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Environmental Study of Groundwater Quality of Selected Wells in Al-Zubair, Southern Iraq and their Uses

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Abstract

Twenty-five groundwater samples from the Al-Zubair area, southern Iraq, were analyzed for physical and chemical variables. The study showed that the groundwater is of acidic type and in it tends towards light alkalinity. Both electrical conductivity and the total dissolved solids showed increased concentrations of sodium, calcium, magnesium, potassium and sulfate, chloride, bicarbonate, and nitrate. The hydrochemical formula for most groundwater wells are (Ca-Cl), (Ca-SO4), (Mg-SO_4), and (Na-Cl) type due to the high concentrations of these ions in the water., it was found that this water is not suitable for human drinking. Due to its high salinity compared to the requirements of international standard and Iraqi standard standards, while it is suitable for drinking animal's construction purposes, it has not exceeded the permissible limits. Also, it has been found that this water is not suitable for industrial and irrigation purposes, where it is possible to grow crops that tolerate high salinity

Keywords: Water type, groundwater, irrigation water, chemical formula

دراسة بيئية لنوعية المياه الجوفية في بعض الابار المختارة في الزبير، جنوبي واستعمالاتها

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الخلاصة

تم اختيار 25 عينة من المياه الجوفية لأبار مختارة من منطقة الزبير جنوب العراق لمعرفة نوعية المياه خلال تحديد المتغيرات الفيزيائية والكيميائية. أظهرت النتائج أن المياه الجوفية في منطقة الدراسة حمضية حيث تميل نحو القلوية الخفيفة. هناك زيادة في تركيز كلا من التوصيلية الكهربائية والمواد الصلبة الذائبة في بعض مياه تلك الابار . اظهرت دراسة تراكيز الايونات: الصوديوم والكالسيوم والمغنيسيوم والبوتاسيوم والكبريتات والكلوريد والبيكربونات والنترات. وكذلك الصيغة الهيدروكيميائية ان مياه معظم الابار الجوفية كانت من نوع (Ca–Cl) و (Ca–SO4) و ($Mg - SO_4$)و (Na–Cl) وعلى التوالي بسبب التراكيز العالية لهذه الأيونات في الماء. وعند مقارنة النتائج البحث مع متطلبات منظمة الصحة العالمية والمواصفة العراقية تبين أن هذه المياه غير صالحة للاستهلاك البشري كمياه شرب . نظرا لارتفاع ملوحتها ، الا انها مناسبة للاستهلاك الحيواني ، لأن

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جميع العناصر والمواد الصلبة الذائبة تقع ضمن حدود مقبولة. في حين أنها تصلح للأغراض الإنشائية ، لأن جميع عناصرها لم تتجاوز الحدود المسموحة ، لذلك فقد وجد أن هذه المياه هي غير صالحة ايضا للأغراض الصناعية والري ،., ويمكن استخدامها لري المحاصيل التي تتحمل الملوحة العالية

Introduction :

Groundwater is the second main water source worldwide. The composition of groundwater is subject to the influence of many climatic factors, topography and hydrographic nature. However, the main effect on groundwater quality is through the chemical composition of the water-bearing rocks and the chemical composition of the deep water that participates in feeding the water-bearing levels located at the top and coming to it through the weak permeability separating layers [1]. Therefore, one of the most important objectives of this research is to study the hydrochemical situation prevailing in the study area, its physical and chemical properties.

Previous study

1- (Nasif and Mahmoud, 2015) [2]. , he studied some wells in Samarra, and the results showed that pH tends to be light alkaloid and that the positive ions have different concentrations and negative ions are located within the natural waters

2- (Aziz, 2018): [3]. It studied the groundwater west of the city of Karbala and found that the percentage of salts and electrical conductivity is high and that the hydrochemical formula for all wells is $CaSO_4$ and that the water is not suitable for drinking

3- (Al-Khafaji et al., 2020) [4] Study of the water wells in the city of Maysan, it was found that the water tends to be slightly acidic, and an increase in salinity and electrical conductivity was found, and the water was not suitable for human drinking

4- (Saad and Adnan, 2020) [5] found during their study of groundwater in the Zubair area that most water was of the type of sodium sulfate. The study showed that the water was not suitable for drinking and that the water was of the average salinity class for irrigation depending on the values of total dissolved solids and electrical conductivity

5- (Mithaq and Muhannad 2021) [6] studied the determination of clay minerals using gamma-ray spectroscopy for the Zubair Formation in Southern Iraq. It has been recognizedSandstone oil reserves are composed of various clay minerals, including kaolinite, illite, and chlorite. These clay minerals have a significant effect on reservoir quality. The upper sandstone member (USS) of Zubair Formation**.**

Study area

Al-Zubayr is located in the far south of Iraq within the Basra Governorate, where it is located within the Arabian Desert in the southern part of it. The region is a flat plain where it slopes towards the northeast. The region contains different geomorphological features, including the presence of shallow valleys, which become a watercourse after the rains. Also, the region contains sand dunes that spread in the south and southwest parts, and the region contains a unique geomorphological feature. It is the presence of Mount Sanam, which is in a circular shape, and its height is about 150 meters above sea level [7]. It is apparent from hydrology that the groundwater is present in the upper part of the Dibdiba formation, which consists of sand and gravel, and it is the main underground reservoir in the Al-Zubair region.

