J.Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 7(10): 757- 766, 2016

Evaluation of Ground Water for Irrigation in Bani Walid District, Libya.

El-Hadidi, E. M. F.[1] ; T. M. El-Zehery[1] and E.S.K. Aboghaiyas[1-2]
[1-] Soils Department, Faculty of Agriculture, Mansoura University, Egypt.
[1-2]Soil and Water Department, Faculty of Agriculture, Azzaytna University, Libya.

ABSTRACT

This investigation has been conducted in the Bani walid district, Libya, that located 180 kilometers from southeast of Libyan capital Tripoli and it is located between latitudes $31^{\circ}22'$ to 31° $49'$ and longitudes $13^{\circ}42'$ to$14^{\circ}29'$ with an objective of understanding the suitability of Bani walid area groundwater quality for irrigation purposes. Ground water is the main source for water supply and irrigation purposes .Groundwater samples have been collected from different wells found in Bani Walid Valleys to evaluate some chemical parameters such as EC, pH, concentration of total dissolved solids (TDS), Ca^{+2}, Mg^{+2} ,Na^{+}, K^{+}, CO_3^{-} ,HCO_3^{-} ,Cl^{-} ,SO_4^{-2} , NH_4^{+} , Mn ,Fe , ,B and NO_3^{-} .The chemical analysis were carried out for fourteen samples. Coordinates of wells samples were recorded using the Global Positioning System (GPS). Physical and chemical parameters were analyzed by means of contour maps to illustrate the spatial distribution of chemical constituents of the ground water samples. The abundance of the major ions is as follows Cl > SO_4 > HCO_3 > CO_3 and Ca > Na > Mg > K. Piper diagram is used to illustrate the suitability and type of ground water as well as Richard and Wilcox classifications are used to show the suitability of study ground water for irrigation. Also, other parameters such as Residual Sodium Carbonate (RSC), Sodium Absorption Ratio (SAR) and Soluble Sodium Percentage (SSP) have also been determined. The distribution pattern of EC and chlorides and SAR which are the general indicators of groundwater quality reveals that ground water samples falls in the field of doubtful to unsuitable for irrigation except samples 2,3,5,6 7 and 8 which they are fell in the field of good to permissible for irrigation. They are mostly located in Tininai Vally.

Keywords: Ground water quality, Irrigation Suitability, Sodium Absorption Ratio (SAR), Global Positioning System (GPS), Bani Walid .

INTRODUCTION

Libya is an arid region and facing serious shortages in water resources ,so sustaining water resource in this country is a high priority for decision makers and scientists .The future development in this area would be in need for water which must can from local ground-water resources in Libya which important for agriculture, (Al-Neiami ,2000). Water suitability for each of its various uses depends on the concentration of the dissolved salts. In general, standards of water quality have been established for every water use. Several criteria in water quality requirements were developed for years, which serve as the guidelines in determining suitability of water for various uses .The chemical parameters of groundwater play a significant role in assessing water quality, which is suitable for irrigation,(Abu-fayed *et al* ,2003). However, irrigation with poor quality water may bring undesirable elements into the soil in excessive quantities. The quality of groundwater has definite command over the yield of crops. Ballas (1978) studied the water resources of Libya and showed that its desert contains much groundwater. Also, divided Libya into five water areas as follows (1- Jifara plain system 2-Murzuk aquifer system 3- El-Kufra-Serir aquifer system 4- El Jebal El-Akhdar system 5- (Jebal Naffusah system – Sofa Al-gen aquifer – the west of surt aquifer – Hamada El-Hamra aquifer)). According to Al-Neiami (2000), the two of the most significant measures for determining irrigation water quality are: 1-The (TDS) total amount of dissolved salts in the water. 2-The concentration of sodium in the water as compared to calcium plus magnesium. The total dissolved salts content is estimated by measuring how will water conducts electricity. Irrigation water quality can be understood through the identification of Sodium Adsorption Ratio (SAR) and Sodium Percentage (Na %) (Karanth 1987). The big pull of groundwater from one of these systems does not affect the other near systems. Gheryan aquifer is located in Bani Walid territory at a depth of 100-150m. The electrical conductivity of this ground water was between 3000-10000 dSm^{-1} and the total soluble salts were between 3000-6000 mgL^{-1}. The ground water quality of this aquifer is chemically variable. The chemical content of this water is often sodium chloride or magnesium sulfate and ions sequences from top to less is as follows: for anions So_4^{--} > Cl^{-} > HCO_3^{-} and for cations Mg^{+2}> Na^{+} > Ca^{+2}.The thickness of aquifer is between 75-125 m. Tgrnah aquifer is at a depth of 175m from earth's surface. The electrical conductivity of this ground water was between (3000-10000 µmhos/cm). The chemical content of this water is often ($NaHCO_3$, Mg $(HCO_3)_2$ or $MgSO_4$, Na_2SO_4) and ions sequences from top to less is as follows: for anions So_4^{--} > Cl^{-} > Hco_3^{-} and for cations Na^{+} > Mg^{+2}> Ca^{+2}. Tgrnah aquifer was considered the oldest in the region and calcareous formations was found down, it such as limestone dolomite of gheryan , yafren sand and the lime stone of Ain-Toby. The wells that take its ground water from this aquifer are located in Bani Walid and Al-Mardum valleys (Mady *et al*., 1976).According to UNESCO (1995), the stocked groundwater of Libya aquifers is 4000 billion m^3 and 2.2 billion m^3/ year was extracted , while 0.8 billion m^3/year was added before the completion of great Man-Made River. This ratio is not constant due to variation of rainfall yearly. Nayar and Hussien., (1978) indicated that, according to the report of general authority for groundwater and water resources of the sofa Al-Gene Valley, the ground water quality of Kikla aquifer is good. The total soluble salts of this groundwater were less than 2000 mgL^{-1}.Ballas

(1978) reported that the total extracted water from Kikla a aquifer every year was 101 million m^3/year as follows: Bani Walid projects (23.7million m^3/year)- Zamzam(22.6million m^3/year)- Neenah (27 million m^3/year)-Al-Washkah (27.7 million m^3/year). Nayar *et al.,* (1987) showed that Tininai Valley was considered the most important tributaries of sofa Al-Gene Valley. In this Valley, the depth of the wells was 1100m underground. Static water level was between 10m above the ground to 43 m underground. The productivity capacity was between 150-200m^3/hour and it is confronted with a decline by 20 m. The ground water quality of tininai valley was a good. Total soluble salts of this water were1500 mgL^{-1} and its temperature was between 40-44 c˚. The FAO aquastat database reports about 470,000ha are under intensive irrigation using both fossil and shallow groundwater, but some of this may now have been abandoned because of water shortages and poor quality water in the coastal aquifers (FAO, 2002). So, this study aimed to evaluate the ground water quality for some private wells to meet their agricultural needs.

MATERIALS AND METHODS

Fourteen ground water samples were collected from different locations of the Bani Walid valleys (soil texture is mostly a sandy texture) at four sites. The samples were taken in December, 2014. The first and second samples were taken near the center of the Bani Walid city (Amresh valley), the first was from Shallow well and the other sample was collected from Great Man-Made River (original ground water).The groundwater samples from the third until the seventh were collected from southern region wells of Bani Walid city(Tininai). The groundwater samples from the eighth until the eleventh were collected from eastern region wells of Bani Walid city (Valley Al-mardum).The water samples from the twelfth until the fourteenth were collected from southeastern region wells of Bani Walid city (Valley Sofa Al-gen) . All samples were taken after half hour from water pumping and preserved for analysis. The locations of well, soil and plant samples were determined by geographic system (GPS) as shown in Table 1 and Fig 1.

