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Groundwater Uses for Irrigation Purposes in Babylon University, Babylon Governorate/ Iraq

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جمهوريـــــة العـــــراق
وزارة التعليم العالي والبحث العلمي
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قسـم علـم الارض التطبيـــــــــقي

مشروع بحث التخرج

استخدامات المياه الجوفية لأغراض الري في جامعة بابل ، محافظة بابل/ العراق

للطالب

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العام الدراسي ٢٠٢٣-٢٠٢٤

بأشراف

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١٤٤٥هجري

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Dedication

To Whom, Allah deputed him a mercy to the creation, our honorable prophet Mohammed, peace be upon him and his descendants I hope to gain his pure and chaste descendants intercession in the day of Resurrection.

To my mother and father who supported me and lights up my life since my birth to this date.

To my brothers and my Sisters for her efforts, moral support and endless encouragement.

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ABSTRACT

Study area located in Babylon university near from the City of Hilla distract /Babylon Governorate , .the study area extends , between Longitude between Longitude (44.3988076- 44.4415311) E and

latitudes (32.3992853- 32.49848) N.Four different wells (hand dig) chosen .The studied area was divided into four shallow groundwater hand dig wells ,were monitored, Depth of these wells ranges between(7-11m)., the total number of well stations are four. GPS instrument was used to locate these stations 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^{+}, $K^{+,}$ Ca^{+},Cl^{-2},$SO4^{-2}$, and HCO_3^{-},)for all examined samples within the studied area are out of recommended guide ,but the concentration of CO_3^{-} 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, but unfortunately the TDS and EC tests shows that its values very high therefore we can't use the ground water for all the four samples in Babylon university for irrigation purposes except some type from plants ore vegetation

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1.1 Introduction

The study area located in Babylon university near from the city of Hilla (center of Babylon governorate) this site have small stream recharged from AL-Hilla river where is the only surface water resource within the study area. depends on AL-Hilla river to supply all of its water needs but not enough to support these needs.

the local farmers in the university drilled some groundwater wells 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.(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. Silt and shale comprise the whole groundwater reservoir deposits in the studied area (Jubouri, ٢٠٠٣). 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 ٠,٤٠–١,٢٥ m with poor quality in most cases where the salinity ranges between ١٠٠٠ to ٣٠٠٠ppm (AL-Ani,١٩٨٦). At some places groundwater appears on the surface of the ground, accordingly, water is exposed to many surface pollution sources, such as. Fertilizers, pesticides and others (Elalfy et. al.,٢٠٠٧)Shatt AL-Hilla is the only surface water resource within the study area. Hilla City depends totally on Shatt AL-Hilla to maintain all of its water needsbut its supply is not enough to support these needs, accordingly, the local consumers compensate their needs from groundwater resources through drilling hand dug wells mainly by the farmers to sustain their irrigation activities especially that the shallow groundwater within the area is always available and

shallow . Also, providing the groundwater supports the local inhabitants needs and local industries as well as supporting civil construction activities.(Al-Enezy, 2012) However, Shatt Al-Hilla, is the only resource for recharging the shallow groundwater system within the studied areas (Lafta and Nayef,١٩٩٩). 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.

١-٢ Location of the Study Area

Study area located in Babylon university near from the City of Hilla distract /Babylon Governorate, and bounded by Geology department and tower 4 in side of Babylon university, the study area extends , between Longitude (44.3988076-44.4415311) E and latitudes (32.3992853- 32.49848) N as shown in table(1-1)and plate(1-1).

Table (١-١) GPS coordinates of study area

Wells	Northing	Easting
St1	32.3992853	44.3988076
St2	32.3961536	44.3990812
St 3	32.3909763	44.3998813
St 4	32.49848	44.4415311


1
2
3
N32°23'47.04"
E 44°23'55.68"