Geology of the area:

The study area and the surroundings are entirely covered by sedimentary rocks of the Cenozoic Era, ranging in age from the Early Eocene to recent Quaternary sediment. Lithological, the following stratigraphic sequence exists:

1- Rus formation (Early Eocene): The Rus formation corresponds to beds previously assigned to the Dammam formation [8]. It comprises recrystallized limestone, which is partly silicified. In the Mesopotamian zone of southern Iraq, the formation consists predominantly of anhydrite with some unfossiliferous limestone, blue shale and marl (9)The formation is not exposed in the study area.

2- Dammam formation (Middle-Late Eocene): It is the only exposed formation of Paleogene Epoch in the study area. It is comprised of limestone, dolomite, marl, and shale. Dammam formation is deposited in the carbonate inner shelf lagoon and shoal] 8]

3- Euphrates formation (Early Miocene): The formation comprises shelly, chalky, well-bedded, recrystallized limestone[9]. The geological conditions of this formation, represented by the abundance of openings and interstitial spaces as a result of the dissolution of limestone, contributed to the formation of this reservoir as an important groundwater reservoir.

4- Nafayil formation (Middle Miocene): The section of Nafayil formation is of a composite type. The lower member is in Garat Nafayil south of Haditha, whereas the upper member is exposed 3km west of Al-Habbania lake. The lower member of the Nafayil formation is exposed in the study area in a limited location, forming Mesas and small spots that overly Euphrates formation to the east of Sawa Lake. Only the lower member of the Nafayil formation, which consists of cyclic deposits, is exposed in the study area.

5- Quaternary sediments: The quaternary deposits consist of the Pleistocene and the Holocene sediments. These deposits cover the study area, marine, river and air sediments, and their thickness ranges from 140 to 200 meters. These sediments are characterized by their high permeability, which helps to filter surface water to the underground layers that can be reservoirs of ground

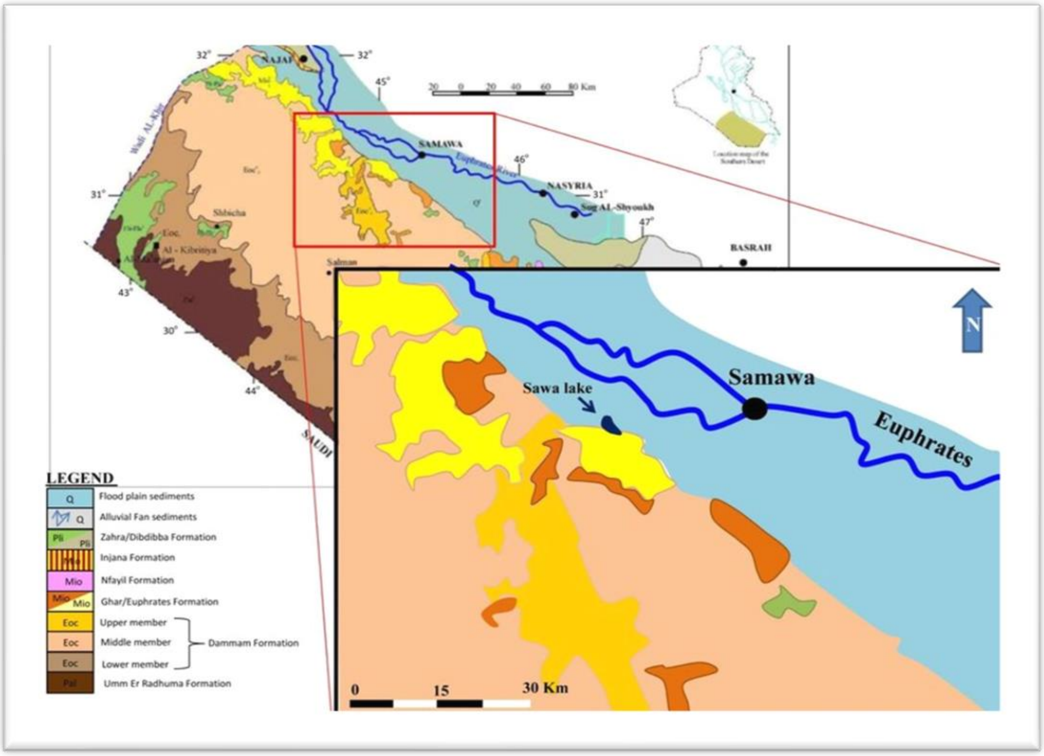

Figure 1: Geological map of the study area [10]

Materials and methods:

Twenty-five wells were selected to study the groundwater system according to the established laboratory conditions. The samples were taken from the wells that were dug by the (Public Groundwater Corporation of the Ministry of Water Resources) in 2020. Depth of the wells was 13.56. Electrical conductivity, pH, total dissolved salts, cations (Ca^{+2}, Mg^{+2}, Na^{+}, K^{+}), and anions (Cl^{-}, SO_4^{2}, $H\text{-}CO_3^{-}$) analyzes were carried out in the General Authority for Drilling Wells and Subsidiary (Groundwater for the Ministry of Water Resources), a guide of meroxide and aerochrome black Tea (EB T) and a (Flame Photometer) device were used to measure sodium, potassium, chloride ducted by correcting it with ($AgNO_3$) and the total dissolved salts were measured by using the gravimetric method by drying and electrical connection to an electrical conductivity device and the acid function device (pH- Meter). Figure 2 shows the site for taking samples