Table 1. The coordinates of groundwater locations for each area.

Sites	Sample No.	Latitude	Longitude	Elevation of the site (m)
Amresh	1	31°41'13.60"N	13°59'18.93"E	252.0
	2	31°43'35.57"N	13°59'33.26"E	260.0
Tininai	3	31°25'27.74"N	13°57'19.61"E	181.66
	4	31°22'23.48"N	13°51'36.12"E	200.26
	5	31°22'16.41"N	13°50'22.55"E	201.49
	6	31°24'5.40"N	13°48'45.80"E	214.69
	7	31°23'53.63"N	13°42'7.78"E	247.45
Al-mardoum	8	31°49'48.00"N	14°10'14.00"E	156.48
	9	31°46'12.97"N	14°23'40.64"E	107.15
	10	31°45'52.00"N	14°27'7.00"E	97.07
	11	31°45'2.00"N	14°29'3.00"E	87.24
Sofa algen	12	31°33'30.44"N	14°22'8.01"E	90.89
	13	31°34'53.54"N	14°22'45.30"E	95.85
	14	31°35'33.67"N	14°21'22.43"E	104.05

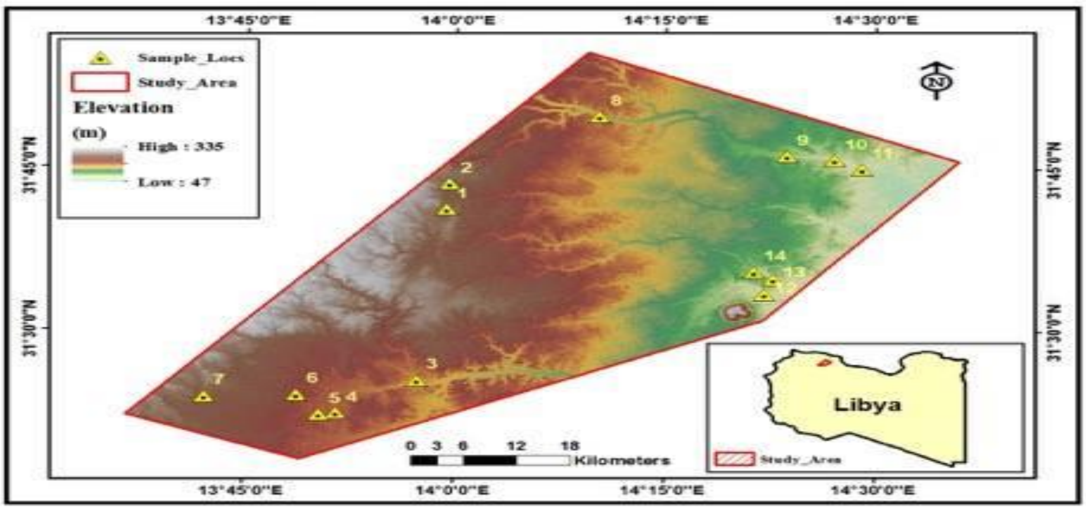

Fig .1. Map of the study area showing water sample locations.

Electrical Conductivity (EC) is measured in units of (μmhoms/cm). The using other analytical procedures for measuring quantities of individual chemicals, such as sodium. The chemicals are usually measured to identifying irrigation water quality as follow: Electrical Conductivity (μmhos/cm), Sodium, Chloride, Ammonium, Nitrate, Calcium, Carbonate, Magnesium, Bicarbonate and Sulfate. To Judge perfectly on the water chemical properties, these methods were used according to the global standard methods. PH was measured by pH meter as mentioned by Richards (1954). Electrical conductivity of water was determined by EC–meter as explained by Jackson (1967). The amounts of soluble ions meq L^{-1} in the soil were determined according to Hesse (1971). Sulfate was determined by calculating the difference between sum of cations (Ca^{++}, Na^{+}, Mg^{++} and K^{+}) and anions (CO_3^{-}, HCO_3^{-}, Cl^{-}). Nitrogen concentration of water (both forms NH_4^{+} and NO_3^{-}) were determined by using macro-Kjeldahl according to Hesse (1971). Sodium and Potassium concentrations of ground water was determined as mentioned by Jackson (1967) using flame photometer. Boron concentration of water was determined by colorimetric method as mentioned by Bingham (1982). Manganese and Iron of water were measured by using Atomic Absorption Spectrophotometer according to Chapman and Pratt. (1961).

Calculations:

The Residual Sodium Carbonate (RSC) meq/L was calculated according to Gupta and Gupta (1987) as follows:

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

The Sodium Adsorption Ratio (SAR) meq/L was calculated by the following equation given by Richards (1954) as follows:

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

The permeability index (m/s) is given by Eison and Anderson (1980) as the following formula:

$$\%PI = \frac{(Na+\sqrt{HCO_3})}{Na+Mg+Ca} \times 100$$

The Sodium Percentage (Na %) was calculated by the following equation Todd (1980) :

$$\%Na = \frac{Na}{Ca+Mg+Na} \times 100$$

The Total Dissolved salt (TDS) mgL^{-1} was calculated according to Kelly(1963) as following:

$$TDS = 0.64 \times EC \times 10^{6}$$

The Exchangeable Sodium Percentage (%ESP) was calculated by the following equation given by Richards (1954) as:

$$\%ESP = \frac{100(-0.0126+0.01475\ SAR)}{1+(-1.0126+0.01475\ SAR)}$$

Soil mechanical analysis was done according to Klute (1986).

RESULTS AND DISCUSSION

1-water types:

A Piper diagram (Fig. 2) was created for the Bani Walid district using the analytical data obtained from the chemical analysis. In general, we can classify the sample points in the piper diagram into 6 fields. They are 1- Ca -HCO_3 type 2-Na -Cl type 3-Ca-Mg-Cl type 4-Ca-Na-HCO_3 type 5-Ca-Cl type 6-Na- HCO_3 type. However, in the present study water types were confined to the types (3, 4 and 5). Majority of the samples (50%) are plotted in the Ca-Mg-Cl field. 14 % of the samples showed Na-Cl type. 36% of the samples showed Ca-Cl type .Rest of them was fall in the Ca-HCO_3 and Na-HCO_3 types.

