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Validity of Dujaila River Water within Wasit Governorate - Central Iraq

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Abstract

Dujaila River is one of the Tigris River branches, its length is 69.45 km, 15 m width and 2.80 m depth, and discharge rate is 42.15m^3/Sec. The river provides the water share for 396 thousand Acres.

The primary objective of this study is to evaluate the suitability of water resources, for various purposes in the Dujaila River, Wasit Governorate-central Iraq. Physical and chemical properties have been investigated for 9 surface samples of the period August 2015- March 2016. The tests have been taken for the water major ions, total dissolved solids, electrical conductivity and acidity. Results indicated that the river water is classified as fresh water, according to the total dissolved solid (TDS), which its value ranges between (665-688) ppm in low water season, too (520-575) ppm in high water season, and showed that the Dujaila River water suitable for all purposes. Moreover, all of the water sample types were (Ca^{+2}-sulfate).

Keywords: Dujaila River, Water type, Hydrochemical Formula

صلاحية مياه نهر الدجيله في محافظة واسط – وسط العراق

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الخلاصة:

نهر الدجيله هو احد فروع نهر دجلة، طوله 69.45 كم وعرضه 15 م وعمقه 2.8 م ومعدل التصريف فيه 42.15 م^3/ ثانية. النهر يزود اكثر من 396 الف دونماً. تهدف الدراسة الى تقييم مدى ملائمة المياه للاغراض المختلفة في نهر الدجيله محافظة واسط –وسط العراق. تم التحقق من الخواص الفيزيائية والكيميائية لتسع عينات سطحية من مياه نهر الدجيله للفتره مابين (اب 2015– اذار 2016) اجريت التحاليل للايونات الرئيسية والمواد الصلبة الكلية والتوصيلية الكهربائية والحامضية. النتائج بينت ان مياه النهر من النوع العذب طبقا الى المواد الذائبة الكلية التي تتراوح مابين (665–668) جزء بالمليون في الموسم الجاف الى (520–575) جزء بالمليون في الموسم الرطب. وبينت الدراسة ان مياه نهر الدجيله ملائمة للاستخدامات المختلفة ,اضافة الى ذلك فأن كل نماذج المياه من نوع كبريتات الكالسيوم.

Introduction:

Al-Dujaila River is branched from the right bank from a point located on a distance 330 m north AL-Kut Dam, and about 650 m south of front of the Al-Garraf River, and it is being toward Shatt Al-Dujaila at the direction the east. The length of the river is 69.45 km, 15 m width and 2.80 m depth, and discharge rate is 42.15 m^3/Sec. The river provides the water share for 396 thousand Acres. Al-Dujaila area lies to the South East of Wasit Governorate, centrality of Iraq, between latitudes (32° 30'-32° 0') N and longitude (45° 50'-46° 37') E, [1]. As shown in Figure-1. Located within the Mesopotamian plain and is covered mostly by Quaternary deposits and is considered as a part of it. The old geological outcrops in the area belong to the Pliocene age represents Bai Hassan and Mukdadiya Formations show in Figure-2. From the topographic point of view the area can be divided into two regions.

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The highland area in the northeastern part and the Mesopotamian plain area. The study area is part of the flood plain, which represents one of the important units cover deposits by Quaternary sediments to form the depositions flood plain valleys of the rivers. It is thickness 150-200 m. And is a divided Quaternary deposit to deposits of old (Pleistocene deposits) and is a new deposit (Holocene), [2].

This study is aimed studying the analyses of the hydrochemical characteristics of the surface water include the major cations (Ca^{+2}, Mg^{+2}, Na^{+} and K^{+}), major anions (HCO_3^- SO_4^{-2} Cl^- and NO_3^-), and their effects on the drinking, livestock and irrigation purposes.

Previous studies:

- Al-Mayahi and Al-Azzawi (2013) in their study about the monthly changes that occurred on some chemical and physical properties of Al- Gharraf River in Al-Hai city.
- AL-Zamili. H.A.A, 2014. The effect of local domestic sewage in water quality of Al-Dujaila River in Al- Kut city/ Iraq.
- Al-Dalemy, 2001 studied the impacts of the industrial factories established on the banks of the Tigris River, showing that the physical and chemical analysis of water results is higher than the Iraqi standard for drinking water.

Method and materials:

Sampling was taken in August 2015, a period of low water season and March 2016, a period of high water season. Sampling included nine sites of the superficial Dujaila River and its branches, Figure-2.

Analytical methods:

The hydrogen ion concentration (pH) and electrical conductivity ($EC\mu/cm^3$) was measured in the field by using a pH meter, portable EC meter respectively, Chemical analysis of the Cations, Calcium (Ca^{+2}), Magnesium (Mg^{+2}), Sodium (Na^{+}) and Potassium (K^{+}), was accomplished in the laboratory of the directorate Wasit environment using an atomic absorption spectrophotometer. The anions, Nitrate (NO_3) and Sulfate (SO_4) were measured by spectrophotometer techniques. Titration methods were used to determine the concentrations of Chloride (Cl^-) and Bicarbonate (HCO_3), Cl was measured by using potassium chromate (K_2CrO_4) as an in Decatur and silver nitrate ($AgNO_3$) as titration solution, HCO_3 was measured by titrating the samples with 0.02 NH_2SO_4, using methyl orange as an indicator. The water samples were analyzed in the laboratory of central environment. The results of Chemical analysis are given in Table-1.

