HYDROCHEMISTRY AND VALIDITY OF TIGRIS RIVER WATER IN KUT CITY

[1]Sattar. O. Maiws Al-Mayyahi, [1]Ehssan Ali Abdul Ameer, [1]Hussein Ali Awad AL-Zamili

[1]Lecturer of College of Science, Wasit University, Wasit, Iraq.

المستخلص

أخذت عشر عينات من نهر دجلة لخمس مواقع قبل (S.1) وخلال (S.2, S.3, S.4) وبعد (S.5) مدينة الكوت ولمدة موسمين. تم تحديد هذه المواقع جغرافيا بواسطة جهاز تحديد المواقع (GPS) وتم اجراء التحاليل الفيزيائية موقعيا (التوصيلية الكهربائية، درجة الحموضة، ودرجة الحرارة) أجريت التحاليل الكيميائية في مختبر البيئة المركزي في مدينة الكوت لتحديد تركيز الايونات الموجبة والسالبة لتحديد صلاحية مياه نهر دجلة للاغراض المختلفة داخل مدينة الكوت جميع نماذج مياه النهر ولكلا الموسمين كانت عديمة اللون والرائحة ونسبة منخفضة من القلوية وكانت قيمة الاس الهيدروجيني تتراوح مابين (7.23 الى 7.55)، اما قيمة الاملاح الذائبة الكلية فتراوحت مابين (520 الى 671) جزء بالمليون لذا صنفت كمياه عذبة لان قيمة الاملاح الذائبة الكلية اقل من 1000 جزء بالمليون. اما معدل قيمة التوصيلية الكهربائية فبلغ (990 الى 1086) ميكروسيمينز وقيمة العسرة الكلية فتراوحت مابين (237 الى 345.5) جزء بالمليون للموسمين حيث كانت عسرة الى عسرة جدا للموسمين . أظهرت نتائج التحاليل للايونات (الموجبة والسالبة) في مياه النهر ان عنصر الكالسيوم هو السائد في الايونات الموجبة وعنصر الكبريتات هو السائد في الايونات السالبة. بمقارنة نوعية مياه النهر مع معايير الأستخدامات المختلفة تبين انها ملائمة للشرب وفقا لمعيار الجودة العراقي 2009 ، أعتمادا على تصنيف (Altoviski,1962) فأن مياه النهر جيدة لغرض شرب المواشي، وأعتمادا على نسبة امتصاص الصوديوم (Todd, 1980) لاغراض الري فان كل عينات مياه نهر دجلة ممتازة ولكلا الموسمين.

Abstract

Ten samples were taken from the Tigris River for five sites before (S.1), during (S.2, S.3 and S.4) and after (S.5) the city of Kut for two seasons. The locations of these samples were geographically determined by GPS, in addition to conducting physical analysis, electrical conductivity, pH and temperature at the site. Chemical analyzers were carried out in the Central Environmental Laboratory in Kut to determine the concentration of cations and anions to determine the validity of the river water for different purposes in the city of Kut. All samples of River water (both for the November, 2017 and February, 2018) do not give any color and odor and low alkalinity and pH value range between (7.23 -7.55). The Range of TDS value is between (520 - 671) ppm, fresh water (TDS<1000 ppm), and the range of EC value of the River water samples is between (990 to 1086) µs/cm. The (TH) values range between (237 to 345.5) ppm for two seasons, all samples from River water are hard to very hard for two seasons. The results of the analysis of major elements (cations and anions), in the River Water, showed that the predominant ion in the anions are (SO_4^{2-}) ions and cations is (Ca^{2+}) ion. Comparing the quality of River water with the standards of different uses, shows that water in Tigris River is suitable as drinking, according to IQS (2009). On the basis of Altoviski 1962) classification, the River is good for livestock uses. On the basis of SAR Todd (1980) classification of irrigation water, all the River water samples belong to excellent water class for both periods.

KEYWORD: Tigris River, suitable for drinking, classification of irrigation water, Wasit, Iraq.

Introduction

The Tigris River flows from Turkish territory and penetrates the Iraqi-Turkish border through Iraq and flows into the Shatt al-Arab and supplies many of the tributaries that originate from Iran and Iraq, such as the Upper and Lower Zab, alezaim and Diyala. The interest in water resources, the preservation of the quality of their water and the deserts of the living are important and vital to ensure domestic and other services such as irrigation, industry, agriculture, transport and power generation. The world's freshwater resources are sufficient if measured by the average current consumption, but the problem is that the water is not distributed evenly on the surface of the earth on the one hand, and that the rivers come from natural sources, making them increase and decrease on the other hand, as well as the passage of many rivers away from Human settlements or land is not suitable for agriculture as in the Amazon River and the rivers of Siberia [1 As well as, many rivers with variable drainage throughout the year may be flooded in wet seasons as water is less needed and dry in dry seasons as the need for water increases [1]. Its rivers are one of the most important water sources, on their banks, civilizations, cities and industries are built. Water has the ability to purify itself from impurities by helping environmental factors with this process of self-purification if pollutants are within the water source's ability to tolerate and treat them [2]. In other words, a certain volume of running water can carry a limited amount and a certain amount of pollutants [3]. Here lies the most serious problem for the Tigris and Euphrates Rivers, on the one hand, the water level in the two rivers decreases year after year due to drought and rain. As well as, the investment of water is increased by neighboring countries, on the other hand. The amount of pollutants in the water are increased, as a result of industry and agriculture that depend on irrigating land and the use of pesticides, fertilizers, poor sanitation and garbage collection methods. Where received the major rivers in Iraq, more than 400 million m^3 years of waste materials. In Mosul alone, the amount of liquid jetsam from the cities estimated to reach the Tigris River is about (6598) m^3 / h of effluent crude [4].