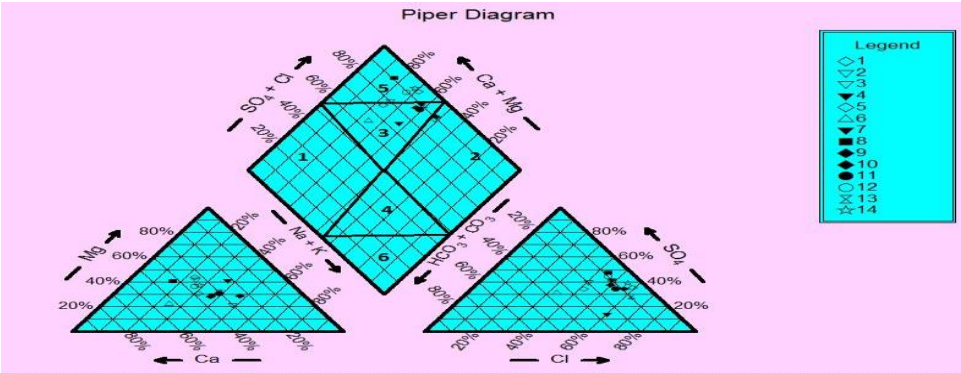

Fig .2. Piper Diagram

Piper Diagram (Hem, 1985) is used to show the Composition of major ions in ground water samples Fig (2). This diagram is exceptionally useful for detecting trends or changes in ground water chemistry across an area or through time according to Sanders (1998). The study was conducted during the post-monsoon season and in this period dissolution of the minerals are the major processes occurring in the groundwater environment. Since the flow is high there will not be much time for precipitation. Predominance of Ca and Mg in the ground water samples collected from the high topography suggested an inverse ion exchange process. During this process Ca from the Aquifer matrix will be exchanged by Na from the groundwater. However, in the lower topographic region water is dominated by the Na and Cl ions, which is represented by the discharge zone. Sluggish flow in these relatively flat regions enables sufficient rock-water interactions.

2-Major Ion Chemistry and Spatial Distribution:

Data in Tables (2 and 3) illustrate some chemical characteristics and resulting parameters of the ground water. As shown in the Tables, the analysis reveals that the ground water of samples (1, 4, 9, 10, 11, 12, 13 and 14) is high saline where the EC was more than 2.5 $dS.m^{-1}$. The value of electrical conductivity varied from 0.830-5.083 $dS.m^{-1}$ .The variation in EC values are shown in Fig (3).

The pH values of the ground-water varied from 7.03 to 7.36. This indicates that water is neutral in nature. The variation in pH values are shown in Fig (4). The concentration value of TDS ranged between 531.2to 2576 mg/L (Fig 5).

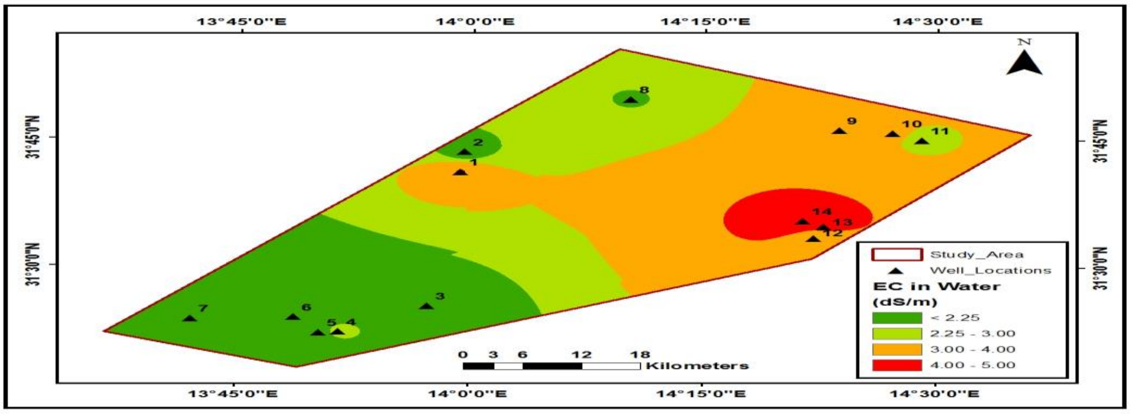

Fig .3. Spatial distribution of electric conductivity (dS/m) of ground water in the studied area.

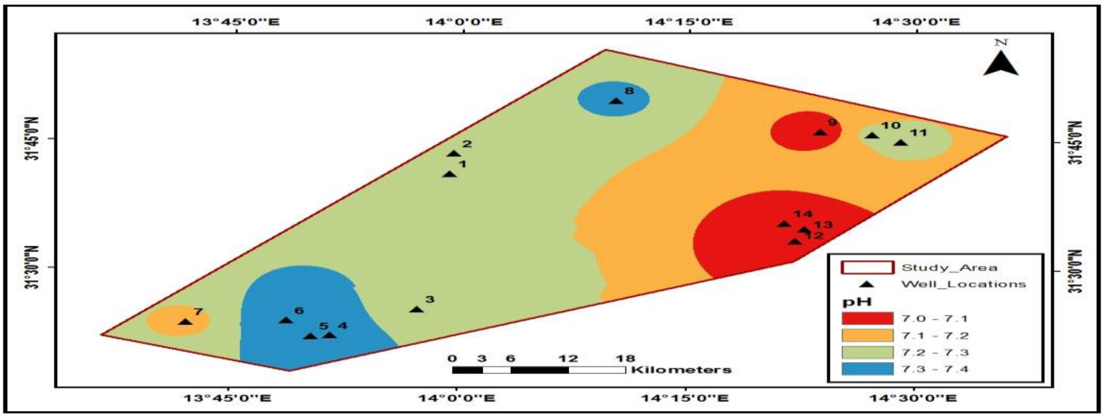

Fig .4. Spatial distribution of pH of ground water in the studied area.

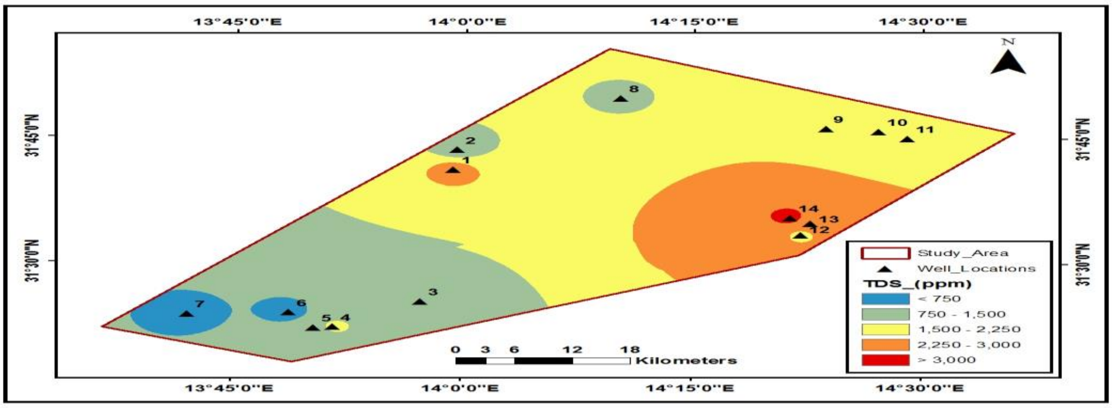

Fig .5. Spatial distribution of TDS of ground water in the studied area.

Table 2. Ions concentration of ground water samples of the studyied area.