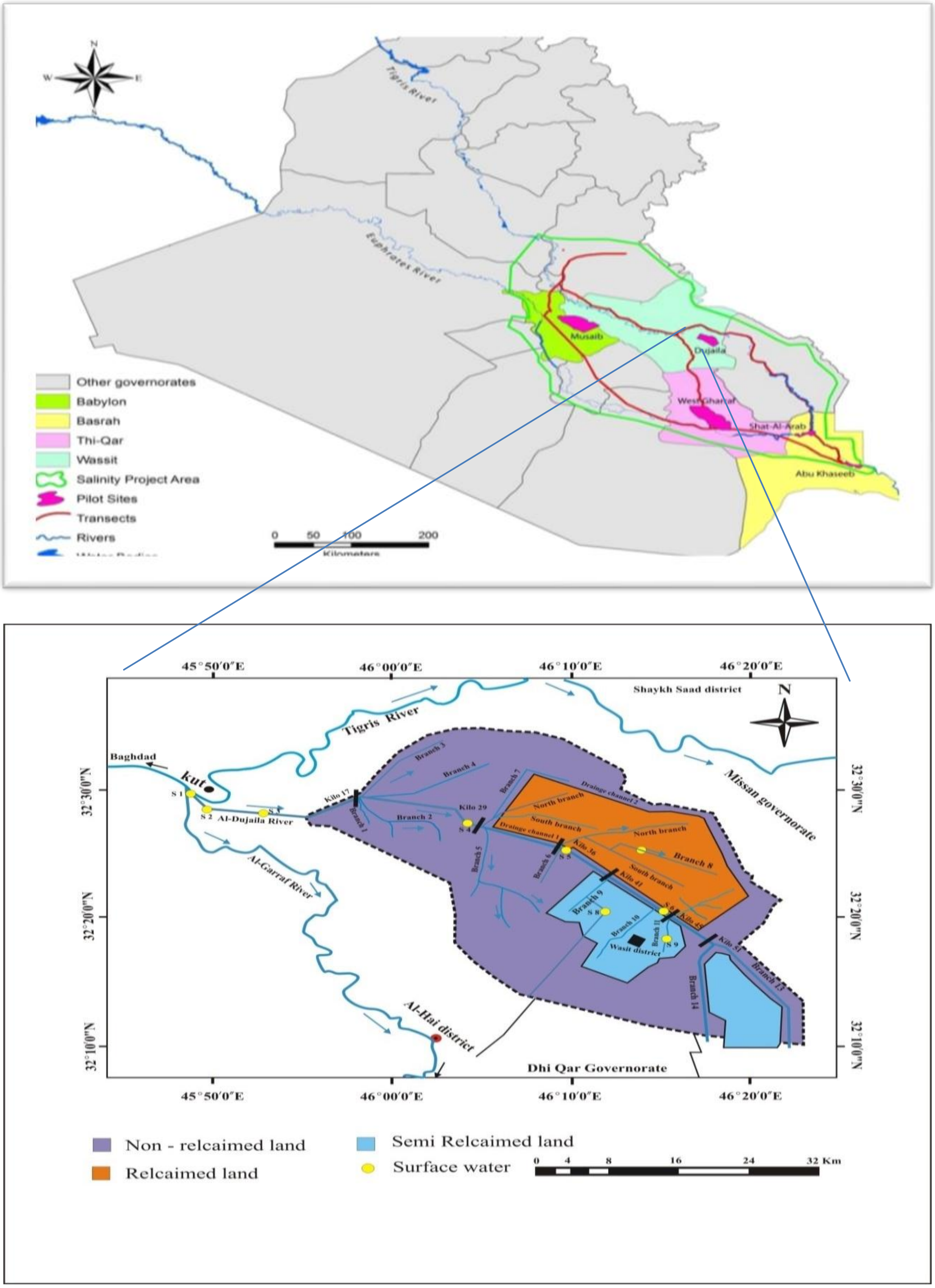

Figure 1- Location and sampling of the study area after (Directorate of Water Resources - Wasit province).

