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Evaluation of Abu Zirig Marshwater quality for irrigation

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Abstract

This study aimed at assessing the quality of irrigation water sourced from Abu ZirigMarsh is located in east of al Nasiriyah city in southern Iraq from September 2019 to January 2020.The quality of the available water must be tested to check its fitness prior to use for irrigation.The collected samples were analyzed chemically, these chemical parameters are Ca^{2+}, Na^{+}, Mg^{2+}, K^{+}, Cl^{-},HCO_3, NiO_3^{-},SO_4^{2-}, TDS, TSS, pH, EC, turbidity, alkalinity, salinity, SAR,Na%,TH,Kelley ratio, boron concentration, MAR%andPIare important parameters in determining water quality for irrigation, since they are directly associated to the concentration of salt in water. Hence, high values of these parameters cause low water quality indices. It was found that nitrate; calcium, magnesium, sulfate and chloride are the most influential inputs on TDS while calcium, magnesium, sulfate and chloride are the most effective on EC. The results of the current study showed that the water of Abu Zirig marsh is unsuitable for irrigation under normal conditions, ituse only in the case of soils with highpermeability and good drainage and it is less dangerousfor crops that are very tolerant to salinity.
.**Keywords:**Abu Zirigmarsh,Irrigation, Unsuitable, Salinity, Irrigation Water quality

Introduction

The agriculture success is highly dependable on the quality of water applied in an agriculture area. Due to the application of poor or hazardous quality water the agriculture land/soil is affected and damages the crop yield in several ways. The accumulation of salts in root zone, limited the availability of water and plant can take up lesser water, which resulted in high plant stress, and decreased crop yields(Shakoor2015).The characteristics of water quality have become important in water resources planning, development for drinking, industrial, and irrigation purposes(Shakoor2015).The irrigation water quality and the associated hazards to soil characteristics and crop yield is often a complex phenomenon that involves the combined effect of many parameters. A water quality index provides a single number that expresses overall water quality at a certain location and time based on several water quality parameters.Although Water Quality Index (WQI) is usually orientated to qualify urban water supply, it has been widely used by environmental planning decision makers. The quality of the irrigation water has to be evaluated to avoid or, at least, to minimize influences on

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agriculture (Mohammed Muthanna 2011). The chemical constituents of irrigation water can effect plant growth directly through toxicity or deficiency, or indirectly by altering availability of nutrients(Ayers and Westcot1985). The presence of metals in irrigation water also has adverse effects on crop production. Also, high concentration of salts can change the plant nutrients balance in the soil meanwhile some salts are toxic to certain plants(Shakoor et al.2015; Irfan et al. 2014).Salinity, sodicity and ion toxicity are major problems in irrigation waters. In aridareas, where rainfall does not adequately leach salts from the soil, an accumulationof salts will occur in the crop's root-zone. Thus, periodic testing of soils and waters isrequired to monitor any change in salt content. Sodicity, the presence of excesssodium, will result in a deterioration of the soil structure, thereby reducing waterpenetration into and through the soil. Toxicity refers to the critical concentration ofsome salts such as chloride, boron, sodium and some trace elements, above whichplant those salts adversely affect growth(Shahid2004).In This paper addresses measurement several parameters for determination for Abu Zirig marsh of irrigation water quality.

Materials and methodology

Description of study area

The Abu Zirig Marsh is a natural depression surrounded by manmade dykes, constructed in 1920, to confine the water within the depression. The marsh is located south and southeast of al Islah town, north to northeast of al Fuhud town, and about 30 km east of al NasiriyahCity(figure 1) at a location of latitude 31°09′54.9″ N, longitude 46°36′33″ E.The main source of water to the marsh is through Shatt Abu Lihia (a lower branch of al Gharraf River). The Abu Lihia channel continues running until it disappears in the Central Marshes of al Qurna. Abu Zirig marsh is about 3% of all marshes area and was included in the dryness processes of 1991. The marsh is divided into two parts separated by a road; the first is the upper zone includes the northwest part, and the other zone is the lower part, contain several pipe culverts and irregular openings hydraulically connect the two parts(Alwash et al2005).Highlighting the vitalityrole of Abu-Ziriq marsh in sustaining the daily life of the local residents. The success of the modelsused in this study gives the possibility to be used in the rest of the marsh, which means reducing thecost and time of water quality monitoring.