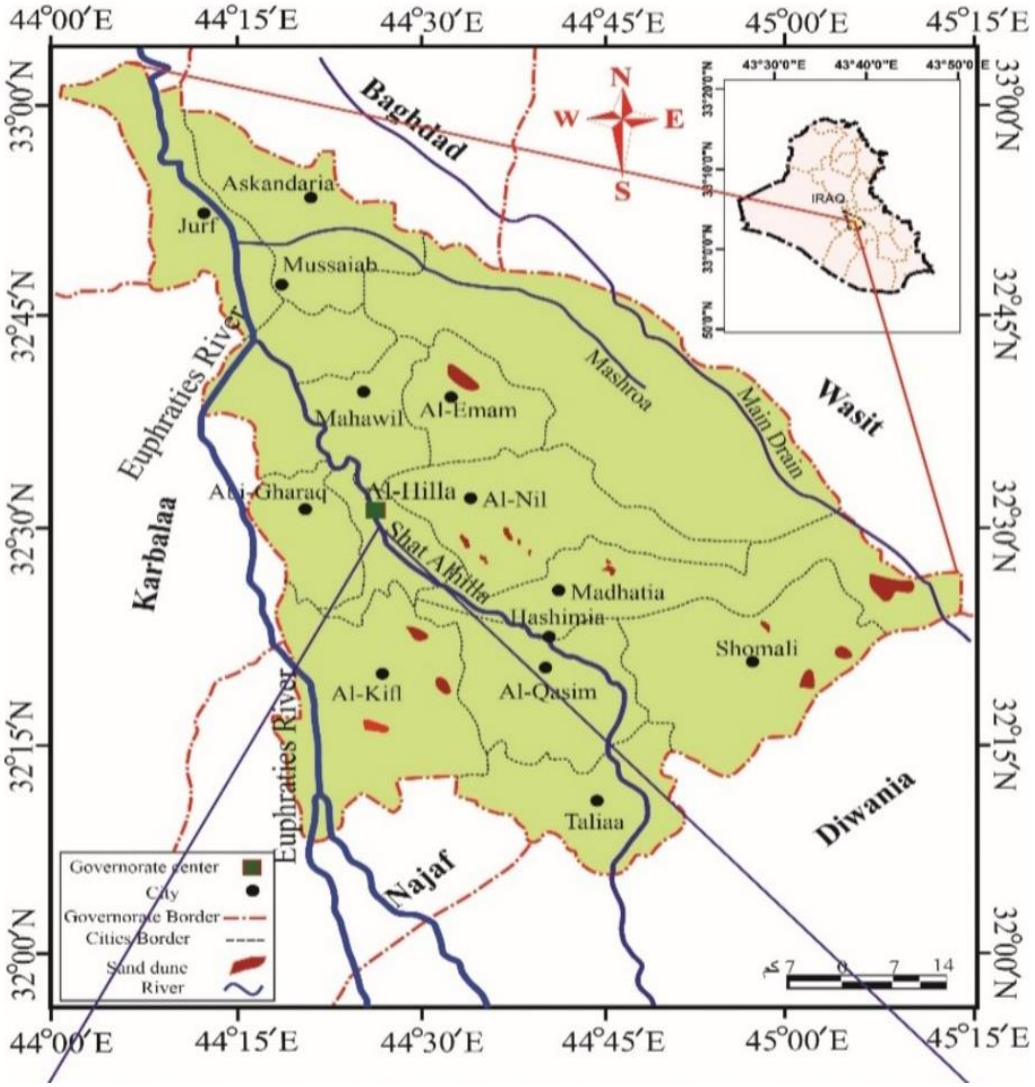

44°00′E
44°15′E
44°30′E
44°45′E
45°00′E
45°15′E
33°00′N
32°45′N
32°30′N
32°15′N
32°00′N
Baghdad
N
W
E
S
Askandaria
Jurf
Mussaiab
Euphraties River
Mahawil
Al-Emam
Mashroa
Main Drain
Wasit
Karbalaa
Abu-Gharaq
Al-Hilla
Al-Nil
Shat Al-Hilla
Madhatia
Hashimia
Shomali
Al-Kifl
Al-Qasim
Euphraties River
Taliaa
Diwania
Najaf
Governorate center
City
Governorate Border
Cities Border
Sand dune
River
IRAQ
43°30'0"E
43°40'0"E
43°50'0"E
7
0
7
14

Plate (1-1) Location map of the study area .

١-٣Aims of the Study:

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 .

١-٤Previous studies

- Parsons, (١٩٥٧) provided large amount of hydrological information within all Iraq Governorates including Babylon Liwa.
- Al-Mussawi, (١٩٨٩) studied geography and irrigation activities within the Babylon Governorate. He studied soil samples taken from the banks of the irrigation canals. He found that soil type is mainly Silty loam and concluded that there were differences in the nature and characteristics of the soil from place to place as well as with depth.
- Al-Sam and ET. Al, (١٩٩٠) 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 (١٩٩٨): studied the geochemistry and hydrochemistry and regional sedimentary of AL-Sabkh within the central and southern of Iraq (including Musayib, Alskandaria, Diwaniyah,kifal, Samawah, Al Hillah, Hashemiate and Mahmudiyahsapkh).
- Lafta and Nayef, (١٩٩٩): They analyzing groundwater samples taken from many hand-dug wells within the Hilla City determine the water quality. They found that the water, in general, was saline of bicarbonate type and

this increased in the direction of groundwater movement from adjacent areas to Al-Shatt Hilla channel course towards residential areas.