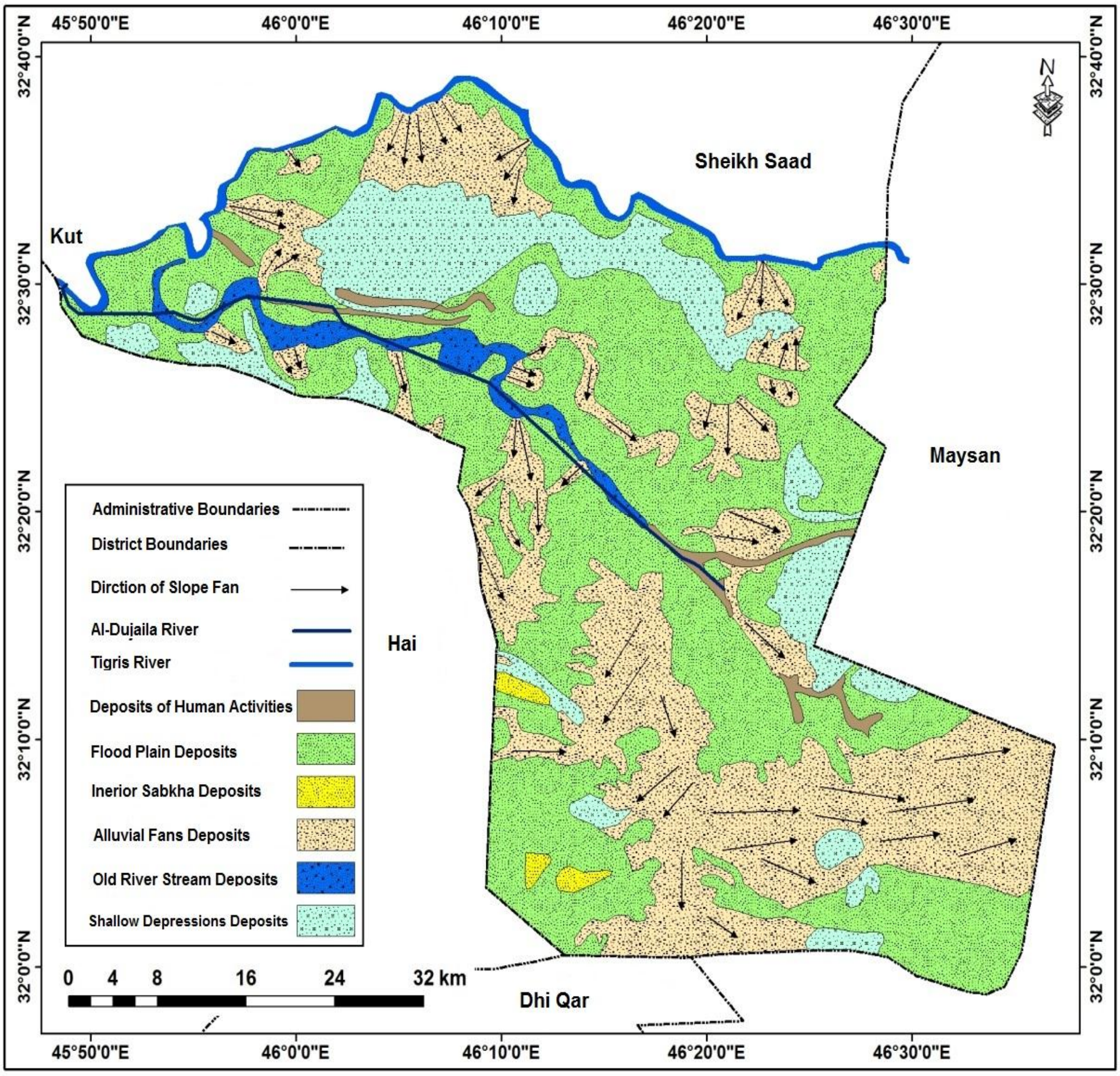

Figure 2- Geological map of the study area.

Table 1- Physical parameters and major chemical cations and anions in Dujaila River **(**low water season August 2015).