Aims of this Study:-

This work aims to Study the physical and chemical properties of Tigris River water moreover, it attempts to estimate the volume of chemical pollution of the river water and Water Quality for different purposes in Kut city.

Sampling

The hydrochemical study involves collecting the water samples, five sites from the Tigris River (Fig. 1), and (Table 1), were collected in November, 2017 and February, 2018. It was analyzed in the laboratories of the Central Environment in Kut City, it involves the major ions including the cations, , Magnesium (Mg^{2+}), Calcium (Ca^{2+}), Potassium (K^{+}) and Sodium (Na^{+}) , the anions, Chloride (Cl^{-}), Sulfate (SO_4^{2-}), Bicarbonate (HCO_3^{-}) , and minor elements Nitrate (NO_3^{-}). Also, it involves the data content of the physical properties (temperature, color, odor, EC, TDS, and TH), (Table 2, 3, 4 and 5), (Fig. 1).

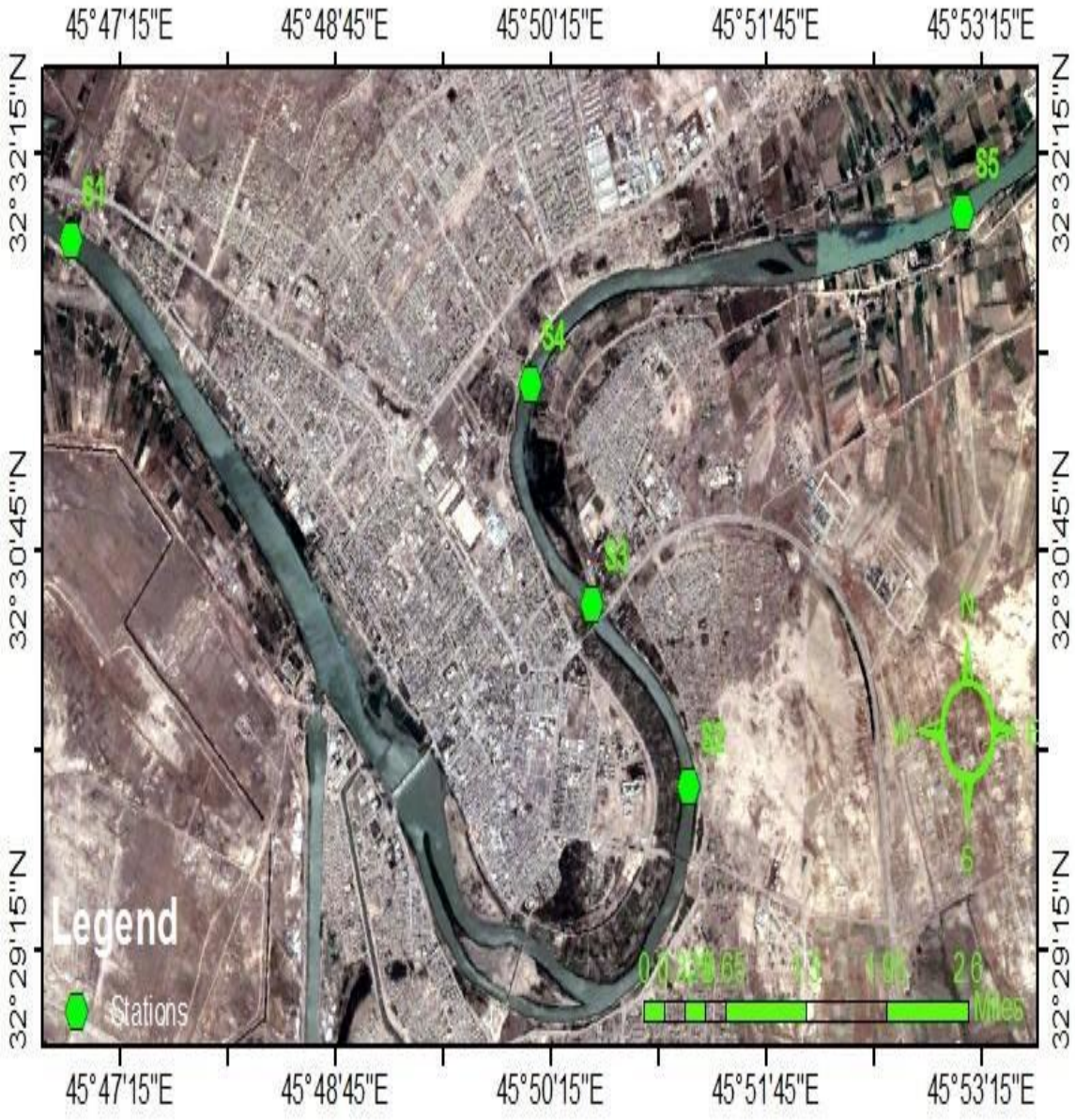

Figure (1): Sampling Map of the Tigris River Water, Land Sat 7 (USGS).

Table (1): Location of All Stations Samples in Tigris River.

Stations	Coordinate
S.1	45˚46'54"E 32˚31'56"N
S.2	45˚51'13"E 32˚29'53"N
S.3	45˚50'33"E 32˚30'33"N
S.4	45˚50'07"E 32˚31'24"N
S.5	45˚53'07"E 32˚32'02"N

Table (2): Major Chemical Cations and Anions in Tigris River in November, 2017.

NO.	Unit	Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}	SUM	SAR	SO_4^{2-}	Cl^{-}	HCO_3	NO_3	SUM	Accu.	Na%
S.1	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	31.2
	epm%	50.05	18.71	0.81	30.42			46.07	24.42	28.95	0.55			
S.2	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	34.5
	epm%	42.65	22.82	0.87	33.65			46.64	27.05	25.87	0.85			
S.3	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	9.26	96.2	33.6
	epm%	45.19	21.24	0.90	32.76			45.24	25.91	28.18	0.006			
S.4	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	32.6
	epm%	45.64	21.72	0.80	31.83			45.17	25.43	28.72	0.65			
S.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	31.8
	epm%	45.73	22.42	0.79	31.05			45.87	24.62	28.74	0.76			

Table (3): Major Chemical Cations and Anions in Tigris River in February, 2018.

NO.	Unit	Ca^{+2}	Mg^{+2}	K^{+1}	Na^{+1}	SUM	SAR	SO_4^{-2}	Cl^{-}	HCO_3	NO_3	SUM	Accu	Na%
S.1	ppm	72.4	13.5	2.8	61.3			150.3	65.4	130.3	3.1			
	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	36.5
