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Sodium Problems in irrigation water from groundwater within the Safwan-Zubair area, Basra, Iraq

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Abstract

The groundwater contains many salts present because of the ability of the water to dissolve the salts, and the quantity and quality of dissolved salts determines the suitability of the water for irrigation and various uses. Five different locations and during three periods, depended on rain season, premoonson period, moonson period, and post moonson spread from August 2018 to April 2019 for sampling and performing laboratory analyzes, according to (APHA, 2005). Groundwater wells were evaluated based on three factors first, which is the rate of sodium adsorption (SAR), with the highest average rate of 14.35 (meq / l) recorded in well 3 and the lowest rate of 7.23 (meq / l) in well 7, and the water was classified using (SAR) as acceptable for irrigation purposes as it was within The first and second level. Secondly, the percentage of sodium ion (Na %) recorded the highest rate of 49.94 % in well 2 and the lowest rate of 45.17 % in well 7 and water was classified using (Na %) as acceptable for irrigation purposes within the third level. Third, the permeability index (PI) recorded the highest rate of 51.59 (meq / l) in well 8 and the lowest rate of 46.44(meq / l) in well4, Based on the permeability index, irrigation water is classified as acceptable and within ClassII, the results showed that all groundwater wells within the study area are suitable for irrigation purposes.

Key Words: Groundwater, dissolved salts, Irrigation Water, Safwan Al-Zubair

Introduction

The increase in population and dramatic climate change has increased the demand for water worldwide (Ma et al, 2009; Farid et al, 2013). Therefore, groundwater has become an important source in many regions of the world for domestic, agricultural and industrial use groundwater is an indispensable source as the only available and economical source of water (Keesari et al, 2014). Groundwater is the main source of water for various uses, the most important of which are domestic and agricultural in the southwestern parts of Basra, especially in desert areas; due to the lack of surface water and the rule of the desert climate (Al-Ruokabi, 2017) The need for detailed studies of the trend towards groundwater use and the suitability of it as an alternative source of surface water was increased (Al Dahaan and Al-Ansari, 2019)

High Groundwater salinity levels are a major problem in water quality due to irrigation and infiltration of seawater, excessive and continuous

pumping of groundwater. Salinity limits water use in irrigation and agriculture, and therefore more attention must be given to assessing water quality. Through hydro-chemical and environmental analyzes, it is necessary to assess groundwater quality (Glynn and Plummer 2005; Edmunds, 2009; Herczeg and Leaney, 2011; Keesari et al, 2014). For instance, the effects of its chemical constituents on both soils and plants may determine the use of groundwater for irrigation (Srinivasa and Gowd 2005; Raju 2007).

The water is suitable for use when its variables meet the pre-determined criteria for that use (Cordoba, 2010). On this basis, water quality has been defined as a description of the water condition in terms of physical, chemical, biological, and radiological properties, is used evaluate, the criteria most commonly used to assess water quality related to environmental health and safety systems for human use. (WHO, 2011).

Evaluating the importance of water resources used for any purpose through the content of chemical (Al-Janabi, 2008) . The suitability of the quality of any groundwater for a specific purpose depends on being acceptable and of appropriate quality Therefore use (Todd, 2007). There are several variables used in this study to determine the suitability of groundwater for irrigation, including sodium absorption ratio (SAR), sodium ion ratio (Na%), and permeability index (PI).

SAR was suggested by the American Salinity Laboratory to put a guide on the seriousness of sodium for irrigation water where the high concentrations of sodium ion in the soil solution reduces the readiness of a number of nutrients, especially calcium, potassium and magnesium by reducing their concentrations on the exchange surfaces and thus impeding their absorption (Al-Adili et al, 2017). It is defined as one of the hydro-chemical variables that clarify the relationship between the ratio of sodium salts to the percentage of calcium and magnesium salts, and that the high ratio reduces the permeability of the soil and the cohesion of the soil in some cases it change into alkaline soils especially in droughts where the soil salinity is high and thus negatively affects the plant) (Todd, 2009) . The high value of the sodium adsorption ratio Lead to damage to the soil through adsorption of sodium ion and bonding with soil particles, so the soil becomes solid, compact and impermeable to water (Fipps, 2003).