NO.	pH	EC μscm^{-1}	TDS mgl^{-1}	TH mgl^{-1}	Unit	Ca^{+2}	Mg^{+2}	K^{+1}	Na^{+1}	SUM	SAR	SO_4^{-2}	Cl^-	HCO_3	NO_3	SUM	Accu.
S.1	7.35	1055	670	338	ppm	98.5	22.1	3.1	68.8			200.3	78.5	160.2	3.6		
					epm	4.92	1.84	0.08	2.99	9.83	1.62	4.17	2.21	2.62	0.05	9.05	95.8
					epm%	50.05	18.71	0.81	30.42			46.07	24.42	28.95	0.55		
S.2	7.32	1085	675	338.5	ppm	88.2	28.4	3.8	80.2			210.5	90.3	148.3	5.2		
					epm	4.41	2.36	0.09	3.48	10.34	1.89	4.38	2.54	2.43	0.08	9.39	95.2
					epm%	42.65	22.82	0.87	33.65			46.64	27.05	25.87	0.85		
S.3	7.23	1086	665	331.5	ppm	90.3	25.5	3.5	75.5			201.3	85.2	159.3	4.3		
					epm	4.51	2.12	0.09	3.27	9.98	1.79	4.19	2.40	2.61	0.06	10.63	96.8
					epm%	45.19	21.24	0.90	32.76			38.47	22.57	24.55	0.56		
S.4	7.30	1089	680	336.5	ppm	91.3	26.1	3.4	73.2			198.2	82.5	160.1	3.8		
					epm	4.56	2.17	0.08	3.18	9.99	1.73	4.12	2.32	2.62	0.06	9.12	95.4
					epm%	45.64	21.72	0.80	31.83			45.17	25.43	28.72	0.65		
S.5	7.28	1067	677	343.5	ppm	92.2	27.2	3.4	72.1			203.4	80.9	161.8	4.4		
					epm	4.61	2.26	0.08	3.13	10.08	1.69	4.23	2.27	2.65	0.07	9.22	95.5
					epm%	45.73	22.42	0.79	31.05			45.87	24.62	28.74	0.76		
S.6	7.25	1060	673	334	ppm	94.7	23.4	3.6	75.5			200.7	79.8	160.5	4.2		
					epm	4.73	1.95	0.09	3.28	10.05	1.80	4.18	2.25	2.63	0.06	9.12	95.1
					epm%	47.06	19.40	0.89	32.64			45.83	24.67	28.84	0.65		
S.7	7.36	1098	685	338	ppm	95.1	24.2	3.5	77.1			210.3	83.3	157.5	4.6		
					epm	4.75	2.01	0.09	3.35	10.20	1.83	4.38	2.34	2.58	0.07	9.37	95.7
					epm%	46.57	19.71	0.88	32.84			46.74	24.97	27.53	0.75		
S.8	7.33	1065	684	350.5	ppm	96.4	26.3	3.7	76.4			212.3	88.4	157.2	4.7		
					epm	4.82	2.19	0.09	3.32	10.42	1.77	4.42	2.49	2.57	0.07	9.55	95.6
					epm%	46.25	21.02	0.86	31.86			46.28	26.07	26.91	0.72		
S.9	7.32	1077	688	345.5	ppm	95.3	25.9	3.7	80.2			215.1	90.2	150.1	5.1		
					epm	4.76	2.15	0.09	3.48	10.48	1.88	4.48	2.54	2.46	0.08	9.56	95.4
					epm%	45.42	20.51	0.86	33.21			46.86	26.57	25.73	0.84		

Table 2- Physical parameters and major chemical cations and anions in Dujaila River **(**high water season March 2016).

NO.	pH	EC μscm^{-1}	TDS mgl^{-1}	TH mgl^{-1}	Unit	Ca^{+2}	Mg^{+2}	K^{+1}	Na^{+1}	SUM	SAR	SO_4^{-2}	Cl^-	HCO_3	NO_3	SUM	Accu.
					ppm	72.4	13.5	2.8	61.3			150.3	65.4	130.3	3.1		
S.1	7.11	990	520	237	epm	3.62	1.12	0.07	2.66	7.47	1.7	3.13	1.84	2.13	0.05	7.15	97.8
					epm%	48.46	14.99	0.93	35.61			43.77	25.73	29.79	0.69		
					ppm	75.7	15.4	3.2	70.1			170.6	75.2	120.4	3.4		
S.2	7.32	1020	550	253	epm	3.78	1.28	0.08	3.04	8.18	1.9	3.55	2.12	1.97	0.05	7.69	96.9
					epm%	46.21	15.65	0.97	37.16			46.16	27.56	24.62	0.65		
					ppm	73.1	14.4	3.1	66.7			160.7	71.6	128.4	3.2		
S.3	7.27	1010	540	242.5	epm	3.65	1.2	0.08	2.9	7.83	1.87	3.35	2.02	2.10	0.05	7.52	97.9
					epm%	46.61	15.32	1.02	37.03			44.54	26.86	27.92	0.66		
					ppm	72.9	13.4	3	65.4			165.4	67.8	135.2	3.3		
S.4	7.23	990	555	237.5	epm	3.64	1.11	0.07	2.84	7.67	1.84	3.44	1.91	2.21	0.05	7.61	99.6
					epm%	47.45	14.47	0.91	37.02			45.60	25.09	29.04	0.65		
					ppm	74.5	15.2	2.9	63.2			166.7	65.9	131.5	4.2		
S.5	7.33	1010	550	250	epm	3.72	1.26	0.07	2.74	7.79	1.74	3.47	1.85	2.15	0.06	7.53	98.3
					epm%	47.75	16.17	0.89	35.17			46.08	24.56	28.55	0.79		
					ppm	75.6	15.7	2.8	66.7			170.2	68.3	132.4	4.6		
S.6	7.35	1025	558	255	epm	3.78	1.31	0.07	2.9	8.06	1.81	3.54	1.92	2.17	0.07	7.7	97.7
					epm%	46.89	16.25	0.86	35.98			45.97	24.93	28.18	0.91		
					ppm	78.8	16.1	3.1	65.9			173.5	70.2	140.7	4.5		
S.7	7.36	1015	570	264	epm	3.94	1.34	0.08	2.86	8.22	1.76	3.61	1.97	2.31	0.07	7.96	98.4
					epm%	47.93	16.30	0.97	34.79			45.35	24.75	29.02	0.88		
					ppm	80.2	.16.2	3.4	71.8			175.9	71.7	138.2	4.8		
S.8	7.25	1030	565	268	epm	4.01	1.35	0.08	3.12	8.56	1.91	3.66	2.02	2.26	0.08	8.02	96.7
					epm%	46.84	15.77	0.93	36.45			45.63	25.18	28.18	0.99		
					ppm	81.3	17.3	3.6	72.1			178.2	92.6	136.9	4.8		
S.9	7.41	1030	575	275	epm	4.06	1.44	0.09	3.13	8.72	1.89	3.71	2.61	2.24	0.08	8.64	99.6
					epm%	46.56	16.51	1.03	35.89			42.94	30.21	25.92	0.92		