- Manah, J. K. (٢٠٠٣): studied the hydro-chemical properties of the ground water and the mineralogy of the soil sediments in the open reservoirs within some selected areas within Babylon Governorate over two successive seasons and concluded that the water can be used for irrigation of most crop types.

- AL-Ammar (٢٠٠٤): 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 (٢٠٠٦): developed a mathematical model to represent the flow withinHilla. His model was used to mange hydrological controls when the discharge of Shatt Al-Hilla exceeds (٣٠٣ m^3 /sec.) Comparing to the current discharge of (٢٣٠ m^3 /sec.).

- Al-Enezy (٢٠١٢): Relationship between surface and shallow groundwater in the eastern side of shatt Al -Hilla, Iraq.

1.5 The Geology of Study Area

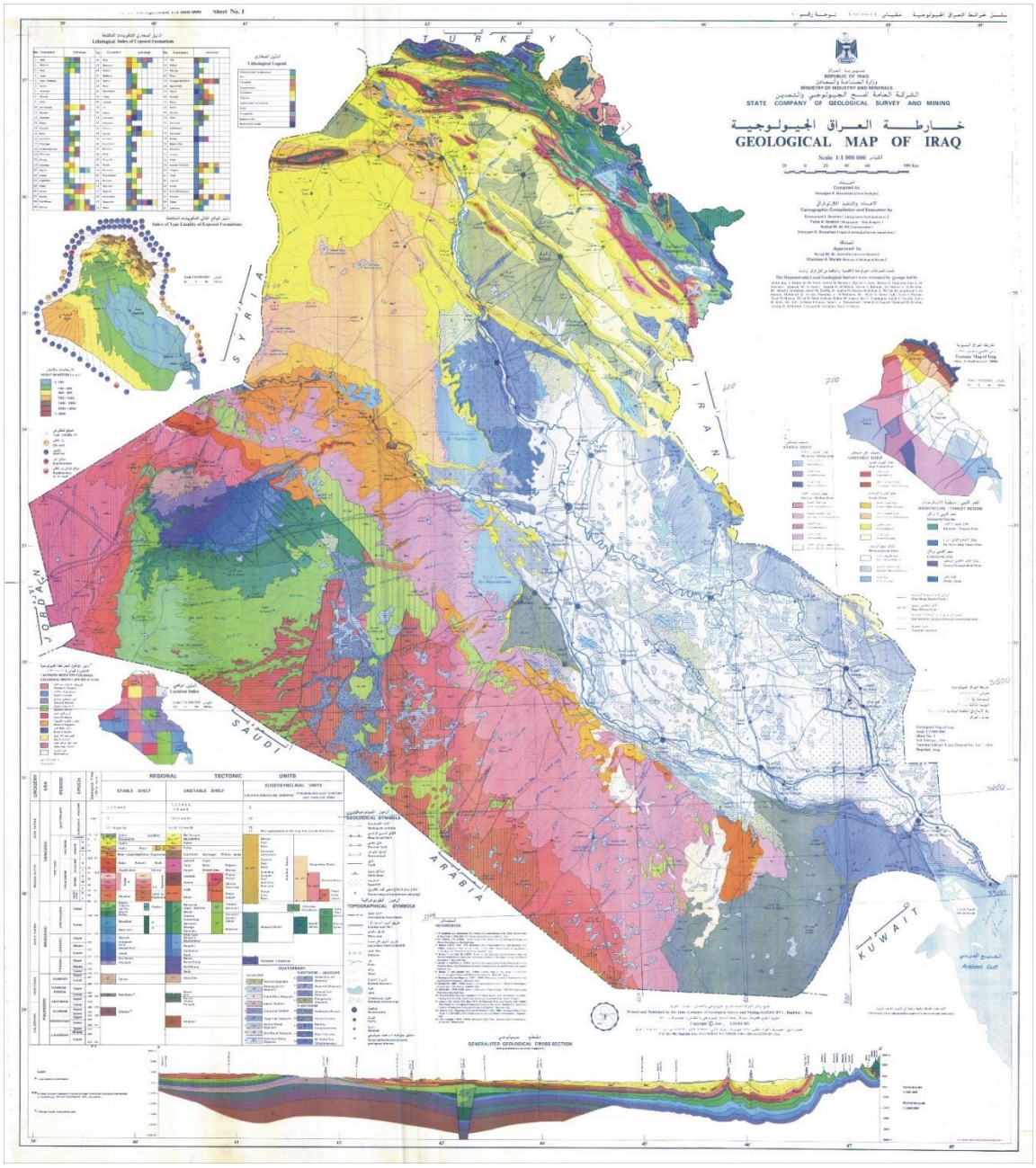
Al Hillah City constitutes a flat land with an elevations range between 25-28 m above sea level. The highest levels have been found at the north of Al Hillah City and along Al Hillah River.

