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Marshes waters sources hydrochemistryof the Bahr Al-Najaf at Najaf Province, Iraq

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Marshes waters sources hydrochemistryof the Bahr Al-Najaf at Najaf Province, Iraq

Hussein Badr Ghalib[1,2*], Adnan B. Al-Hawash[3,4],Wasan S. Al-Qurnaw[1], Basim Hameed Sultan[1]and Arshad W. Al-enzy[5]

[1]University of Basrah, College of Science, Geology Department, Basra, Iraq

[2]Selcuk University, college ofEngineering, Geology Department, Selcuk, Turkey

[3]Ministry of Education, Directorate of Education, Basra 61001, Iraq

[4]College of Life Science and Technology, Huazhong University of Science and Technology, Wuhan, China

[5]General Commission of Groundwater, Najaf, Ministry of water Resources, Najaf, Iraq

*Corresponding Author: hbggeo@gmail.com

Abstract: Bahar Al- Najaf basin is located in the western part of Al-Najaf governorate, center of Iraq. This work was aimed to determine the water sources for marshes, water discharges and factors which causing to the rise and low of the water level in these marshes.Five sources recharge for the marshes water were detected; rainwater, Al-Dammam confined aquifer flowing wells, sieve factures, water of springs and the irrigation water.The hydrochemistry analysis was investigated for all water sources of marshes using major and minor elements (Ca, Na, K, Mg, Cl, SO_4, NO_3, HCO_3 and Br) and field measurements such as (T, pH, EC, TDS). The hydrochemical results shows that the all sources of water are not suitable for drinking water, while it's classified as a good to permissible water for irrigation except water of marshes. Water quality standards for livestock is vary from very good water type in the irrigation streams to the can be used in a water marshes.

Keywords: Marshes, waters sources, Bahr Al-Najaf, Water quality, Hydrochemistry

1. Introduction

Marshes are wetland that dominated by herbaceous rather than woody plant species [1] Marshes are transition from the aquatic and terrestrial ecosystems which dominated by grasses, rushes or reeds, thus that form of vegetation is what differentiates marshes from other types of wetland such as swamps, which are dominated by trees, and mires, which are wetlands that have accumulated deposits of acidic peat [2].The marshes are low land, where the water is collecting; in case of flood seasons it causing many problems such as sinking the farms, many of the residential houses and brick factories in the region. Several investigative conducted in the province of Al-Najaf for causes of flooding and drowning the buildings since 2012 -2013. The Iraqi farmers have been challenged for many years from poor environmental conditions, with few affordable measures for adapting to salinity, climate, drought, pests, crop and livestock diseases, and input shortages, as well as related challenges of poor technology and institutions, and inadequate science-formulated policies [3].Recently, the Iraq faces special problems connected to water and food security due to poor water management plans and the policies of neighboring countries where most of the surface water resources (the Euphrates and Tigris rivers and their attributes) are located [4]. In addition, the shortage of precipitation aggravates the problem in the last ten years on those lands away from the river or those that do not have groundwater, to increase non-planted areas, although those areas are cultivable (Fig.1). More than that, the rise in temperature significantly led to highlighting the phenomenon of desertification and drought, which led to a clear impact on the areas of arable land and thus on the agricultural sector in general (MOWR, 2015). Therefore, the proper management of surface and groundwater resources is crucial to avoiding water shortage and can be achieved through the integrated use of water resources. The optimal use of surface water (such as floodwater through storage in surface reservoirs, lake and marshes) andits hydrochemical characteristics studying are useful strategies for coping with water scarcity [5].Hydrochemical methodology offer effective tool for solving various problems in hydrology,in particular in the arid and semi-arid regions [6-11]. Multi-tracer investigations are commonly used to understand surface movement, salinity origin, evaporation processes, and recharge periods [12]Such information which is needed to improve water resource management strategies is of particular importance for aquifers located in arid and semi-arid areas and characterized by complex lithology. This is the case of the west desert plain in Central Iraq.The maximum value of rain may be attended during November and the minimum in May. The maximum and minimum of monthly rainfall rate of the study area for the period (1962-2018) are 27.17mm and 4.04 mm respectively with average 8.29 mm. The maximum and minimum value of evaporation rate is 499.88 mm and 77.88 mm, respectively. Several previous studies have been conducted on groundwater and have not been interested in studying the sources of marshes and its hydrochemistry. Therefore, this study aimed to determine source of the marshes water and the chemical characteristics for these waters, the most relevant controls on the water quality, and the dominant chemical processes, which control. Thus, using the hydrochemical analysis to conjunction between these sources of water and to knowledge of water hydrochemistry of water marshes and their suitability for the different purposes in addition to the possible of use.

2. Materials and Methods

2.1. Study area

2.1.1 General and geological description

The study area is located in Bahr Al-Najaf, west of Al-Najaf province, Iraq. The East sideof Bahr Al-Najaf is graveyard, which formed a permanent marsh, where the waters is collecting throughout the year. The marshes are extends at North west-South east direction of an area about 360-750 Km2, of coordinates longitude 43˚ 40 - 44˚ 25 E and latitude 31˚ 40 - 32˚ 10 N and altitude elevation of about 11 m a. s. l. [12,13], (Fig.1). Geologically, Bahar Al-Najaf area is located within the boundaries of Al-Salman subzone including the stable shelf that specializes in its simple structures, [14]. The exposed rocks are sedimentary rocks of upper Cretaceous and Quaternary period [15,16]. Tar Al-Najaf is limits the marshes from the east side while the Sothern Desert is bordering the marshes from Western side. The common climate in the area is Sub-arid to arid [17].