Results and Discussion

Accuracy is the agreement with standard measures [3]. The accuracy of the results of the water sample analysis can be indicated by the results of the reaction error test (U) [4], [3], [5]. When (U) uncertainty or reaction error is ($U \leq 5$ %) them the resolutions could be accepted for interpretation, but if (5 %$\leq$ U$\leq$ 10 %) then the results acceptable to gamble and if ($U > 10$ %), and so the outcomes uncertain. All about results of accuracy of surface water are certain Table-1 and Table-2.

Physical properties:

Odor, Color and Taste:

The Surface water in Dujaila River is odorless and colorless,.

pH Values:

The pH value of the surface water was ranging between (7.23-7.36) with a mean value of (7.30), in low water season, but in the high water season ranges between (7.11-7.41) with a mean value of (7.29), Table-1 and Table-2.

Total Dissolved Solid (TDS):

Total dissolved solid comprises in organic salt (calcium, magnesium, Sodium, potassium, bicarbonate, chloride, and sulfate) and small a moment of organic matter that is dissolved in water [6]. According to, (Davis, and Dewiest, 1966), [7] and (Drever, 1997), [8]. Classification water on the base of the (TDS). The (TDS) value of surface water samples were ranged between (665 – 688.5) mgl^{-1} with a mean of (677.4) mgl^{-1} from (low water season), and ranged between (520–575) mgl^{-1} with a mean of (553.6) mgl^{-1} from (high water season), All surface water is classified fresh water, Table-1 and Table-2.

Electrical Conductivity (EC):

The ability of ground water to conduct an electrical current is called electrical conductance or electrical conductivity [9]. The (EC) value ranged between (1055- 1098) µs/cm with a mean of (1075.7) µs/cm from (low water season), and ranged between (990- 1030), µs/cm with a mean of (1013.3) µs/cm from (high water season), Table-1 and Table-2.

Total Hardness (TH):

Total hardness mainly reflects, water contents of calcium and magnesium ion, and it is expressed by its equivalent from calcium carbonate, according to the following equation, [10, 11]:

TH= 2.497 Ca +4.115 Mg

Where TH, Ca, Mg expressed in (ppm).

The TH value ranged between (331.5-350.5) mg/l with a mean of (339.5) mg/l from(low water season), and ranged between (237-275) mg/l with a mean of (253.5) mg/l from (high water season), Table-1 and Table-2.

Chemical properties
Major Elements
1-Potassium Ion K^+

Common sources of potassium are the products formed by the weathering of orthoclase, biotite, leusite and nepheline in igneous and metamorphic rocks. Waters percolated through evaporating deposits may contain very large quantities derived from the dissolution of sulfide. Although the abundance of potassium in the earth's crust is about the same as sodium, potassium is commonly less than one tenth the concentration of sodium in natural water. This very mobile of potassium is owing, first, to the fact that potassium enters into the structure of certain land like mine during weathering, and second, to the higher resistance to weathering of many potassium minerals in relation to the sodium minerals [7]. The potassium ion (K^+) concentration of surface water samples were shown in the table 1 and table 2. The low concentration of potassium ion in water samples due to very mobile of the potassium ion to the weathering process.

2-Sodium Ion Na^+

The primary sources of most sodium in natural water are from the release of soluble products during the weathering of plagioclase feldspars [4]. In the area of evaporated deposits, the solution of halite is important. Clay minerals under certain condition, release large quantities of exchangeable sodium [7]. All natural water contains measurable amounts of sodium. Actual concentrations range from about (0.2 ppm) in some rain and snow for more than (100000 p.p.m) in brines in contact with salt beds [12]. The source of sodium ion in the studied area is from the clay minerals, which exist in the study of the soil area and from evaporation deposits. The sodium ion (Na^+) concentration of surface water samples were shown in the Table-1 and Table-2. The change of Sodium Ion concentration in water samples due to change of clay layers in the studied area.

3-Calcium Ion Ca^{+2}

Calcium in ground water is chemical weathering of rocks. The sources of calcium ion in groundwater are, calcite, aragonite, dolomite, limestone, gypsum in sedimentary rocks and pyroxene, amphibole, and feldspar in igneous and metamorphic rocks. Calcium cements material in dissolution of rock fragments and soil [7]. The calcium percent in sedimentary rocks is 30.23 % [11].

The calcium (Ca^{+2}) concentration of surface water samples were shown in the Table-1 and Table-2.

