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The Quality of Ground Water for Selected Area in South of Babylon Governorate/Iraq

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Abstract: *City of Hillasuffers from the high shallow groundwater levels which causes serious problems to agricultural and civil construction activities. five different tracks perpendicular to Shatt Al-Hilla channel are selected beside large number of hand dug wells within the area to monitor the relationships among the levels of water between these two water resources during one year,the results of many hydrochemical parameters confirm the similar pattern of inter-relationships between the two water bodies. According to hydrogeochemical measurements ,we find that the proportion of sulfates rate for these wells high and it hurts in the use of water for several purposes ,the ratio of chlorides and other high and this shows that the water wells unfit for uses of Agriculture purposes, but there is one well we have that shows the proportion of chlorides is a few , a high proportion of sulfates From Sholler classification of study area with high concentration of Na +k and SO4was observed because of the Fat'ha Formation, which contains gypsum, anhydrite and dolomite , are believed to be the major source of SO4 and Mg in the water.*

Key words: *Ground water, Hydrogeochemical measurements, Chemical Ions. Shatt Al-Hilla channel*

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I. Introduction

Groundwater is an important component of water resources management within the studied area. The shallow groundwater systems with good, meaningful and sustainable management can lead to overcoming the water scarcity situation. Understanding the chemistry of groundwater is vital to improve the agricultural productivity in the studied area. (Al-Enezy, 2012). However, the groundwater within the study area lies within the lower Mesopotamian area of the Quaternary deposits, which is composed of sequences of silt mixture of layers of sand and gravel in most sites.Al-Sam and ET. Al, (1990) studied the drainage and soil salinity in the Mesopotamia. He found and explained the existed increase in the salinity of the soil and shallow groundwater and pointed out the necessity to carry out systematic drainage network to control the increase of this phenomenon. Alani (1998): studied the geochemistry and hydrochemistry and regional sedimentary of AL-Sabkh within the central and southern of Iraq (including Musayib, Alskandaria, Diwaniyah, kiful, Samawah, Al Hilla, Hashemiate and Mahmudiyahsapkh). AL-Ammar (2004): studied the hydro-chemistry of shallow ground water, water drains and stream water within Babylon Governorate. He found that the water was hard with high concentrations of sulphate and chloride due to the high existing of gypsum in the soil.Nariman (2006): developed a mathematical model to represent the flow within Hilla. His model was used to mange hydrological controls when the discharge of Shatt Al-Hilla exceeds (303 m 3 /sec.) Comparing to the current discharge of (230 m 3 /sec.). Al-Enezy (2012): Relationship between surface and shallow groundwater in the eastern side of shatt Al -Hilla, Iraq.

II. Materials And Methods

Location of the Study Area

The study area occupies some of the central parts of the Mesopotamian plain, (about 600 km2) ,it is located within Babylon Governorate and bounded by Al-Seyahi village from east and Abu Garagh district from west ,Al-Mahaweel distract from north and Alkifil distract from south ,the study area extends between longitudes (44° 30' - 44° 05') E and latitudes (32° 20' - 32°40') N as in Fig.(1).

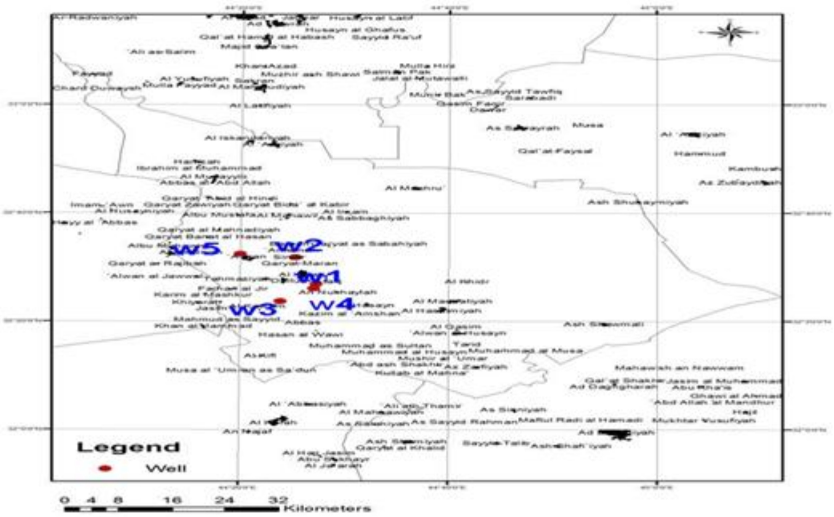

Figure (1) Location map of the study area in the central part of Iraq from satellite image.