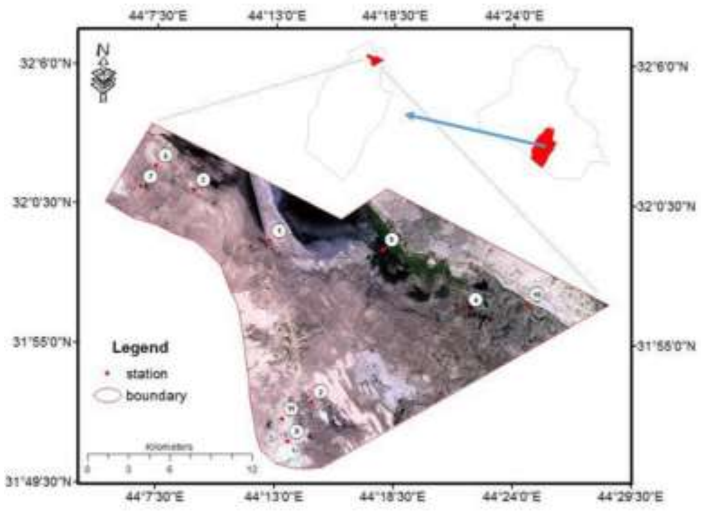

Fig.1. Location and position of water samples in the study area.

The geomorphology districts the flow regime of (sub) -surface water (Wadies) and (dis) -recharge areas depending on the gravity forces, which inclines to the East and Northeast down to the discharge zone. As well as, it is affected by the climate elements like distribution of precipitation. Geomorphological, a few reliefs mark the studied area, and it has a ground surface elevation range (15-267m) approximately, above sea level. The area slopes gradually from the West and Southwest towards the North and Northeast.Where the land surface rises gradually from Northeast to Southwest 50m every 10-15 km, [18]. On the other hand,at the eastern edge of the study area, it's seen as a closed topographic depression, which isa lower land relative to the surrounding, and it represents as a discharge zone (Bahir Al-Najaf). Generally, the study area is characterized by some Wades, which can discharge of rainwater from the West and South- West to East and Northeast directions which be coincide with the decline direction of the regional topography ([19].

Such of these Wades are Wade Haussab and Wade Al-Khur and other smaller valleys as Al-Rhimawi and Abo Kumssat which could participate the pooled of water and recharge the aquifers of the basin [20]. This situation makes some eastern and Northeastern parts of the studied area periodically contain amounts of water, and appear as marshes.A huge fault which extend in the far eastern side forms the limits of the stable boundary which is called the Euphrates fault, this fault and the rest of the faults in the area play an important role for controlling with ground water movement in study area, existing of the spring which considered as a good evidence of the presence of deep faults [21]. It could be considered that the fault zone represents a transitional zone between the two shelves the stable and the unstable zones (Mesopotamian plain), which marked by a shelf system known as (Heet-Abu Jir) that extends from Hadeetha in the north to Abu Jir and pass through Najaf in its way to Samawa in the south [22]. Abu jir fault zone, including the Euphrates fault extends perpendicular to the other trending faults, which make a barrier that allow the water to pass through and circulate within this net of faults.

2.1.2 Hydrological setting

The studied area are characterized with a rolling and / or undulating terrain, most parts of the study area, it is a slightly rolling or flat, and decreasing in its height towards the East and northeast. Despite the studied area has a climate of dried desert, the rainfall sometimes happens as sporadic heavy flushes occur once every several years, usually one or two times every four years, which causes a superficial flux for the rainwater which creating many of the ephemeral and temporarily rivers in the desert, most of these rivers are flowing to the large Wadies, whereas the small valleys have gathered its water in the small spaces in a form of temporary ponds called "Al-fidah", its waters are infiltrating through the soil column and the other part is evaporated to the atmosphere over the time (Fig.2). All of these Wadies within the study area are discharging its water towards the marshes, which it lay to the East of the studied area bordering of Tar Al-Najaf, the most important of these Wades are Wade Hassoub, and Wade Al-Khur, in addition to Wade Waair, Abu Khamesat and Wade Al-Rahimawi. Marshes has a water depth exceeds 2 m in some of the regions and its ground surface elevation is 10 m at the sea level, while the maximum elevation is 217 m (a.s.l), in the West and Southwest of the study area. Therefore, the Wades is collecting the rainwater and transfer it to the marshes, which makes them to be one of the sources of marsh waters, (Plate -1). Wades also are represented as facilitates from operation of surface water filtration, where the draining system in the Southern Desert is internal, with most of the surface water percolating to underground through permeable strata, fractures, fissures and karats cavities [23].