4-Magnesium Ion Mg^{+2}

One of the most abundant elements of the alkaline earth group of metals, magnesium makes up about 2.1% weight of the earth's crust [13].

The most usual sources of Mg in the hydrosphere are the dolomite in sedimentary rocks, olivine, biotite, hornblende, and augite in igneous rocks, and serpentine, talc, Diopside, and tremolite in metamorphic rocks. In addition to them mostly calcite contains some magnesium, so a solution of limestone commonly yields abundance of magnesium as well as calcium. The solubility of magnesium carbonate controlled by the presence of carbon dioxide. Magnesium is generally found in lesser concentrations in natural waters than of calcium [7]. This difference is probably owing to the slow dissolution of dolomite together with the greater abundance of calcium in the earth's crust [7].

The presence of magnesium ions in the water like that of calcium ions causes hardening of water [10]. The magnesium (Mg^{+2}) concentration of surface water samples were at the Table-1 and Table-2.

5- Chloride Ion Cl^-

Chloride is a minor part of the earth's crust, but a major dissolved constituent of most natural water. Most chloride in ground water comes from four different sources. First, chloride from the ancient sea water entrapped in sediments, second, the solution of halite and related minerals in evaporating deposits, third, concentration by evaporation of chloride contributed by rain or snow, and fourth, solution of dry fallout from the atmospheres particularly in a ride regions [7].

In addition to natural sources, according to WHO (2004) chloride ions in drinking water originate also from sewage and industrial effluents, urban runoff containing de-icing salt and saline intrusion. The chloride (Cl^-) ion concentration of surface water samples were shown in the Table-1 and Table-2.

6-Sulfates Ions (SO_4^{-2})

Sulfate ions are largely recycled from the atmosphere and from the solution of sulfur minerals in sedimentary rocks. Sedimentary rocks, particularity organic shale, may also yield large amount of sulfates through the oxidation of Marcasite and pyrite [7]. The releasing of sulfate ions in water, due to washing from the upper layers of soil and transporting downward to groundwater [14]. All atmospheric precipitation contains sulfate [7]. Sulfates naturally present in groundwater and may be linked with hydrogen sulfide gas, which is caused by the action of sulfur bacteria, as well as by other types of bacteria on decaying organic matter [15]. The source of sulfate in the studied area, from the evaporate rocks. The Sulfates ion concentration of surface water samples were shown in the Table-1 and Table-2.

7-Alkalinity (HCO_3^-), (CO_3^{-2})

Alkalinity is a true measure of carbonate and bicarbonate ions for most natural water. Most carbonate and bicarbonate ions in ground water are derived from the carbon dioxide in the soil and solution of carbonate rocks. Some groundwater probably obtains bicarbonate from the carbon dioxide generated by diagnosis of organic compounds. The principal source of carbon dioxide species that product alkalinity in surface or groundwater is the CO_2 gas fraction of the atmosphere, or the atmospheric gases present in the soil or in the unsaturated zone lying between the surface of the land and the water table [16]. In the studied area the total alkalinity is due to the bicarbonate ions, because if the (pH) value of the water samples are less than (8.2) and above (4.5) then the alkalinity is due to bicarbonates only [7]. The bicarbonate (HCO_3) ion concentration of surface water samples were shown in the Table-1 and Table-2.

Minor elements

Nitrate (NO_3^-)

Most nitrates in natural water come from organic sources or from industrial and agricultural sources. Nitrates are extremely soluble substances, through nitrate contents of natural waters unaffected by pollution is usually less than 50 mg/l, and very limited amounts of nitrates are derived from the water bearing materials, the principle source is organic processes in the soil. The important source is the oxidation by bacteria of nitrogen or nitrogenous substance in decomposing organic matter or sewage [17].

Nitrate also originates from agricultural activities due the use of fertilizers and nonagricultural source like animal waste [18]. The highest accepted limits of nitrate concentration in drinking water is (50 mg/l) and the threshold No. is 45 mg/l [10]. The main source of nitrate in studying area is from animal waste. The nitrate ion concentration of surface water samples wrer shown in the Table-1 and Table-2.

Water classification

1. Hydrochemical Formula and water Type

According to (Ivanov *et al*,1968),[19]. The hydrochemical classification of the waters depends on the (epm%) of the major cations and anions that arranged in diminishing order.

The cataions are located at the base and the anions above, and the (TDS in gm/l) and (PH) values are added to them. The type of water will be known from the cations and anions (epm %) which are above (15%):

$$\text{TDS (gm /l)} \quad \frac{\text{Anions (epm \%) in decreasing order}}{\text{Cataions (epm \%) in decreasing order}} \quad \text{pH}$$

The hydrochemical formula for the surface water samples in the studied area show in Table-3 and Table-4.

Table 3 - Hydrochemical formula of Dujaila River water samples during Jul.2015, (low water season).

