR	Total Hardness mg/l	TDS mg/l	SO_4^{-2} mg/l	Cl^{-1} mg/l	K^{+1} mg/l	Na^{+1} mg/l	Mg^{+2} mg/l	Ca^{+2} mg/l
Site (1)	Max.	1840	43	2.63	711	1650	349	242	5	138	70	130
	Min.	673	31	1.83	158	438	132	45	3	55	17	26
	Mean	1018	-	-	325	743	240	134	4.2	97	32	68
		Max. at Jan.1993 Min. at Jan.1998			Max. at Jan.1993 Min. at Jan.1995	Max. at Jan.1993 Min. at Jan.1997	Max. at Jan.1998 Min. at Jan.1998	Max. at Jan.1993 Min. at Jan.1998		Max. at Jan.1992 Min. at Jan.1993	Max. at Jan.1993 Min. at Jan.1995	Max. at Jan.1993 Min. at Jan.1995
Site (2)	Max.	1780	26	2.23	757	1687	399	298	6	140	90	163
	Min.	812	35	1.59	250	627	181	88	4	62	22	45
	Mean	1287	-	-	522	998	299	189	5.2	105	59	102
		Max. at Jan.1997 Min. at Jan.1997			Max. at Jan.1993 Min. at Jan.1995	Max. at Jan.1993 Min. at Jan.1998	Max. at Jan.1993 Min. at Jan.1997	Max. at Jan.1994 Min. at Jan.1998		Max. at Jan.1992 Min. at Jan.1998	Max. at Jan.1992 Min. at Jan.1997	Max. at Jan.1993 Min. at Jan.1998

Table (3): Correlation Coefficients of the Water Quality Parameters at sites (1)

	TDS	Mg^{+2}	Ca^{+2}	Cl^{-1}	SO_4^{-2}	EC	T.H.	Na^{+1}	K^{+1}
TDS	1								
Mg^{+2}	0.859	1							
Ca^{+2}	0.829	0.896	1						
Cl^{-1}	0.783	0.622	0.779	1					
SO_4^{-2}	0.876	0.782	0.876	0.879	1				
EC	0.922	0.865	0.866	0.814	0.881	1			
T.H.	0.915	0.954	0.907	0.701	0.852	0.906	1		
Na^{+1}	0.791	0.751	0.738	0.646	0.758	0.790	0.808	1	
K^{+1}	0.173	0.207	0.227	0.234	0.201	0.227	0.226	0.124	1

Table (4): Correlation Coefficients of the Water Quality Parameters at sites (2)

	TDS	Mg^{+2}	Ca^{+2}	Cl^{-1}	SO_4^{-2}	EC	T.H.	Na^{+1}	K^{+1}
TDS	1								
Mg^{+2}	0.861	1							
Ca^{+2}	0.841	0.938	1						
Cl^{-1}	0.899	0.904	0.839	1					
SO_4^{-2}	0.875	0.877	0.857	0.955	1				
EC	0.885	0.898	0.864	0.918	0.919	1			
T.H.	0.902	0.908	0.948	0.943	0.919	0.940	1		
Na^{+1}	0.558	0.669	0.694	0.603	0.668	0.755	0.729	1	
K^{+1}	0.070	0.100	0.191	0.056	0.071	0.074	0.084	0.060	1

Results and Discussion

1- Variation of water quality parameters with time.

In order to examine the variation of water quality parameters under consideration, the mean monthly values of each one parameter are plotted against time for a period of seven years (1992-1998) in the two sites, as shown in Figs. (2-a, b, c, d, e, f, g, h, i). It was observed the most of parameters under study change not only with season but also from one year to another. Some years are dry others are wet. There is also a decrease in the total dissolved solids and other parameters by about (20-40%) was observed for the year 1996 to 1998.

Figs. (2-a,b) show variations of total dissolved solids (TDS) and electrical conductivity (EC) during time intervals in two sites. The (TDS) and (EC) are an average of 743 mg/L and 1018 mg/L, respectively, and increases in site (2) which have an average of 998 mg/L and 1287mg/L, respectively. The maximum and minimum values of these parameters during the period of study are shown in Table (2).