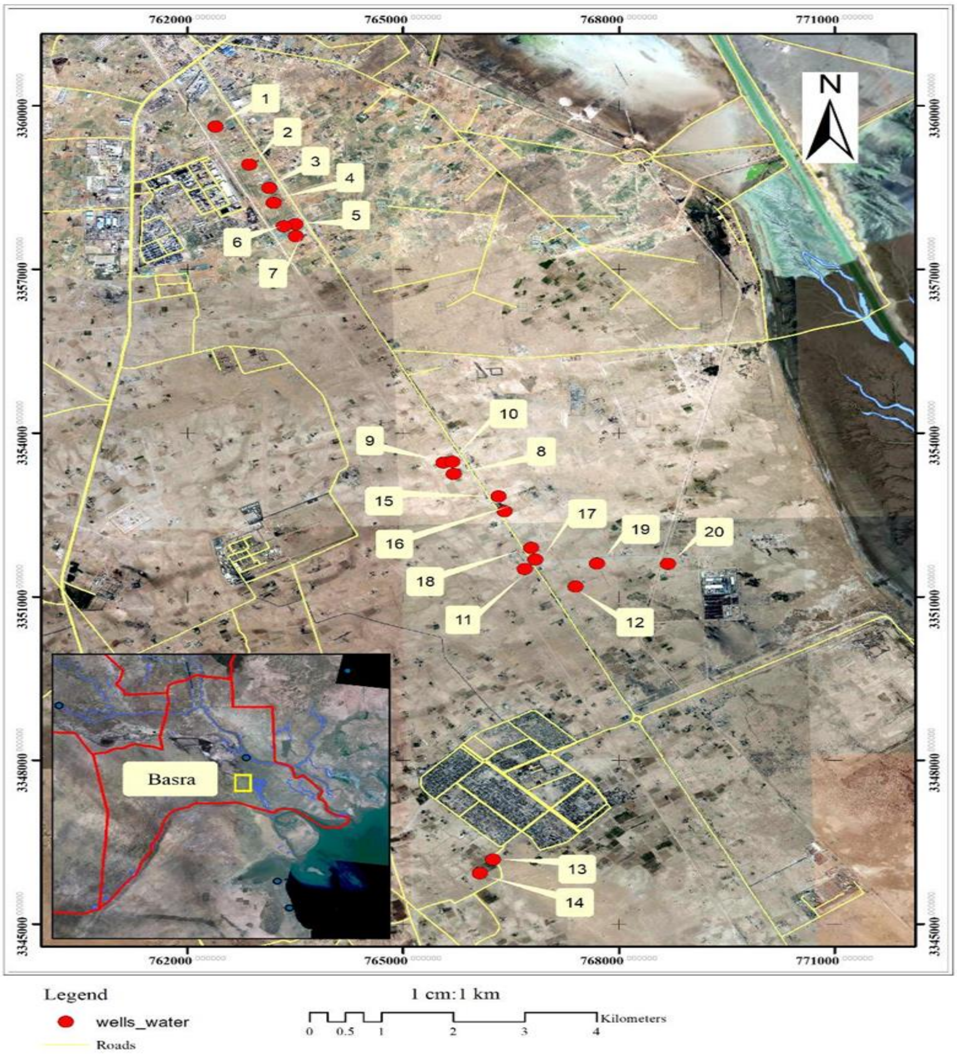

Figure 2: map of sites samples

Results and discussion:

Physical properties:

The acidic function (pH) is the negative logarithm of the concentration of the hydrogen ion, and it is considered a measure of the acidity and basicity in normal temperature and pressure [10]. The highest value pH. was in Well No. (1). This reached (8.7), and the lowest value was in Wells No. (2) (7.1). Table. (1) . Electrical conductivity (EC): The conductivity of (1) cm3 of groundwater to the electric current at (25) centigrade, where it reached (15400µs / cm) in well no. (1) and (6150µs / cm) in well no. (13), and the average was (µs/cm9530). The increased electrical connection in wells in the study area is high electrical conductivity and water impurities. Water samples are classified as overly mineralized water (Tables 1 and 2). Total dissolved Solids (TDS) can be defined as all dissolved solids in groundwater, whether ionized or non-ionized, and it does not include dissolved gases, suspended and colloidal substances (15). As for salinity, it is the concentration of dissolved salts in the water, estimated in units (ppm). Its highest value was in Well no. (17) (57320), and its lowest value was in Well no. (21) (31). The high concentrations of dissolved solids (TDS) in most of the water in the study area are due to its impact on evaporation processes because it is of low depth Table. 1**:**

Table. 1: the physical characteristics of groundwater for the study area

No.	pH	EC (µs\cm)	TDS (mg/l)
1	8.7	15400	**10980**
2	7.1	10760	**7750**
3	7.3	8260	**6820**
4	7.3	8520	**6190**
5	7.3	8700	**6230**
6	7.2	8760	**6350**
7	7.3	12290	**8690**
8	7.3	12330	**8740**
9	7.5	8540	**6090**
10	7.3	12980	**9190**
11	7.4	11450	**8090**
12	7.4	7400	**6090**
13	7.4	6150	**4940**
14	7.5	10220	**7030**
15	7.8	9670	**7480**
16	7.7	8140	**5430**
17	7.6	9490	**7250**
18	7.6	9920	**7180**
19	7.7	7110	**5930**
20	7.6	8030	**6590**
21	7.6	7580	**5690**
22	7.4	9230	**6830**
23	7.5	8730	**6330**
24	7.6	9240	**5600**
25	7.6	9300	**5580**