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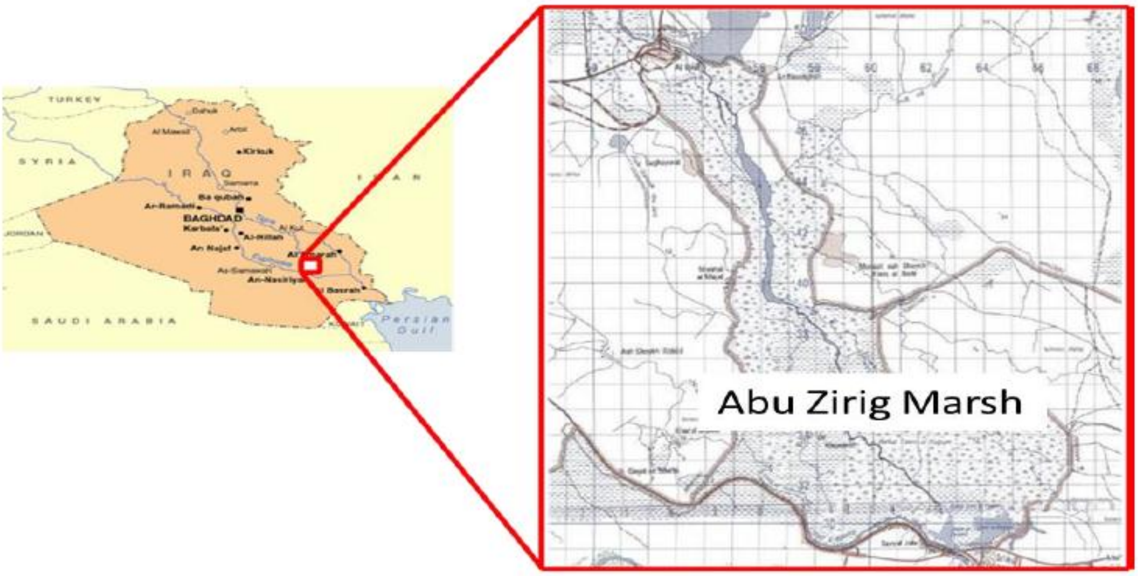

Figure 1.Location of Abu Zirig marsh(Al-Mukhtar and Al-Yaseen2019**)**

Study area

Three stations were selected alongthe Abu Zirig marsh. Sampling points were collectedusing geographical positioning system (GPS) the N 59.88 9 32, E 44.84 450 22 (station 1); N 58.31 320 13 E 59.86 450 28 (station 2); N 46.82 320 13 E 14.94450 13 (station 3).

Collections of samples

Collection of Water: Representative water samples (*n*=40) of about 1 liter werecollected from the sampling sites in polypropylene 500ml cleaned bottles. At thesampling time, these bottles were also washed with the respective river water. Thesamples were collected below the surface about 2-3 feet away from the river banks insuch a way that no bubbles were allowed. These water samples were filtered andpreserved in 5 ml of 55% HNO_3 per liter of water to prevent metal adsorption on theinner surface of the container and stored at 4°C before their analyses(Khan et al. 2018).

Analysis of samples

PH and electrical conductivity were measured at the time of sample collection. PH was measured in the Portable pH-meter field, the type HANNA (MX-645), and conductivity with conductivity meter, type (WTW cond 330i/SET). An integrated thermometer in the measurement of conductivity and pH-meter measured the temperature. Surface water samples were collected in the study stations from the upper 30 cm and 2-4 m from the riverbank. Two liter polyethylene bottles were used, each was pre-washed by riverwater, soap solution, distilled water and 1% nitric acid(American Public Health Association 1915).

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Irrigation Water Quality Calculated Parameters

Physicochemical Parametersinclude; concentration of cations such as Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Sodium (Na^{+}), Potassium (K^{+}) and concentration of anions such as Chloride (Cl^{-}), Sulfate (SO_4^{2-}), Nitrate (NO_3^{-}) and Bicarbonate (HCO_3). Temperature, pH, Electrical Conductivity(EC), Total Dissolved Solid (TDS), Total suspended solids (TSS), Sodium Adsorption Ratio (SAR), Sodium Percentage (Na%),Total Alkalinity, Salinity, Turbidity, Total Hardness (TH), Boron (B), Kelley Ratio (KR),Magnesium Adsorption Ratio (MAR%)and Permeability Index (PI) were estimated using the equations as shown in Table 1. The results from the various calculations were compared with values for each of the methods as established by FAO standard guidelines and the American Salinity Laboratory.

Results and discussion

The concentration of important cations of the irrigation water is presented as in Table 1.

Calcium content

The results of the study showed that the highest value of calcium ion in the waters of Abu Zirig marsh was 146 mg/L in the second station during September monthand the lowest value was recordedin September in the first station, as it was 121 mg/L. The reason for the increase in calcium concentration during September is due to the impact of dust storms calcium carbonate is the main component of soil particles, by means of which(Sullivan et al. 2007).The low values are calcium for the month of January as a result of consumption from organisms or its deposition when forming insoluble compounds in the water also the relatively higher concentration of the calcium cations can be linked with the existence of the calcium bicarbonate in the river(American Public Health Association 1915).