The sources of salts mainly in site (1) is the drainage water which is discharged about (4.5) m3/sec in the Euphrates River upstream of Al-Ramadi barrage with an average concentrations of (TDS) about 1200 mg/L [14]. The (TDS) and (EC) increase in site 2 during the time interval. This is due to the effect of Al-Warrar canal, which receives an amount of wastes from different populated sources [12], in addition to the effect

of water retention in Al-Habbaniyah lake which helps to increase concentrations of salts in Al-Dhiban canal.

On the other hand, the rise in TDS during winter for most years (Fig. 2-a) and Table (2) may be attributed to the agricultural pollutants carried by streams during a rain season. Harper and Stewart [3] concluded that the concentration of salts causes alkalinity increasing during the winter season.

The variations of the ions concentrations (anions and cations) during the study period of two sites are shown in Figs. (2-d, e, f, g, i). The principle source of dissolved ions in water is, the dissolution of the underneath geological Formations and hydrological effects. Concerning the study of locations, there are many factors that are more effective to increase salts and ions concentrations in the study area (as will be stated lateral on).

The wide variations in anions and cations concentrations are probably due to the variation in the river discharge, and the variation of both quantities and qualities of the effluent received. The ions concentration shows increases in site (2), which is due to the effect of Al-Warrar canal and Al-Habbanyah Lake (as mentioned previously). There is also another factor which is effective, the groundwater in the surrounding areas is feeding Al-Warrar canal and lake with high concentrations of sulfate and chloride especially when water level decreases in the surface water [2]. It is also observed that ions concentrations increases mostly during the winter season (Table 2) as a result of the water current that carries a way the superficial soil containing sulfate and chloride in high concentrations. Harper and Stewzar [3] noticed that industrial aerial pollution, rains and torrent drain to the lake basin cause an increase in sulphar concentration.

On the other hand, the highest concentrations of the ions under study location are those of sulphate followed by chloride, calcium, sodium, and magnesium. The potassium is less a abundant in the water which seems to be very little variation values ranging between (3-5) mg/L in site (1) and (4-6) mg/L in site (2), respectively as shown in Fig. (2-i). However, Al-Obaydi [11] found that sulfate is higher than chloride concentration and for cations sodium is more than calcium and more than magnesium in the Euphrates River at Ramadi location. However the sulphate is more than chloride concentrations in Al-Habbaniyah lake.

The variation in total hardness during the interval study is presented in Fig. (2-c). The concentrations of total hardness are an average (325)mg/L in site (1), increasing to (522)mg/L in site (2). The increase of total hardness is the result of increase of salts and ions concentrations (as mentioned previously). The maximum and minimum values of this parameters respect to month during time interval are shown in Table (2).

The water quality parameters under study seem to be higher than the values observed by Al-Obaydi [1]. The difference is due to the fact that Al-Obaydi considered only one year of measurement (1982/1983). This indicates the importance of long time studies on water quality parameters, and the results of the operation of Al-Qadisyah Dam.

The correlation coefficients for each water quality parameters were displayed in Table (3&4). The results revealed that these parameters have relatively high positive correlation coefficients whose coefficients range from (0.558 to 0.955). However, the relationship between potassium with other parameters seems to be weekly corrected. This relationship of good correlation was observed between groups of ions concentrations and hardness with total dissolved solids and electrical conductivity. This is due to the fact that the anions and cations were found as dissolved components in water which allows the electrical current to pass through.

The sources of ions concentrations found in the study locations are the drainage water, in addition to the soil across which the river passes and which contains chloride and sulfate concentrations.