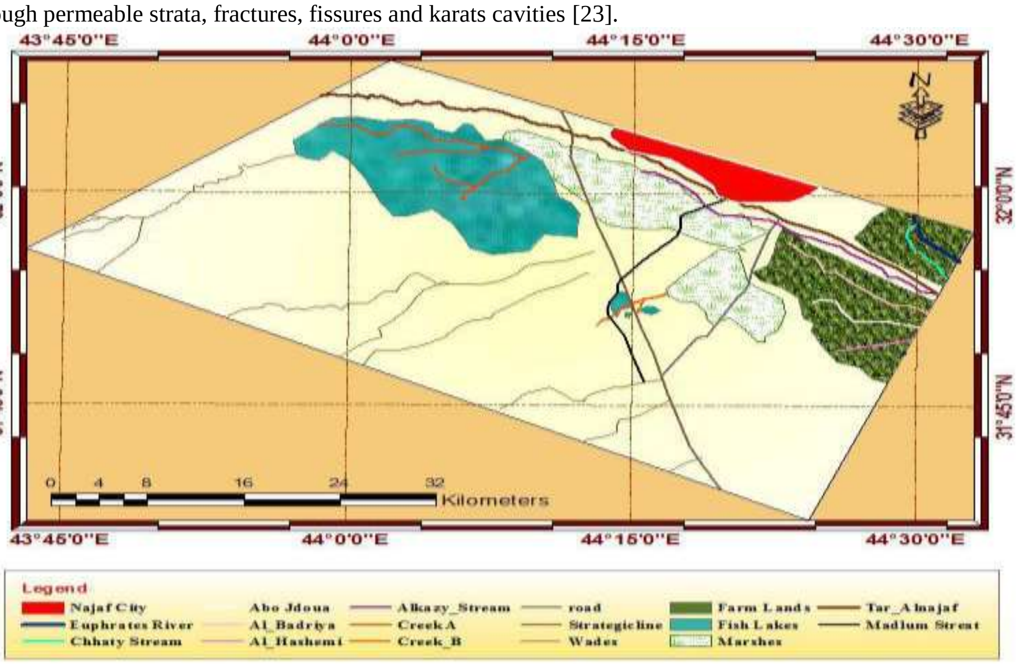

Fig 2. Surface features and surface water resources in the study area.

2.2. Methods analysis

Several of the field tours have been conducted to investigate from sources of marshes water in the Bahar Al-Najaf. Five sources of water have been found in the study area, which they feeding the marshes. These sources are (floods water that come via Wadies, creeks that come from lakes of breeding fish, Creeks that come from the Euphrates River, water that come from sieve factures and springs), all of these sources of the water are ending its water in the marshes. Eleven samples have been collected from eleven station of water in November 2017.The samplesrepresent the sources of surface water in Bahr Al-Najaf, these stations are (Marshes Water (MW), Irrigation Creeks (IC), Springs Water (SW), Factories Water (FW), Creeks that come from Fish Lakes (FLC)).The sampling locations are shown in Fig. 2.Physicochemical parameters including EC (uS/cm) and pH were measured in the field using portable measuring instruments. The bottles were washed with the water to be sampled before sampling. Two water samples were collected for each sample point using polyethylene bottles. The samples taken for cation analysis were acidified using pure HNO_3 to prevent precipitation and preserved in refrigerator at a temperature of about 4°C until analysis. The parameters were determined by following standard and recommended analysis methods [24]All samples were analyzed for major cations (K^+, Na^+, Ca^{2+}, and Mg^{2+}) and major anions (CO_3^{2+}, HCO_3^-, SO_4^{2-}, and Cl^-), as well as the secondary anions (NO_3^-) and trace elements (Cd, Mn, Zn, Fe and Pb), in the Sciences and Technology Ministry Laboratories, Baghdad, Iraq.The majority of the analyzed samples show ion balanceerrors within ±5%, indicating the results are generallyacceptable. The TDS concentration was calculated using the results of the chemical analyses. The distribution of major ion concentrations and correlation analysis of parameters and elements in groundwater samples were studied through the statistical and hydrochemical graphs. The correlation coefficient was determined to reveal the relationship between parameters by means of SPSS (version 15.0). The results of the chemical analyses in the study area compare with Iraqi standards and WHO to detect the validity of the surface water for the different purposes. The variations of element concentrations andparameter values in aquifer were illustrated on zoningmaps through Arc G1S 10.5 [25].

3. Results and Discussion

3.1. Sources of marshes waters

There are different sources of marshes water and they have a different origin. Generally, these sources can be summarized as follows:

1. Rainwater that comes via the Wadies (RW).

The rainwater flows in the study area from the high topography toward the low land (Bahr Al-Najaf),and it pours into the marshes. Rainfall occurs during winter months in the form of heavy showers and rather sporadic, but occurs very rapidly during a short time; mean annual amount of rainfall ranges between (75 – 100mm) [26]. Marshes in Bahr Al-Najaf is receiving surface waters from the western side via the watercourses that bring water on a seasonal basis from the upland desert to the west after any heavy rains [27]. Although the climate of the study area is arid to semi-arid but it, flood waves may happen every a few years, causing many problems in the region, the most important is the smashing of bridges, destruction of the paved roads, fish breeding lakes and agricultural land. Also, the sinking of the brick factories, and residential buildings(plate.1and plate.2).


Plate.1: Rainwater flow through wadieHassoub in November 2015. Plate.2: Bahr Al-Najaf in November 2015.

2. Irrigation creeks (IC)

Many of the creeks (streams) are existing in the maximum of the Southeastern side of the study area, these creeks are established to irrigation the farmlands that is characterized by cultivation of rice crop (fig.2). Most of these creeks are ending its waters in the marshes either directly or through drainage of water surplus that resulting from irrigation of rice crop. There are four creeks of water that have different lengths and they vary in its discharge that feeding the agricultural lands in the study area. These creeks are received its water from the right side of Chhaty stream (Table.1); (General Commission of groundwater in Najaf). Chhaty stream by discharge of water reach to (15m^3/Sec), received its water from the right side of the Euphrates River by raising the water level to (19.20 m) a.s.l in the main channel via Al-Mashkhab regulator. However, the amount of water that discharging from these crakes to the marshes is about 2-3 m^3/Sec.

Table1. Characteristics of irrigation creeks in the study area (General Commission of groundwater in Najaf).

