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EVALUATION THE SUITABILITY OF SHATT AL-ARAB RIVER WATER FOR DRINKING AND IRRIGATION USED ACCORDING TO INTERNATIONAL CLASSIFICATION SYSTEMS

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ABSTRACT

Water samples were collected monthly from December 2012 until November 2013 from three stations selected along the Shatt al-Arab revir in Basra governorate (Qurnah Al-Dair and Abu Khassib). The chemical analysis were applied to determine the pH,EC,TDS,Ca,Mg,Na,K,SO_4,Cl and HCO_3. Two types of classification were used to evaluate water use. The first classification aimed to test the water for human use according to the World Health Organization standard of drinking water (WHO, 2004) which showed that the water is unsuitable for drinking, hence Shatt Al-Arab river can be considered inadequate for civilian use according to WHO and Iraqi Quality limitation of drinking water(IQS 2009). The second classification aimed to test the water for agricultural uses using three systems; the first is the United State Department of Agriculture (USDA) Classification System (1954), the second is the FAO Classification System (1985), and the third is the FAO Classification System (1992). The results of the second classification showed that the "Water with moderate to severe problems" for salt concentration represented by EC but for SAR the effect of Na concentration on soil permeability, the result was "No problem to use water for irrigation. The water quality of Shatt Al-Arab River can be evaluated according to the irrigation standard (US-Salinity Lab) as C4S1 which was saline to extremely saline with low sodicity hazard. Soil type and the appropriate selection of the irrigation system should be taken into consideration.

KEYWORDS: Classification, Water Quality, Shatt Al-Arab, Irrigation, Drinking

INTRODUCTION

Water is one of the most important compounds of the ecosystem, but due to increased human population, industrialization, use of fertilizers in the agriculture and man-made

activity the natural aquatic resources are causing heavy and various pollution in aquatic environment leading to pollute water quality and exhaustion of aquatic biota. It is therefore necessary that the quality of drinking and irrigation water should be classified and checked at fixed time of interval, due to use of contaminated drinking and irrigation water , human population suffers from varied of water borne diseases. (Basavaraja et al, .2011; Al-Kuzaiea 2014;Al-Malkey et al.,2015).

The Shatt Al-Arab River has played a very important role in the development of the industrial and agricultural stations in the country and has additional values in terms of transportation, irrigation and providing of drinking water (Abaychi & Mustafa 1988; Hussein et al. 1991;Moyel 2015).The water quality of this river has worsened as a result of a significant decline in water discharge affecting Iraqi rivers in recent years (Al-Mahmood, Al-Shawi& Al-Imarah 2008; Hassan et al. 2011;Al-Mahmood et al.,2015). The salinity of the Shatt Al-Arab River has been influenced by many factors including the quality and quantity of water received by this river, the variability of the water discharged into it, the impact of temperature and sunshine, the amount of rainfall and evaporation rates; and the impact of the type of land areas that this river crosses (Hussein et al. 1991; Hassan et al.,2011). In the province of Basra, many important industries rely on river water. These include paper production, fertilizing, petrochemical and power plants, and the oil industry. The deterioration of water quality and quantity negatively affects these industries and will result in increased costs to provide a suitable quality of water for such industries (Hassan et al. 2011 ; Al- Mahdi 2015).