Aims of the Study

The examined area is characterized by shallow groundwater systems which leads to many negative impacts on the socio-economic, agricultural and 1civil construction activities in addition to the negative impact on the health of inhabitants in the area (Elalfy et, al,2007). Shallow groundwater systems present another problem in the studied area i.e. (soil salinity and soil alkalization which affects the productivity of agricultural land in the area, affect building foundations through weakening the soil stability and reduce its bearing capacity) as well as devastating the paved roads. Agricultural lands some of center parts of Hilla City suffer from a noticeable deficit in the amount of water, accordingly, all users especially the farmers compensate water deficit from the shallow ground systems within the studied area through drilling large numbers of hand dig wells within the suited area, thus the main aim of study is determine the hydrochemical characteristics of ground water systems in the studied area to confirm the main finding of this study .

Geology and topography of the studied area

The studied area is affected by the regional tectonic movements that created a symmetric concave fold of the sedimentary plain and continues to land filling the tub with the river sediments and other (Buday, 1980 and Yacoub, et. al.1983) Figure (2). The study area mainly lies within the alluvial plain of the recent sediments Quaternary in the period of Pleistocene - Holo (Buday, 1980).Geologically, the study area includes, mainly, Quaternary sediments of both types (Pliocene to Miocene age) .Sediment logically, the area is characterized by flood plains deposits which consist of thin layers of fine sand and silt, clay and silt clay with succession layers of clay, sand and shale,.Babylon Governorates within the studied area characterized by plain surface with gentle gradient around 22cm/km (Al-Jubori2002).. Some sand dunes in some isolated areas such as southern parts of Hilla City were found (Al-Sadoun,1988). To the south of Musayib, Euphrates River is divided into two branches Shatt AL- Hindya to the west and Shatt Al-Hilla to the east.

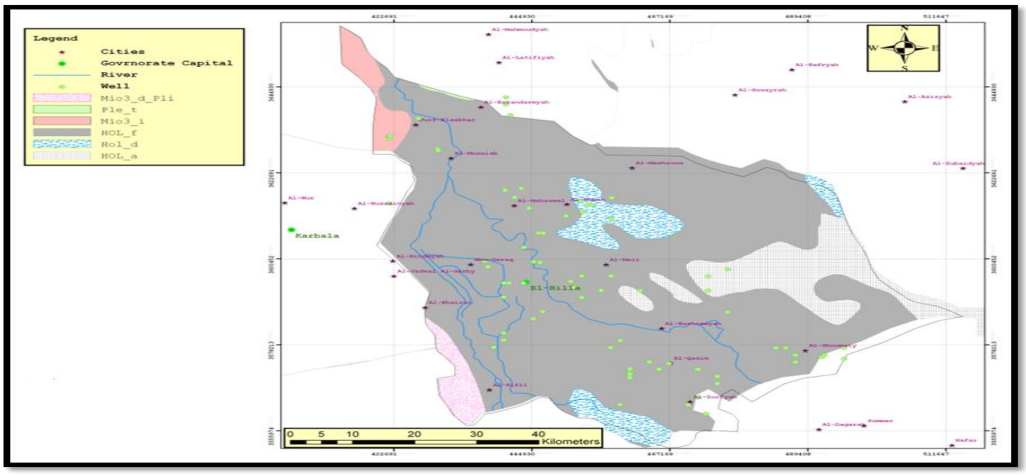

Figure (2): Topographic map for study area (GCFGW,**2010**).

Field work

The studied area was divided into five shallow groundwater hand dug wells as in plats 1,2 and 3, were monitored, Depth of these wells ranges from 7m to 12 .The distance between wells ranged between 10 km to 20 km approximately, the total number of water points are Five Table(1). GPS device was used to locate these points in order to fix their exact locations Figure(1).

Table (1) GPS device was used to locate this point

Easting	Northing	Wells
E 04427°' 17. 2"	**N 3226°' 59. 3"**	W1
E 04425°' 17. 1"	**N 3231°' 56. 2"**	W2
E 04423°' 45. 5"	**N 3223°' 53. 3"**	W3
E 04427°' 03. 7"	**N 3226°' 38. 0"**	W4
E 04419°' 54. 7"	**N 3232°' 26. 9"**	W5

Laboratory Work

The major cat'ions and anions are analyzed in the laboratories of the Ministry of Environment / Babylon Governorate to determine the concentrations for the main cat'ions (Ca2+, Mg2+, Na+, K+) and main an'ions (HCO3,-, CO3, SO42-, Cl-) and other important an'ions, i.e. Nitrate (NO3-) and (po43-).