Magnesium content

The concentration of magnesium in water plays apivotal role in deciding the quality of water for irrigation purposes, therefore, agricultural use(Sappaand Ferranti2014). Generally, calcium and magnesium maintain a state of equilibrium in most waters. More magnesium in water will adversely affect crop yields as the soils become more alkaline. In the present study, the magnesium content of the water of Abu Zirigmarsh from 85mg/L to 117mg/L. Magnesium as a result of erosion from neighboring soils or its outflow from factories, sewers, ortrenchesor maybe it was due to the number of wanders. The results showed that the concentration of magnesium ions was not within the permissible limits for theirrigation water. According to what was stated in the World Food and Agriculture Organization in1985, whenthis organization warned using irrigation water contains more than60mg/L of ion magnesium(Ayers and Westcot1985).

Sodium Content

The results of the study in showed that the highest value of the sodium ion appeared in the second station during the month of September 844 mg/L, and the lowest value was recordedin September in the first station, as it was 568 mg/L. The high sodium values are due to the flow of drainage water from agricultural lands adjacent to Abu Zirig marsh. In which chemical fertilizers, soil leaching processes and geological formations are used.Sodium toxicity is modified or reduced if sufficient calcium is available in the soil. The factor of Na could cause many problems to the crop, such as formatting crusting the beds of seed, temporal saturation of soil surface soil corrosion and insufficient nutrient obtainability. There are more factors related to these problems such as the rate of salinity and soil type (Maia and Rodrigues2012). .***PotassiumContent***As potassium is an essential nutrient for plants and the area around the river is mainly agricultural land, the high values in this ion will probably cannot be as a problem(Al-Saady, and Abdullah 2014).Theresults of the study showed that the highest value of potassium ion was recorded in the second station354mg/L during the month of Septemberwhile the lowestvalue was in the firststation during the month of January;it was 88mg/L. The reason for the high calcium concentration in Abu Zirig marsh water is due to theagriculturaldrainage water as for the valueslow potassium ions in water were recordedduringthemonth of January, and this may be due to the fact that the nutrient water the river in this month does not contain high concentrations of this element in addition to the difficulty of its release from rocks the container for him.

.**Table1. Concentration of cations in the Abu Zirig mars**

Parameters	**September**			**January**		
	Station $_1$	**Station $_2$**	**Station $_3$**	**Station $_1$**	**Station $_2$**	**Station $_3$**
Ca^{2+} mg/ L	125	146	136	123	130	129
Ma^{2+} mg/ L	87	117	93	82	89	98
Na^{+} mg/ L	625	844	732	568	656	632
K^{+} mg/ L	233	354	212	88	121	125

The concentration of important anions of the irrigation water is presented as in Table 2.

Chloride content

Chloride is considered as the most common toxic ion in irrigation water. Since, chlorideis not adsorbed by the soil colloids, therefore, it travels easily with soil water, is absorbed by the crop(Ayers and Westcot1985).The results of the current study in (Table 2) showed that the highest value of chloride ionin the waters of Abu Zirig marsh was recorded at the stationthe second was 932 mg/Lin September,and the lowest value was shown in the first station in January.As it reached571 mg/L. We notice an increase in the concentration of chloride ionduring the month ofSeptember due tothe higher temperaturesand increased evaporation processes as well as the flow of salts loaded with chloride from neighboring agricultural and especially the sodiumchloride salt, which is present in large quantities in the lands surrounding Abu Zirig marsh, and thus an increase the chloride ion in water. As for the decrease in the chloride ionconcentration during January, it is due to lower degreesheat and low evaporation rates.The results were shownchloride concentration > 350 mgL^{-1}(Hopkins 2007)causes severeproblem in the crops is the higher of permissible limit for irrigation than the FAO standard(Adhikary2014).

Nitrite Content

The nitrate ion values ranged between 4.11mg/L during the month of September as amaximum in the waters of Abu Zirig marsh insecond station and 0.98mg/L in the first stationduring the month of January as a minimum. The nitrate ion during the month of September may be dueto increased evaporation due to higher temperatures, which causes an increasedissolved salts and increased organic decomposition.

Sulfate Content

The results of the study showed that the highest values of the sulfate ion in the waters of the Abu Zirig marsh were recorded in the second station in September, it reached1126mg/L, while the lowest value was recorded in the first station in a month in January, It was 848mg/L. High sulfate values were observed in the waters of theAbu Zirig marsh during the month of January, which is attributed to the gypsum nature of sedimentary soils, which is a directsource of dissolved sulfatesnaturalwaters(Ayers and Westcot1985), which may be attributed to the influx of water with a high content of sulfate salts during thismonth. It led to anincrease in the sulfate ionin the water or perhaps due to the decomposition of organic matter, which led to an increase in the sulfate ion concentration, or it maybe attributed to the flow of agricultural wastewatercontaining sulfates as a result of use fertilizers in agriculture, especially wheat and barley cultivation, during this month, as for the low ionconcentration the sulfate in the September hair is due to the low concentration of dissolved oxygen inthe water during this month that leads to sulfate reduction. These values in all stations show the concentrationof sulfate is the higher of permissible limit for irrigation.