Chemical properties:

Captions

Calcium Ca^{2+}: It is one of the most widespread alkaline earth elements, and it is considered one of the basic elements of plants and animals; and it comes from the chemical weathering of rocks and minerals that contain this ion, represented by the minerals of igneous rocks such as pyroxene, amphibole, and feldspar, as well as sedimentary rocks minerals such as calcite, dolomite, aragonite, fluorite, and gypsum [11]. the highest concentration of this ion (1162.3) mg/l in Well No. (10) and the lowest value (204.8) mg/liter in Well No. (20). The average concentration was (672.7) mg/liter Table No. (3)

Magnesium Mg^{+2}: It is the main element in dolomite besides calcium, also the second most important element in carbonate mineral. It is also found in ferromagnesian minerals of igneous rocks such as olivine, pyroxene, amphibole, and clay minerals, which are the source of magnesium ions in water [12]. The results showed the highest percentage of Mg in well No 20 (582.7), and an average of (133.4) mg/liter in well No13 and the average was (253.2) (mg/l). (Table (3) the high concentration of magnesium ions in areas is due to the effect of the ion exchange process and the effect of evaporation processes. It is considered a source of magnesium ion in agricultural areas[13]

Sodium Na^{+1}: This ion is found in groundwater due to the dissolution of plagioclase minerals and evaporation such as halite, as well as the weathering of clay minerals [14]. (the highest sodium concentration is (538.2) mg/liter in well No. (15). The lowest concentration was 203 mg/l in well No. (3) The average was (366.1) mg/liter (Table (3). The high sodium concentration in the water is due to the dissolution of the concentrated sodium salts in the soil [13].

Potassium k^{+}: It is one of the alkaline metals and is considered less abundant than sodium and comes from chemical weathering of minerals containing potassium such as feldspar, orthoclase, and microcline, and is found in evaporate such as sulfite [15]. the highest potassium ion concentration reached (64.6) mg/liter in Well No. (15). The lowest concentration was 29.3 mg/l in Well No. (3), and the average was (42.3) mg/l (Table (3), meaning an increase of potassium ions in the groundwater. It may be due to chemical fertilizers or the natural quality of the evaporation in the water reservoir.

Table. 3: the cationic ions concentrations of groundwater in the study area sites

Well no.		Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	∑Cations
1	Ppm	881.6	328.3	383.4	49.6	**849.9**
	Epm	44.1	27.1	16.7	2.6	**90.5**
	epm%	48.7	29.9	18.5	2.9	**100**
2	Ppm	861.7	267.3	232.8	38.7	**1400.5**
	Epm	43.1	22.3	10.1	2	**77.5**
	epm%	55.6	28.8	13	2.6	**100**
3	Ppm	701.4	535.9	201.1	29.3	**1467.7**
	Epm	35.1	44.7	8,7	2	**90.5**
	epm%	38.8	49.4	9.6	2.2	**100**
4	Ppm	921.8	242.9	205.4	39.1	**1409.2**
	Epm	46.1	20.3	9	2.1	**80.5**
	epm%	57.3	25.2	11.2	2.6	**100**
5	Ppm	741.5	157.7	209.2	37.3	**1145.7**
	Epm	37.1	13.1	9.1	2	**61.3**

	epm%	60.5	21.4	14.8	3.2	**100**
6	Ppm	962	145	203	34	**1344**
	Epm	48.1	12.1	8.9	2	**71.1**
	epm%	67.7	17	12.5	2.8	**100**
7	Ppm	1102	230.4	329.6	44	**1706**
	Epm	55.1	19.2	14.3	2.3	**90.9**
	epm%	60.6	21.1	15.7	2.5	**100**
8	Ppm	1082.2	218.3	328.3	47.4	**3576.2**
	Epm	54.1	18.2	14.3	2.5	**89.1**
	epm%	60.7	20.4	16	2.8	**100**
9	Ppm	721.4	291.9	247.1	41.6	**1302**
	Epm	36.1	42.3	10. 7	1.2	**90.3**
	epm%	40	46.8	12	1.3	**100**
10	Ppm	1162.3	303.6	244.8	49	**1759.7**
	Epm	58.1	25.3	10.6	3	**97**
	epm%	59.9	26.1	11	3.1	**100**
11	Ppm	1042.1	145.1	316.6	40.7	**4393.9**
	Epm	52.1	12.1	13. 8	2.1	**80.1**
	epm%	65	15.1	17.2	2.6	**100**
12	Ppm	681.6	255.2	252.3	36.7	**1225.8**
	Epm	34.1	21.2	11	2	**68.3**
	epm%	50	31	16	3	**100**
13	Ppm	681.4	133.4	219.1	43.7	**1077.6**
	Epm	34.1	11.1	10	2.3	**57.5**
	epm%	59.3	19.3	17.4	4	**100**
14	Ppm	741.5	169.9	243.2	54.7	**1209.3**
	Epm	37.1	14.2	11	3	**65.3**
	epm%	56.8	21.7	16.8	4.6	**100**
15	Ppm	621.2	304.2	538.2	64.6	**1528.2**
	Epm	31.1	25.4	26	3.4	**85.9**
	epm%	36.2	29.6	30.3	4	**100**
16	Ppm	701.4	60.1	472.2	55.3	**1289**
	Epm	35.1	5	21	3	**64.1**
	Epm%	54.8	7.8	18.7	4.7	**100**
17	Ppm	721.4	316.3	492.3	45.7	**1575.7**
	Epm	36.1	26.4	21.4	3	**86.9**
	Epm%	41.5	30.4	24.6	3.5	**100**
18	Ppm	841.7	206.4	530.5	47.6	**1626.2**
	Epm	42.1	17.2	23.1	3	**85.4**
	Epm%	49.3	20.1	27	3.5	**100**
19	Ppm	621.2	279.9	440.1	39	**1380.2**
	Epm	31.1	23.3	19.1	2	**75.5**
	Epm%	41.2	30.9	25.3	2.7	**100**
20	Ppm	204.8	582.7	476.4	45.1	**1309**