III. Results And Discussion

Climate of Study area

The climate is one of the most important components of natural environment and has significant impact on the other environmental components, such as vegetation cover, soil, geomorphic features, precipitation and water quantity and quality also it is the cause of the substantive changes that take place within the local environment and it is linked to activities of living organism .

The study area lies within the dominantly prevailing arid and/or semi-arid desert climate characterized by very hot summer and limited seasonal rains, affected by global climatic change, as indicated by increase of the temperature, evaporation, and are blowing in Iraq and the middle east region doubled during 2008.(Al-Khafaji,2009).The station of Hilla is record the climatic elements were used, such as rainfall , temperature, relative humidity, evaporation, wind speed , and evapo-transpiration, for the years 1980-2012.These parameters are analyzed in three stations as in tables (2)

Table (2): Mean annual and monthly values of climate elements for the period (**1980-2012**). (Iraqi meteorological organization- Al-Hilla station).

Months	Temp ^{0}C	Sun Shine Hours	Evaporation Mm	RelativeHumidity`%	Rain Fall Mm	Wind speed M/s
Oct	24.7	9	175	50.6	2.4	2.5
Nov	17.7	7	90	62.8	9.3	2.4
Dec	12.9	6.5	57	75	19.3	2.3
Jan	10.9	6	50	78.8	20.3	2.5
Feb	12.9	7.5	77	67.2	11.7	2.8
Mar	16.6	8.5	130	60.4	12.7	3.2
Apr	23.5	9	195	50.2	14.6	3.2
May	29.8	10.5	290	38	14.5	3.3
Jun	33.3	13	330	34.2	0.07	3.9
Jul	34.9	12	390	33.2	0	4.2
Aug	34.5	11.5	325	35.8	0	3.7
Sep	30.4	10.5	260	41.4	0.02	2.7

Rainfall:

The mean monthly rainfall (mm) for the period (1980-2012) varieswith the season, being minimum (0mm) in (Jul. and Aug.). The maximum mean monthly rainfall values are inJan., being20.3mm Fig. (2).

From the tables(2), it appears that the mean annual rainfall values for the period (1980-2012)is (104.89mm) so that the mean annual rainfall decreases in Hilla and ,the mean annual rainfall value is low(around 100mm) ,this indicates arid to semi arid climate.

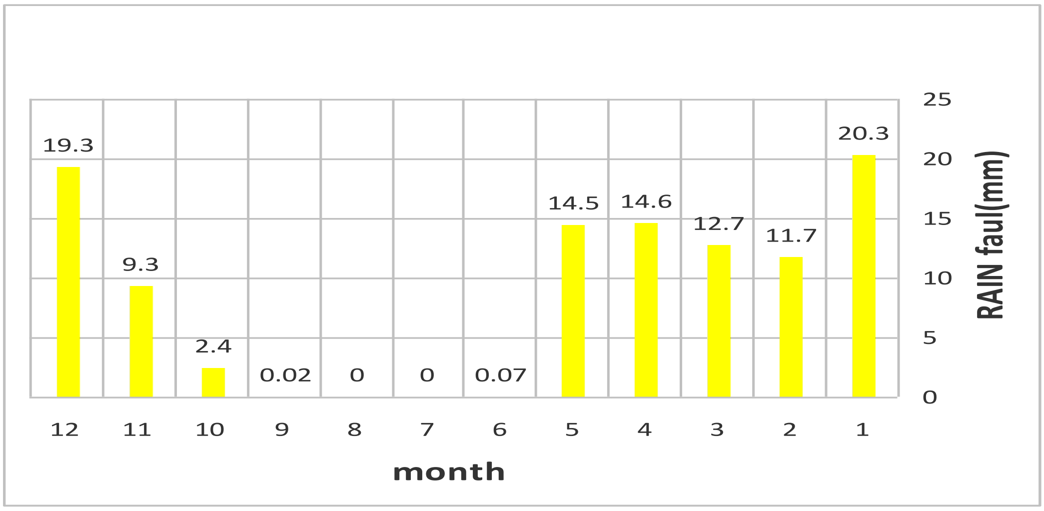

Figure (3): Mean monthly Rain fall for years (**1975-2011**)

Temperature:

