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Quality of Goundwater Uses for Irrigation Purposes in Some Villages from Babylon Govornorate/Iraq

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Key words: Chemical tests, physical tests, SAR, NA% and RSC tests

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Abstract: The study area is located around the City of Hilla (Babylon Governorate), 100 km South of Baghdad City, between longitude (44°35' 30"-44°36' 43") E and latitudes (32°29' 42"-32°29' 37") N five different wells (hand dig) chosen from some villages near from Al-Hilla city center, this wells recharged from the rivers near from them this small rivers take their water from Shatt Al-Hilla. To examine the water of wells for irrigation purposes, we found the total dissolved solid salt TDS within shallow groundwater system are high concentrations and the salinity of water samples of study area are of class (Primary drainage water and groundwater), the concentrations of the examined chemical ions (Mg^{2+}, Na^{+}, K^{+},-, HCO_3^- and CO_3^-) for all examined samples within the studied area, the CO_3^- concentrations in all the water samples (are zero). After the chemical tests for all the samples we found the water sample in the study area suitable for irrigation purpose, depend on SAR, Na% and RSC value.

INTRODUCTION

The study area located in some village from Babylon Governorate around the city of Hilla (Center of Babylon Governorate) these village have small stream, all these village recharged from AL-Hilla river where is the only surface water resource within the study area. All villages depends on AL-Hilla river to supply all of its water needs but not enough to support these needs.

The local farmers in the villages drilled some hand dig to obtain their irrigation activities. The shallow groundwater within the area is always available and shallow. Thus, Al-Hilla river is the only resource for recharging the shallow groundwater system within the studied areas were the farmers need the ground water for irrigation purposes[1].

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. Silt and shale comprise the whole groundwater reservoir deposits in the studied area[2]. The hydraulic connection of groundwater systems in the studied area is good. The quality of groundwater in the area varies spatially depending on the quantity of infiltrated water from Shatt AL-Hilla channel and the irrigation channel network. The groundwater levels are shallow and range between 0.40-1.25 m with poor quality in most cases where the salinity ranges between 1000-3000 ppm[3]. At some places groundwater appears on the surface of the ground, accordingly, water is exposed to many surface pollution sources such as.

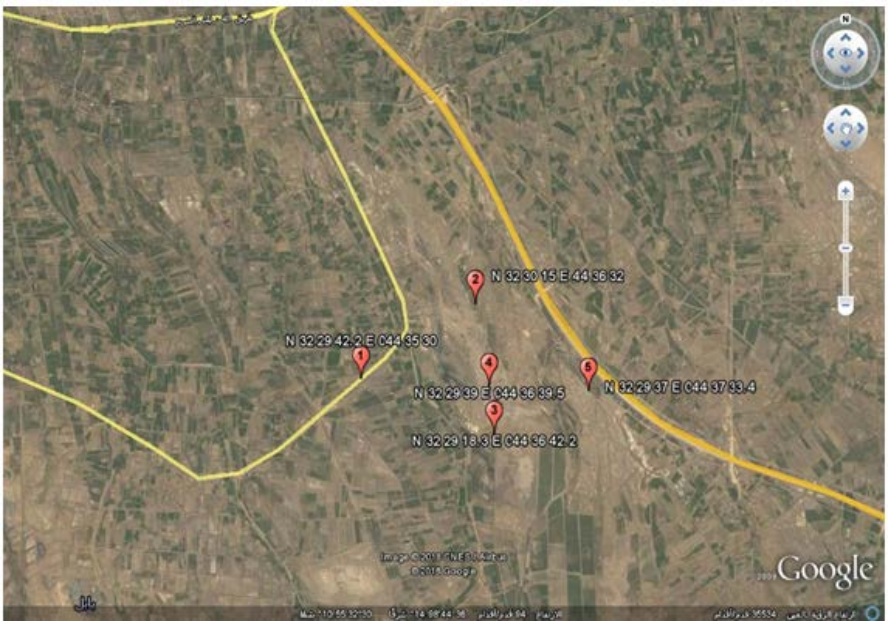

Fig. 1: Site map for study area

Also, providing the groundwater supports the local inhabitants needs and local industries as well as supporting civil construction activities[4]. However, Shatt Al-Hilla is the only resource for recharging the shallow groundwater system within the studied areas. Inter-relationship between surface and shallow groundwater determines the quantity and quality of available water and its validity of groundwater for different human consumption, mainly agriculture activities.