	epm%	48.46	14.99	0.93	35.61			43.77	25.73	29.79	0.69			
S.2	ppm	75.7	15.4	3.2	70.1			170.6	75.2	120.4	3.4			
	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	38.1
	epm%	46.21	15.65	0.97	37.16			46.16	27.56	24.62	0.65			
S.3	ppm	73.1	14.4	3.1	66.7			160.7	71.6	128.4	3.2			
	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	38
	epm%	46.61	15.32	1.02	37.03			44.54	26.86	27.92	0.66			
S.4	ppm	72.9	13.4	3	65.4			165.4	67.8	135.2	3.3			
	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	37.9
	epm%	47.45	14.47	0.91	37.02			45.60	25.09	29.04	0.65			
S.5	ppm	74.5	15.2	2.9	63.2			166.7	65.9	131.5	4.2			
	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	36
	epm%	47.75	16.17	0.89	35.17			46.08	24.56	28.55	0.79			

Table (4): Physical Parameters in Tigris River in November, 2017.

NO.	pH	EC µscm^{-1}	TDS mgl^{-1}	TH mgl^{-1}
S.1	7.35	1055	663	338
S.2	7.32	1060	664	338.5
S.3	7.23	1085	671	331.5
S.4	7.30	1086	671	336.5
S.5	7.32	1077	669	345.5

Table (5): Physical parameters in Tigris River in February, 2018.

NO.	pH	EC µscm^{-1}	TDS mgl^{-1}	TH mgl^{-1}
S.1	7.45	990	520	237
S.2	7.55	1020	562	253
S.3	7.42	1010	548	242
S.4	7.50	1008	545	237
S.5	7.45	1011	550	250

Accuracy:

Accuracy is the coincidence with standard measures [5]. The results of the accuracy of the water sample analysis can be indicated by the results of the reaction error test (U), [5], [6], [7] and [8],

(Table 6).

r ∑ Cation = r K+ r Na+ r Mg + r Ca

r ∑ Anion = r HCO3 + r SO4 + r Cl + r NO3

ı r ∑ Cation – ∑ Anion ı =Δ

S = r ∑ Cation + ∑ Anion

U % = (Δ/S) X 100

A = 100 – U

:Where

= Difference absolute value of sum of .cation and anion

.S = sum of cations and anions

.U = (uncertainty) or reaction error

A = Accuracy

Table (6): Classification of Accuracy According to [6]**.**

U	A	Class or type
U ≤ 5 %	A ≥ 95 %	Certain
10 % ≥ U > 5 %	90 % ≤ A < 95 %	Probable certain
U > 10 %	A < 90	Uncertain

When (U) reaction error or uncertainty is (U ≤ 5 %) then the arrangement could be accepted for interpretation, but if (5 %≤ U≤ 10 %) then the results are acceptable to gamble and if (U > 10 %), and hence the results are uncertain. The reaction error was identified between the acceptable with some risk to acceptable values. Therefore, the accuracy of the surface water of Tigris River water, (Table 7) for November, 2017 and (Table 8), for February, 2018.