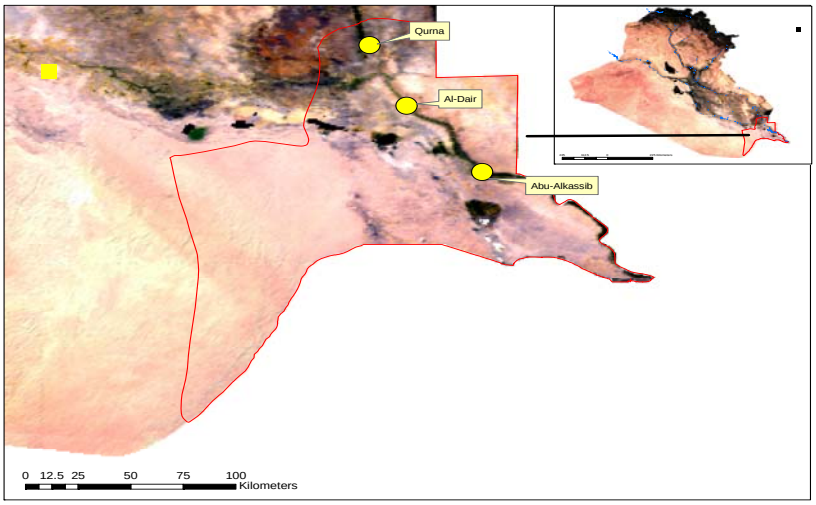
Assessing water quality is an important factor in preserving environmental ecosystems. There are many physical and chemical properties of water which can be taken into consideration in order to assess water quality. Suitable methods were selected to conduct field and laboratory measurements in order to assess the water quality of the Shatt Al-Arab River. In order to classify the quality of water in the Shatt Al-Arab River, it is important to have some standards as the basis for comparison (Al-Malkey 2015). There are many standards which can be used for that purpose. This research will focus on two types of standard: the water standard for drinking purposes and other standards for irrigation purposes. This study will use the U.S. Salinity Laboratory’s taxonomic system of irrigation water and Ayers and Westcott which is based on two indicators: the main electrical conductivity (EC); and the percentage of adsorption of sodium, known as the Sodium Adsorption Ratio (SAR), which expresses the seriousness of the Sodicity hazard (Richards, Gardner & Ogata 1956 and

Ayers and Westcott 1994). Concerning the water drinking standard, this study intends to use the World Health Organization (WHO) existing standard for assessing and determining the water quality of the Shatt Al-Arab River.

The aim of this study is to evaluate the water quality of the Shatt Al-Arab River based on some chemical and physical parameters [electrical conductivity (EC) and Sodium Adsorption Ratio (SAR)] depending on commonly used classification systems to determine their suitability for drinking and irrigation water.

Materials and methods

Water samples were collected monthly from three selected stations in the Shatt Al-Arab channel during one year starting in December 2012 until November 2013. The rate of values for the three months were recorded according to the seasons of the year. The first station is Al-Qurna ,in North of Basra, the second is Aldear, and the third is Abu Khasib. Samples were collected in plastic containers 1-litre sterile for applying certain chemical measurements.



Fig(1) location map of the study area

Field tests: The pH and electrical conductivity (E.C) determined in the field using WTW meters.

Laboratory tests: The Cations and Anions (Ca, Mg, Na, K, HCO_3, Cl and SO_4) were analyzed by using the standard procedure of (APHA 2005).Calcium and Magnesium were titrated with 0.01N Na_2EDTA.Sodium and Potassium were determined by flame photometer (JENWAY PEP7).HCO_3 titration with 0.01N H_2SO_4. Chloride was determined volumetrically by titration with 0.01N $AgNO_3$ and Sulphate was also determined by

spectrophotometer (shamus CEIL CE292) using turbidity method. Sodium Adsorption Ratio (SAR) which is called Sodicity Hazards (meq/ l) was calculated as to the following equation.

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}}$$

Result and dissection

As shown in fig 2, tables 1 and 2 there is a significant deference in the pH of water samples among the stations and seasons. The pH value ranged from 6.90 to 7.90 with mean 7.73 ±0.29. There is a significant deference in electric conductivity EC in different station but not seasons, ranged from 2.83-4.65 mS/cm with mean 3.09±0.8 mS/cm.Also there is an increasing of EC from up to downstream, the main reason of this is the discharge of swag and the salt wedge (Alkhuzai,2014; Al-Milkey 2015).

In general, previous studies have shown high concentrations of salt in the river, especially in spring, as opposite to winter. There has also been an increase in the chloride (524.5-788.18 mg/l with mean 627.52±75.68), calcium(104.20-214.20 mg/l with mean 174.88±33.02 mg/l), magnesium (52.42-138.06 mg/l with mean 86.44±24.18mg/l), sulphates (499.46-1224.50 with mean 752.88±194.89 mg/l) potassium (3.64-8.40 mg/l the total mean 4.22 ±4.22mg/l),sodium (315.31-495.17 with mean 387.67±200 mg/l) and bicarbonate(172.13-786.90 with mean 272.58±170.27).The water quality of this river has worsened as a result of a significant decline in water discharge affecting Iraqi rivers in recent years(Al-Milkey 2015)combined with an increase in the amount of pollutants such as human waste, agricultural and industrial sewage entering the river from different sources (Hussein et al. 2011; Al-Mahmood, Al-Shawi& Al-Imarah 2008,Hassan et al 2011).