	Epm	10.2	48,6	20.7	2.3	**81.8**
	Epm%	12.5	59.4	25.3	2.8	**100**
21	Ppm	701.4	145.5	482.1	42.9	**1371.9**
	Epm	35.1	12.1	21	2.3	**70.5**
	Epm%	49.8	17.4	29.8	3.3	**100**
22	Ppm	801.6	255.2	529.8	45.2	**1309**
	Epm	40.1	21.3	23	2.4	**86.8**
	Epm%	46.2	24.5	26.5	2.8	**100**
23	Ppm	821.6	267.4	477	41.9	**1607.9**
	Epm	41.1	22.3	21	2.2	**86.6**
	Epm%	47.5	25.8	24.2	2.5	**100**
24	Ppm	741.5	230.9	531.1	43.1	**1546.6**
	Epm	37.1	19.3	23.1	2.3	**81.8**
	epm%	45.3	23.6	28.2	2.8	**100**
25	Ppm	721.4	255.3	537.6	43.2	**1557.5**
	Epm	36.1	21.3	23.4	2.3	**83.1**
	Epm%	43.4	25.6	28.2	2.8	**100**

Negative ions (Anions)

Sulfate SO_4^{-2}: This ion may be found in the water as a result of the evaporite dissolving. It also and also produced from the oxidation of pyrite in the shale and clay [16]. The highest rate in well No. (15) reached (3696) mg. / l and less forgotten in well No. (11), where it reached (1824) mg/liter, and the average was (2116.3) Table (4). the increase in the sulfate ion (SO_2) is due to the effect of the destruction of materials that contain sulfur salts and fertilizers. Chemicals and cleaning materials in addition to the presence of sulfur salts in the soil [17]

Chloride (Cl^-): The sources of this ion vary in the water between the magmatic water and the ancient marine waters in the pores of sedimentary rocks resulting from the dissolving of the halite mineral and the process of evaporation [18] the highest concentration in well No. (10) (5098.4) mg / l. The lowest value was in well No. (6), which was (1199.6) mg/liter, and the average was (2355.3) mg/liter. (Table. 4) the increase in chloride ion concentration is derived from the natural origins of chloride in waters are attributable to the leaching of salts from underlying rock strata (mostly sedimentary rocks of marine origin).

Bicarbonate (HCO_3^-): This ion is a source of alkalinity, and it refers to the ability of water to interact with (H^+). As for total alkalinity, [19] and the highest percentage for it was in well No. (3). It was 854 mg/liter, and the lowest percentage was in well No. (21), and it was (183) mg/l. It reached (242.2) mg/liter (Table 4). The reason for its increased concentration is due to the dissolution of sodium bicarbonate present in the soil [20]

Nitrates : NO_3^-: Most of the nitrates in the groundwater come from the decomposition of organic materials, agricultural activities, and chemical fertilizers (28). Some bacteria oxidize the ammonia in the soil to nitrite and then into nitrate, called nitrification [21]. The highest concentration of nitrates in the water of the study area was (7.8) mg/liter in well No. (6), and the lowest concentration was (3.3) mg/liter in well No. (3). The general average nitrate concentration in the studied water(was 0.6 mg/liter. (Table 4) the increase in nitrate concentration in some of the studied samples is attributed to agricultural fertilizers [22].