Sites	Sample NO.	pH	E C dsm^{-1}	Chemical properties: Ions concentrations $meqL^{-1}$								mgL^{-1}				
				Na^+	K^+	Ca^{++}	Mg^{++}	CL^-	SO_4^{--}	CO_3^{--}	$HCO3^-$	NH_4^+	NO_3^-	Fe	Mn	B
	1	7.3	4.026	12.59	0.167	15.32	12.35	23.86	14.24	Non	2.32	3.43	9.31	0.06	0.06	0.796
Amresh	2	7.27	1.615	7.7	0.206	4.83	3.45	7.95	6.356	Non	1.88	0.49	3.43	0.1	0.03	0.233
	3	7.26	1.939	4.71	0.131	6.44	8.05	7.76	7.481	Non	4.09	0.49	6.37	0.09	0.03	0.439
Tininai	4	7.3	2.683	9.74	0.154	8.74	7.82	12.8	10.89	Non	2.76	0.49	2.94	0.08	0.03	0.313
	5	7.36	1.272	2.93	0.098	4.14	5.52	5.23	4.248	Non	3.21	0.49	3.92	0.11	0.03	0.205
	6	7.38	0.83	1.98	0.088	4.37	1.84	2.71	2.478	Non	3.09	0.49	4.41	0.1	0.04	0.133
	7	7.17	0.957	3.5	0.088	2.07	3.91	5.62	1.298	Non	2.65	1.47	1.47	0.1	0.02	0.163
	8	7.32	2.211	3.71	0.22	9.66	9.2	10.08	10.61	Non	2.1	0.49	3.43	0.12	0.02	0.226
Al-Mardum	9	7.03	3.375	15.9	0.179	7.82	9.43	18.62	11.27	Non	3.43	0.98	2.94	0.1	0.02	0.641
	10	7.22	3.081	11.13	0.248	10.58	8.51	15.13	11.13	Non	4.2	0.98	10.78	0.09	0.03	0.549
	11	7.23	2.851	11.19	0.179	8.74	8.74	15.22	9.759	Non	3.87	0.98	3.92	0.09	0.04	0.487
Sofa Al-gan	12	7.03	3.312	8.89	0.45	12.19	12.19	15.32	14.53	Non	3.87	1.47	1.96	0.11	0.06	1.08
	13	7.09	4.088	15.4	0.22	11.96	12.65	24.92	11.11	Non	4.2	1.47	2.45	0.11	0.04	0.582
	14	7.07	5.083	14.29	0.179	17.25	18.4	27.93	19.21	Non	2.98	0.98	16.17	0.12	0.04	0.691

Table 3. resulting parameters of the studied groundwater samples.

Sites	Sample NO.	PI (m/s)	RSC meq L^{-1}	TDS mg L^{-1}	SAR	Na %	ESP %
Amresh (A)	1	40	-25.3	2576	3.38	31.27	3.6
	2	59.81	-6.40	1033	3.78	48.19	4.14
	3	39.31	-10.4	1241	1.75	24.53	1.3
Tininai	4	47.67	-13.8	1717	3.38	37.03	3.6
	5	41.93	-6.45	814.0	1.33	23.27	0.7
	6	40.74	-3.12	531.2	1.12	24.18	0.4
	7	57.78	-3.33	612.4	2.02	36.92	1.7
Al-Mardum	8	29.88	-16.76	1415	1.21	16.44	0.52
	9	57.23	-13.82	2160	5.41	47.96	6.3
	10	46.48	-14.89	1972	3.6	36.83	3.9
	11	49.34	-13.61	1824	3.79	39.03	4.14
Sofa Al-gen	12	37.21	-20.51	2119	2.55	26.72	2.43
	13	47.38	-20.41	2616	4.39	38.49	4.96
	14	37.2	-32.67	3253	3.38	28.61	3.6

PI=Permeability Index RSC=Residual Sodium Carbonate TDS=Total Dissolved Salts
SAR=Sodium Adsorption Ratio Na%= Sodium Percentage
ESP= Exchangeable Sodium Percentage

In this study area, the concentration of chloride (Cl^-) is found to range between 2.71 – 27.93 meq L^{-1}. The mean values of chloride in samples are below the maximum admissible concentration of 250 mg/L (FAO, 1985). Too much of chloride leads to bad taste in water and also chloride ion combines with the Na (that is being derived from the weathering of granitic terrains) and forms NaCl, which excess presence in water makes it unfit for irrigation purposes. Here too, as exhibited by contours, the chloride value decreases during post-monsoon. The variation in chloride values are shown in Table (2). According to FAO (1985), the limits of chloride ion in irrigation water are 4-10 meqL^{-1}.

The sulphate ion (SO_4^{--}) causes no particular harmful effects on soils or plants; however, it contributes to increase the salinity in the soil solution. Sulfur is an essential element for plant nutrition and in the form of sulfate it is readily available to plants. Sulfate ion varied from 1.29 to 19.209 meq L^{-1} in groundwater samples in the studied area.

Bicarbonate ion varied from 1.88 to 4.2 and with mean value of 3.26 meq L^{-1} in the groundwater samples.

The adverse effect of sodium on the soil was more closely related to the ratio of sodium to the total cations in the irrigation water than to the absolute concentration of sodium. It has now been recognized that as percent of sodium increases in the soil solution larger quantities are absorbed during the exchange, replacing calcium and magnesium, thus resulting in alkali soil. The concentration of sodium in the water samples collected vary from 1.98 to 15.4 meq L^{-1} .

Calcium and magnesium ions present in groundwater of nearby coastal areas are derived from leaching of limestone, dolomite, gypsum and anhydrites, Garrels (1976). Calcium in normal potable ground water has concentration between 10 and 100 ppm. In the present study, the concentration of calcium ranged from 2.07 to 17.25 meq L^{-1} and thence is suitable for irrigation purposes, according to FAO (1985). Also, in the present study, the concentration of magnesium ranged from 1.84 to 18.4 meq L^{-1}

Iron is an essential element for plants .Although iron has little concern as a health hazard, it is still considered as a nuisance in excessive quantities. The concentration of iron in the groundwater samples collected varied from 0.06 to 0.12 mgL^{-1}.

Ammonium and nitrate ions varied from 0.49 to1.47 and 3.43 to 16.17, respectively, in the groundwater samples. According to FAO (1985),The limits of ammonium and nitrate in irrigation water are 0-5 and 0-10 mgL^{-1}, respectively.

The concentration of boron element in the groundwater samples collected vary from 0.133 to 1.08 mgL^{-1}.

3-Water Quality for Irrigation:

Water for agricultural purposes must be good for both animals and plants. Good quality of waters for irrigation is characterized by acceptable range of: 1)Electric Conductivity (EC) 2)The Sodium Adsorption Ratio (SAR). 3)The Permeability Index(PI). 4)The Residual Sodium Carbonate (RSC) 5) The Sodium Percentage (Na %). All these parameters are calculated and mentioned in Table 3.

Electric Conductivity (EC): the total concentration of soluble salts in irrigation water can be adequately expressed for purposes of diagnosis and classification in terms of electrical conductivity. Law –salinity water (C1) has EC < 250 µmhos/cm can be used for irrigation with most crop on most soils. Medium –salinity water (C2) has EC 250- 750 µmhos/cm can be used if moderate amount of leaching occurs. Plant with moderate salt tolerance can be grown in most cases without special practice for salinity control. High –salinity water (C3) has EC 750- 2250 µmhos/cm cannot be used on soils with restricted drainage, even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected. Very High –salinity water (C4) has EC > 2250 is not suitable for irrigation under ordinary conditions, but may be used occasionally under very special circumstance .The soil must be permeable, drainage must be adequate irrigation water must be applied in excess to provide considerable leaching .and very salt tolerant crops must be cultivated . According to this, data of Table 2 and Fig 6 illustrate that ground water samples 2,3,4,5,6,7,8,9,10,11 and 12, indicating high salinity(C3) which are suitable for irrigation under sandy soils of Bani walid area as well as samples 1,13 and 14 , indicating very high salinity(C4) which can be also used for irrigation with care to salinity under sandy conditions.