Fig(2)Chemical properties of water in the three studied Station at four seasons

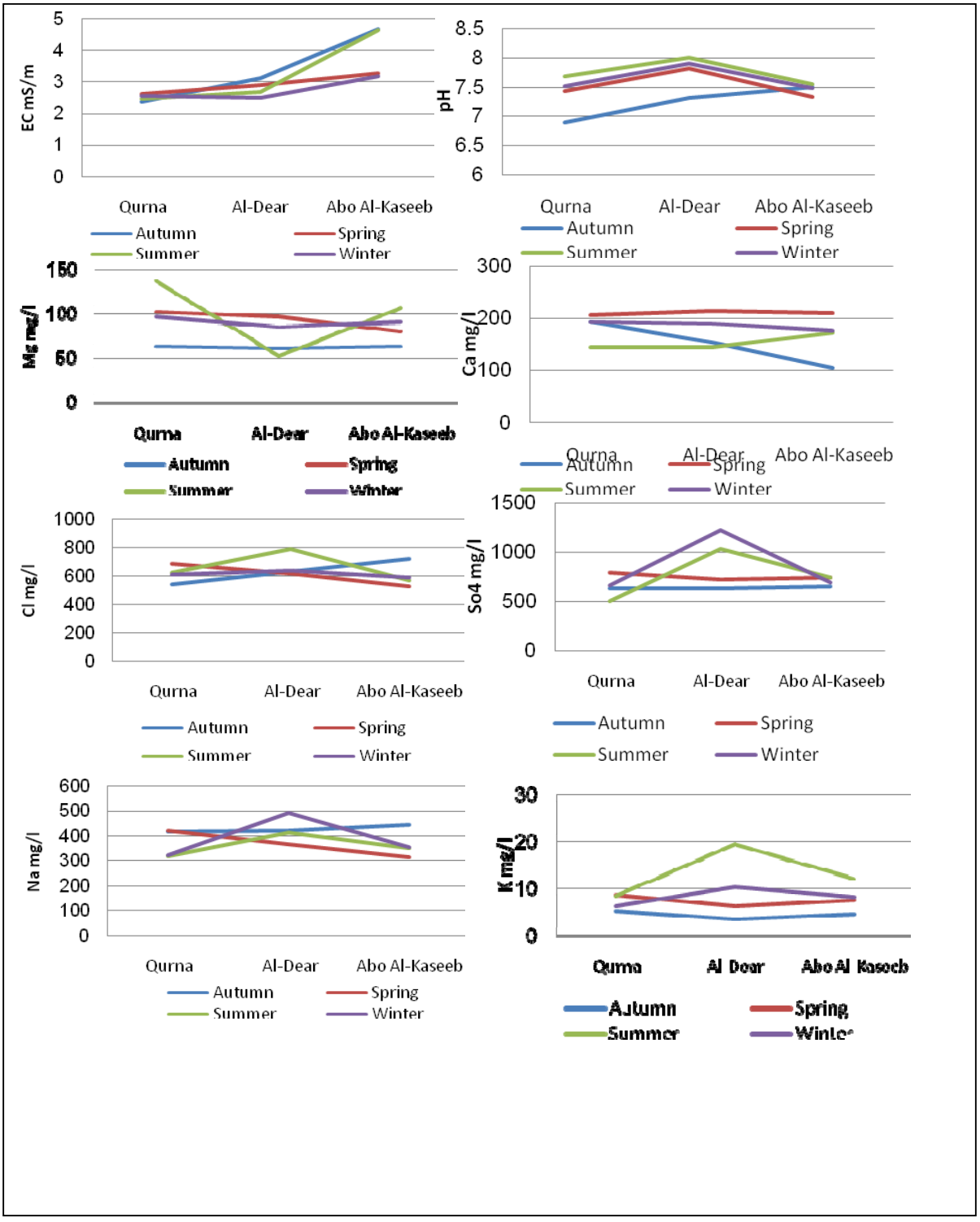


Table (1) Chemical properties of the Shatt AL-Arab river comparison with WHO(2003) and IQS(2009) drinking water standard.