Table. 4: the concentrations of anions in groundwater of the study area

No.		NO_3^-	CO_3^{-2}	HCO_3^-	SO_4^{-2}	Cl^-	∑Cations
1	Ppm	5.3	90	427	2064	4498.6	**70849**
	Epm	0.1	3	7	43	126.7	**179.8**
	epm%	0.1	1.7	3.8	23.9	70.5	**100**
2	Ppm	5.3	240	793	960	2599.2	**45975**
	Epm	0.1	8	13	20	73.2	**114.3**
	epm%	0.1	7	11.4	17.5	64	**100**
3	Ppm	3.3	180	854	3360	2249.3	**6646.6**
	Epm	0.1	6	14	70	63.3	**153.4**
	epm%	0.1	3.9	9.1	45.6	41.3	**100**
4	Ppm	5.2	180	518.5	2400	1949.4	**5053.1**
	Epm	0.1	6	8.5	50	54.9	**119.5**
	epm%	0.1	5	7.1	41.8	45.9	**100**
5	Ppm	6.3	240	549	2496	1699.5	**4990.8**
	Ppm	0.1	8	9	52	47.9	**117**
	epm%	0.1	6.8	7.7	44.4	40.9	**100**
6	Ppm	7.8	180	579.5	2640	1999.4	**5406.7**
	Epm	0.1	6	9.5	55	56.3	**126.9**
	epm%	0.1	4.7	7.5	43.3	44.4	**100**
7	Ppm	7.9	120	366.1	1920	4398.6	**6812.6**
	Epm	0.1	4	6	40	123.9	**174**
	epm%	0.1	2.3	3.4	23	71.2	**100**
8	Ppm	7.4	120	396.6	2208	4098.7	**6830.7**
	Epm	0.1	4	6.5	46	115.4	**172**
	epm%	0.1	2.3	3.8	26.7	67.1	**100**
9	Ppm	8	90	579.7	1920	2449.2	**5046.9**
	Epm	0.1	3	9.5	40	69	**121.6**
	epm%	0.1	2.5	7.8	33	56.7	**100**
10	Ppm	7	150	610.2	1920	5098.4	**7785.6**
	Epm	0.1	5	10	40	143.6	**196.2**
	epm%	0.1	2.5	5.1	20.4	73	**100**
11	Ppm	6.2	60	549.2	1824	4048.7	**6488.1**
	Epm	0,1	2	9	38	114	**163.1**
	epm%	0.1	1.2	0.5	23.3	69.9	**100**
12	Ppm	4.9	60	518.7	2160	2099.3	**4842.9**
	Epm	0,1	2	8.5	45	59.1	**114.7**
	epm%	0.1	1.7	7.4	50.9	51.5	**100**
13	Ppm	3.9	90	274.6	2160	1399.6	**3928.1**
	Epm	0.1	3	4.5	45	39.4	**92**
	epm%	0.1	3.3	4.9	48.9	42.8	**100**
14	Ppm	2.7	90	701.7	2256	1749.4	**4799.8**

	Epm	0.1	3	11.5	47	49.3	**110.9**
	epm%	0.1	2.7	10.4	48.9	44.5	**100**
15	Ppm	6.7	30	335.5	3696	1799.4	**5867.6**
	Epm	0.1	1	5.5	77	50.6	**134.2**
	epm%	0.1	0.7	4.1	57.3	37.7	**100**
16	Ppm	7.1	30	305	2352	1399.6	**4093.7**
	Epm	0.1	1	5	49	39.4	**94.5**
	epm%	0.1	1.1	5.3	51.9	41.7	**100**
17	Ppm	6.3	15	228.8	3312	2049.4	**4743.5**
	Epm	0.1	0.5	3.8	69	57.7	**131.1**
	epm%	0.1	0.4	2.9	52.6	44	**100**
18	Ppm	6.4	30	213.5	3072	2149.3	**5471.2**
	Epm	0.1	1	3.5	64	60.6	**129.2**
	epm%	0.1	0.8	2.7	49.5	46.9	**100**
19	Ppm	5.8	30	213.5	3024	1199.6	**4472.9**
	Epm	0.1	1	3.5	63	33.8	**101.4**
	epm%	0.1	1	3.5	62.1	33.3	**100**
20	Ppm	5.8	30	244	3456	1499.5	**4472.8**
	Epm	0.1	1	4	72	42.5	**119.6**
	epm%	0.1	0.8	3.3	60.2	35.5	**100**
21	Ppm	6.7	30	183	2640	1349.6	**4209.3**
	Epm	0.1	1	3	55	38	**97**
	epm%	0.1	1	3.1	56.7	39.2	**100**
22	Ppm	6.7	30	305	2784	1999.4	**5125.1**
	Epm	0.1	1	5	58	56.3	**120.4**
	epm%	0.1	0.8	4.2	48.2	46.8	**100**
23	Ppm	6	30	305	2544	1799.4	**6684.4**
	Epm	0.1	1	5	53	50.6	**109.7**
	epm%	0.1	0.9	4.6	48.3	46.1	**100**
24	Ppm	6.2	30	244	1872	1749.5	**1749.5**
	Epm	0.1	1	4	39	49.2	**93.3**
	epm%	0.1	1.1	4.3	41.8	52.7	**100**
25	Ppm	6.4	30	244	2112	1549.5	**3941.9**
	Epm	0.1	1	4	44	43.6	**92.7**
	epm%	0.1	1.1	4.3	47.5	47	**100**

Hydrochemical formula and type for hydration:

The hydrochemical formula for water by the main positive and negative ions in units (equivalents per million%). The TDS in units (mg/l) and the value of the acidic function (pH) [23] It was noted from Table (5) that the main type of water in the study area is Ca –Cl and the other is Ca-SO4 and to a lesser extent there is Na – Cl and Mg-SO_4 type due to the presence of amounts of dissolved ions of Na^{++} ion), (Mg^{++}) (Table 5)