Table (7): Accuracy of Chemical Analysis of the Tigris River Water Samples, November, 2017.

No.	∑ Cat. (epm)	∑Ani. (epm)	Δ	S	U%	A	Type
S.1	9.83	9.05	0.78	18.88	4.1	95.9	Certain
S.2	10.34	9.39	0.95	19.73	4.8	95.2	Certain
S.3	9.98	9.26	0.72	19.24	3.7	96.2	Certain
S.4	9.99	9.12	0.87	19.11	4.6	95.4	Certain
S.5	10.08	9.22	0.86	19.3	4.5	95.5	Certain

Table (8): Accuracy of Chemical Analysis of the Tigris River Water Sample, February, 2018.

No.	∑Cat. (epm)	∑Ani. (epm)	Δ	S	U%	A	Type
S.1	7.47	7.15	0.32	14.62	2.2	97.8	Certain
S.2	8.18	7.69	0.49	15.87	3	97	Certain
S.3	7.83	7.52	0.31	15.35	2	98	Certain
S.4	7.67	7.61	0.06	15.28	0.4	99.6	Certain
S.5	7.79	7.53	0.26	15.32	1.7	98.3	Certain

1-Result and Discussion

1-1- Physical Properties

1-1-1- Color, Odor and Taste

Color, odor, and taste are very important properties of surface water. In natural water the odor and color come from homes compounds and algae [9], and [10].

The water in the Tigris River was odorless and colorless.

1-1-2- Temperature

The temperature of water to be completed measurement by (thermometer) in the area. The temperature is affected by the groundwater depth and movement [11], and water temperature is very important for geochemical reactions and the lifespan of an organism. The range and average temperature values of River water for two periods are shown in (Table, 9).

The temperature value in the Tigris River water samples in November, 2017, ranges between (24.5-25.5 C^o) with an average value of (25 C^o). Whereas, in February, 2018, the temperature value of the River water samples ranged between (16.5-18.5 C^o) with an average value of (17.2 C^o).

Table (9): Range and Average temperature(C^o)for two periods in the study area.

November, 2017	Range	24.4-25.5
	Average	25
February, 2018	Range	16.5-18.5
	Average	17.2

1-1-3- pH Value

pH is one of the most important operational quality parameters of water [12]. The pH of a solution indicates the effective concentration of the hydrogen ion, (H^+). The units of pH are the negative logarithm of hydrogen ion concentration, expressed in moles per liter [13]:

$$pH = - \log H^+$$

High pH values are normally connected with water high in carbonates [9], this relation is open with the final results of the present study. PH value in the River water samples in November, 2017, ranges between (7.23-7.35). Whereas, in February, 2018, the pH value of the River water samples ranged between (7.42-7.55). The pH value in February, 2018 is more eminent than those of the November, 2017 because of increasing dilution as a result of CO^2 reaction with rain, which heads to release the bicarbonate ion and increase alkalinity. (Table 4 and 5).

1-1-4- Total dissolved Solid (TDS)

Total dissolved solid represents the entire amount of cations and anions [14]. It is measured by the (ppm) or (mg/l) units. Total dissolved solid is a measure of the total of minerals dissolved in water, it is a very good parameter in the evaluation of water quality [15]. It is named as salinity [16]. Total dissolved solid comprises an inorganic salt (calcium, magnesium, Sodium, potassium, bicarbonate, chloride, and sulfate) and a small amount of organic matter that is dissolved in water [17]. However, [9] and [18] defined total dissolved Solid as the all solid material in the solution, whether ionized or not and does not include suspended sediment, colloids and dissolved gasses. The range TDS values of River water for two periods shown in (Table 4, 5 and 7).

The TDS value in the samples of River water of the study area in November, 2017, ranges between (663-671) ppm. Whereas, in February, 2018 the TDS value of the River water samples ranged between (520-562) ppm, (Table 4 and 5).

1-1-5- Electrical conductivity (EC): Electrical conductivity of water is the ability of water to conduct an electrical current, it is measured in micro-Siemens per centimeter (μs/cm), and it is a function of temperature, concentration of different ions and type of ions present (Hem, 1989 and Todd, 1980). Specific conductance readings are commonly set to 25 C°, so that variations in conductance are a function only on the concentration and character of dissolved constituent present (Walton, 1970).

The (EC) of the Tigris river water samples were measured in the field by a Digital device that adjusted to (25) C°. The EC value in the River water samples in November, 2017, ranges between (1055-1086) μs/cm. Whereas, in February, 2018 the EC value of the river water samples ranged between (990-1020) μs/cm, (Table 4 and 5).