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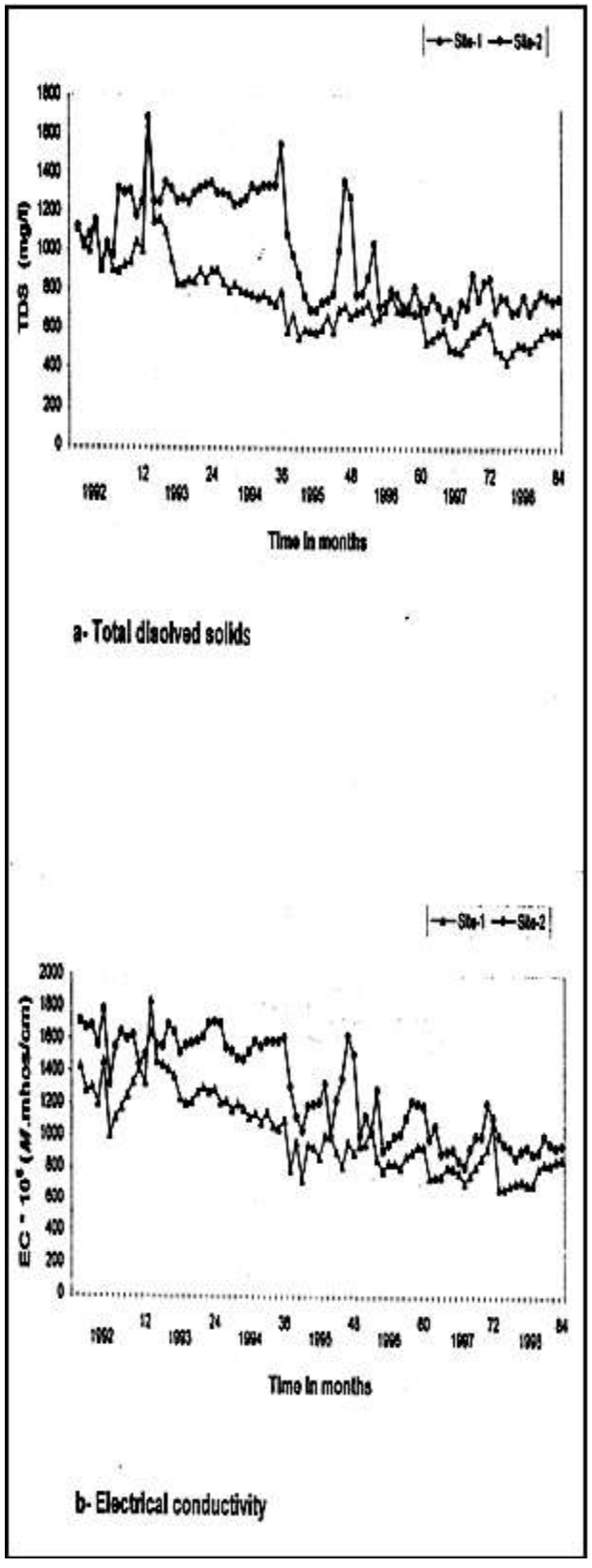
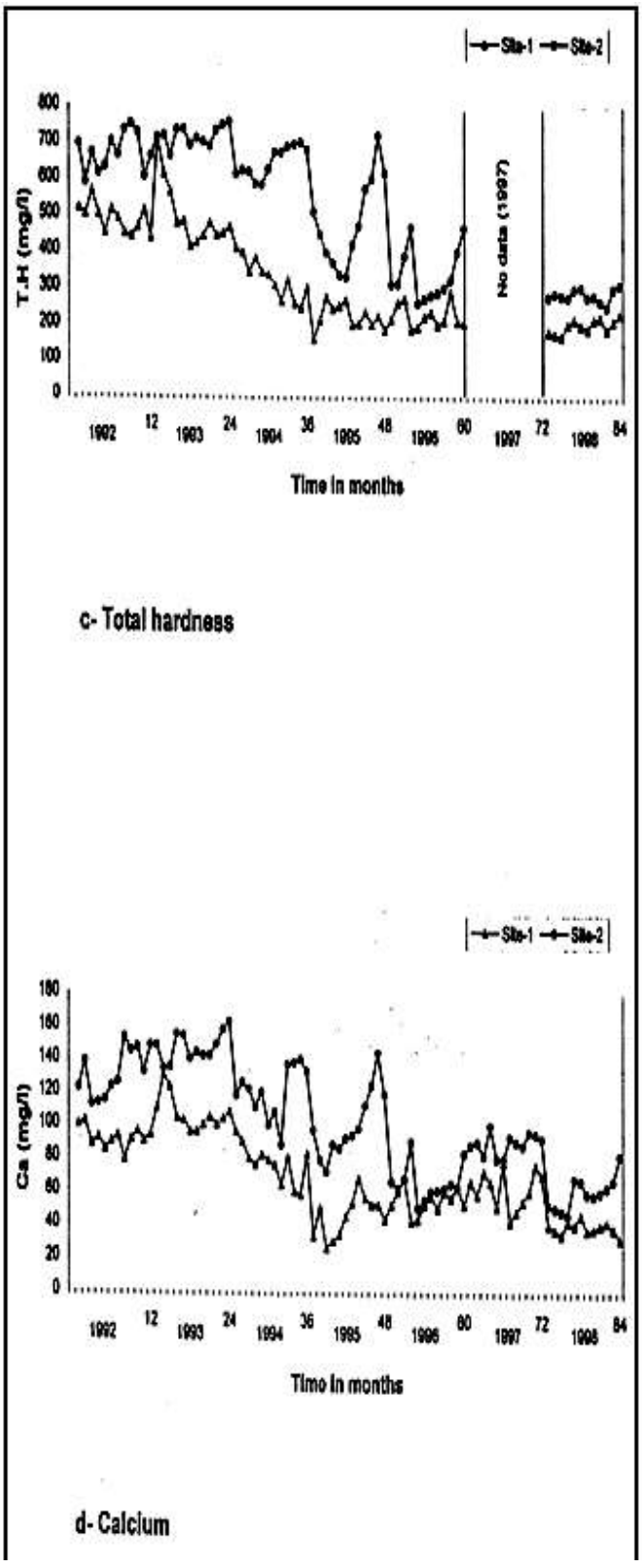