Sodium Adsorption Ratio (SAR): influences infiltration rate of water. Thus, low SAR is always desirable. The expression of SAR was recommended by the USDA classification (Richards, 1954). Where the Water is divided in to four classes with respect to SAR (a- Low Na^+ water =0-10 (S_1) little danger. b-Medium Na^+ water =10-18 (S_2). Problems may be found with finely textured soils and sodium sensitive plants, especially under low-leaching conditions. Soils should have good permeability. c. High Na^+ water =18-26 (S_3) Problems on most soils. Good salt tolerant plants are required, along with special management, such as the use of gypsum. d. Very high Na^+ water=>26 (S_4) Unsatisfactory except with low or medium salinity. Fig (6) is used to determine irrigation ground water classes in which a given quality of water can be placed using SAR and EC values. This system uses conductivity units of Micro mhos/cm (dS m^{-1}) and SAR values for classifying water. It is a simplified diagram developed in the laboratory for use in classifying irrigation waters. SAR values are listed on the left from bottom to top. EC values are shown on both sides top and bottom of the diagram. EC is measured from low (C_1= EC <250 micro mhos/cm) through to very high (C_4 = EC> 2250 micro mhos/cm). Sodium hazard is measured from S1= SAR (low sodium) to S4=SAR (very high sodium). Each sample can therefore be given a C_{1}-$_{4}$, S_{1}-$_{4}$ classification. In the studied samples, SAR values were ranged between 1.12 - 5.41. SAR is an essential parameter for determining suitability of groundwater for irrigation because it is a measure of alkali/sodium hazards to crops thus this SAR is S_1 and S_2 class which is a very good water (low to medium) due to sodium concentration in relation to Ca+Mg .Relationship between SAR and electrical conductivity (EC) was plotted according to the US salinity diagram (Richards,1954) Fig.(6 and 7) illustrate that groundwater samples 2,3,5,6,7 and 8 fall in the field of C_3S_1, indicating high hazard salinity and low SAR which can be used for irrigation with care to salinity .samples 4, 10 and 12 fall in C_4S_1 indicating very high salinity and low Na so it can be used for irrigation with cultivation of crops with high tolerance to salinity . Ground water samples 1, 9, 11, 13 and 14 fall in C_4S_2, indicating very high salinity and medium alkalinity hazard. This can be suitable for durable plants for salinity and also restricts their suitability for irrigation.

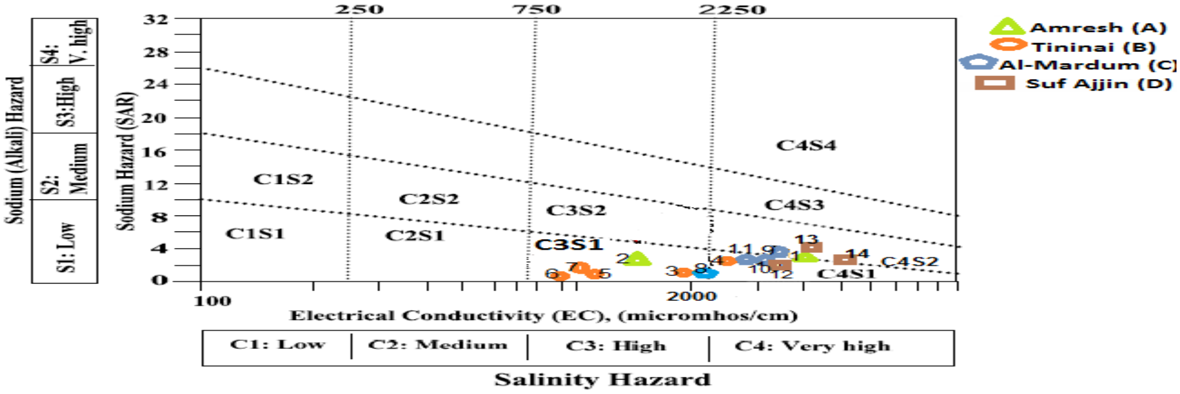

Fig .6. Richards classification of groundwater samples of the studied area

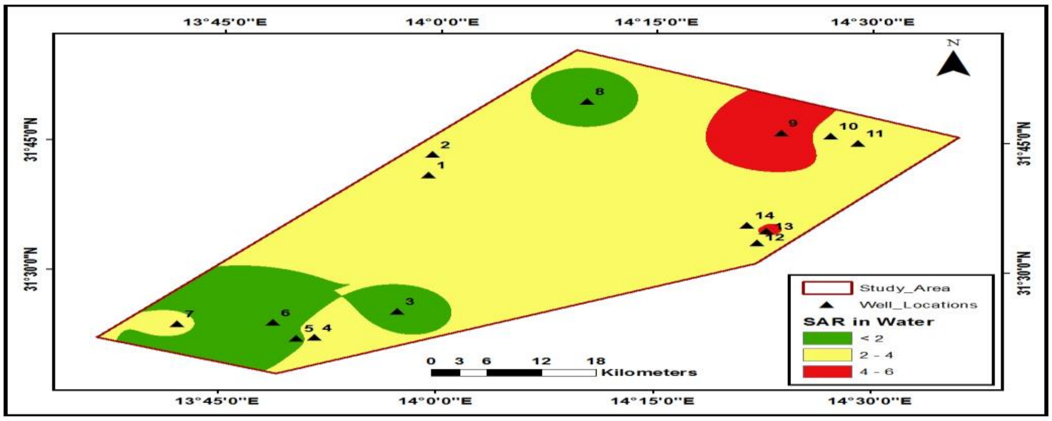

Fig .7. Spatial distribution of SAR of groundwater in the studied area.

Permeability index

The soil permeability of an area eventually decreases due to continuous irrigational practices and is defined based on the quantity of bicarbonate, sodium, calcium and magnesium in water. A modified criterion based on the solubility of salts and the reaction occurring in the soil solution from cation exchange for estimating the quality of agricultural waters was developed (Doneen, 1964). According to this, soil permeability, is influenced by (a) total dissolved solids, (b) sodium contents, (c) bicarbonate content, and the texture type of the soil. To combine the first three items, Doneen has empirically developed a term called, 'Permeability Index' after conducting a series of experiments for which he has used a large number of irrigation ground waters varying in ionic relationships and concentration. where ions are expressed in $meqL^{-1}$. PI ranges from 29.88 % to 59.81%. According to PI values, the groundwater in the study area can be assigned to class I and II (25- 75%) that shows the groundwater in the study area is suitable for irrigational purposes (Fig8)

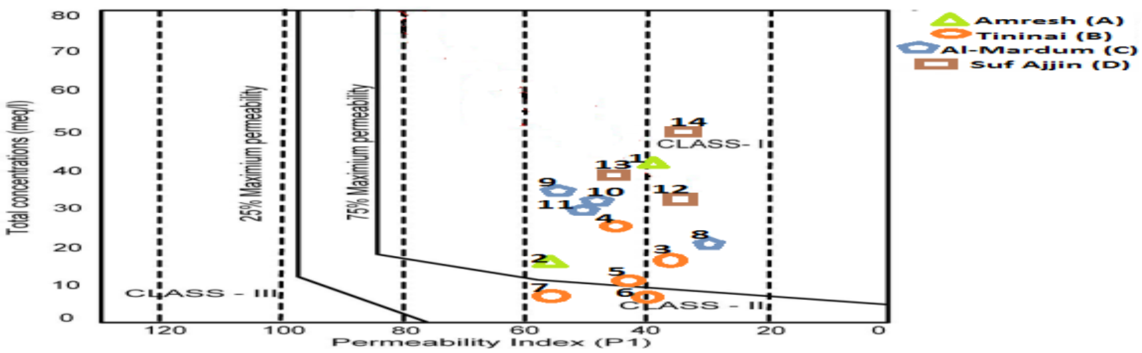

Fig .8. diagram to show the groundwater suitability for irrigation purpose.