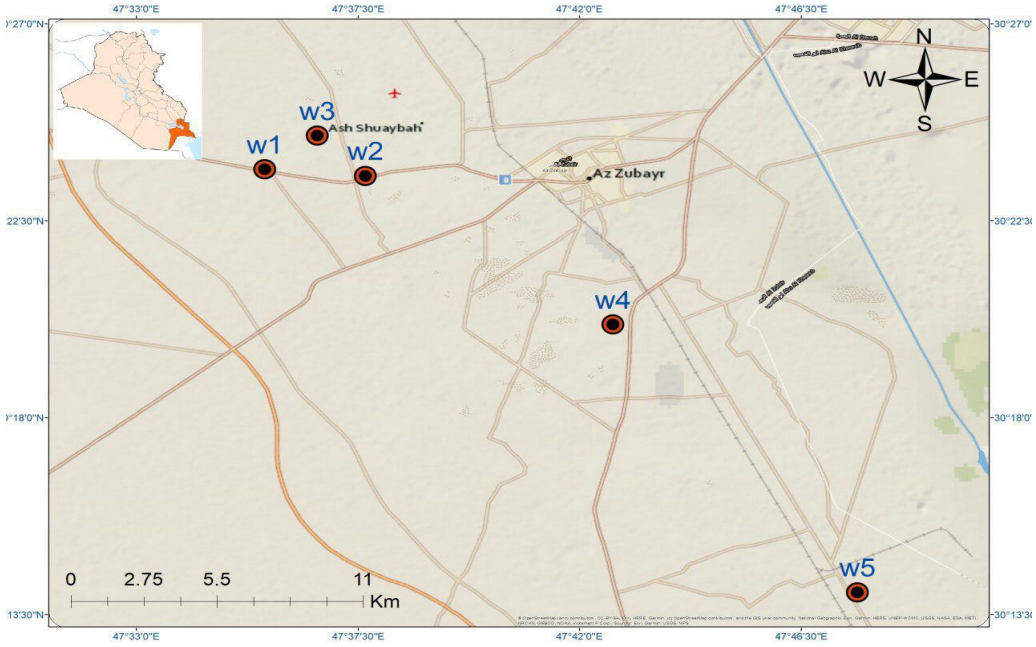
(Na%) term used for sodium in irrigation water classifications. The concentration of sodium can be calculated using a mathematical equation (Todd, 2007). In water, the concentration of sodium ion plays a major role in the classification of water for irrigation, due to the soil being affected by the reaction of sodium as a result of its interference with soil particles and thus reducing permeability, which affects the ability of the plant to absorb water.

(PI) important indicator to know the suitability of groundwater for irrigation uses, and the most important elements affecting the permeability values are total dissolved solids, bicarbonate, sodium, calcium, magnesium, soil type, where soil permeability is affected by the use of long-term irrigation water (Nagaraju, et al, 2006).

Study area

The study area is located in the western part of Basra, including the Zubair - Safwan. It is located between latitude (30º03 "30º30") and longitude (47º30 "47º00"). The area receive average annual rainfall rate (148) mm or less, while evaporation rates are very high up to (350 mm), groundwater is a major natural resource in the study area

due to the absence of a permanent river, both of Safwan and Zubair within the Dabdaba Plain which is part of the Iraqi Western Desert. The terrain is relatively flat with a moderate general slope towards the Euphrates River from the north and the Shatt Al Arab River from East and southeast, the average natural elevation of the Earth's surface ranges from (17 23 m) above sea level, (Al-Aboodi,2018).