According to meteorological stations in the study area, the mean monthly temperature (in0C) for years from 1980 to 2012 reflects that the maximum mean monthly temperature values lie in July (34.90C) , and lowest the minimum mean monthly temperature values lie in January (10.90C)

Relative Humidity:

The Mean Monthly Relative Humidity percentage for the period(1980to2012) varies from minimum values in July (33.2%) to maximum values in January (78.8%), fig.4

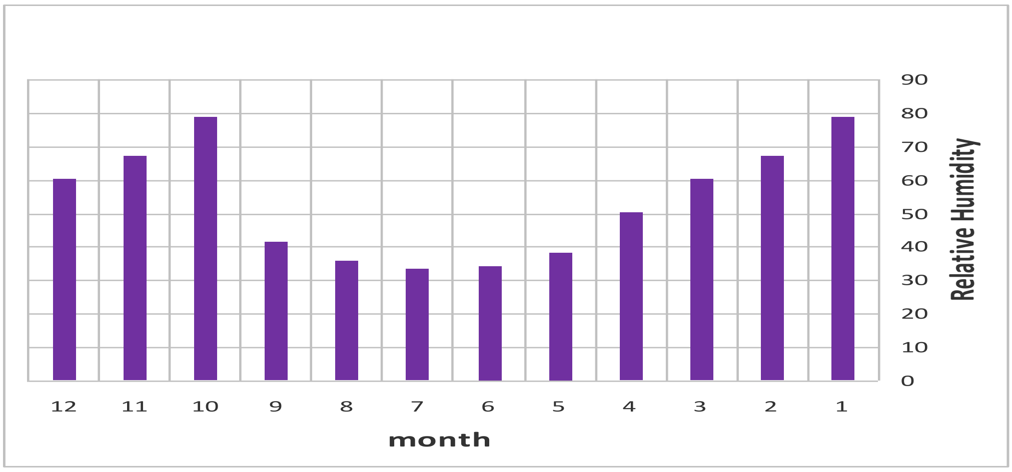

Figure (4) Mean monthly relative humidity for years (**1980-2012**)

Evaporation

The average mean values is considerably increased during the summer months due to high temperature , clear sky that makes a direct effect, in addition the activity of the sun rays is intensified during the longer day time, in the summer than in winter.

The mean monthly evaporation for the period (1980to2012) in the study area shows the lowest values (minimum) evaporation values during January (50mm) and the maximum evaporation during July is (390mm)

Wind speed

The mean monthly wind speed (m/s) for years from (1980-2012) Shows minimum values in December (2.3)and maximum values in July (4.2)for Hilla meteorological Stations .It is noticed from table(2-2), that the mean monthly wind speed in Hilla, ranges from Calm wind during December when their wind speed is less than 3.3m/s, that is increased during July to be less than 5.4 m/s which is classified as Low speed wind.

Table (3) some of chemical analysis in (ppm) unit and some physical analysis for water samples

St	Ca^{+}	Mg^{+2}	Na^{+}	K^{+}	Cl^{-}	SO_4^{-2}	HCO_3^{-} Co_3	TDS	EC µm/s	PH	T (^{0}C)	PO_4	NO_3
1	290	209	350	9.5	1034.7	542.357	9.76	3824	3850	7.15	31	0.32	3.52
2	296	177	390	11	1625.9	3583.34	6.1	17854	18820	7.33	30	0.43	6.54
3	321	136	269	9.5	142	1770.27	8.54	994	1080	6.9	31	0.87	2.21
4	213	212	312	12	1349	1013.94	6.1	2106	3850	7.2	32	2.11	4.30
5	187	185	189	14	1377	5867.99	6.1	4396	6890	6.72	30	1.54	1.11
AV	261.4	183.8	203	11.2	1105.72	2555.579	7.32	5834.8	6898	7.06	30.8	1.054	3.536

Physical properties:

Color and Odor generally originated from organic matter, humans activates and dissolved components, which is enhanced at high water temperature (WHO,2004).All the water samples of the study area are colorless and odorless.

The temperature of water is important for geochemical reactions and the life of organism (Hem, 1985). The Water temperatures of the study area as in table(3-1) ranges between the maximum value is 320C in well (4),the minimum value is 300C in well (5, 2,) and the average values is 30.80C .