Station N.	Hydro Chemicl Formula	Water Type
S.1	TDS 0.670 $\frac{SO4^{-2}\ 46.07\ HCO^{-3}\ 28.95\ Cl^{-}\ 24.42}{Ca^{+2}\ 50.05\ Na^{+}30.42\ Mg^{+2}\ 18.71}$ pH 7.35	Ca^{+2} - $SO4^{-2}$ Sulfate
S.2	TDS 0.675 $\frac{SO4^{-2}\ 46.64\ Cl^{-}\ 27.05\ HCO^{-3}\ 25.87}{Ca^{+2}\ 42.65\ Na^{+}\ 33.65\ Mg^{+2}\ 22.82}$ pH 7.32	Ca^{+2} - $SO4^{-2}$ Sulfate
S.3	TDS 0.665 $\frac{SO4^{-2}\ 38.47\ HCO^{-3}\ 24.55\ Cl^{-}\ 22.57}{Ca^{+2}\ 45.19\ Na^{+}32.76\ Mg^{+2}\ 21.24}$ pH 7.23	Ca^{+2} - $SO4^{-2}$ Sulfate
S.4	TDS 0.68 $\frac{SO4^{-2}\ 45.17\ HCO^{-3}\ 28.72\ Cl^{-}\ 25.43}{Ca^{+2}\ 45.64\ Na^{+}31.83\ Mg^{+2}\ 21.72}$ pH 7.3	Ca^{+2} - $SO4^{-2}$ Sulfate
S.5	TDS 0.677 $\frac{SO4^{-2}\ 45.87\ HCO^{-3}\ 28.74\ Cl^{-}\ 24.62}{Ca^{+2}\ 45.73\ Na^{+}31.05\ Mg^{+2}\ 22.42}$ pH 7.28	Ca^{+2} - $SO4^{-2}$ Sulfate
S.6	TDS 0.673 $\frac{SO4^{-2}\ 45.83\ HCO^{-3}\ 28.84\ Cl^{-}\ 24.67}{Ca^{+2}\ 47.06\ Na^{+}\ 32.64\ Mg^{+2}\ 19.40}$ pH 7.25	Ca^{+2} - $SO4^{-2}$ Sulfate
S.7	TDS 0.685 $\frac{SO4^{-2}\ 46.74\ HCO^{-3}\ 27.53\ Cl^{-}\ 24.97}{C\ a^{+2}\ 46.57\ Na^{+}\ 32.84\ Mg^{+2}\ {}^{+}19.71}$ pH 7.36	$C\ a^{+2}$- $SO4^{-2}$ Sulfate
S.8	TDS 0.684 $\frac{SO4^{-2}\ 46.82\ HCO^{-3}\ 26.91\ Cl^{-}\ 26.07}{Ca^{+2}\ 46.25\ Na^{+}\ 31.86\ Mg^{+2}\ 21.02}$ pH 7.33	Ca^{+2} - $SO4^{-2}$ Sulfate
S.9	TDS 0.688 $\frac{SO4^{-2}\ 46.86\ Cl^{-}\ 26.57\ HCO^{-3}\ 25.73}{Ca^{+2}\ 45.42\ Na^{+}33.21\ Mg^{+2}\ 20.51.}$ pH 7.32	Ca^{+2} - $SO4^{-2}$ Sulfate

Table 4- Hydrochemical formula of Dujaila River water samples during March 2016, (high water season).

Station N.	Hydro Chemicl Formula	Water Type
S.1	TDS 0.52 $\frac{SO4^{-2}\ 43.77\ HCO^{-}\ 29.79\ Cl^{-}25.73}{Ca^{+2}48.46\ Na^{+}35.61\ Mg^{+2}\ 14.99}$ pH 7.11	Ca^{+2} - $SO4^{-2}$ Sulfate
S.2	TDS 0.55 $\frac{SO4^{-2}\ 46.16\ Cl^{-}\ 27.56\ HCO^{-3}\ 24.62}{Ca^{+2}\ 46.21\ Na^{+}\ 37.16\ Mg^{+2}\ 15.65}$ pH 7.32	Ca^{+2} - $SO4^{-2}$ Sulfate
S.3	TDS 0.54 $\frac{SO4^{-2}\ 44.45\ HCO^{-3}\ 27.92\ Cl^{-}\ 26.86}{Ca^{+2}\ 46.61\ Na^{+}37.03\ Mg^{+2}\ 15.32}$ pH 7.27	Ca^{+2} - $SO4^{-2}$ Sulfate
S.4	TDS 0.555 $\frac{SO4^{-2}\ 45.60\ HCO^{-3}\ 29.04\ Cl^{-}\ 25.09}{Ca^{+2}\ 47.45\ Na^{+}37.02\ Mg^{+2}\ 14.47}$ pH 7.23	Ca^{+2} - $SO4^{-2}$ Sulfate
S.5	TDS 0.55 $\frac{SO4^{-2}\ 46.08\ HCO^{-3}\ 28.55\ Cl^{-}\ 24.56}{Ca^{+2}\ 47.75\ Na^{+}35.17\ Mg^{+2}\ 16.17}$ pH 7.33	Ca^{+2} - $SO4^{-2}$ Sulfate
S.6	TDS 0.5583 $\frac{SO4^{-2}\ 45.97\ HCO^{-3}\ 28.18\ Cl^{-}\ 24.93}{Ca^{+2}\ 46.89\ Na^{+}\ 35.98\ Mg^{+2}\ 16.25}$ pH 7.35	Ca^{+2} - $SO4^{-2}$ Sulfate
S.7	TDS 0.57 $\frac{SO4^{-2}\ 46.74\ HCO^{-3}\ 27.53\ Cl^{-}\ 24.97}{C\ a^{+2}\ 47.93\ Na^{+}\ 34.79\ Mg^{+2}\ {}^{+}16.3}$ pH 7.36	$C\ a^{+2}$- $SO4^{-2}$ Sulfate
S.8	TDS 0.565 $\frac{SO4^{-2}\ 45.63\ HCO^{-3}\ 28.18\ Cl^{-}\ 25.18}{Ca^{+2}\ 46.84\ Na^{+}\ 36.45\ Mg^{+2}\ 15.77}$ pH 7.25	Ca^{+2} - $SO4^{-2}$ Sulfate
S.9	TDS 0.575 $\frac{SO4^{-2}\ 42.94\ Cl^{-}\ 30.21\ HCO^{-3}\ 25.92}{Ca^{+2}\ 46.56\ Na^{+}35.89\ Mg^{+2}\ 16.51}$ pH 7.41	Ca^{+2} - $SO4^{-2}$ Sulfate