.***Bicarbonate Content***

The bicarbonate (HCO_3) values influence the irrigation systems operation and production quality. The long-term use of irrigation water with high bicarbonate values can determine clogging issues in irrigation systems (emitters, sprinkler nozzles, pipes), calcite or lime deposition in the soil, and reduction of production quality due to its whitish deposition on leaves and/or fruits impacted by irrigation water droplets. Irrigation water with high HCO_3content may contribute to iron chlorosis(Bortolini 2018). The resultsof the study in (Table 2) showed that the highest values of the bicarbonate ion in the waters of the Abu Zirig marsh were recorded in the second station in September, it reached 794mg/L(>500,unsuitable for irrigation), while the lowest value was recorded in the first station in a month in January, it was 315mg/L(90–500), it is includedpermissible limit for irrigation than the FAO).Waters high in bicarbonates will tend to precipitate$CaCO_3$ and $MgCO_3$, when the solution becomesconcentrated through evapotranspiration. This means that the SAR value will increase, and the relative proportion of sodium ions will become greater. This situation in turn will increase the sodium hazard of the soil-water to a levelgreater than indicated by the SAR value.

Table 2. Anion concentration in the Abu Zirig marsh

Parameters	**September**			**January**		
	Station $_1$	**Station $_2$**	**Station $_3$**	**Station $_1$**	**Station $_2$**	**Station $_3$**
Cl^- mg/ L	754	932	822	571	728	606
NO_3^- mg/ L	3.43	4.11	3.60	0.98	1.68	1.42
SO_4^{2-} mg/ L	885	1126	957	848	933	1076
HCO_3^- mg/L	563	794	488	315	442	683

Temperature

Temperature is one of the most important environmental factors because it affectsthe presence of organisms in the aquatic environment as well as their effect on physicaland chemical properties in water(Ahipathy andPuttaiah 2006).The lowest air temperature values of 18°C wererecorded at the first station in January, while the highest values at second station were 35°C inSeptember, while the water temperature recorded the lowest value of 13°Cat the firststationin January, while the highest values at second station of 29°C in September, thefluctuation in water temperature of the river depends on the separation, geographicallocation, sampling time and the degree of flow into the river(Ahipathy andPuttaiah 2006).

PH

The parameter pH is the negative logarithm of hydrogen ionactivity. The pH scale ranges from 0 to 14. If pH is less than 7 it isconsidered as acidic in nature, greater than 7 is alkaline and pH of 7 istreated as neutral. Therefore, pH is a measure of acidity or alkalinity ofwater. The principal use of pH is quick evaluation of the possibility ofwater being normal or abnormal. The normal range of irrigation wateris from pH 6.5 to 8.4(Ayers and Westcot1985).Irrigation water pH is a parameter that should be monitoredfrequently proposed

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using pH as the indicatorparameter to assess recycled irrigation water quality because it is easy to access and has a strong correlation with other water chemicalcharacteristics. As is well- known, too high or too low pH values in irrigation water indicate the presence of organicand/or inorganic pollutants.As the pH of the irrigation water increases above 8.2, thepotential for sodium problems enhances(Hopkins 2007).The higher pH ofgroundwater may be due to considerable sodium, calcium, magnesium, carbonate and bicarbonate concentration as carbonatesand bicarbonates are hydroxyl generating ions(Al-Tabbal and Al-Zboon2007; Bhat 2014).The results showed that the highest pH value of the water of Abu Zirig marsh at the secondstation amounted to8.33 in September, while thelowest value in the first station forthe month of January, which amounted to7.02. This increase in the value ofpH to the lowtemperature and low concentration of the second Carbon dioxide, highdissolved oxygen values andbase ions(Wilson2003) while their decrease is due to hightemperature, low dissolved oxygenvalues, organic matter degradation and carbondioxide release(Abdul-Zahra et al. 2001).It was found that the values of the degree of reaction of Abu Zirig marsh water fall within the permissible limits(6.5-7 and 8-8.5) for irrigation water according to the World Food and AgricultureOrganization, 1985.