Properties	Mean	Minimum	Maximum	Std. Deviation	WHO,2004 Standard	IQS 2009 ppm
pH	7.5333	6.90	8.00	.29537	6.5-8.5	-
E.C	3.0917	2.38	4.69	.79525	1.5	
TDS	2074.3675	1243.00	3762.61	620.80126	1000	1000
Ca	174.8800	104.20	214.20	33.02436	75-200	150
Mg	86.4433	52.42	138.06	24.18891	30-150	100
Na	387.6767	315.31	495.17	56.40772	200	200
K	8.3975	3.64	19.50	4.22182	10	-
Cl	627.5292	524.50	788.18	75.68026	250	350
SO4	752.8867	499.46	1224.50	194.89231	250	400
HCO3	272.5833	172.13	786.90	170.27046	100	-

Table(2)Chemical properties of water in three studied Stations in Shatt AL-Arab river

Station		pH	E.C	TDS	Ca	Mg	Na	K	Cl	SO4	HCO3
			mS/cm	mg/l							
Abo Al-Kaseeb	Mean	7.46	3.95	2326	165.42	85.35	367.95	8.13	600.36	705.53	216.36
	SD	0.10	0.83	1104	44.22	18.28	56.29	3.08	86.11	41.83	30.93
Al-Dear	Mean	7.76	2.81	1946	175.14	74.04	423.57	9.92	668.41	904.70	391.24
	SD	0.30	0.28	250	32.43	20.54	53.61	6.93	80.51	273.16	277.15
Qurna	Mean	7.38	2.51	1950	184.08	99.94	371.51	7.14	613.82	648.43	210.15
	SD	0.34	0.11	56	27.57	30.66	55.12	1.59	60.34	120.97	18.76
LSD at P=0.05		0.03	1.14	NS	NS	NS	NS	NS	NS	NS	NS

Water classification for drinking / stock watering purposes

For the purpose of quickly assessing the potential water quality of the Shatt Al-Arab River for human drinking use, international standard such as WHO 2004 and Iraqi Quality limitation of drinking water are used. This standard list a maximum and/or minimum acceptable range of selected cations, anions and physical properties. Structurally, the water in the Shatt Al-Arab River was too saline for long term direct consumption by humans, with TDS averaging over double the acceptable level(table 1). The ions present in the water would make the water taste salty and unpleasant, and health issues could arise with long term consumption, if untreated.

In general Acid function values (pH) of the water river samples was slightly alkaline in nature and within the permissible limit suggested by WHO and IQS. It did not show any spatial or progressive differences(Table 1,2) They were almost average and were within the allowed limits of the qualities of drinking water established by the WHO(2004) and IQS(2009) Central Organization for standardization and quality control of Iraq , the permissible limits of acidic function in standard no. 417 [19] (6.5-8.5) Electrical conductively, WHO (1998) was set a global standard in which it classified the quality of water according to its electric conductively for its use in the civil purposes as shown in Table (3) .However the EU countries allow an electric conductivity in drinking water about 1.25 dS/m.The chloride ion concentration in river water samples were more than the maximum allowable limits of the WHO(2003) and IQS(2009) standards. This is applied in all station at all seasons.

Table(3) water quality indication according to the electrical manual outreach WHO

water quality	Electric Conductivity(ds/m)
Excellent Water	0.05 to 0.40
good water	0.40 to 0.750
medium water	0.750 to 1.50
high mineral water	more than 1.50

Water Classification for agriculture purpose

According to the US Salinity Lab Classification (Richards, Gardner & Ogata 1956), FAO (1985)and FAO (1992)Shatt Al-Arab water can be classified in terms of EC(mS/cm) as *"very high to Extremely Saline water"*(in class C4very high saline water) (Table4). This

severely limits the types of plants that can grow and also the irrigation techniques. (Al-Kuziea 2014).

However, the SAR calculation showed limited or no sodicity hazard. SAR values were in the Class S1- suitable for most soil and drainage types and for long term irrigation use. It is in agreement with (Al-Sabah (2007) and Al-Malkey (2015).

Through the results in tables (4), Shatt al-Arab water in all the sites and season under study fall in the extreme salinity water, as far as its validity to agriculture use.

The results showed in table (4) that the classification of water quality of the Shatt al-Arab depending on salinity, according to Richards, 1954, Ayers and Westcott, 1985 , lies within salty and extremely salty in most of the water samples studied during the seasons of study lies within the class C4 (very high salinity water). These results are consistent with the findings of Moyal (2010) in the evaluation of the Shatt al-Arab water in the cases of tide, which showed that the Shatt Al-Arab water is located within the class C4 according to the classification of the U.S Salinity Laboratory (Richards, 1954).