a- Total dissolved solids

b- Electrical conductivity



c- Total hardness

d- Calcium

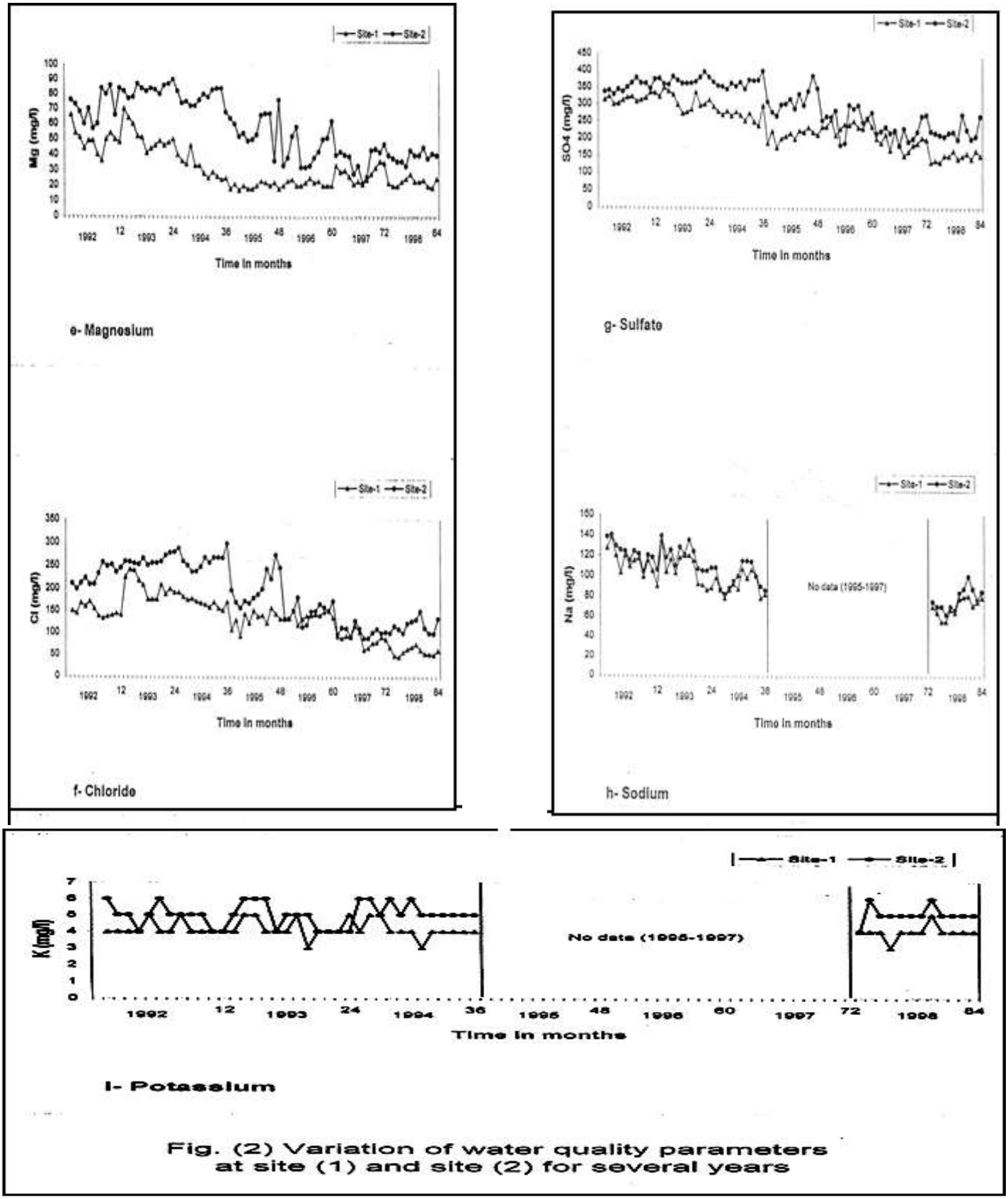


Fig. (2) Variation of water quality parameters at site (1) and site (2) for several years

2- Water Uses

Uses of water for different purposes depend upon the type and concentration of existing ions. Comparison with U-S-P-H-S, WHO and Iraqi standard specifications for drinking water [8,9,13] indicates that the water in two sites is suitable for drinking (Table 5), except total hardness which exceeds the maximum permissible level for some months of years especially in site (2).

In order to evaluate the quality of irrigation waters, standards and guidelines have to be considered, according to Todd's classification [6], four criteria must be considered namely; total dissolved solids, chloride concentration, percentage of sodium (Na%), and sodium adsorption ratio (SAR). The parameters used in this study are compared with Todd classification as shown in (Table 6). From this comparison, it has been found that water can be used for irrigation with no problem. The U.S. salinity laboratory classification [7] has been extensively used in Iraq, when the water quality has an electrical conductivity values ranging for medium (C2), i.e. (EC x 106 = 750-2250 micro mhos/cm). Moreover the sodium adsorption ratio (SAR) values are low (S1) less than 3, (Table 6). Therefore it can classified between (C2-S1) and (C3-S1) (i.e., water are suitable to irrigation of crops). Considering Wilcox classification [10], the same water can also be classified between good to permissible regarding salinity and (SAR).