Residual Sodium Carbonates (RSC)

water of irrigation which have (RSC) >2.50 mmoL.L^{-1} Invalid for irrigation, but if (RSC) range between 1.25-2.50 mmoL.L^{-1} is considerable useable for agricultural irrigation, and (RSC) less 1.25 water is safe for irrigation all soils (Eation 1950) .According to this, data of Table 3 and Fig. 9 illustrate that all groundwater samples are safety and suitable for irrigation purposes.

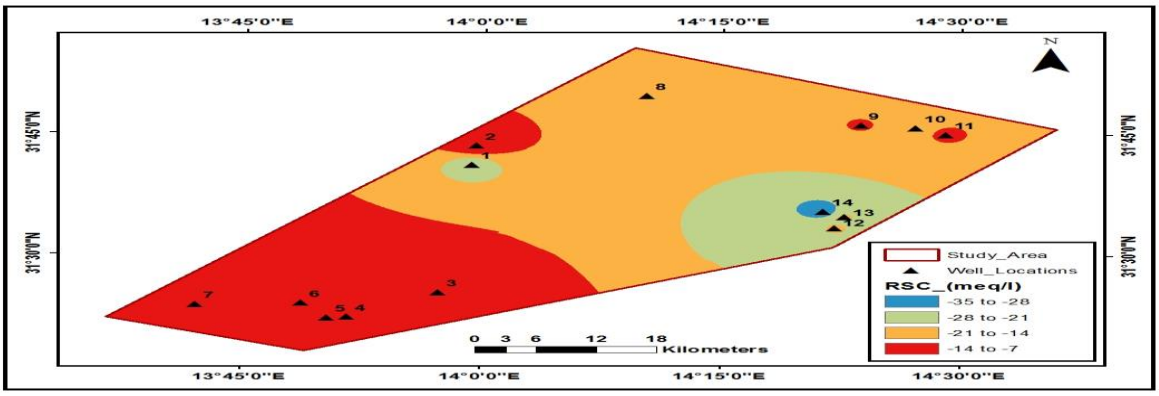

Fig .9. Spatial distribution of RSC of ground water in the studied area.

Sodium Percentage (Na %).

Establishment of water quality from the standpoint of the sodium hazard is more complicated than for salinity hazard. Also, Although plant growth is primarily limited by the salinity (EC_w) level of the irrigation water, the application of water with a sodium imbalance can further reduce yield under certain soil texture conditions. Reductions in water infiltration can occur when irrigation water contains high sodium relative to the calcium and magnesium contents (Richards, 1954) Where the Water is divided in to five classes (A- water is excellent %Na<20. B- Water is good%Na20-40. C. water is permissible %Na40-60 D. water is doubtful %Na60-80 .E. water is unsuitable %Na>80. Data of Table 3 illustrate that ground water samples 8 fall in class A , indicating low %Na which is very suitable for irrigation .samples 1,3,4,5,6,7,10,11,12,13 and 14 fall in class B , indicating low to medium% Na which can be used well for irrigation. Ground water samples 2 and 9 fall in class C, indicating medium % Na which is suitable for irrigation with care to alkalinity. The interaction between Na% and total concentration of ions (EC) on the Wilcox (1955) diagram Fig.(10) shows that most of the ground water samples were doubtful and unsuitable for irrigation except samples 2,3,5,6 and 7 which were good to permissible for irrigation. High concentration of sodium in irrigation water reduces soil permeability.

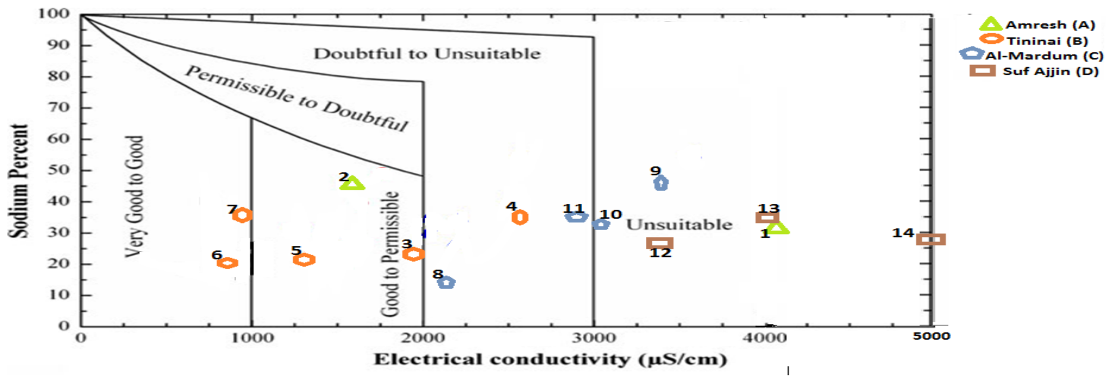

Fig .10. Wilcox classification of groundwater samples of the studied area

4 - Exchangeable Sodium Percentage (%ESP)

From data in Table 3 and Fig. 11, the percentage of Exchangeable Sodium (%ESP) found to vary between 0.4 -4.96 %. Where the most ground water samples are safety and suitable for irrigation purposes because its (%ESP) is less than 15% according to Richards (1954).

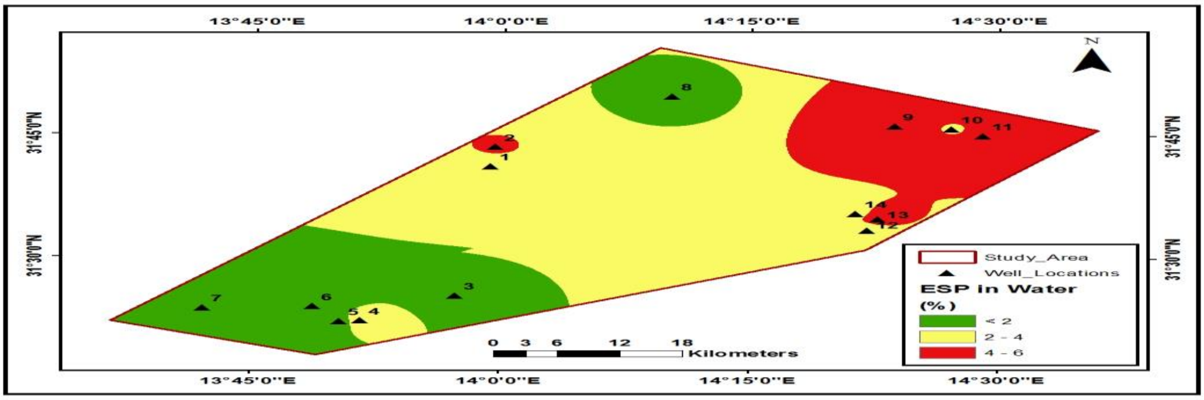

Fig .11. Spatial distribution of %ESP of ground water in the studied area.