Table. 5: the hydrochemical formula of groundwater wells in the study area

Samples	Formula kurlov	Type water

1	10980 $\frac{Cl(70.5)SO4(23.9)}{Ca(48.7)Mg(29.9)Na(18.5)}$ 8.7	**Mg- Ca-SO₄-Cl CaCl₂**
2	7750 7.1 $\frac{Cl(64)SO4(17.5)}{Ca(55.6)Mg(28.8)}$	**Mg-Ca - -SO₄-Cl CaCl₂**
3	6820 $\frac{SO4(45.6)Cl(41.3)}{Mg(49.4)Ca(38.8)}$ 7.3	**Mg-Ca-Cl-SO₄ MgSO4**
4	6190 $\frac{Cl(45.9)SO4(41.8)}{Ca(57.3)Mg(25.2)}$ 7.3	**Mg-Ca-Cl-SO₄ CaSO4**
5	6230 $\frac{SO4(44.4)Cl(40.9)}{Ca(60.5)Mg(21.4)}$ 7.3	**Mg-Ca-Cl-SO₄ CaSO4**
6	6350 7.2 $\frac{Cl(44.4)SO4(43.3)}{Ca(67.7)Mg(17)}$	**Na-Ca-Cl-SO₄ CaCl₂**
7	8690 $\frac{Cl(71.2)SO4(23)}{Ca(60.6)Mg(21.1)Na(20)}$ 7.3	**Na-Mg-Ca-Cl-SO₄ CaSO₄**
8	8740 $\frac{Cl(67.1)SO4(26.7)}{Ca(60.7)Mg(20.4)Na(16)}$ 7.3	**Na-Mg-Ca-Cl-SO4 CaCl₂**
9	6090 $\frac{Cl(56.7)SO4(33)}{Ca(40)Mg(46.8)}$ 7.5	**Mg-Ca-Cl-SO₄ CaCl₂**
10	9190 $\frac{Cl(65.5)SO4(73)}{Ca(59.9)Mg(26.1)}$ 7.3	**Mg- Ca- Mg – Cl Ca Cl₂**
11	8090 $\frac{Cl(69.9)SO4(23.3)}{Ca(65)Na(17.2)Mg(15.1)}$ 7.4	**Na-Mg-Ca-Cl-SO4 NaCl**
12	6090 $\frac{Cl(51.5)SO4(50.9)}{Ca(50)Mg(31)Na(16)}$ 7.4	**Na-Mg-Ca-Cl-SO₄ Ca Cl₂**
13	4940 $\frac{SO4(48.9)Cl(42.8)}{Ca(59.3)Mg(19.3)Na(17.4)}$ 7.4	**Na-Mg-Ca-Cl-SO4 Ca S0₄**
14	7030 7.5 $\frac{SO4(48.9)Cl(44.5)}{Ca(56.8)Mg(21.7)Na(16.8)}$	**Na-Mg -Ca- Cl-SO₄ CaSO₄**
15	7480 $\frac{SO4(57.3)Cl(37.7)}{Ca(36.2)Na(30.3)Mg(29.6)}$ 7.8	**Mg-Na-Ca- Cl Ca SO₄**
16	5430 $\frac{SO4(51.9)Cl(41.7)}{Ca(54.8)Na(18.7)}$ 7.7	**Mg-Ca- Cl-SO₄ Ca SO₄**
17	7250 $\frac{SO4(52.6)Cl(44)}{Ca(36.1)Mg(26.4)Na(21.4)}$ 7.5	**Na-Mg-Ca- Cl-SO₄ Ca SO₄**
18	7180 $\frac{SO4(49.5)Cl(46.9)}{Ca(49.3)Na(27)Mg(20.1)}$ 7.6	**Mg-Na-Ca- Cl-SO₄ Ca SO₄**

19	5930 $\frac{SO4(62.1)Cl(33.3)}{Ca(41.2)Mg(23.3)Na(19.1)}$ 7.7	**Mg-Na-Ca- Cl-SO₄ Ca SO₄**
20	6590 $\frac{SO4(60.2)Cl(35.5)}{Mg(59.4)Na(25.3)}$ 7.6	**Mg-Na-Ca- Cl-SO₄ Mg SO₄**
21	5690 $\frac{SO4(56.7)Cl(39.2)}{Ca(49.8)Na(29.8)Mg(17.4)}$ 7.6	**Mg-Na-Ca- Cl-SO₄ Ca SO₄**
22	6830 $\frac{SO4(66.1)Cl(46.8)}{Ca(49.1)Na(32.4)Mg(15.6)}$ 7.4	**Mg-Na-Ca- Cl-SO₄ Ca SO₄**
23	6330 $\frac{SO4(60.4)Cl(42.7)}{Ca(46.2)Na(26.5)Mg(24.5)}$ 7.5	**Mg-Na-Ca- Cl-SO₄ Ca SO₄**
24	5600 $\frac{Cl(52.7)SO4(41.8)}{Ca(45.3)Na(28.2)Mg(23.6)}$ 7.6	**Mg-Na-Ca- Cl-SO₄ Ca SO₄**
25	5580 $\frac{SO4(47.5)Cl(47)}{Ca(43.4)Na(28.2)Mg(25.6)}$ 7.6	**Mg-Na-Ca- Cl-SO₄ Ca SO₄**

1- Human drinking: The assessment of the validity of the water in the study area for human drinking and its contents were compared with the Iraqi standard specifications for the year 2009[24] and international standard specifications(WHO) for the year 2017 [25] (Table 6).