2- Assessment Water Resources of Tigris River

2-1- Major Ions-Cations

2-1-1- Potassium Ion K^+

Weathering results are an important source of potassium production such as of biotite, orthoclase, nepheline and leusite in igneous and metamorphic rocks [13]. The solubilities of potassium salt are all high and generally similar in magnitude to the solubilities of sodium salts [9] and

[19]. The potassium ion (K^+) concentration of the river+ water samples in November, 2017, ranges between (3.1-3.8) ppm. Whereas, in February, 2018 the potassium ion (K^+) concentration of the river water samples ranged between (2.8-3.2) ppm, (Table 2 and 3).

2-1-2-Sodium Ion Na^+

The main sources of sodium in natural water are from the release of soluble products during the weathering of plagioclase feldspars [7]. In the evaporated deposits, the solution of halite is very important. Under certain condition, the clay minerals release large quantities of exchangeable sodium [9]. All natural water contains measurable quantities of sodium. The source of sodium ion in the Tigris River Water is from the clay minerals, which exist in the study of the soil area and from evaporation deposits. The Sodium Ion (Na^+) concentration of the river water samples in November, 2017, ranges between (68.8-80.2)ppm. Whereas, in February, 2018, the Sodium Ion (Na^+) concentration of the river water samples ranged between (61.3-70.1)ppm. The change of Sodium Ion concentration in Tigris River water samples due to change of clay layers in the studied area. The decrease of (Na^+) concentrations in November due to the dilution process by rainfall, (Table, 2 and 3).

2-1-3-Calcium Ion Ca^{2+}

The primary origin of calcium ion in water is chemical weathering of rocks. Calcium ion is one of the most common cations in water. The source of calcium ion in ground water is calcite, aragonite, dolomite, limestone, gypsum in sedimentary rocks and pyroxene, amphibole, and feldspar in igneous and metamorphic rocks. Calcium cement material is in dissolution of rock fragments and soil [9]. The calcium percent in sedimentary rocks are 30.23 % [20].

The Calcium Ion (Ca^{2+}) concentration of the river water samples in the November, 2017, ranges between (88.2-98.5) ppm. Whereas, in February, 2018, the calcium Ion (Ca^{2+}) concentration of the river water samples ranged between (72.4-75.7) ppm, (Table, 2 and 3).

2-1-4-Magnesium Ion Mg^{2+}

The most abundant constituents of the alkaline earth group of metals, magnesium forms approximately 2.1% weight of the earth's crust [21].

The most usual sources of Mg^{+2} 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. This remainder is probably owing to the slow dissolution of dolomite together with the greater abundance of calcium in the earth's crust [9].

The presence of magnesium ions in the water like that of calcium ions causes hardening of water [11]. The magnesium Ion (Mg^{2+}) concentration of the river water samples in November, 2017, ranges between (22.1-28.4) ppm. Whereas, in February, 2018, the magnesium Ion (Mg^{2+}) concentration of the river water samples ranges between (13.4-15.4) ppm, (Table, 2 and3).

2-2-Major Ions-Anions

2-2-1-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. The first source , chloride comes from the ancient sea water trapped in sediments, the second one, comes from the solution of halite and related minerals in evaporating deposits, the third comes from concentration by evaporation of chloride contributed by rain or snow, and the fourth, comes from the solution of dry fallout from the atmospheres particularly in a ride regions [9]. In surface water, the concentrations of chloride are lower than those of bicarbonate or sulfate. Exceptions occur where water receives inflows of industrial waste or high chloride groundwater [19]. In addition to natural sources, according to [17] chloride ions in drinking water originate also from industrial effluents and sewage, urban runoff containing de-icing salt and saline intrusion. The chloride ion concentration of the river water samples in November, 2017, ranges between (78.5- 90.3)ppm. Whereas, in February, 2018, the chloride ion concentration of the river water samples ranged between (65.4-75.2) ppm, (Table, 2 and3).

2-2-2-Sulfates Ion (SO_4^{2-})

Sulfate ions are mostly recycled from the atmosphere and from the solution of sulfur minerals in sedimentary rocks. Sedimentary rocks, particularity organic shale, may also generate large amount of sulfates through the oxidation of Marcasite and pyrite [9], dissolution of evaporates rocks like gypsum, anhydrite and sulfate sodium. All atmospheric precipitation contains sulfate [9]. The Sulfate ion concentration of the river water samples in November, 2017, ranges between (198.2- 210.5) ppm. Whereas, in February, 2018, the sulfate ion concentration of the river water samples ranged between (150.3-170.6) ppm, (Table, 2 and3).