For evaluating water for different industrial requirements, attention should paid be to such factors as total hardness, chloride, calcium and magnesium. Water quality parameters under study are compared with the standard specification for some industrial purposes [5] as indicated in table (7). It is found that water can be used in most industries, except hardness, which is beyond the permissible limit. According to Todd classification [6] water is considered to be very hard (i.e. more than 300 mg/L).

In view of the previous analysis, the following conclusions have been drawn:

1. The difference in water quality parameters between the Euphrates River at Al-Ramadi city site (1) and Al-Dhiban canal site (2) are due to the effect of Al-Warrar canal and water retention in Al-Habbanitah Lake which causes an increases in parameters in site (2).
2. Water quality parameters under study are suitable for drinking and for irrigation many crops and industrial purposes.
3. The ions concentrations obtained are Ca+2 > Na+1 > Mg+2 > K+1 for cations and SO4-2 > Cl-1 for anions.
4. Considering the water quality parameters values for site (1) and site (2), the study shows there are high correlation coefficients between parameters except potassium which has low correlation coefficients.

Table (5): Comparison between the standard chemical composition for drinking water and water quality Parameters

Parameters	Site (1)		Site (2)		U-S-P-H-S 1992	WHO 1983		Iraqi Standard Specifications 1984
	Range	Mean	Range	Mean		A	B	
TDS	438-1650	743	627-1687	998	1000	500	1500	1000
Ca^{+2}	26-130	102	46-163	134	200	75	200	200
Mg^{+2}	17-70	59	22-86	68	125	-	150	50
Na^{+1}	55-138	97	62-140	105	200	-	-	200
K^{+1}	3-5	4.2	4-6	5.2	20	-	-	-
Cl^{-1}	45-242	134	88-298	189	250	200	600	250
SO_4^{-2}	132-349	240	181-399	299	250	200	400	400
T.H. mg/l	158-711	325	250-757	522	-	100	500	500

A = Highest desirable level. B = Maximum permissible level.