Table3.PH valuesfor the Abu Zirig marsh

Parameter	September			January		
	Station $_1$	Station $_2$	Station $_3$	Station $_1$	Station $_2$	Station $_3$
pH	7.66	8.33	7.18	7.02	7.88	8.10

Electrical conductivity

The results showed that the highest value of electrical conductivity at the third station was16112 µs/cm during September, while the lowest electrical conductivityrecorded at the firststation was 5997 µs/cm in January. The rise in the month ofSeptember due to the impact of severe dust storms and increase the rates of dry fall tothe surface water sources and increase theconcentrations of salts, especially calciumsalts and chlorides(Goddard et al 2009), which led to an increasein the rates of EC, which increases theincrease of TDS concentrations(SA Health2008, Aboud 2010). The valueof electrical conductivity decreased duringJanuary, due to the increase in water levelsand precipitation in that period, as itreduces the amount of soluble salts relativeto the volumeof water, as well as theamount of salts added by the erosion of soilcaused by the fallof rain(Al-Safi and Al-Mousawi 2012).

Total dissolved salts (TDS)

Water used for irrigation can vary greatly in quality depending upon type and quantity of dissolved salts. Salts are present in irrigation water in relatively small but significant amounts. They originate from dissolution or weathering of the rocks and soil, including dissolution of lime, gypsum and other slowly dissolved soil minerals. These salts are carried with the water to wherever it is used. In the case of irrigation, the salts are applied with the water and remain behind in the soil as water evaporates or is used by the crop (Al-Hassen et.al.2019). The study showed that the highest value of total dissolved solids were recorded in the second station, as it was 3067mg/L during the month of September, while the lowest value was recorded during the month of January in the first station, which was 1533mg/L.The increase in the values during themonth ofSeptember is attributed to the low water levels and the high cases of evaporationof water and the addition of calcium and magnesium. The reason for the decrease intotal dissolved solids in the water during the month of January is due todilution(Reddy et al. 2020).

Table 4.The values of the EC and the TDS of Abu Zirig marsh water

Parameters	**September**			**January**		
	Station $_1$	**Station $_2$**	**Station $_3$**	**Station $_1$**	**Station $_2$**	**Station $_3$**
EC µs/cm	9620	16112	11397	5997	10145	8580
TDS mg/ L	2585	3067	2670	1533	1811	2312

The study of the validity of Abu Zerk water for irrigation relied on the classification of irrigation water according to the American Salinity Laboratory(Al-Rawi1994),which relies on two factors to evaluate the irrigation water, which are the salinity factor and sodicity factorit is based on measuringboth the concentration of total soluble solids and the electrical conductivity for the salinity measurement and it is based SAR for the sodicity factor measurement.

Table 5.Classification of irrigation water with respect to salinity hazards according to the American Salinity Laboratory(Al-Rawi1994)

Classify irrigation water	**Classify**	**EC (µs/cm)**	**TDS (mg / L)**	**Specifications**
Low saline water	C_1	< 250	< 200	Water suitable for irrigation of all crops and in various soils
Water of medium salinity	C_2	250-750	200-500	Water suitable for irrigation of most medium tolerant crops
High salinity water	C_3	750-2250	500-1500	This water is used only with a network of efficient drainage and for highly tolerant salt crops
Very high salinity	C_4	2250-5000	1500-3000	Water that is not suitable for

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water	irrigation under normal conditions and can only be used in the case of soils with high permeability and good drainage and for crops that are very tolerant to salinity

When comparing the results of electrical conductivity and the amount of total dissolved salts with table (5) and (FAO,1985) we find that the specifications of Abu Zirig marsh water used for irrigation are classify (C_4) of the type is unsuitable purposes irrigation. Because the values of electrical conductivity and the amount of total dissolved salts are bypass permissible limits, under normal conditions and can use it only in the case of soils with high permeability and good drainage and for crops that are very tolerant to salinity.

Total suspended solids (TSS)

Total suspended solids (TSS) are the fine particles consisted of microorganisms, algae,mineral particles and organic matter, suspended in water. Total suspended solid is an indicator of erosion and sediment transport and it absorbs heat energy from sun resulted inwater temperature increase and consequently, decrease the level of dissolved oxygen as we know warmer water holds less oxygen than cooler water. The total value of suspended matterobtained from equal to all cooled mine solids was 395.063 mg/L, While the lowest value was recorded for it, as it reached278.956mg/L during the month of January, meaning that itincreased in September and decreased in January due to high water levels and their impactby by the mitigation factor (Hassan 2004).The results were considered irrigation water TSS is not in the optimal range (200-400mg/L).