5 -Concentration of ammonium (NH_4^+) and nitrate (NO_3^-)

Nitrogen in irrigation water is largely a fertility issue, the nitrate ion often occurs in a higher concentrations than ammonium in irrigation water. Waters high in N can cause quality problems for crops such as barley and sugar beets and excessive vegetative growth in some vegetables. However, these problems can usually be overcome by good fertilizer and irrigation management. Regardless of the crop, nitrate should be credited toward the fertilizer rate especially when the concentration exceeds 5 $mg.L^{-1}$(NH_4^+-N) and 30 $mg.L^{-1}$ (NO_3-N). Richards (1954). Data in Table 2 and Fig (12 and 13) show the concentrations of ammonium (NH_4^+) and nitrate (NO_3^-) are found to vary between 0.49-3.34 and 1.47-16.17 mg/L, respectively. Thus, the most of ground water samples are suitable for irrigation purposes.

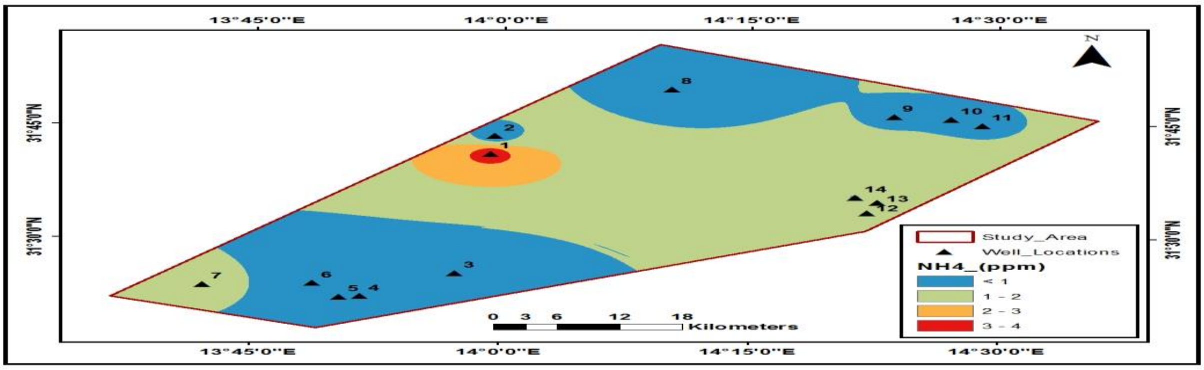

Fig .12. Spatial distribution of NH_4^- of ground water in the studied area

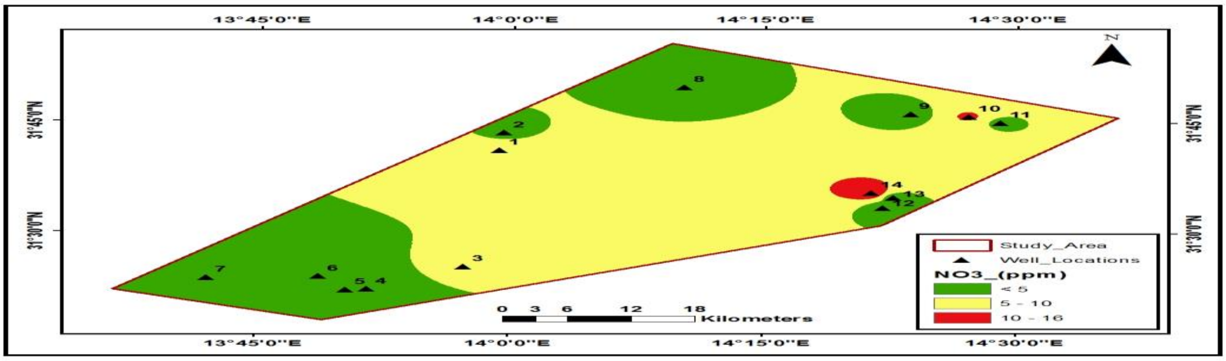

Fig .13. Spatial distribution of NO_3^{--} of ground water in the studied area.

6 - Concentrations of boron element (B)

From data in Table 2 and Fig (14), the concentrations of boron element (B) found to vary between 0.133 -1.08 mg/L, respectively. Where ground water samples (2, 3, 4,5,6,7 and 8) are safety and suitable for irrigation purposes because its boron concentration is less than 0.5 mgL^{-1} according to Scofield (1936) who proposed the limits of boron concentration in irrigation water ,where the water is divided in to two classes (A- water is good B<0.33 mgL^{-1}. B- Water isn't good B>1 mgL^{-1} .

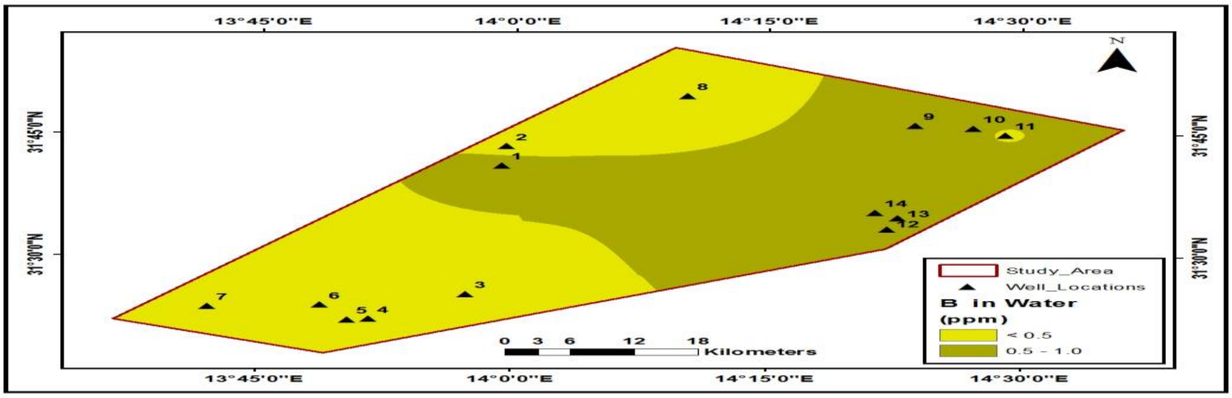

Fig .14. Spatial distribution of boron concentration of ground water in the studied area.