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Creek name	Length	Design discharge (m^3/sec)
Al-Gazi	31 km	6
Al- Badriyah	28 km	5
Al- Hashemi	15 km	4
Abu Jdoua	26 km	3

3. Groundwater Creeks (GWC).

Groundwater creeks means that waters which come from the flowing wells (Self-flow wells) which intervention to the lakes of fish, then drains to the marshes via the main creek which it collecting the waters from several small creeks which outs from the lakes. There are two main creeks from the groundwater flowing wells, one of them lies in the northeast of the study area, which is the biggest (creek A) due to the large numbers of fish lakes in these regions, while the other creek is located in the south side of the study area (creek B).The amount of drainage waters from these creeks is depending on the numbers of fish lakes in the region that mean numbers of flowing wells. Hundreds of flowing wells exist in the study area, some of these wells have a discharge reach more than 75 L/Sec; subsequently the water of these wells reaches to the marshes. However, the amount of water have been calculated for both creeks which drains its water to the marshes depending on equation no.1, after the field measurements were done for both creeks, as it following [28].:

$Q = V \times A$ .... (1)

Where:

Q: is the discharge of water.

V: Velocity of water and can be obtained via divided the distance over the time, for a float body

A: Cross-section area for the main creek and can be obtained via multiplying the width of channel with its depth.

I. *Discharge of water in the creek A.*

The velocity of water has been measured by calculating a float body time for a distance 15 m. However, the time is 1^0, $20^=$, depth of channel is 0.75m, width of channel is 3.71m.

$V=\frac{15}{80} = 0.1875$ m/Sec.

$A= 0.75 \times 3.71 = 2.782$ m^2.

$Q = 0.1875 \times 2.782 = 0.521$ m^3/ Sec.

II. *Discharge of water in the creek B.*

In the same way in above, the discharge of creek B was (0.274) m^2/Sec.So, the total amount of waters that come from the self-flow wells through lakes of fish and across the water creeks is (0.795 m^3/ Sec) on a daily basis.

4. Waters that come from the sieve factories (SFW).

It is difficult to determine the amount of water that come from the sieve factories due to it is a large number and different locations. Generally, more than a hundred of these factories are existing in the study area. They are used a submersible pump to extract the groundwater with an average discharge reach 7 l/sec for 8 hours per day. Some of these factories are thrown its water after use into the marshes directly, other of these factories are using the artificial channels to drain its water to the marshes, and some of the other dropping its water in a specific region to form a swamp and therefore, the water does not reach to the marshes. However, if we assume that 50 of these factories are reaching its water to the marshes directly or indirectly (by channels), the amount of water that results from multiplying the number of these factories by the value of the discharge for one pump it is equal to (0.35 m^3/sec). Knowing, the numbers of working hour's in the factories is eight hours per day.

5. Springs water (SW).

There are a few amounts of water that come from the springs. This water is seeping from joints and the cracks, which are existing in limestone rocks andit mixed with the water of sieve factures due it drains its water in the same channel which it ending to the marshes. As a result of the points above, the amount of water that reaches to the marshes can be summarized in (Table.2). Could not calculate the amount of water that coming via the wadies due to the lack of sufficient rainfall to get on runoff during the study period.

Table2. Amounts of waters that discharging in the marshes.

Source of water	Discharge (m^3/sec)
Irrigations streams	3
Groundwater creeks	0.795
sieve factories water	0.35
Total Discharge	4.145

3.2 .Hydrochemistry of waters.
Understanding the water quality is important as it is the main factor determining itssuitability for drinking, domestic, agricultural and industrial purposes [28]. Evaluations of water provides an idea about the reactions that produce natural water chemistry [29]. Marshes is the lowest land in the region, thus all surface water resources are accumulating in it.

3.3. Physical properties
There is a marked variation in water temperature due to differ its sources and locations. Generally, temperature of water creeks is lowest than temperature of marshes due to flow of the water. The range of the surface water temperature was(28.7-34.9 ^{0}C) with an average 31.27 ^{0}C. pH of water sources is moderate to alkaline in nature, where the variation of pH value is depends on temperature of water.The pH values were within the range of (7.1-7.6) with an average 7.3. A high variation was found in EC and TDS, where the maximum values of TDS were found in the samples of marshes water, while the lowest values were in the samples of irrigation creeks, the high values of TDS its a result to the evaporation process which happen in the marshes and concentrated the salts. TDS and ECin water samples were within the range of (1130-12690 ppm), with an average 4798 ppm. Therefore, the waters are varying from brackish water to saline water according to [30] water classification (Table 3). The EC ranging of (1525-17131 µS/cm),with an average 6478 µS/cm. Total Hardness (T.H) showed that all water samples is very hard according to [31] classification (Table 4), where the values were ranging of (650-7471 ppm) with an average 2633 ppm. All physical parameters are shown in(Table 5 and Fig.3).

Table 3.Classification of water according to TDS (ppm)

Water class	(Drever, 1997)	(Todd, 2007)
Fresh water	< 1000	10 - 1000
Slightly water	1000 – 2000	----
Slightly-brackish water	2000 – 20 000	1000 – 10 000
Brackish water	----	10 000 – 100 000
Saline water	35 000	----
Brine water	> 35 000	> 100 000

Table 4. Classification of water according to the total hardness [31]

Term	Degree of Water Hardness
Soft	$0 < TH \leq 60$
Moderately hard	$60 < TH \leq 120$
Hard	$120 < TH \leq 180$
Very hard	$180 < TH$

Table 5: physical analytical data for the samples water in the study area.