Table 6. The values of the total suspended solids (TSS) of Abu Zirig marsh water

Parameter	**September**			**January**		
	Station $_1$	**Station $_2$**	**Station $_3$**	**Station $_1$**	**Station $_2$**	**Station $_3$**
TSS mg/ L	280.135	395.063	313.789	278.956	310.376	295.465

Sodium Adsorption Ratio (SAR)

Sodium adsorption ratio (SAR) is the effective factor or parameterused for ascertaining the suitability of water for irrigationpurposes. Based on SAR values, irrigation water is classified intodifferent classes (Table 8), which indicates that SAR value between 0-10, i.e., lowsodium water poses almost no risk of exchangeable sodium, mediumsodium water having SAR 10-18 can show considerable hazard, whileon the contrary, high and very-high sodium water with SAR 18-26 andgreater than 26, respectively are regarded as unfavorable as they canlead to detrimental levels of exchangeablesodium in soils(Toumi et al. 2015).The SARfor soil solution is increased with the increase in SAR of irrigation water, which eventually increases the exchangeable sodium of the soil(Ayers and Westcot1985,Isaac et al. 2009). Sodium replacing adsorbed calcium and magnesium is a hazard as it causes damage to the soil structure. It becomes compact and impervious. The results of the study showed the highest percentageof sodium adsorption in Abu Zirig water recorded at the second station73.603 mg/L during the month of September, while the lowest value was recorded in the first station during the month of January, which it was 55.966 mg/L. High sodium adsorption ratio due to relationshipbetween the sodium adsorption percentage and the sodium ion concentration is positive.

Sodium Adsorption Ratio (SAR) can be calculated as follow(Richards1954, Abdullah2018):

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

Criteria: <10, excellent,10– 18 good, 18– 26 doubtful, > 26 unsuitable.

Table 7.The values of the Sodium Adsorption Ratio (SAR)of Abu Zirig marsh water

Parameter	September			January		
	Station $_1$	Station $_2$	Station $_3$	Station $_1$	Station $_2$	Station $_3$
SAR mg/ L	60.703	73.603	68.411	55.966	62.691	59.320

Table 8. The water classification according to the SAR American Classification(Fipps 2003)

no.	SAR value	Classify irrigation water	Specifications
1	0 < SAR ≤ 10	Low sodium water	It can be used to irrigate most of the soil with a note showing a few harmful sodium levels.
2	10 < SAR ≤ 18	Medium sodium water	It is possible to cause sodium risk in soft soils where there are few conditions of washing and can be used in rough soil with high permeability.
3	18 < SAR ≤ 26	High sodium water	May result in sodium risk and need special soil management.
4	26 < SAR	Very High sodium water	It is usually not suitable for irrigation purposes.

Whenthe comparison between SAR values and theclassification of the American SalinityLaboratory (Table 8), which showed that Abu Zirig marsh water in all stations is of the type unsuitable for irrigation under natural conditions in the case of soils with high permeability and drainage and for crops very high tolerance to salinity (very High sodium water).

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Sodium Percentage (Na%)

Sodium percent is another important factor to study sodium hazard. It is calculated as thepercentage of sodium and potassium against all cationic concentration(Bhandari and Joshi, 2013). It is also used for adjudging the quality of water for the use of agricultural purpose. The use of high percentage sodium water for irrigation purpose stunts the plant growth. Sodium reacts with soil to reduce its permeability (Nagarajuet al. 2006).Sodium percent in water is a parameter computed to evaluate thesuitability for irrigation. The finer the soil texture and the greater the organic matter content, the greater the impact of sodium on water infiltration and aeration. The high sodium percent value of Abu Zirig marsh was recorded in the second station 81.999% in September, while the lowest value was recorded in the first station 76.102% in January month. The results of calculated indices for the studied areas as shown in Table 9, it can be doubtful and unsuitable Water with high percent of Na % may cause sodium accumulation in the soil profile and affect the physical properties of soil(Regional Salinity Laboratory1954).Gypsum can be added to the soil to reduce the effect of high percentage of sodium in irrigation water.

Sodium content (Na%) is determined by the following equation(Todd and Larry 2005).

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

Criteria: <20 excellent, 20–40 good, 40–60 permissible, 60–80 doubtful,and>80unsuitable.

Table 9.The values of the Sodium Percentage (Na%) of Abu Zirig marsh water

Parameter	September			January		
	Station $_1$	Station $_2$	Station $_3$	Station $_1$	Station $_2$	Station $_3$
(Na%)	80.187	81.999	80.477	76.190	78.012	76.931

Total Hardness (TH)

It is a group of salts consisting of carbonates, bicarbonate, chlorides, nitrates, magnesium and calcium, all of which are the main source of hardness. The results of the current study showed the highest value of total hardness recorded in the second station during September, it was 843.24mg/Land the lowest value was recorded in the firststation 642.47mg/Lduring January.The increase in the harshness values duringSeptember is due to increased decomposition of organic residues, increased evaporation and a decrease precipitation that led to an increase in salts.Irrigation criterion (TH) more than 300 very hard for irrigation.Total Hardness is determined by the following equation(Aghazadeh andMogaddam2010).