Water uses for human drinking purpose:

The standard has been used (WHO), 2006**,** [6], as guides for the water quality evaluation for drinking purpose Table-5. The Surface water in Dujaila River water is suitable for drinking.

Table 5- WHO (2007), guidelines for drinking water and range of value of chemical species in the surface water **-** low and high water season in study area.

Parameters	WHO standard (2007)		Low water season		High water season	
	Acceptable level	MPL	Range	Mean	Range	Mean
Ca^{+2} (mg/l)	75	200	88.2-98.5	93.5	72.4-81.3	76.05
Mg^{+2} (mg/l)		50	22.1-28.4	25.4	13.4-17.3	15.24
Na^{+} (mg/l)	20	175	68.8-80.2	75.4	61.3-72.1	67.02
K^{+} (mg/l)			3.1-3.8	3.5	2.8-3.6	3.1
HCO_3^{-}(mg/l)			148.3-161.8	157.2	120.4-140.7	132.6
SO_4^{-2}(mg/l)		250	198.2-215.1	205.7	150.3-178.2	167.94
Cl^{-}(mg/l)		300	78.5-90.3	84.3	65.4-92.6	72.07
NO_3^{-}(mg/l)		50	3.6-5.2	4.4	3.1-4.8	4
TDS (mg/l)		1000	665-688	677.4	520.575	553.6
pH	6.5	8	7.23-7.3	7.30	7.11-7.41	7.29
TH (mg/l)	100	500	331.5-350.5	339.5	237-275	253.5

Water Uses for Livestock purpose:

On the base of [20] classification, the surface water samples of class (very good) type, Table-6.

Table 6- Classification of livestock water, according to [20].

Para.	Very good water mg/l	Good water mg/l	Permeable mg/l	Can be used mg/l	Threshold mg/l	Low water saeson mg/l	High water saeson mg/l
Na^{+} (mg/l)	800	1500	2000	2500	4000	68.8-80.2	61.3-72.1
Ca^{+2} (mg/l)	350	700	800	900	1000	88.2-98.5	72.4-81.3
Mg^{+2} (mg/l)	150	350	500	600	700	22.1-28.4	13.4-17.3
Cl^{-}(mg/l)	900	2000	3000	4000	6000	78.5-90.3	65.4-92.6
SO_4^{-2} (mg/l)	1000	2500	3000	4000	6000	198.2-215.1	150.3-178.2
TDS (mg/l)	3000	5000	7000	10000	15000	665-688	520-575
TH (mg/l)	1500	3200	4000	4700	54000	331.5-350.5	237-275

Water Uses of Irrigation:

The water was evaluated for irrigation using the Sodium Absorption Ratio (SAR) values to determine its suitability. The SAR was computed using the expression developed by Todd, 1980, [10] as:

$$\mathbf{SAR = rNa / [r (Ca+Mg) /2]^{0.5}}$$

On the basis of Todd classification all of the surface water samples belong to excellent water class, in which SAR < 10, Table-1 and Table-2.

Conclusion:

In both dry and wet seasons; calcium, sodium, magnesium, sulphate and chloride, are the abundant ions in the Dujaila River water. The concentration of cations and anions showed low values in general because dilution, where calcium ion is a predominant cation, and sulphate is a predominant anion. The general type of the water is (Ca^{+2} -Sulphate) for the both seasons, which indicating the similarity of the hydrogeochemical processes in both seasons, that reflect the fact of presence the evaporate rocks and halite mineral, which consider the main sources of these ions. All water samples are suitable for human drinking, livestock and irrigation purposes.

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