Type of water	E	N	pH	TDS (mg/l)	EC (μs/cm)	T (^{0}C)	TH (mg/l)
FLC 1	428590	3527199	7.2	3265	4407	30.7	1525.74
FLC 2	417268	3544415	7.4	3212	4336	30.2	1701.42
FLC 3	416204	3542895	7.6	2530	3415	28.7	1101.76
CE 1	439889	3533899	7.4	1930	2605	29.3	950.37
CE 2	444369	3534297	7.4	1130	1525	31.3	650.37
SW 1	427425	3524875	7.2	1570	2119	32.7	808.59
SW 2	427119	3524406	7.2	2002	2702	32.1	1207.26
SFW	426459	3525993	7.3	3215	4339	30.1	1703
MW1	425555	3538919	7.1	12690	17131	34.9	7471.23
MW2	420040	3542648	7.4	5950	8032	29.6	2437.04
MW3	433775	3538298	7.1	11070	14944	33.4	6554.22
Min	-	-	7.1	1130	1525	28.7	650.37
Max	-	-	7.6	12690	17131	34.9	7471.23
Average	-	-	7.3	4798	6478	31.27	2633

CE: Creek water that come from Euphrates River.

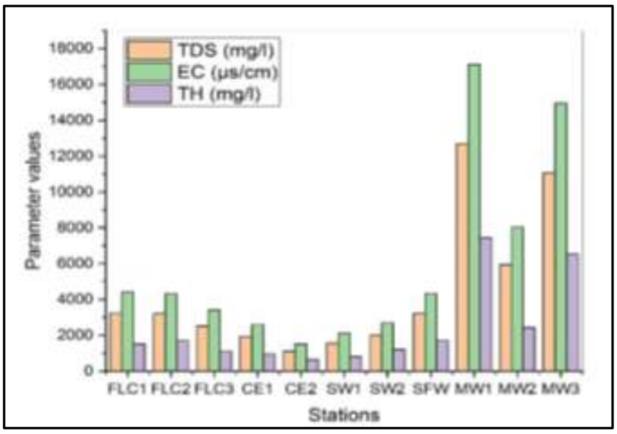

Fig3. Physical parameters chart for the water samples in the study area.

3.4. Major ions

The major ions are consisted of Cations and Anions; naturally, it has a wide variety in the surface and groundwater due to local geological, climatic and geographical conditions. Major ions in the samples of water sources within the study area are lasted in the (Table 6)and they are illustrated in (Fig. 4). The most dominant Cation is Na^+, where it forms 45.39 % in average, Calcium consist of (33.91%) in average, whilst Cl^- and So_4^{2-} are the most dominant anions and they forms 48.57 %, 47.39% respectively from the total Ions. The detail ionic constituents in the sources of water are clearly displayed by Pie diagram (Fig.5). Piper diagram displays that most of surface water samples is fall in class (E); (Fig.6). The class E means Calcium carbonate type; secondary alkalinity (Hardness more than 50%), which reflects solubility of calcium ion from Al-Dammam formation by the groundwater. While the other samples fall in class (g) which represents alkaline water with prevailing Sulfate and Chloride. Cations (Na, Ca, Mg and K) they have an average values 908ppm,742ppm,238ppm and 29.5ppm respectively, while the anion are (Cl, SO_4 and HCO_3) with un average values 1709ppm, 1994ppm and 128.5ppm.Sodium chloride; primary salinity; secondary alkalinity, the hydrochemistry reflects the image of rocks; limestone and dolomite in addition to mainly gypsum and halite. Marshes water have high values from major cations and anions. Which mean that the main water source in the marshes are from the groundwater.

Table 6:Major Cations, Anions data of water samples in the studied area.

Type of water	E	N	Na ppm	K ppm	Ca ppm	Mg ppm	SO_4 ppm	HCO_3 ppm	Cl ppm	CO_3 ppm
FLC 1	428590	3527199	780	18	390	134	1590	39	1090	0

FLC 2	417268	3544415	650	2.9	480	122	1532	122	949	2
FLC 3	416204	3542895	685	10	250	116	1123	49	979	0
CE 1	439889	3533899	411	9.8	270	67	860	116	600	7
CE 2	444369	3534297	171	2	150	67	510	146	249	2
SW 1	427425	3524875	308	12	210	69	756	67	449	6
SW 2	427119	3524406	321	7.9	210	166	789	164	657	6
SFW	426459	3525993	655	3.1	516	127	1538	126	955	2
MW1	425555	3538919	2000	78	2589	243	5090	110	4567	5
MW 2	420040	3542648	1660	70	623	214	2321	237	2456	6
MW 3	433775	3538298	2001	84	1221	852	4213	219	4460	6
Min	-	-	171	2	150	67	510	39	249	0
Max	-	-	2001	84	2589	852	5090	237	4567	7
Average	-	-	908	29	742	238	1994	128	1709	3.76

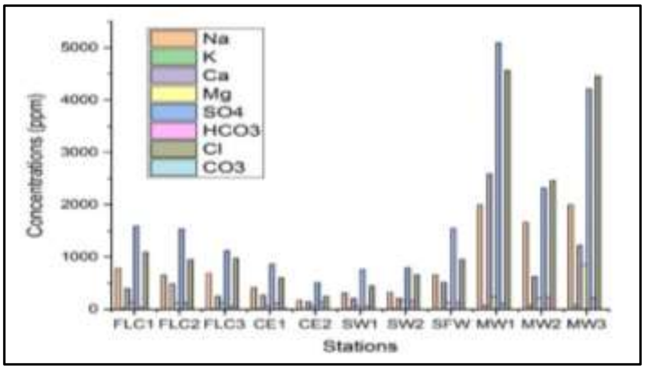

Fig.4. Major ions chart for the surface water within the studied area.