Site map for studied area: The site that's studied in this research in south of of Hilla Distract, Babylon governorate including some villages same like Albo-Taaff village and some villages in Al-Hashmeya District.

The study area extends between longitude (44°35' 30"-44°36' 43") E and latitudes (32°29' 42"-32°29' 37") N. as in Fig. 1.

Aims of study: The tested area is shallow groundwater systems which leads to many negative impacts on the socio-economic and agricultural activities[5]. Shallow groundwater systems present another problem in the studied area. Agricultural lands some of villages 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 show which well from the wells of study area suitable for irrigation purposes.

The geology of study area: Al Hillah City constitutes a flat land with an elevations range between 25-28 m above sea level. The highest levels have been found at the north of Al Hillah City and along Al Hillah river. Mesopotamia represented transgression and regression of sea level started with in calcareous Sualy and Yamama formations, then clastic Ratawi and Zubair formations and calcareous Sha'uba formation, then clastic Nahrumr formation and continue with a repetitive succession of clastic and calcareous rock. Uplift might be sufficient to raise the shelf of the Mesopotamian passive-margin basin above sea level. Uplift period designated disappear of Touronian age in the south Iraq. Iraq can be considered as a large anticline that has the trend of NW-SE and contain many small folds (Syncline and anticlines) as shown in Fig. 1. The geologic mapping of the site consists of quaternary deposits and upper Miocene. Quaternary deposits are flood plain deposits of the Euphrates river and depression fill deposits which may be accumulated by floods. In general, the deposits consist of fine sand, silt and silty clay which may be found everywhere. Dry Marsh and Aeolian deposits are also found especially, in the Eastern parts of the area. Sabkha soil (flat salty plane) is widely spread in Al Hillah area. Injana formation exposes at NW of Al Hillah City which in turn belongs to upper Miocene. The surface layer of the area is composed of alluvial

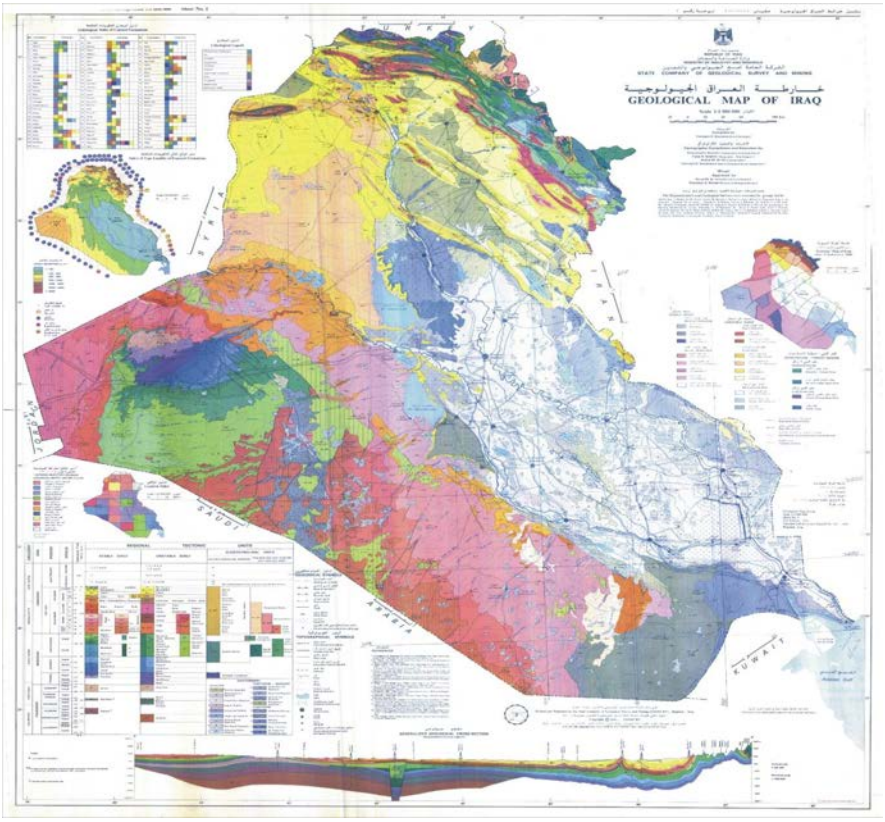

Fig. 2: Geological map of Iraq

deposits. Deposits are usually accumulated by human activities to form geomorphologic of the Earth‘s crust of the ancient Babylon City as shown in Fig. 2.