Total dissolved solid is a measure of the total amount of minerals dissolved in water and is a very useful parameter in the evaluation of water quality (Heath,1983). It is named salinity (WHO,1996). Dissolved solids also come from inorganic materials such as, rocks, air and may contain calcium bicarbonate, nitrogen, iron phosphorous, Sulphur, and other elements. Many of these materials form salts, which are compounds that contain both a metal and a nonmetal. Salts usually dissolve in water forming ions. Ions are particles that have a positive or negative charge (Hem,1989 in AL Amar,2014).According to,(Altoiviski,1962) ,(Davies and Dewiest,1966), (Todd,1980),and Drever (1997)the classification of water on the basis of the (TDS), is shown in table (3). Electrical conductivity is the ability of one cm3 of water to conduct electrical current, at temperature of 25°C measured by micromohs/cm (µhs/cm) or (Mhs/cm).

EC depends on the concentration of soluble salts and the temperature of the water (Hem,1985). The EC values of study area samples as shown in table(3-1) ranges between the maximum value is 18820µhs/cm in well(2) ,the minimum value is 1080µhs/cm in well(3), and the average values is 6898µhs/cm

The Chemical properties

The primary sources of most sodium in natural water are from the release of soluble products during the weathering of plagioclase feldspars (Hem,1958 . The Sodium (Na+) , the study area as in table(3) ranges between the maximum value 390ppm in well (2) and ,the minimum value of 189ppm in well (5), and the average value is 203 ppm .

Although potassium is an abundant element and its common salts are highly soluble, it seldom occurs in high concentrations in natural waters. The Potassium(K+)concentration of the study area as in table(3-1) ranges between the maximum value of 14 ppm in well (5), and the minimum value of 9.5ppm in well 1,3, and the average value is 11.2ppm .

Magnesium is the eighth most abundant natural element. It makes up to 2.5 percent of the Earth's crust and is commonly found in such minerals as magnetite, dolomite, olivine, talc, and asbestos. The Magnesium (Mg2+) concentration of the study area as in table (3) ranges between the maximum value of 212 ppm in well (4), and the minimum value of 136ppmin well (3), and the average values is 183.8ppm.

According to Todd (1980), the sources of Mg2+ are the weathering of Mg-bearing rocks and minerals such as, dolomite ,magnesite, olivine, pyroxene and clay minerals.

Calcium is the most abundant of the alkaline earth metals and is a major constituent of many common rock minerals. It is essential elements for plant and animal life form, and is major component of solutes in most natural water (Hem,1989) . Calcium(Ca2+)concentration of the study area as in table(3) ranges between the maximum value 321 ppm in well (3)and ,the minimum value of 187 ppm in well (5), and the average value is 261.4 ppm .

Chloride is the anion of the element chlorine. Chlorine seldom occurs in nature, but is usually found as chloride .The Chloride(Cl-) concentration of the study area as in table(3) ranges between the maximum value of 1625.9 ppm in well (2) and the minimum value of 142ppm in well(3) , and the average value is 1105.72 ppm .

Bicarbonate Carbonate (HCO3-1),(CO3)

Alkalinity is reliable measure of carbonate and bicarbonate ions for most natural water. Most carbonate and bicarbonate ions in ground water are derived from the carbon dioxide in the soil and solution of carbonate rocks. Some groundwater probably obtains bicarbonate from the carbon dioxide generated by digenesis of organic compounds. The principal source of carbon dioxide species that product alkalinity in surface or groundwater is the CO2 gas fraction of the atmosphere, or the atmospheric gases present in the soil or in the unsaturated zone lying between the surface of the land and the water table (Ljungberg,2004).

In the studied area, the total alkalinity is due to the bicarbonate ions, because if the (pH) value of the water samples are less than (8.2) and above (4.5) then the alkalinity is due to bicarbonates only (Davis and DeWeist,1966). The Bicarbonate concentration of the study areas in table (3) ranges between the maximum value of 9.76ppm in well (1) and the minimum value is 6.1ppminwell (2), and the average value is 7.22ppm. Gypsum (CaSO4) is the most important source for sulfate (Gypsum is one of the more common minerals in sedimentary environments,The sulfate(SO42-)concentration of the study area as in table(3) ranges between the maximum value 5867.99 ppm in well (5)and the minimum value is 542.357ppm in well (1), and the average value is 2555.579 ppm .The litho logical units of the Fatha Formation, which contains gypsum and anhydrite, are believed to be the major source of SO4-2 in the water. Nitrate is a stable ion over a considerable range of conditions and is very mobile in water (Hem, 1985). Nitrate has a significant influence on plant growth and may present a hazard for drinking water sources if its levels exceeded 10 ppm (Lands hoot, 2007). Nitrate originates mainly from fertilizers used in agricultural activities (AL-Qaraghuli, 2005).The Nitrate (NO3-)concentration of the study area as in table(3) ranges between the maximum value of 6.54ppm in well (2)and the minimum value of 1.11ppm in well (5), and the average value is 3.536 ppm .