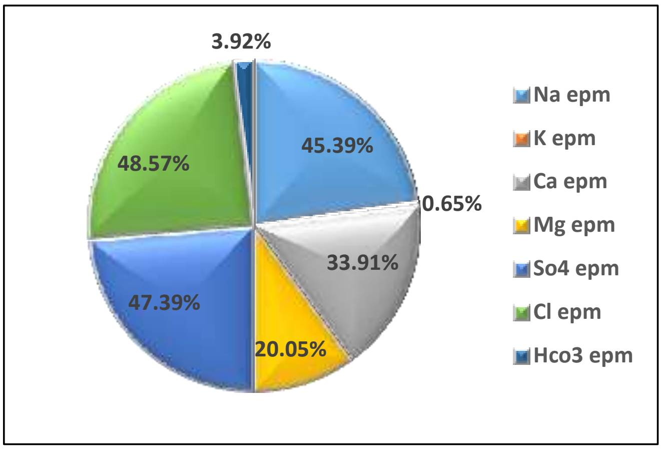

Fig.5. Pie diagram displays the average ionic constituents of water samples.

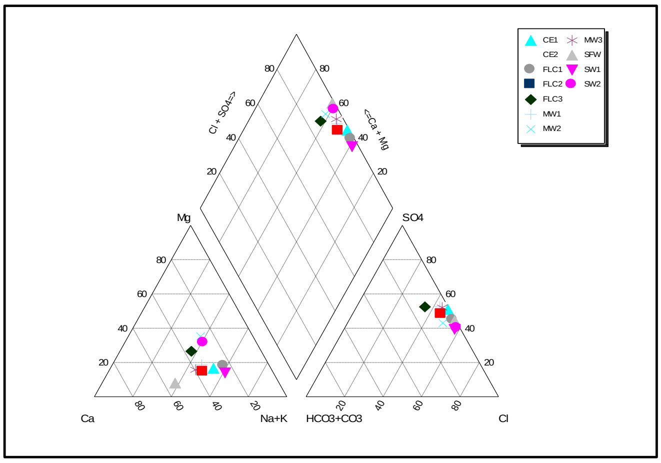

Fig.6. Piper diagram displays sources of water facies.

3.5. **Minor element**

Nitrate have been analyzed as a minor element, where it has represents very important element to waterquality and for the agriculture.In lakes and rivers, nitrate concentration associated with inorganic nitrogen, usually the enrichment in nitrate is due to enrichment of dissolve oxygen [32].The increase of nitrate concentrations in the sources of surface water may be due to the transformation of ammonia that produced by the fishinto nitrite by the nitrification process.

$$2NH_3 + 3O_2 \longrightarrow 2NO^-_2 + 2H^+ + 2H_2O \quad \ldots\ldots (2)$$

Therefore, the high concentrations were found in the creek of lakes(FLC1) and in the position of creek that come from the lakes, which it drops its waters in the marshes (MW2); (Fig.1). The concentration of nitrate for sources of surface water in the study area were ranged of 0.8-34ppm with an average 10.13ppm, (Table 7). Fig.7shows the ranges of Nitrate in the sources of surface water within the study area.

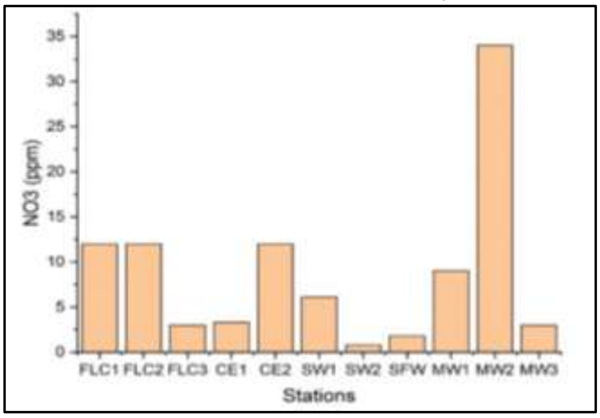

Fig.7. Chart of Nitrate values in the sources of surface water within the study area.

3.6. **Trace elements**

The values concentrations of trace element in water samples within study area are listed in (Table 7) and itsdiversityare exhibited in (Fig.8). Generally, manganese concentration as a water quality mast not exceed more than 0.1 mg/l [7] and [32]. The concentration of manganese in the surface water in the study area were ranged of (0.003-0.06ppm) with an average (0.024ppm).Cadmium is relatively rare in the geological deposits, it is occupying 0.0013 mg/l in the earth's crust, thus it is mainly exists as carbonate and hydroxide forms (Boyd, 2000).The concentrations of Cadmium range from (104 to 105 ppb) in most surface waters, while in seawater it has an average of 0.11ppb [6,7]. Concentration of Zinc ion usually is low due to the controlled minerals have low solubility within the pH range of most natural waters [31]. Zinc concentration in fresh water ranged between (0.2-100ppb) and in the seawater (0.2─48ppb) [22]. The concentration of zinc for the surface water in the study area were ranged of (0.09-0.19ppm) with an average (0.117ppm). Iron in water may come from dissolution of iron containing minerals, organic matter decay, and human activities and the iron concentration in the sea water it has an average of 0.01mg/l, while the average of iron concentration are 0.7 mg/l in the surface water [20]. Whoever, the USEPA (2012) and WHO (2011) they has recommended for drinking water standards for the Iron at 0.3 mg/l. The concentration of iron for the surface water in the study area were ranged of (0.11-0.31ppm) with an average (0.192ppm). Lead is a relatively common element in the earth’s crust. Freshwaters usually contain more lead than the oceans which has a residence time is approximately 100-200 years [12]. Seawater have an average Lead concentration of (0.03 ppb), (Boyd, 2000), while the rainwater have an average of (1ppb), [7]. The concentration of lead for the surface water in the study area were ranged of (0.001-0.02ppm) with an average (0.006ppm).