Picture: (1) five sites chosen in the study (Safwan Al-Zubair)

Materials and methods

Eight wells were identified within the study area table (1) and in five different locations as the picture (1) The sample collected depended on rain season through in three periods, the first period (premoonson period) the second period (moonson period) the third period (post moonson period). Standard methods have been adopted for collecting, transporting, storing and analyses samples, according to the American Public Health Association standard methods (APHA, 2005). polyethylene plastic bottles was used to collect samples, where the water was raised by electric pumps and then filled to its full capacity and the samples were kept in a cool box to ensure the preservation of the nature of the samples until analysis in Lab.

Table : 1 studies wells, depths and coordinates

Site	Depth of Well (m)	Well coordinates		symbol	Wells
		E	N		
Albrjisia	7	E- 47° 35′3 .6"	N-30° 23 41′. 7"	W1	1
	12	E- 47° 35′3 .6"	N-30° 23 41′. 7"	W2	2
	18	E- 47° 35′3 .6"	N-30° 23 41′. 7"	W3	3
Al-Zubair	18	E-47° 37° 39.8"	N-30° 23′ 32.7"	W4	4
	21	E-47° 37° 39.8"	N-30° 23′ 32.7"	W5	5
Shuaiba	25	E-47° 39′ 40.0"	N-30° 24′ 27. 0"	W6	6
Safwan	24	E-47° 42′ 41.3"	N-30° 20′ 08.1"	W7	7
Khor Al-Zubair	18	E-47° 47′ 39.0"	N-30°14, 0.1"	W8	8

Results and Discussions

Sodium adsorption ratio (SAR)

The rate of sodium adsorption was estimated by concentrations of sodium, calcium and magnesium by the calculation method shown in (APHA, 2005) according to the following formula:

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

Sodium ion adsorption rates varied for the wells studied and during study periods Table (2) shows that the highest rate of adsorption of sodium was recorded in Well 2 was 16.5 (meq / l) during the third period while the lowest rate was recorded 4.96 (meq / l) in Well7 During the second period, through statistical analysis, the results showed that there was a significant difference between the study wells and also a significant difference between the study seasons at the probability level ($P < 0.05$). The results showed in table (2) the presence of local differences between the wells and differences between the study periods and these differences came in line with the differences occurring with the sodium ion and as confirmed by the strong positive correlation relationship, the results shown in Table (3) showed the validity of the groundwater for irrigation and for all wells studied, and this explains Agricultural activity within the study area.

Table: 2 SAR rates (meq / L) in study water wells

Well No / Periods	W1	W2	W3	W4	W5	W6	W7	W8	average
P1	10.32	12.38	14.04	9.15	9.04	6.88	5.74	6.17	9.22
P2	12.77	13.2	13.19	7.8	7.84	6.11	4.96	11.02	9.61
P3	16.2	16.5	15.83	16.22	15.74	17.13	10.99	14.01	15.33
average	13.10	14.03	14.35	11.06	10.87	10.04	7.23	10.4	

Table 3 Water classification for irrigation based on sodium adsorption ratio (meq / l)

Hazard	Wells	Present Study	SAR	Level
There are no harmful effects for sodium	W7	7.23	<10	1
	W6	10.04		
	W8	10.4		
	W5	10.87		
High sodium adsorption value, but can be used if sandy soil has high permeability	W4	11.06	10-18	2
	W2	13.10		
	W1	14.03		
	W3	14.35		
Harmful effects occur in most types of soils, but the soil can be treated through the use of gypsum, as it works to exchange sodium ions			18-26	3
Not suitable for irrigation			>26	4

Sodium percentage (Na %)

(Na%) is calculated according to the following formula (Todd, 1980).

$$Na\% = \left(\frac{Na^{+}+K^{+}}{Ca^{+2}+Mg^{+2}+Na^{+}+K^{+}}\right) * 100$$

Through the results shown in Table (4) based on the classification of the sodium ion ratio for groundwater for irrigation purposes, it was found that the groundwater for the study wells was all acceptable within the third level for irrigation purposes.