Table (6): Comparison between constituents of standard water used for irrigation and water quality Parameters (After Todd, 1963)

Constituent	water quality Parameters				Standard water constituent used for irrigation		
	Site (1)		Site (2)				
	Range	Mean	Range	Mean	Water entirely save for irrigation	Intermediate water for certain crops	Water too grest to be save for irrigation
TDS (mg/l)	438-1650	743	327-1687	998	700	2000	2000
Chloride (mg/l)	45-242	134	88-298	189	150	500	500
Na%	31-43	-	26-35	-	60	60-75	75
SAR	1.83-2.63	-	1.59-223	-	Excellent 10	Good 10-8	Fair (18-20) Poor (> 26)

Table (7): Comparison between standard water used for some industrial purposes and water quality Parameters

Parameters	water quality Parameters				Different industries				
	Site (1)		Site (2)						
	Range	Mean	Range	Mean	Paper manufacture	Oil refineries	Chemical manufacture	Cement factory	Food stuff manufacture
Total hardness (mg/l)	158-725	725	250-757	522	475	900	1000	-	310
Cl^{-1} (meq/l)	1.26-6.82	3.77	2.48-8.4	5.33	5.63	45.13	14.10	7.05	8.46
Mg^{+2} (meq/l)	1.39-5.75	4.85	1.8-7.1	5.6	0.99	-	-	-	8.23
Ca^{+2} (meq/l)	1.29-6.48	5.1	2.3-8.13	6.68	0.99	10.97	9.98	-	5.99
SO_4^{-2} (meq/l)	2.75-7.26	4.99	3.76-8.3	6.22	-	11.87	17.69	5.21	5.20

References

1. Al-Faraj, F.A. and Mansor, M.J., (1987): Evaluation of water quality in lower Euphrates. J. Agric. And water Reso. Res., Vol.6, No.2, Pp.243-256, Baghdad, Iraq.
2. Al-Mudaris, M.M., (1994): Effect of Al-Qadisyah Lake on the Euphrates river water quality. M. Sc. Thesis, Coll. of Engineering, Baghdad University.
3. Harper, D. M. and Stewart, W.D.R., (1987): The effects of land use upon water chemistry, particularly nutrient enrichment in shallow low land lake. Hydrobio. Vol. 148.
4. Murdoch, J. and Barnes, J.A., (1974): Statistical tables for science, engineering, management and business studies. Macmillan.
5. Salvato, P.E., (1982): Environmental engineering and sanitation. New York, USA.
6. Todd, D.K., (1980): Ground water hydrology. John Wiley Sons, Inc. London, P.535.
7. USDA, (1969): Diagnosis and improvement of salin and alkali soils. Handbook 60. Washington D.C. USA.
8. U.S.P.H.S., (1962): Drinking water standards publ 956. Washington D.C., p.61. USA.
9. WHO, (1983): International standard for drinking water. World Health Organization, (4th ed.) Geneva.
10. Wilcox, L.V. (1948): The quality of water for . U.S. irrigation use. U.S. Dept. Agric. Tech. Bull.
11. العبيدي، محمود ارزيج (1983): هايدروجيوكيميائية نهر الفرات والتلوث البيئي المحتمل من القائم حتى الحلة. رسالة ماجستير غير منشورة، كلية العلوم، جامعة بغداد.

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تقييم متغيرات نوعية مياه نهر الفرات بين مدينة الرمادي وناظم الذبان

اياد صليبي مصطفى

الخلاصة:

يهدف البحث الى تقييم نوعية مياه نهر الفرات في مدينة الرمادي وقناة الذبان للاغراض المختلفة. تم دراسة تغاير الايونات الموجبة، التوصيلية الكهربائية، مجموع المواد الصلبة الذائبة، العسرة الكلية، نسبة امتصاص الصوديوم والنسبة المئوية للصوديوم للفترة (1992–1998). اوضحت النتائج الى صلاحية مياه نهر الفرات وقناة الذبان لاغراض الشرب والري وللاغراض الصناعية المختلفة استناداً الى المقاييس العالمية والعراقية فيما عدا العسرة الكلية التي تجاوزت الحدود المسموح بها ولبعض الاشهر خلال مدة الدراسة مما يحدد من استخدام الماء للاغراض المنزلية والصناعية. ابرزت النتائج زيادة في قيم المتغيرات في قناة الذبان مقارنة بموقع الرمادي نتيجة تاثير قناة الوروار وبحيرة الحبانية. خلصت الدراسة الى ان الكالسيوم هو الايون الموجب الاكثر تواجداً في كلا الموقعين، تليه عناصر الصوديوم ثم المغنسيوم واخيراً البوتاسيوم. وبالنسبة للايونات السالبة لوحظ بان تراكيز ايونات الكبريتات اعلى من تراكيز ايونات الكلوريدات.