CONCLUSION

Fourteen groundwater samples were analyzed in terms of their chemical properties using standard methods. Ground water quality in Bani Walid districts, Libya revealed that pH and TDS values of some collected ground water samples were safe for irrigation purpose for samples (2,3,5,6 and 7) Amresh and Tininai areas. Electrical conductivity is a decisive parameter in determining suitability of water for particular purpose and is classified according to electrical conductivity as shown in Table 2. Other elements such as calcium (Ca), magnesium (Mg), chloride (Cl), iron (Fe), (HCO_3), sodium (Na), and sulfate (SO_4) are within the permissible limits in some locations such as Amresh and Tininai areas. Chemical parameters plotted in the U.S. Salinity diagram indicate that the waters from the present area are of C_3-S_1, C_4-S_1 (need to cultivation of crops with high tolerance to salinity) and C4-S_2 types (This can be suitable for plants having good salt tolerance and also restricts their suitability for irrigation). The results of chemical analysis revealed the values of Sodium Adsorption Ratio which indicate that the groundwater of the area falls under the category of low and medium sodium hazard. Thus, there was neither alkalinity nor toxicity problem of irrigation water, and hence the groundwater can safely be used for long term irrigation with care to use tolerant plant for salinity.

REFERENCES

Abu-fayed; A. A, M. K. A. Elghuel and M. Rashed(2003). Desalination: a viable supplemental source of water for the arid states of North Africa. College of Engineering, AlFateh University, P.O. Box 13626, Tripoli, Libya.

Al-Neiami, F.H(2000). "Hydrogeology of Wadi Al-Shour". Unpub.Msc. thesis,Univ.of Mosul .Collage of Science, 2000

Ballas,B. (1978). Water resources of the Socialist People Libyan Arab Jamahiriya. The Geology of Libya , Volume 2. AL-WR-204.

Bingham, F.T. (1982).Boron .In A.L.Page et al., (ed) . "Methods of soil analysis" (2^{nd})ed. Agron. ASA, Madison, Wisconsim.9:431:447.

Chapman; H. D. and P. F. Pratt (1961). "Methods of Analysis for Soils, Plants and Waters". DIV. of Agric. Sci., California Univ., Berkely, USA.

Doneen, L.D(1964). Notes on water quality in agriculture.Published as a water science and engineering paper 4001, Department of Water Science and Engineering, University of California.

Eation (1950). Significance of carbonates in irrigation waters. Soil. Sci.69:123-133.

Eison.C and M. P. Anderson(1980). “The Effects of urbanization on Groundwater Quality,” In: R. E. Jackson, Ed., Aquifer Contamination and Protection, UNESCO Press, Paris, pp. 378-390.

FAO. (1985). Water Quality for Agriculture.Ayers, R.S.and D.V. Westcot. Irrigation and drainage paper 26. Food and Agriculture Organization for the United Nations, Rome revised

FAO, (2002). Crops and drops, making the best use of water for agriculture, publishing management service. Information division FAO. the land and water development division, FAO, Rome, Italy.

Garrels;A (1976). “Survey of Low Temperature Water M Rela tions in Interpretation of Environmental Isotope and Hydrogeochemical Data in Groundwater Hydrology,” In- ternational Atomic Energy Agency, Vienna, 1976. Iner al

Gupta.S.K and I. C. Gupta(1987). “Management of Saline Soils and Water,” Oxford and IBH Publication,Co.,New Delhi.

Hem;J.D. (1985) "Study and interpretation of the chemical characteristics of natural water" ,2^{nd} ed. U.S. Geological Survey water -supply paper ,473,363pp.

Hesse, P. R. (1971)." A Text Book of Soil Chemical Analysis". Juan Murry (Publisher) Ltd, London.

Jackson, M. L. (1967). "Soil Chemical Analysis". Printice-Hall of India, New Delhi.

Karanth, K.R. (1987) Ground water assessment, development and management. Tata McGraw Hill, New Delhi, pp720 .

Kelly, W.P. (1963) Use of saline irrigation water. Soil Sci., 95(4): 355-391.

Klute,A.(1986). "Methods of Soil Analysis". Part 1 :Physical and Mineralogical Methods, 2 nd- Ed. Amer, Soc. Agron. Madison Wiscinsim, U.S.A.

Mady, L; B. R Nayar , S . Abd El-Moghait,M .S. Hussein,A. Belhag and A. Ashour (1976).The ground water of Bani Walid area. unpublished report. General Water Authority (A branch of the Central Region).

Nayar; B.R and M.S.Hussien . (1978). Water resources of the sofa gene Valley. AW-HO-266.

Nayar .B.R; A.Hiba and M.Abd El-maksod (1987). Water resources of the Taninaa area. unpublished report. General Authority for Water in Libya.,

Richards, L. A. (1954). "Diagnosis and improving of Saline and Alkaline Soils". U. S., Salinity Laboratory Staff. Agric. Handbook, No.60.

Sanders;L.L(1998) "A manual of field hydrogeology", Prentice -Hall, Inc.

Scofield (1936). The salinity of irrigation water .Smithsn .Inst .Ann. Rpt.1935.275-287.illus

Todd; D. K. (1980). “Ground Water Hydrogeology,” 2nd Edition, John Wiley and Sons Inc., Hoboken, 315.

UNESCO,ACSAD (1995), Ground water protection in the Arab region ,Paris, Cario. AL-WR-354.

Wilcox, L.V.(1955) "Classification and use of irrigation waters". USDA, Circular 969, Washington, DC, USA.

تقييم المياه الجوفية لإغراض الري في منطقة بني وليد ـ ليبيا

السيد محمود فوزي الحديدي[1] و طارق محمد رجب الزهيري[1] و أمحمد سعد خليفه ابوغياس[2-1]

[-1] قسم الأراضي, كلية الزراعة، جامعة المنصورة

[2-1] قسم التربة والمياه، كلية الزراعة، جامعة الزيتونة ـ ليبيا

تم تنفيذ هذه الدراسة بمنطقة بني وليد التي تقع غلي بعد 180 كم من جنوب شرق العاصمة الليبية (طرابلس).وذلك لمعرفة مدي ملائمة جودة المياه الجوفية لإغراض الري حيث انه تعتبر هي المصدر الأساسي للمياه المستخدمة في الزراعة، تمت دراسة أربع عشرة عينة من المياه الجوفية من أماكن مختلفة بأودية بني وليد وذلك لتقييم بعض الخواص الكيميائية، تم تحديد المواقع المدروسة باستخدام نظام تحديد المواقع العالمي (GPS). نم توضيح الصفات التي درست باستخدام خرائط كنتورية توضح التوزيع المكاني لتركيزات المكونات الكيميائية لعينات المياه الجوفية المأخوذة. ترتيب تواجد الانيونات كان كما يلي كلوريد > كبريتات > بكربونات > كربونات والكاتيونات كان كما يلي كالسيوم > صوديوم > مغناسيوم > بوتاسيوم. أيضا تم استخدام مخطط بايبر لتوضيح نوعيه المياه وكذلك تم استخدام تصنيف ريتشارد و ويلكوكس لمعرفه مدي ملائمة العينات المدروسة لأغراض الري .من الصفات التي تم تقديرها النسبة الإدمصاصية للصوديوم (SAR) وكربونات الصوديوم المتبقيه (RSC) والملوحة إذ أنها تعتبر مؤشرات لمدي ملائمة مياه الآبار المدروسة لأغراض الري والزراعة. هذه النتائج أشارت إلي أن العينات معظمها لا تصلح للري وان استخدمة لندرة المياه فتستحدم لري محاصيل عالية التحمل للملوحة فقط فيما عدا العينات رقم 2و3و5و6و7و8 والتي تقع في منطقه جيده تتيح لها ري محاصيل عديدة.