Table(4). The Shatt Al-Arab water classification for irrigation purposes according to US-Salinity lab criteria for four season.

Month	E.CmS/cm				SARmeq/l				
	Qurna	Al-Dear	Abo AlKaseeb	Mean	Qurna	AlDear	Abo AlKaseeb	mean	Water Class
Autumn	2.38	3.14	4.69	3.40	6.67	7.26	8.54	7.49	C4S1
Spring	2.62	2.91	3.29	2.94	5.99	5.21	4.69	5.30	C4S1
Summer	2.47	2.70	4.65	3.27	4.60	7.50	5.21	5.77	C4S1
Winter	2.57	2.50	3.18	2.75	4.78	7.51	5.44	5.91	C4S1
Mean	2.51	2.81	3.95	3.09	5.51	6.87	5.97	6.12	C4S1
Min.	2.38	2.50	3.18	2.38	4.60	5.21	4.69	4.60	
Max.	2.62	3.14	4.69	4.69	6.67	7.51	8.54	8.54	
SD	0.11	0.28	0.83	0.80	0.99	1.11	1.74	1.33	

The results also agree with Alkhuzai (2014) in its examination of the chemical and physical properties of four kinds of irrigation water used in the region, including the Shatt Al-Arab by assessing it, suitability for irrigation, he found that the quality of the Shatt al-Arab and other

waters lie within the class C4 according to the salinity laboratory of the United States. But the limits of the use of this type of irrigation water is constricted according to the specifications and characteristics of soil and the nature of the cultured plants. When irrigation water quality was classified as Ayers & Westcott (1985) its moderate to severe salinity showed negative impacts to sensitive crops. This underlines the need for good management of the quality of irrigation, a water for crop irrigation this result agrees with Al-Milkey(2015).

The results of the current study did not show any significant differences between the values of the salinity of the Shatt al-Arab in the three stations during the study seasons(table 4), which conclude, that the water quality was not affected as a result of the continued operations of the biological and chemical degradation of the different sources of water pollution and the nature of the payload of the Shatt al-Arab from different sources.

Problem of Sodicity

Results in table (4) show that sodium adsorption ratio values (SAR) ranged from 4.69 to 7.51 during winter and spring seasonal of the study and between 4.60 to 8.54 during summer and autumn. And when water quality was classified according to the classification system of the U.S Salinity Laboratory (Richards, 1954), the class water under study was found within the class S1 (a low content of water-sodium) during the four seasons of the study.

We find that EC-SAR fall within the category C4S1 (high salinity – low sodicity) during the four seasons and for the three stations under study. The quality of water must be used only in medium and coarse soils with good puncture tissues and used with high salt stress crops. The quality of the of the Shatt al-Arab water is located within a little sodoet during the seasons of the study and these conclusions coincid with that of Al – Khuzai (2014). Also we find the quality of the Shatt al-Arab water was poor in most sites, especially in Abo AL-Kaseab which is in the downstream of the river and during summer and autumn of the period of the study especially in the downstream .these results agreement with Al-Malikey 2015.

The problem of toxicity

Results in fig (1) and tables (1) show that the chloride ion concentration of the Shatt Al-Arab water ranged from 586.94 to 606.14 mg/l in winter and between 524.5 to 687.83 mg/l in spring and 566.5 to 788.18 mg/l in summer and 540.47 723.5 to mg/l in autumn. As far as that of the stations, it is recorded in Abu Alkhaseeb during spring with lower values of

524.5 mg/l while in Al- Dear recorded 788.18 mg/L during the summer. The water quality in accordance with the toxic problem was seen as moderate to severe according to the classification of Ayers and Westcott, (1985). Glem (1997) has found that the Iraqi waters that cause a problem with chloride and according to the classification of Marsh, (1982) is 20.0% causing a growing problem is % 32.5, and that which cause severe problem is % 47.5respectively.

the concentration of chloride ions in the Shatt AL-Arab was less than that of the branches and channels, which underlines the impact of household waste caused to raising the salinity of the river water, However and cherish both the Hassan et al., (2011) and Al-Malkey(2015) have amplified low salinity waters of the Shatt al-Arab, due to the ease of the Karun River.

Conclusions

The results showed that the water under study is found unsuitable for civil use and irrigation except for plant with high salinity endurance due to the high salinity which is approved according to more than one classification.

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