TH ($CaCO_3$) mg/L = 2.49(Ca^{2+}) mg/L + 4.1(Mg^{2+}) mg/L Criteria:<75 soft,75–150 moderate, 150 – 300 good, >300 very hard

Table 10. The values of the Total Hardness (TH)of Abu Zirig marsh water

Parameter	September			January		
	Station $_1$	Station $_2$	Station $_3$	Station $_1$	Station $_2$	Station $_3$
TH	667.95	843.24	834.74	642.47	688.60	723.01

Total alkalinity

The ability of water to neutralize the added acids is known as alkalinity, the mostimportant factor determining root media pH. Over the time, the water having high alkalinity adversely affects the pH. Alkalinity can assessed with themeasure level of calcium bicarbonate or calcium carbonate. In the present study, the highest alkalinity value was recorded in the second station during the month of September, and it was 264.583 mg/L, while the lowest value it was recorded in the first station during January and it was 204.113mg/L. The values are high in water base,it may be attribute to higher temperatures, increased decomposition rates of organic matter, and then increased carbonate conversioncalcium insoluble to bicarbonate.

Table 11. The values of the total alkalinity of Abu Zirig marsh water

Parameter	September			January		
	Station $_1$	**Station $_2$**	**Station $_3$**	**Station $_1$**	**Station $_2$**	**Station $_3$**
Alkalinity mg/ L	214.677	264.583	221.805	204.113	216.243	211.338

Turbidity

The amount of cloudiness in the water is known as turbidity, which is caused,by dissolved or total suspended solids and most of the time those are invisible to the naked eye as smoke in air. It is important parameter to measure for water quality. I.e. Silt, sand and mud; bacteria and germs can cause turbidity; chemical precipitates**.** The turbidity is measured in Nephelometric Turbidity Units defined by USEnvironmental Monitoring Standard unit. Turbidity is the values of light absorbingor light scattering property of water.The current study showedthat the highest values of water turbidity was recorded in the second station during the month of September, as they reached 145.325 NTU, while the lowest value was recorded in the first station in January, when it was 8.226 NTU. The reason for the high turbidity during the month of September is due to the various human activities in the stations such as the movement of boats Grazing of buffalo, reed monster and other activities that lead to mixingof water and stirring up suspended substances causing it a clear increase in turbidity.

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Table 12. The values of the turbidity of Abu Zirig marsh water

Parameter	September			January		
	Station $_1$	Station $_2$	Station $_3$	Station $_1$	Station $_2$	Station $_3$
Turbidity NTU	102.112	145.325	128.423	8.226	10.110	8.471

Salinity

There are many types of factors that increase salinity in irrigation water such asevaporation, sewage effluent, agricultural drainage, evaporate bedrock, and dissolution of limestone. The salinity of water irrigation leads to accumulation of salt in root zone of crop, thus reducing ability of plant to get sufficient water from the soil and causes yield reduction(Al-Shujairi2013).The results were indicated that the highest values of salinity were recorded during the month of September, reaching 10.312g/L in the second station and its lowest value in the firststation during the month of January, which recorded 3.838 g/L. High salinity values for the month ofSeptember due to high temperature and increased evaporation rate as well as theresult of the enclosure the marsh with agricultural lands contributes to raising the salinity ratio whenwashing the soil with watering. The trocars that pour into itplays a major role inincreasing the salinity, and the waters of Abu Zirig marsh were classified as salinity water.As for the lowersalinity during January, it will return to mitigation due to rain.**Table 13. The values of the salinity of Abu Zirig marsh water**

Parameters	September			January		
	Station $_1$	Station $_2$	Station $_3$	Station $_1$	Station $_2$	Station $_3$
Salinity g/L	6.157	10.312	7.294	3.838	6.493	5.419

Boron concentration

Boron is an essential element to the plants, but the amount required is low. However, where present in excessive amounts, it is extremely toxic, In order to sustain an adequate supply of boron to the plant at least 0.02ppm of boronin the irrigation water may be required. However, to avoid toxicity, boron levels inirrigation water should, ideallybe lower than 0.3ppm. Higher concentrations ofboron will likely require that the intended crop type must first be evaluated withrespect to its boron tolerance. Although boron toxicity is not a problem in most areas,it can be an important irrigation water quality parameter. Interestingly, plants grownin soils high in lime may tolerate higher levels of boron than those grown innon-calcareous soils.Boron levels that have developed in the soil water (saturation extract of soils) through irrigation can have a range of effects on crop yields. Wilcox (1960)presented three classes of crops with regard to boron toxicity: tolerant (2-4ppm), semi-tolerant (1-2ppm), and sensitive (0.3-1ppm). Fruit crops are among the mostboron sensitive, and yields of citrus and some stone fruit species are decreased byboron even at soil solution concentrations less than 0.5ppm(Ayers and Westcot1985,Bauder et al.2011). In the present study was founded thehighest boron concentration in the second stationduring September, it was1.886mg/L, and the lowest value was recorded in the first station 0.344mg/L during January.