2-2-3-BicarbonateIon (HCO_3^-), (CO_3^{2-})

Alkalinity is a trusty measure of carbonate and bicarbonate ions for most natural water. The main source of carbon dioxide types that product alkalinity in groundwater or surface water is the CO^2 gas fraction of the atmosphere, or the atmospheric gases present in the dirt or in the unsaturated zone lying between the surface of the ground and the water table [22]. 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 [9]. The bicarbonate (HCO_3) ion concentration of their water samples in November, 2017, ranges between (148.3- 161.8) ppm. Whereas, in February, 2018, the bicarbonate ion concentration of the river water samples ranged between (120.4-135.2) ppm, (Table, 2 and 3).

3-Minor Ions:

3-1- Nitrate (NO_3^-)

Nitrate is a stable ion over a considerable range of conditions and is very mobile in water [7]. The important source is the oxidation by bacteria of nitrogen or nitrogenous substance in decomposing organic matter or sewage [23]. Nitrate also originates from agricultural activities due the use of plant foods and non-agricultural source like animal waste [24].

The nitrate ion concentration of the river water samples in the November, 2017, ranges between (3.6- 5.2) ppm. Whereas, in the February, 2018, the nitrate ion concentration of the river water samples ranged between (3.1- 4.2) ppm, (Table, 2 and 3).

4- Total Hardness (TH):

Total hardness mainly reflects, water contents of calcium and magnesium ion, and it is told by its equivalent from calcium carbonate, according to the next equation, [7], total hardness as:

TH = (Ca + Mg) x 50

Where TH, Ca^{2+} and Mg^{2+} expressed in (epm).

According to [11] and [20]:

TH= 2.497 Ca +4.115 Mg

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

The (TH) values concentration of the river water samples in November, 2017, ranges between (331.5 -345.5) ppm. Whereas, in February, 2018, the (TH) values concentration of the river water samples ranged between (237-253 ppm), (Table, 2 and 3).

5-Total dissolved solid (TDS) classification:

According to [9] and [25] classification water on the base of the (TDS), (Table, 10). All water samples considered in Tigris River water to be of fresh water (TDS<1000 ppm).

Table (10): Classification of Tigris River Water Depending on (TDS) According to [Davis and Dewiest, 1966] and [Drever, 1997].

Water Class	TDS (ppm) [Davis and Dewiest, 1966]	TDS (ppm) [Drever, 1997]	Range of TDS in Tigris River water		Class of water in the Tigris River
			November, 2017	February, 2018	
Fresh water	0-1000	<1000	663-671	520-562	Fresh water
Brackish water	1000-10000	1000-2000			
Salty water	10000-100000	----			
Saline water		35000			
Brine water	>100000	>35000			

6- Water Quality for different purposes:

River water by giving quality is suitable for a particular purpose depends on the criteria or standards of acceptable quality for that use. Quality limits of water supply for industrial purpose, drinking water and irrigation because of its extended development for this purpose [11]. Hence it is necessary to divide water according to the world and local standard specifications to see the suitability of water to the different uses. Tigris River water utilized for different aims, so it is necessary to determine its suitability for the different functions.

6-1-Tigris River water Uses for Human Drinking Purposes:

Usage water for drinking depends on the ionic concentration of water, TDS and other components. The [17] and [26] were used as a standard specification in this

study. When the ionic concentrations exceed the allowable limits for drinking water, water, then is not recommended for drinking. Water quality can be standardized and specified by means of indications expressing the limiting concentrations of relevant components and other water properties with respect to their health effect. At that place values have to be inferred from the character and intensity of impact of the relevant portions of the human organism [27]. The water in Tigris River is suitable as drinking, according to IQS (2009), (Table, 11).

Table (11): Comparison of the River Water in the Studied Area with the [Iraqi standards, 2009] and [WHO, 2008] Standard of Human Drinking Purpose.

Components	Iraqi Standard (2009) (ppm	WHO Standar2008) (ppm	Tigris River Water	
			November, 2017	February, 2018
			Range	Range
PH	6.5-8.5	7-8	7.23-7.35	7.42-7.55
EC	1500	1530	1055-1086	990-1020
TDS	1000	1000	663-671	520-562
TH	500	100-500	331.5-345.5	237-253
Ca^{+2}	100	75-200	88.2-98.5	72.4-75.7
Mg^{+2}	50	30-150	22.1-28.4	13.4-15.4
Na^{+}	200	200	68.8-80.2	61.3-70.1
K^{+}	-	12	3.1-3.8	2.8-3.2
Cl^{+}	350	250	78.5-90.3	65.4-75.2
SO_4	400	250	198.2-210.5	150.3-170.6
HCO_3	-	-	148.3-161.8	120.4-135.2
NO_3	50	50	3.6-5.2	3.1-4.2

6-2-Tigris River Water Uses for Livestock Purpose:

6-2-1- Suitability according to major ions, TDS, and TH

The Tigris River had been evaluated for livestock uses depending on the classification suggested by [28]. This classification is based on some of the major cations and anions, Total Dissolved Solids (TDS), and Total Hardness (T.H) are considered as a base for assessment. On the basis of Altoviski classification the River water is very good for livestock uses for November, 2017 and February, 2018, (Table, 12).