The climate of study area: Al-Hillah City is located in the Middle of Iraq, the four summer months (June-September) are completely dry and the rain may fall in the winter months (December-April). The average temperatures range from >48° in July and August to below freezing in January. A majority of the rainfall occurs from December through April.

The average annual rainfall in Hillah was 100.5 mm for a duration from 1970-2017. The maximum rainfall intensity for the duration of 1 h was about 73.3 mm h^{-1} happened on 25/12/2012. However, in spite of that the rainfall and other climatic elements cause changes to the moisture contents of subsurface layers and may direct influencing the stability and strength of these materials, the amount of rainfall in the investigated area is insufficient and is considered to be very low rainfall.

Field work: The studied area was divided into five shallow groundwater hand dig wells as in Fig. 3-7 were monitored, depth of these wells ranges between (7-11 m),

Fig. 3: The well No. 1 of study area

the total number of well stations are five as in Table 1. GPS instrument was used to locate these stations as in plate 1-1.

Office work: Reviewing the references and previous studies and collecting geological information’s of the studied area, collecting the climatic data about the studied area from the Hilla Meteorological Stations, creating the topographic map by using GPS coordinates (E-N) of the studied area processing of calculations for water levels

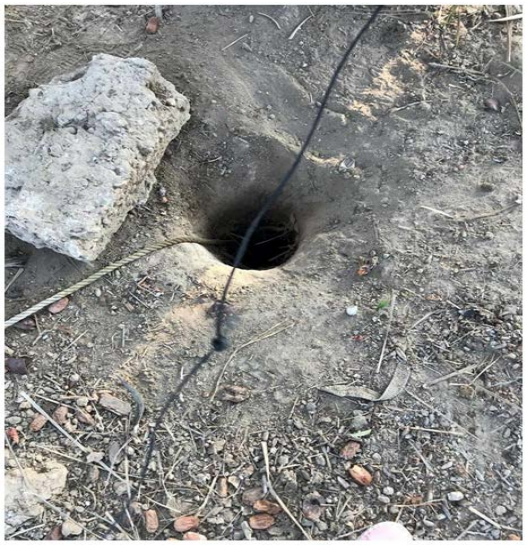

Fig. 4: Well No. 2

Fig. 6: Well No. 4

Fig. 5: Well No. 3

Fig. 7: Well No. 5

Table 1: GPS device was used to determined stations

Wells	'Northing"	'Easting"
St 1	32 29 42	044 3530
St2	32 30 15	044 36 32
St 3	32 29 18	044 36 42
St 4	32 29 39	044 36 39
St 5	32 29 37	044 36 93

within the selected dug wells. Make interpretation for the data that's collected from the wells of study area.

Lab. works: The following chemical concentrations test are analyzing in Babylon University, College of Science, Consultative Bureau, Chemical Lab because they are very important to determine the suitability of water for the irrigation purpose cat'ions (Ca_2^+, Mg_2^+, Na_+, K_+), main an'ions (HCO_3,-, CO_3) and TDS. This tests deals with the hydrochemical characteristics of study area which could be useful for the water irrigation purposes determination. The following elements (Ca^{+2}, Mg^{+2}, Na^+, K^+, CO_3-2, HCO_3^-) was tested in the lab of consultative Bureau/ College of Science, Babylon University as in Table 2 and physical tests also measured too.

The groundwater use for irrigation: TDS and sodium concentration N% both very important in Irrigation water

Table 2: Chemical and physical tests in ppm for study area water samples

St	Ca+	Mg^{+2}	Na^{+}	K^{+}	CO_3^{-}	HCO_3^{-}	TDS
1	296	199	324	9.70		351	2280
2	260	216	347	9.10		345	3160
3	271	209	361	9.00		380	3300
4	270	218	343	9.20		396	3890
5	318	193	316	9.30		366	2430
AV	283	207	338	9.27		367.5	3012