Table.7. Concentration of minor and trace elements in the surface water samples in (ppb).

Stations	NO3 (ppm)	Mn (ppb)	Cd (ppb)	Zn (ppb)	Fe (ppb)	Pb (ppb)
FLC1	12	BDL	0.03	0.11	0.15	0.002
FLC2	12	BDL	0.002	0.19	0.22	0.002
FLC3	3	BDL	BDL	0.12	0.11	0.02
CE1	3.3	0.06	BDL	0.09	0.31	0.002
CE2	12	0.014	0.002	0.1	0.2	BDL
SW1	6.1	0.01	BDL	0.1	0.31	BDL
SW2	0.8	0.02	BDL	0.09	0.11	BDL
SFW	1.8	0.003	0.004	0.12	0.13	0.009
MW1	9	0.02	0.03	0.1	0.3	0.002
MW2	34	0.01	0.02	0.12	0.12	0.001
MW3	3	0.04	0.002	0.11	0.12	0.009

BDL: Less than measurement

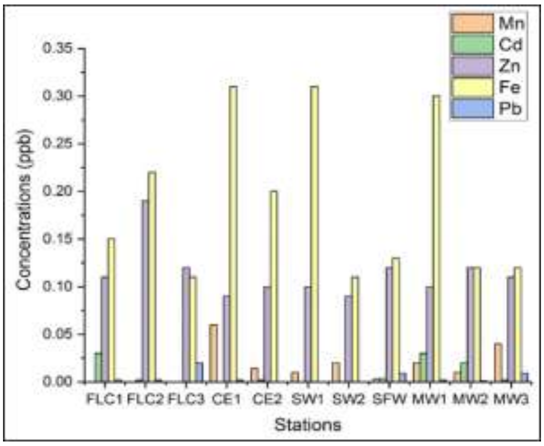

Fig.8. Chart of minor and trace elements values in the sources of surface water within the study area.

3.7. **Uses of water.**

The knowledge of water quality can provide an important insight into the nature of the resource that it is very important to uses for deferent purposes; where it will be used for drinking water, industrial and irrigation. In order to set criteria for quality of water, measurements of chemical, physical and biological properties must be done under standards methods [29].Many methods have been used in classification of water to evaluate the quality of water for all purposes. All these methods depend on absolute values (epm, epm %) for Cations and Anions.However, according to [7, 30], all surface water are not suitable for drinking water (Table 8).

Table 8. Water Samples with [7,30] the standards of Drinking Water

Parameter	**IQS 2009**	**WHO 2007**	**Water Samples**		**Exceeding limits**
			Range	Average	
TDS	1000	1000	1130-12690	4414.91	Exceed
PH	6.5-8.5	6.5-8.5	7.1-7.6	7.31	Not Exceed

TH	500	500	650 -7471	2374	Exceed
Ca	150	75	150-2589	628.10	Exceed
Mg	100	125	67-852	197.91	Exceed
Na	200	200	171-2001	876.54	Exceed
K	-	12	Feb-84	27.00	Exceed
Cl	350	250	249-4567	1582.8	Exceed
SO4	400	250	510-5090	639	Exceed
NO3	50	50	0.8-34	9	Not Exceed
Zn	3	3	0.09-0.19	0.1180	Not Exceed
Pb	0.01	0.01	0.0011-0.02	0.01	Not Exceed
Cd	0.003	0.003	0.002-0.03	0.013	Exceed
Fe	0.3	0.3	0.11-0.31	0.2	Not Exceed
Mn	0.01	0.01	0.003-0.06	0.022	Exceed

3.8. Surface water suitability for irrigation purposes

One of the earliest systems of classification of water for use in irrigation was given by Wilcox, (1955) which is based on electrical conductivity (EC), percent of sodium (% Na) and boron concentration (fig. 9).The classification has been achieved based on sodium adsorption (SAR), electrical conductivity (EC) and Na% [12], to assessment the water suitability for irrigation purpose. Thus, the sources of surface water in the study area are classified as a good to permissible water for irrigation except water of marshes.Water quality standards for livestock purposes depend on Altoviski (1962); They are variation from very good water type in the irrigation creeks to can be used in water of marshes (Table 9). Water quality standards for building purposes compared with Cations and Anions of water in the area, according to [13]. The sources of surface water were within permissible except marshes water.

Plants tolerance differs for total dissolved solids and electrical conductivity [31], (Table 11,12). Comparing groundwater with those standards (specifications), it is clear that the groundwater of the studied area is suitable for all kind of crops.

$$\%Na = \frac{Na^{+} + K^{+}}{Ca^{+2} + Mg^{+2} + Na^{+} + K^{+}} \times 100 \quad (3)$$

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{+2} + Mg^{+2}}{2}}} \quad (4)$$

Table 9.Classification of irrigation waters according to Don (1995)

EC µS\ cm	**TDS ppm**	**SAR**	**Na%**	**pH**	**Water Quality**
250	175	3	20	6.5	Excellent
250-750	175-525	3-5	20-40	6.5-6.8	Good
750-2000	525-1400	5-10	40-60	6.8-7.0	Permissible
2000-3000	1400-2100	10-15	60-80	7-8	Doubtful
>3000	>2100	>15	>80	>8	Unsuitable