Table 4: Water classification for irrigation based on sodium ion ratio.

Grade	Wells	Present Study (Average %)	Na%	Level
Excellent	——	——	< 20	1
good	——	——	20-40	2
Acceptable	W1	48.03	40-60	3
	W2	49.94		
	W3	48.60		
	W4	46.15		
	W5	46.62		
	W6	47.36		
	W7	45.17		
	W8	46.98		
Unsecured	——	——	60-80	4
Unacceptable	——	——	> 80	5

Permeability index (PI)

Permeability is calculated according to the formula:

$$PI = \frac{Na^{+} + \sqrt{HCO3^{-}}}{Ca^{+2} + Mg^{+2} + Na^{+}} * 100$$

Doneen (1962) developed a standard for assessing the suitability of water for irrigation based on the permeability index and the groundwater is classified into three categories according to the permeability index (PI): class, class II, class III the first degree is excellent for irrigation by 75%; the second degree is good for irrigation When the value of PI is between 25-75%, and the third degree is inappropriate for irrigation purposes when the value of PI is <25% (Ghalib, 2017). The results shown in Table (5) for the permeability index values showed that all groundwater wells in the study area are suitable for irrigation purposes as they ranged from good to acceptable within class II.

Table 5: Water classification for irrigation based on permeability index (mEq / L)

Grade	Wells	Present Study (Average)	PI	Class
Excellent	——	——	>75	I
Good to passable	W1	47.99	25 -75	II
	W2	49.91		
	W3	49.88		
	W4	46.44		
	W5	47.05		
	W6	47.87		
	W7	46.89		
	W8	51.59		
Unacceptable	——	——	< 25	III

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مشاكل الصوديوم في مياه الري من المياه الجوفية ضمن منطقة سفوان – الزبير البصرة ، العراق

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المستخلص

تحتوي المياه الجوفية على املاح مذابة وهذه الاملاح تتواجد نتيجة لقابلية الكثير من العناصر والايونات على الذوبان والتفاعل مع المياه ، وان كمية الاملاح المذابة ونوعيتها تحدد صلاحية هذه المياه في استخدامها للري ، جمعت عينات ابار المياه الجوفية من منطقة سفوان – الزبير البصرة اذا اختيرت ثمانية ابار من خمس مواقع مختلفة وخلال ثلاثة فترات ، فترة الجفاف وفترة الامطار والفترة بعد الامطار امتدت من أب 2018 الى أيار 2019 للأخذ العينات واجراء التحاليل المختبرية وفقا لما ورد في (APHA,2005) . وتم تقيم مياه الابار الجوفية بناءً على ثلاثة عوامل أولا وهي نسبة امتزاز الصوديوم (SAR) أذ سجل اعلى معدل 14.35 (ملي مكافئ/لتر) في بئر3 وادنى معدل 7.23 (ملي مكافئ/لتر) في بئر 7 وصنفت المياه بالاعتماد على (SAR) بانها مقبولة الاغراض الري وتقع ضمن المستوى الأول والثاني . وثانيا النسبة المئوية للأيون الصوديوم (Na %) سجل اعلى معدل 49.94% في بئر 2 وادنى معدل 45.17 %في بئر 7 وصنفت المياه بالاعتماد على (Na %) بانها مقبولة الأغراض الري ضمن المستوى الثالث . ثالثا ومؤشر النفاذية (PI) سجل اعلى معدل51.59 (ملي مكافئ/لتر) في بئر 8 وادنى معدل 46.44(ملي مكافئ/لتر) في بئر 4 وبناءً على مؤشر النفاذية صنفت مياه الري بانها مقبولة وضمن الصنف II، بينت النتائج ان جميع ابار المياه الجوفية ضمن منطقة الدراسة صالحة الاغراض الري.