Table 3: Chemical tests in epm for study area

St	Ca+	Mg^{+2}	Na^{+}	K^{+}	CO_3^{-}	HCO_3^{-}
1	14.8	16.9	14.8	0.25	0	0.588
2	13.0	18.0	15.1	0.23	0	0.580
3	13.6	17.4	15.7	0.23	0	0.640
4	13.5	18.1	14.9	0.24	0	0.664
5	11.7	22.6	16.5	0.23	0	6.030

Table 4: Classification of irrigation water according to TDS

Water class	TDS (mg L^{-1})	Type of water
Non-saline	<500	Use as drinking and irrigation water
Slightly saline	500-1500	Use as irrigation water
Moderately saline	1500-7000	Use as primary drainage water and groundwater
Highly saline	7000-15000	Use as secondary drainage water and groundwater
Very highly saline	15000-35000	Use as very saline groundwater
Brine	>35000	Use as sea water

classification instead the SAR and RSC. The growth of plant depend on the salt amount in irrigation water, soil structure and climate also effected[6].

The uses water for irrigation which is consider the most important to determine by their elements which include its total Dissolvesalt content, groundwater is classified depend on it's Total Dissolve Solid (TDS) by FAO classification for irrigation water as shows in Table 3 and 4.

According to Table 2 and 4 the salinity of water samples of study are of class (Moderately Saline and Use as Primary drainage water and groundwater). In order to determine the suitability of groundwater must be find the following terms:

(SAR) Sodium Adsorption Ration: "The sodium (Alkali) hazard in water that's using for irrigation purpose can be calculated from the Sodium Adsorption Ratio (SAR) formula because of its direct relation to the absorption of sodium by soil[7], it defined by:

$$SAR = Na^{+}/((Ca^{+2} + Mg^{+2})/2) \quad (1)$$

The classification of ground water for irrigation depend SAR values is shows in Table 5 after[7]. According to Table 5 and 6, all the water samples of study area are excellent water class were SAR<10.

(Na%) of sodium: Na^{+} very important with excess the soil structure and reduce crops yield so when its concentration high tend to be absorbed by clay particles

Table 5: Classification of irrigation of groundwater depend up to SAR values

SAR	Water class
<10	Excellent
10-18	Good
18-26	Fair
>26	Poor

Table 6: Shown all the values of "Na% ,SAR and RSC" in studied area

Station No.	SAR(epm)	Na%	RSC (epm)
1	5.25	32.10	-25.8
2	5.43	33.10	-25.2
3	5.64	33.90	-24.6
4	5.72	32.40	-24.9
5	5.68	32.22	-28.2

Table 7: Classification of irrigation of groundwater depend to Na%[6]

Water class	Na %	Ec (μ cm^{-1})
Excellent	<20	<250
Good	20-40	250-750
Permissible	40-60	750-2000
Doubtful	60-80	2000-3000
Unsuitable	>80	>3000

Table 8: Classification of irrigation of groundwater depend on RSC values

RSC (epm)	Water class
<1.25	Safe
1.25-2.5	Marginal
>2.5	Unsuitable

this exchange effected by reduces the permeability of soil. The NA% can be calculated from the formula below[7]:

$$Na\% = (Na+K)*100/(Ca+Mg+Na+K) \quad (2)$$

The concentrations in epm/liter based on Todd[7], classification of irrigation water according to the percent sodium as in Table 7. According to Table 7 and 6, all the water samples of study area are good irrigation water class.

Residual Sodium Carbonater (RSC): The sodium hazard will increase if RSC increase because of it is came with the rain. The Residual Sodium Carbonate (RSC) which introduced by Eaton calculated from below:

$$RSC = (CO_3^{-2} + HCO_3^{-}) - (Ca^{+2} + Mg^{+2}) \quad (3)$$

RSC = Residual sodium carbonate. The concentrations in epm/liter Todd[7], the classification of irrigation water based on RSC values shows in Table 8. According to

Table 8 and 6, water samples of study area for RSC<0, thus, all samples classify as safe water class and suitable for irrigation.

CONCLUSION

The total dissolved solid salt TDS within shallow groundwater system are high concentrations the salinity of water samples of study area are of class (Primary drainage water and groundwater). The concentrations of the examined chemical ions (Ca^{+}, Mg^{2+}, Na^{+}, K^{+}, CO^{3-}, HCO_3^{-}) for all examined samples within the studied area are higher within samples representing the water sample in the study area suitable for irrigation purpose, depends on SAR, Na% and RSC values.

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