Table (12): Classification of livestock water [Altoviski, 1962].

Elements	Very Good water (ppm)	Good Water (ppm)	Permi (ppm)	Can be used (ppm)	hreshold	River Water	
						Novembr, 2017 Average	February, 2018 Average
Na	800	1500	2000	2500	4000	73.9	65.3
Ca	350	700	800	900	1000	92.1	73.7
Mg	150	350	500	600	700	25.8	14.3
Cl	900	2000	3000	4000	6000	83.5	69.2
SO_4	1000	2500	3000	4000	6000	202.7	162.7
TDS	3000	5000	7000	10000	15000	667.6	545
TH	1500	3200	4000	4700	54000	338	243.8

6-3- River water Uses of Irrigation and Agricultural use:

The standard of Irrigation water depends on the types of plants amount of irrigation water, climate and soil [9]. The suitability of water for irrigation depends upon its own quality as well as upon the other factors. The same quality of water may considered as suitable for a certain type of soil or crop, but is unsuitable for others [29].

6-3-1- Salinity (TDS): The quality of irrigation water which is considered the most significant element is defined by their soluble component which includes its total salt content ionic composition, and presence of minor components. Surface water is classified according to its salinity by (FAO classification) for irrigation water according to its salinity which lies in six categories after [30], (Table, 13).Based on this classification, the Water samples of Tigris River are of class (Slightly Saline) type for both periods.

Table (13): Classification of Irrigation Water According to Salinity [Rhoades, *et.al*, 1992].

Water Class	EC ds/m	TDS (mg/l)	Type of water
Non-Saline	< 0.7	< 500	Drinking and irrigation water
Slightly Saline	0.7-2	500-1500	Irrigation water
Moderate Saline	2-10	1500-7000	Primary drainage water and groundwater
Highly Saline	10-25	7000-15000	Secondary drainage water and groundwater
Very highly Saline	25-45	15000-35000	Very Saline groundwater
Brine	> 45	> 35000	Sea water

6-3-2- Percent Sodium, Na%:

The sodium content is commonly expressed in term of percent sodium. It is an approximation of the sodium hazard of irrigation water, it expresses of sodium out of the total cations. Na% is calculated by the following formula [11]:

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

The concentration is expressed in milliequivalents per liter, based on the [11], classification of irrigation water according to the percent sodium, in the River water samples indicate good irrigation water class for two periods, (14).

Table (14): Classification of Irrigation Water Based on a Na % [Todd, 1980].

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

6-3-3- Sodium Adsorption Ratio (SAR):

The sodium hazard is limited by the absolute and relative concentrations of the cataions and can be measured through the (SAR) sodium adsorption ratio, because of its direct relation to the absorption of sodium of soil [11], it is delimited by:

$$SAR = rNa / [r (Ca+Mg) /2]0.5$$

Classification of irrigation water based on SAR values is shown in table (15) by [11].

Table (15): Classification of Irrigation Water Based on SAR Values [Todd, 1980].

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

On the basis of this classification, all of the River water samples for excellent water class of both periods, in which SAR < 10.0, (Table, 15).

Conclusion:

1- All samples of River water (both for the November, 2017 and February, 2018) do not give any color and odor.

2- All water samples in the study area are generally of low alkalinity, with (pH) value range between (7.23 to 7.55).

3- The temperature value in the River water samples in November, 2017, is (25

C^o). Whereas, in February, 2018, the temperature value is (17.2 C^o).

4- The TDS value in the River water samples in November, 2017, with an average value of (667.6) ppm. Whereas, in February, 2018, it is (545) ppm. All water samples considered in Tigris River water to be of fresh water (TDS<1000 ppm), Salinity decreases through February, 2018, in river water because the dilution of water from rainfall.

5- The EC value in the River water samples in November, 2017, (1072.6) μs/cm. Whereas, in February, 2018, it is (1007.8) μs/cm.

6- The (TH) values concentration of the river water samples in November, 2017, is (338) ppm. Whereas, in February, 2018, the (TH) values concentration of the river water samples is (243.8) ppm, all samples from River are very hard in November, 2017, but all samples from River water is hard in February, 2018.

7- The results of the analysis of major elements (cations and anions) in the River water showed that the predominant ion in the cations is (Ca^{2+}) ion and anions are (SO_4^{2-}) ions.

8- The nitrate ion concentration of the river water samples in November, 2017, is (4.26) ppm. Whereas, in February, 2018, the nitrate ion concentration of the river water samples is (3.44) ppm.

9- Comparing the quality of River water with the standards of different uses shows that water in Tigris River is suitable as drinking, according to IQS (2009). On the basis of Altoviski classification, the River is good for livestock uses. On the SAR basis, Todd, 1980 classification of irrigation water, all samples of the River water belong to excellent water class for both periods.

References

1- **Al-Tameemi, A. Sh. (2004).** Ecological and bacteriological study on Tigris River water and Dijala water south Baghdad. M.Sc., Thesis. College of Science, University of Baghdad, Iraq. (In Arabic).