Mesopotamia represented transgression and regression of sea level started with in calcareous Sualy and Yamama Formations, then clasticRatawi and Zubair Formations and calcareous Sha'uba Formation, then clasticNahrumr 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). The northeastern limb of this anticline has suffered from recumbence and then thrusting over the southwestern limb. Because of colliding of the Arabian and Iranian plates now Iraq is divided tectonically to, Western desert, Mesopotamian (Unfolded Zone), Low, High, Imbricated and Thrust Zones from southwest to northwest as shown in Plate 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 deposits. Deposits are usually accumulated by human activities to form geomorphologic features of the earth's crust of the ancient Babylon City as shown in Plate (1-2).



Plate(1-2): Geological Map of Iraq.

1.6 The Climate of Study Area

Al-Hillah city is located in the middle of Iraq, the four summer months (June, July, August and September) are completely dry and the rain may fall in the winter months (December, January, February, March, and April). The average temperatures range from higher than 48 degrees in July and August to below freezing in January. A majority of the rainfall occurs from December through April. The summer months are marked by two kinds of wind phenomena: the

northwesterly and westerly dry, dusty wind with occasional gusts to 14 m/s in April/2017 and 20 m/s in May and June/2017 as recorded at the Hillah forecasting station.

The average annual rainfall in Hillah was 100.5 mm for a duration from 1970 to 2017. The maximum rainfall intensity for the duration of one hour was about 73.3 mm/hrs 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 .

CHATER TWO

Field and laboratory works

2.1Field work

The studied area was divided into four shallow groundwater hand dig wells as in plats (٢-١), (٢-٢),(٢-٣), and (٢-٤), were monitored, Depth of these wells ranges between(7-١1m)., the total number of well stations are four as in Table(١-١).

Plat 2-1 the well No.1 of study area

Plat (2-2) well No.2

plat (2-3)well No.3 **plat (2-4)well No.4**

2.2 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 within the selected dug wells. Make interpretation for the data that's collected from the samples of wells of study area and lab. of geology department college of science /Babylon university .

2.3Laboratory Works

The following chemical concentrations test are analyzing in Babylon university/college of science /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^{2-}) and TDS

As shown in plate (2-5)

Plate(2-5). Shows the lab work

CHAPTER THREE

Hydrochemistry of Study Area

3.1 Preface

This section deals with the hydrochemical characteristics of study area , which could be useful for the water irrigation purposes determination. Analyzing and interpreting the chemistry of water can provide valuable insights into ground water interactions. The elements bellow was tested in the lab. (Ca^{+2},Mg^{+2},Na^{+},K^{+}, CO_3^{-2},HCO_3^{-}), and physical properties (TDS), have been measured .The physical properties of water were completely measured by portable multimeter instrument, and the chemical properties were tested in consultative Bureau lab./college of science/Babylon university as in table(3-1).

Table (3-1) Some of chemical analysis in(ppm)unit and some physical analysis for water samples of study area(PPM)

ST	Ca^{+}	Mg^{+}	Na^{+}	K^{+}	Cl^{-}	So_4^{-}	HCo_3^{-}	Co_3^{-}	TDS	EC	PH
١	١٤٨	١١٩,١	٣٢٠	٨	١٣٢	١٠٩٥	٠,٠٥٨	0	٣٤٦٠	٤٨٧٠	٧,٦
٢	١٢٤	٩٠,٩	٢٦٠	٥	١٢٧	٩٩٦	٠,٠٣٨	0	٩٩٢	١٤٠٠	٧,٧
٣	١٠٨	٦١,٨	٣٠٣	٣	١٣٠	٨٧٠	٠,٠٨	0	١٨٧١	٢٦٤٠	٧,٦
٤	٩٨	٩٣,٨	٢٠٨	٥,٢	١٢٢	٧٣٠	٢,٠٧٤	0	١٧٢٢	٢٤٣٠	٧,٤
AV	١١٩,٥	٩١,٤	٢٧٢,٧٥	٥,٣	١٢٧,٧٥	٩٢٢,٧٥	٠,٥٦٢٥	0	.٢٠١١	٢٨٣٥	٧,٥٧٥

3-2Water 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 quality and 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).The quality of irrigation water which is considered the most important factors is determined by their soluble component which includes its total salt content ionic composition,

Groundwater is classified it's salinity by FAO classification for irrigation water lies in (6) categories after (Rhoades, 1992), as shown in table (3-1).