Table 10. Values of (SAR & Na %) for wells in the studied area

Well No.	Na% ratio	SAR (meq/l)
FLC1	52.850	8.69
FLC2	45.34	6.86
FLC3	57.54	8.98
CE1	48.71	5.80
CE2	36.40	2.92
SW1	45.74	4.71
SW2	36.79	4.02
SFW	45.33	6.70
MW1	37.27	10.07
MW2	60.16	14.63
MW3	40.30	10.75

Continued use of water with high SAR value leads to a breakdown in the physical structure of the soil caused by excessive amounts of colloidally adsorbed sodium. The soil then becomes hard and compact when dry and increasingly impervious to water penetration. SAR in all samples ranged from 2.92 to 10.75 meq/l, as shown in Table 10. In this respect, the US salinity diagram (Fig. 9) which is based on the integrated effect of EC (salinity hazard), and SAR (alkalinity hazard), has been used to assess the water suitability for irrigation. When the analytical data of EC and SAR plotted on the US salinity diagram, it is illustrated that water samples of FLC3 fall in the class of C3-S1 indicating high salinity with low sodium water, which can be used for irrigation on almost all types of soil, with only a minimum risk of exchangeable sodium. This type of water can be suitable for plants having good salt tolerance but restricts its suitability for irrigation, especially in soils with restricted drainage, while water samples of FLC1 and CE1 fall in the class of C4-S3 and the rest fall in the class C4-S2 indicating very high salinity with medium to high sodium water, generally very high salinity water (C4) is not suitable for irrigation.

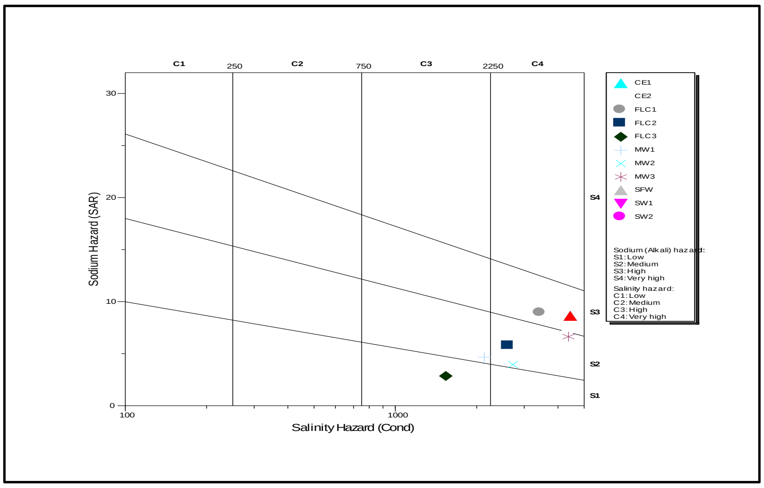

Fig 9. Classification of irrigation Water (After U.S. Salinity Laboratory Staff 1954)

Table 11. Relative tolerances of crops to salt concentrations [31]

Crops Division	Low salt tolerance crops Ec (μs /cm)	Medium salt tolerance crops Ec (μs /cm)	High salt tolerance crops Ec (μs /cm)
Fruit Crops	0 - 3000 Limon, Apricot, Orange, Apple. Pear, Peach.	3000 - 4000 Olive, Figs, Cantaloupe, Pomegranate.	4000- 10000 Date palm.
Vegetable Crops	3000 - 4000 Green beans, Celery, Radish.	4000 —10000 Cucumber, Onion, Carrot, potatoes. Lettuce Tomato, Cauliflower.	10000-12000 Spinach, beets

Field Crops	4000 - 6000 Fields beans	6000- 10000 Sunflower, Flax, Corn, Rice. Sorghum	10000- 16000 Cotton, Sugar beet, Barley(grains)

Table 12.Specifications of waters for Livestock consumption purposes [13].

Elements& Parameters	Very good Water	Good Water	Acceptable Water for use	Can be used	High limits
Na+	800	1500	2000	2500	4000
Ca+2	350	700	800	900	1000
Mg+2	150	350	500	600	700
Cl^-	900	2000	3000	4000	6000
SO^{-2}	1000	2500	3000	4000	6000
TDS	3000	5000	7000	10000	15000
T.H	1500	3200	4000	4700	54000
		Unit(ppm)			

4. Conclusions

- Five sources of waters, that form marshes of Bahar Al-Najaf and they representing sources of the surface water in the study area including marshes water. The amount of water that discharged to the marshes from these sources are 4.145 m^3/s daily, and can be increased or decreased. Except the water that come from the Wadies. Twice in the year,a large quantity of water is freed from the lakes of breeding fish to the marshes in case of marketingof fish, this occur in the Spring and Autumn season usually that mean excess in amount of discharging water. A huge amount of rainwater reach to the marshes across the Wadies, One or more times every four years that causes flooding in the marshes.
- Most of water samples is Calcium carbonate type; secondary alkalinity (Hardness more than 50%). While the other samples is alkaline water with prevailing Sulfate and Chloride which reflects the groundwater origin.
- Evaporation is very effective process in the marshes, where the Sodium Chloride was found deposited on the edges of the marshes after the dropsthe water level to more than 1 m during the summer.
- Allsources of water are not suitable for drinking water, while its classified as a good to permissible water for irrigation except water of marshes. Water quality standards for livestock is vary from very good water type in the irrigation streams to the can be used in a water marshes. Water quality standards for building purposes compared with Cations and Anions of water in the area; so, all water samples are within permissible except the marshes water.
- Many factors that effect on (quantity, quality and fluctuate of water level) in the marshes, the most important are:
  1- Amount of rainwater that come via the Wadies.
  2- Amount of water that release from lakes of fish.
  3- Ratio of evaporation from water of marshes.
  4- Amount of irrigation water that released from agriculture lands.

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