2- **Al-Mashhadani, Y. D., and Al-Sangari, M. N. (2007).** Some specific characteristics of the Tigris River water within the city of Mosul, Proceedings of the first scientific conference of the Center for Environmental Research and Pollution Control, University of Mosul 5-6 June: 56-66. (In Arabic).

3- **Adewoye, S.O. (2010).** Effects of detergent effluent discharges on the aspect of water quality of ASA river Ilorin, Nigeria. Agre. BIO. J. Of North America, 1 (4): 731-736.

4- **Al-Safawi, A. Y. T. (2007).** Study of the quantity and quality of effluents from the city of Mosul and its impact on the quality of water of the Tigris River, Proceedings of the first scientific conference of the Center for Environmental Research and Pollution Control, University of Mosul 5-6 June: 1-10. (In Arabic).

5- **Mazor, M. (1990**). *Applied Chemical and isotopic groundwater hydrology*, Open University press, New York 274 p.

6- **Stoodly, K. D., Lewis, T., and Staintion, C. L. (1980).** *Applied Statistical technique*, John Wiley and Sons, London.

7- **Hem, J. D. (1985).** *Study and interpretation of the chemical characteristics of natural water*. 3rd Ed. U.S. G.S. Water supply paper. 2254-263 p.

8- **Appelo, C. A. G., and Postma, D. (1999).** *Geochemistry, groundwater and pollution*, Rotterdam: A. A. Balkama, 536 p.

9- **Davis S. N, and Dewiest R.J.M. (1966).** *Hydrogeology*. John Wiley & Sons. Inc New York. 463p.

10- **Pierce, J. J, and Weiner, R. F., Vesilind, P. A. (1998).** *Environmental pollution and control* (4th Ed). Butterworth-Heineman, USA, 392 p.

11- **Todd, D. K.(1980).** *Groundwater Hydrology*, John Wiley, New York, USA, 535 p.

12- **WHO (World Health Organization). (2006).** *Guidelines for Drinking Water Quality (3rd Ed.)* Vol.1, Recommendations, Geneva, 595 p.

13- **Langmuir, D. (1997).** Aqueous environment geochemistry Prentice Hall, USA, 600 p.

14- **Mathers, G. (1982**). The properties of groundwater, Department of Environmental science England, John Wiley and sons Inc., New York, U S A 406 p.

15- **Heath, R. C. (1983**). Basic Ggoundwater Hydrology, U. S. Geological Survey, Water Supply Paper, 220, 86p.

16- **WHO (World Health Organization). (1993).** *Guidelines for Drinking-Water Quality*, 2nd Ed., Vol. 1, recommendations, Geneva, 188 p.

17- **WHO (World Health Organization). (2008).** *Guidelines for drinking water quality*. 3rd Ed., Vol. 1, recommendations, Geneva, 516p.

18- **Walton, C. W. (1970).** *Groundwater Resources Evaluation*, McGraw Hill Co., 664 p.

19- **Hem, J. D. (1989).** *Study and interpretation of the chemical characteristics of natural water* U.S geological survey, water supply paper 2254, 246 P.

20- **Faure, G. (1998).** *Principles and application of geochemistry* (2nd Ed.), Prentice Hall, Inc., USA, P. 600.

21- **Collins A. G. (1975).** *Geochemistry of oil field water*, development in petroleum Science. L, Elsevier, Amsterdam, Holland. 496p.

22- **Ljungberg, V. (2004).** Assessment of Groundwater flow and Pollutant Transport through Modeling. M. Sc. Thesis, Unpublished, College of Science, Stokholm. Sweden. 110 p.

23- **Al-Sawaf, F. D.S. (1977).** Hydrogeology of South Sinjar Plain, Northwest Iraq. Unpublished pH. D. Thesis, University of London.370 P.

24- **Lerner, D. N. (2003).** Estimating Urban Loads of Nitrogen to Ground Water of Hydrology Vol.17, No. 4, pp (239-244).

25- **Drever, J.I. (1997).** *The Geochemistry of natural water, surface and groundwater environments*, (3rd Ed). Prentice Hall, USA, 436p.

26- **Iraqi standards (2009).** *Iraqi Standard of Drinking Water* No. 417modification No.1.

27- **Jerman, M. K. (1987).** Development in water science, Water Resources and Water Management, Elesever publ. Inc.385p.

28- **Altoviski, M.E. (1962).** Handbook of Hydrogeology, Gosgoelitzdat, Moscow USSR. 614p.

29- **Van Hoorn, J. W. (1970**). *Quality of irrigation water, limits of use and prediction of long term effects*, salinity seminar Baghdad, Irrigation and Drainage paper No. 7, FAO, pp 117-135.

30- **Rhoades, J. D., Kandiash, A., Mashali, A. M. (1992** The use of saline water for crop production. Irrigation and drainage paper, No.48, FAO, Rome, Italy.