Table (3-2) Classification of irrigation water according to salinity (Rhoades, 1992)in (AL-Shammary,2008).

Water Class	TDS (mg/l)	Type of water
Non-Saline	< 500	Drinking and irrigation water
Slightly Saline	500-1500	Irrigation water
Moderately Saline	1500-7000	Primary drainage water and groundwater
Highly Saline	7000-15000	Secondary drainage water and groundwater
Very highly Saline	15000-35000	Very Saline groundwater
Brine	> 35000	Sea water

According to table(3-1)and table(3-2) the salinity of water samples of study area are of class (Primary drainage water and groundwater) .

3.3 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 defined by:

$$SAR = \frac{Na^{+}}{\sqrt{(Ca^{+2} + Mg^{+2}) / 2}} \qquad (٣\text{-}1)$$

Classification of irrigation water based on SAR values is shown in table (٣-4) after (Todd, 1980).

Table (٣-4) Classification of irrigation water based on SAR values (Todd, 1980)

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

According to table(٣-4)and table (٣-5),all the water samples of study area ranges from good Fair water class.

Table (3-5) Shows the values of SAR, Na% and RSC in study area

Station NO.	SAR(epm)	Na%	RSC(epm)
١	٢٢,١٥٨١١	٤١,٨٧٥٣٦	-٤٨٩,٤٢
٢	٢٥,٣٥٩٩٩	٤٥,٨٨١٠١	-٤٦٦,٩
٣	17.788	٣٧,٨٦٥٤	-٤٤٨,٤٦
٤	٢١,٢٤٣٠٢	٤٣,٢٥٧٦٨	-٤١٨,٩

3.4 Sodium Percent Na%

Sodium content is usually expressed in term of percent sodium (also known as soluble sodium percentage SSP),it is an estimation of the sodium hazard of irrigation water, it expresses sodium out of the total cataions. Na% is calculated by the following formula (Todd, 1980):

$$Na\% = \frac{(Na + K)*100}{Ca + Mg + Na + K} \quad \text{.....(3-2)}$$

The concentrations are expressed classification of irrigation water according to the percent sodium, as shown in table (3-5) .

According to table(3-5)and table (3-6),all the water samples of study area ranges from good to permissible irrigation water class,

Table (3-6) Classification of irrigation water based on Na % (Todd, 1980)

Water Class	Na %	Ec µ/cm
Excellent	< 20	< 250
Good	20-40	250-750
Permissible	40-60	750-2000
Doubtful	60-80	2000-3000
Unsuitable	> 80	> 3000

3.5 Residual Sodium Carbonate (RSC):

A high concentration of bicarbonate in irrigation water may lead to precipitation of calcium and magnesium in the soil and thus to a relative increase of sodium concentration. Thus, the sodium hazard will increase (Van Hoorn, 1970). The bicarbonate hazard expressed by residual sodium carbonate (RSC) which introduced by Eaton (1950):

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

RSC=Residual sodium carbonate **.**

The Classification of irrigation water based on RSC values shown in Table (3-5) after (Eaton, 1950).

Table (3-7) Classification of irrigation water based on RSC values (Eaton, 1950)

RSC	Water Class
< 1.25	Safe
1.25 -2.5	Marginal
> 2.5	Unsuitable

According to table(3-5)and table (3-7),all the water samples of study area ,all the (RSC) values less than zero, therefore, all the samples are **Safe** water class and it is suitable for irrigation uses.

CHATER FOURE
Conclusions and Recommendations

4-1 Conclusions

1- 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**)

2- 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 .

4-the water sample in the study area suitable for irrigation purpose, depends on SAR, Na% and RSC values

-Preventing (by law) any new drilling of new shallow wells in other locations in the distracts and city of Hilla for discharging the sewage water to the shallow groundwater in the area.

1. Establishing drainage network for collecting water from the agricultural activities for reusing after some treatment for far away land irrigations
2. From the TDS and EC tests shows that its values very high therefore we cant use the ground water for all the four samples in Babylon university for irrigation purposes except some type from plants ore vegetation

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