Table 14. The values of the boron concentration of Abu Zirig marsh water

Parameter	**September**			**January**		
	Station $_1$	Station $_2$	Station $_3$	Station $_1$	Station $_2$	Station $_3$
Boron mg/ L	1.463	1.886	0.715	0.344	0.523	0.609

Magnesium adsorption ratio (MAR)

The magnesium content is considered one of the most importantindicators to assess water quality for irrigation. At high concentrationsof magnesium, crops are harmfully affected as the soil becomes more saline(Rengasamy 2006). Harmful effects on soils are expected when water MAR values are larger than 50(Ayers and Westcot1985). Broadly speaking, in groundwater alkaline earth metals are in stateof equilibrium. Since, magnesium is an essential nutrient for plantgrowth and its deficiency causes yellowing and reduction in growthand yield of crops. The concentration of magnesium in water plays apivotal role in deciding the quality of water for irrigation purposes,therefore, agricultural use(Sappa and Ferranti2014). Magnesium percent is very important for the effects on plant growth. When this percent less than 50% then none of important on the plant growth, but it is dangerous when this percent more than 50%.

Magnesium hazard of water forirrigation is calculated by the formula(Raghunath 1987).

$$MAR(\%) = \frac{Mg^{2+}}{Ca^{2+} + Mg^{2+}} \times 100$$

Criteria: <50 suitable, >50 unsuitable.

Table 15. The values of the magnesium adsorption ratio of Abu Zirig marsh water

Parameter	**September**			**January**		
	Station $_1$	Station $_2$	Station $_3$	Station $_1$	Station $_2$	Station $_3$
MAR (%)	41.038	44.487	40.611	40.000	40.639	43.172

Kelley ratio (KR)

This ratio is based on the premise that as the concentration of Naincreases, Na^+ tends to replace Ca^{2+}. Continued irrigation and rainleach out the replaced $Ca^{2+}$with the resulting dispersion of the soil, where Ca^{2+} plays a significant role in the mineral nutrition of plants.Likewise, the uptake of K^+ is stimulated, while the absorption of $Na^+$is repressed, by Ca^{2+}, even when the concentration of Ca^{2+} is very low(Kelley 1963).The resultswere shown the highest Kelley ratio in the second stationduring September, it was3.209 mg/L, and thelowest value was recorded in the first station 2.770mg/L during January. According to (Kelley1963) all samples from the cropland wereunsuitablefor irrigation.

Kelley ratio (KR)calculated by the following equation(Kelley1963).

$$KR = \frac{Na^{+}}{Ca^{2+} + Mg^{2+}}$$

Criteria: <1 suitable, >1 unsuitable

Table 12.The values of the Kelley ratio (KR)of Abu Zirig marsh water

Parameter	September			January		
	Station $_1$	Station $_2$	Station $_3$	Station $_1$	Station $_2$	Station $_3$
KR mg/L	2.948	3.209	3.197	2.770	2.995	2.784

Permeability Index (PI)

The soil permeability is affected by long term use of irrigation water. Sodium, calcium, magnesium and bicarbonate content of the soil influence it. Doneen evolved a criterion for assessing the suitability of water for irrigation based on the permeability index.PI is greatly influenced by HCO_3^-, Na^+, Mg^{2+} and Ca^{2+}. The PI values were computed and classified using Doneen (1964) and Raghunath (1987) methods(Doneen1964,Raghunath 1987). Accordingly, for the methods waters can be classified as class I, Class II and Class III orders. Class I is excellent if the value is less than 25 and Class II is good if the value is from 25 to 75, and Class III waterareunsuitable for irrigation when the value is more than 75. In the present study was founded the maximum value of P.I. is 78.788 and the minimum value of P.I. is75.776and thus the water is classified as unsuitable for irrigation.

Permeability Index (PI) calculated by the following equation(Doneen1964):

$$\mathbf{PI} = \frac{Na^{+} + \sqrt{(HCO_3^{-})}}{Na^{+} + Ca^{2+} + Mg^{2+}} \times 100$$

Criteria: <25 excellent, 25 – 75 good,and >75 unsuitable.

Table 15. The values of the Permeability Index (PI)of Abu Zirig marsh water

Parameter	September			January		
	Station $_1$	Station $_2$	Station $_3$	Station $_1$	Station $_2$	Station $_3$
PI	77.506	78.788	78.469	75.776	77.198	76.616

Conclusions

In the present study, according to physicochemical parameters for irrigation water quality are most of the parameters measured were outside the normal range when compared with standard measurements of the Food and Agriculture Organization and the American Salinity Laboratory, therefore the water of the Abu Zirig marsh unsuitable for irrigation in the circumstances usual, except for crops with high tolerance to salinity and permeability high and this the soil needs continuous care operations. It is suggested that monitoring of the river is necessary for proper management to solve pollution problems in the river system.

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