Phosphate is one of the most common mineral in the soil and originates from the fertilizer used within the agricultural activities and sewage systems.The Phosphate (PO4) concentration of the study area as in table (3) ranges between the maximum value of 2.11ppm in well (4) and ,the minimum value 0.32 ppm in well (1), and the average value is 1.054 ppm .

Water Quality of study area for different purposes.

Whether a water of given quality is suitable for a particular purpose depends on the criteria or standards of acceptable quality for that use. Quality limits of water supplies for drinking water, industrial purpose and irrigation apply to water because of its extensive development for this purpose (Todd, 1980). The water in the study area may be utilized for different purposes, therefore it is necessary to check itssuitability for the different purposes. Water quality can be defined and standardized by means of indications expressing the limiting concentrations of relevant components and other water properties with regard to theirhealth effect. There values have to be derived from the character and intensity of impact of the relevant components of human organism (Jermar, 1987).

Table (4) The drinking water standards according to (WHO guidelines, (**2004**) ,Iraqi standard (**1996**) and USA public Health service,(**1972**).

Components	(I.G.W.Q,1996) (ppm)	(WHO, 2006) (ppm)	(UPHS,1972) (ppm)	Components	(I.G.W.Q,1996) (ppm)	(WHO,2006) (ppm)	(UPHS,1972) (ppm)
Mg^{++}	50	50	125	Cr	-	0.05	-
Na^{+}	200	200	200	Hg	-	0.001	0.001
Ca^{++}	50	75	200	PH	6.5-8.5	6.5-8.5	-
Cl^{-}	250	250	250	TDS	1000	1000	1000
$SO4^{=}$	250	250	250	EC		1530	1500
$NO3^{-}$	50	50	-	TH	500	500-1000	500
HCO_3^{-}	-	200	500				
F	-	1.5	-				

Water Uses for Livestock Purpose

The water of Study areahad been evaluated for livestock uses depending on the classification proposed by Altoviski (1962) as shown in table(6). This classification is based on some of the major elements (cataions and anions), their values for the study area are shown in table(3-)

Water Uses for Building Purpose:

Altoviski, (1962) classification for building purposes is depending on the most of the major cataions and anions. This classification had been used to evaluate the water samples of study area for building purpose. According to table (3) and table (7), all water samples of study area can be used for building purpose, except W2, W3, W5 because the high concentration.

Water Uses for Agricultural purpose:

The tolerance of plants for TDS and EC are different from plant kind to another as in Todd, (1980) classification .

Water Uses for Irrigation purpose:

Irrigation water criteria depend on the types of plants amount of irrigation water, soil and climate (Davis and Deweist,1966). The suitability of water for irrigation depends upon its own quality as well as upon the other factors, the same quality of water may be considered as suitable for a certain type of soil or crop but is unsuitable for other (Al-Shammary,2008).

Sodium Adsorption Ratio (SAR):

The sodium hazard is determined by the absolute and relative concentrations of the cataions and can be evaluated through the sodium adsorption ratio (SAR), because of its direct relation to the absorption of sodium by soil (Todd,1980), it is defined by:

Table (5) the values of SAR, Na% and RSCin the study area.

Station NO.	SAR(epm)	Na%	RSC(epm)
1	22.15811	41.87536	-489.24
2	25.35999	45.88101	-466.9
3	17.79547	37.8654	- 448.46
4	21.24302	43.25768	-418.9
5	13.85811	35.30435	-365.9

IV. Conclusions

All groundwater samples within the studied area examined water conditions within the Sholler classification and shows the water class as followingShallow groundwater system does not recharge surface water system because of declining in the water level within the shallow groundwater systems in the area, thus, the re- charging groundwater by rain in the winter, or to increase the river's water level by leaking water from the river, or from improper irrigation land excessively.

V. Recommendations

Using all available climatologically data in the area to implement a comprehensive research plans concerning the climatic changes in the area in order to explore all feasible adaptation and mitigation process which can be implemented in the area.

To control one of the main sources of pollution within the area we recommend construction of a sewage network and proper water treatment plan for recycling of sewage followed by reusing these treated water again in the agricultural activities.

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