Table 6: The validity of groundwater for drinking purposes

Variables		The average of variables in Water of study area	International specifications (WHO 2017)	Iraqi specifications 2009
PH		7.5	9.5 – 6.5	**8.5 – 6.5**
EC µs/cm		9528	1530	**1530**
T.D.S	(ppm)	6942.8	1000	**1000**
Ca^{+2}	(ppm)	672.7	75	**150**
Mg^{+2}	(ppm)	253.2	100	**100**
Na^{+}	(ppm)	366.1	200	**200**
K^{+}	(ppm)	42.3	12	**12**
SO_4^{-2}	(ppm)	2116.3	250	**400**
Cl^{-}	(ppm)	2355.3	250	**350**
HCO_3^{-}	(ppm)	242.2	400	**400**

The above Table notes that groundwater in the study area is not suitable for human drinking due to the high salinity and exceeding all the permissible limits for cations and anions

2- To drink animals

The validity of the groundwater for drinking animals or for animal husbandry, the results shows

Table 7: Specifications of the water used for drinking animals

Elements (ppm)	Results of the studied area	the highest rate	Can be used	Permitted water	Good water	Very good water

Na^{+}	366.1	400	2500	2000	1500	**800**
Ca^{+2}	672.7	1000	900	800	700	**350**
Mg^{+2}	253.2	700	600	500	350	**150**
Cl^{-}	2355.3	6000	4000	3000	2000	**900**
SO_4^{-2}	2116.3	6000	3000	3000	2500	**1000**
TDS	6942.8	15000	10000	7000	5000	**3000**

that the groundwater in the study area is suitable for drinking animals for their breeding, as all elements and dissolved solids did not exceed the permissible limits for animal drinking, which were set by [26].

3- For industrial purposes:

The validity of groundwater for industrial purposes and the results of chemical analyzes of water in the study area were compared with the standard specifications for water used in various industries, which are mentioned in 26 and (Table 8).

Table 8: Suggested limits for water used for some industrial purposes [26]

Industry type **variable (ppm)**	**The rate in the studied area**	**Paper Industry**	**Textile industries**	**Petroleum products**	**Fruit industry**
Ca^{+2}	672.7	20	100	75	**-**
Mg^{+2}	253.2	12	50	30	**-**
Cl^{-}	2355.3	200	500	300	**250**
HCO_3^{-}	242.2	-	250	-	**-**
SO_4^{-2}	2116.3	-	100	-	**250**
TDS	6942.8	-	1000	1000	**500**
PH	7.5	10 – 6	8 -6.5	9 -6	**6.8 – 6.5**

Table 8 shows that groundwater is unsuitable for industrial purposes, and its quality can be improved by adding some chemical conditioners.

4- For building and construction purposes

The validity of groundwater in the study area for construction and construction purposes was compared with classification [27] and (9) (Table 9).

Table 9: the permissible limit for construction purposes for different ions

Ions	**The average in the studied area**	**Permissible limit**
Na^{+}	366.1	**1160**
Ca^{+2}	672.7	**437**
Mg^{+2}	253.2	**417**
Cl^{-}	2355.3	**2187**
SO_4^{-2}	2116.3	**1460**
HCO_3^{-}	242.2	**350**

The results show that there is a possibility for the use of groundwater in the study area for construction purposes because the elements are within the permissible limit

6- **Irrigation purposes**: The standard specifications for irrigation water are represented by classification[28]and (Table 10).
7-

Table 10: The usual range for irrigation purposes compared with the values of the current study

Totals	Variable	The average in the studied area	The standard term	Unit
Salinity	EC	9528	3000 – 0	**s/cmμ**
	TDS	6942.8	2000 – 0	**Ppm**
Positive ions	Mg^{+2}	21.64	5 – 0	**Epm**
	Ca^{+2}	39.76	20 – 0	**Epm**
	Na^{+}	16.4	40 – 0	**Epm**
Nutrients	K^{+}	2.44	2 – 0	**Epm**
Negative ions	HCO_3^{-}	7.12	10 -0	**Epm**
	SO_4^{-2}	50.9	20-0	**Epm**
	Cl^{-}	73.96	30 -0	**Epm**
Acidic function	PH	7.5	8.5 -6	**(14 - 1)**

The results indicate that groundwater wells in the studied area are not valid for the irrigation of plants due to the high salinity and the excess of many positive elements exceeding the permissible limits and cations.

Conclusions:

Most water in the study area is unsuitable for human drinking due to its high salinity, excessing cations within the permissible limits, and pH. The electrical conductivity has also exceeded the permissible limits. Accordingly, water is suitable for drinking animals but not for industrial purposes. Its quality can be improved by adding some chemical conditioners. It is valid for construction because the elements are within the permissible limit. It is considered unsuitable for irrigating plants due to the high salinity and the excess of many cations and anions

References

[1] S.M. Awadhi, R. Muslim, The formation models of gypsum barrier, chemical temporal changes and assessments the water quality of Sawa Lake, Southern Iraq. *Iraqi Journal of Science*, vol. 55, no. 1, pp.161-173**,** 2014.

[2] A. Muhammad, *Applied Hydrogeology, Department of Geology. Faculty of Science, Tishreen University. (In Arabic),* 2013

[3] M. Nassif, Raad, M. Ali," Study of the chemical and physical properties of the water of some underground wells and the extent of their influence in the city of Samarra in 2013". *Diyala Journal of Pure Sciences*, v.11, no. 4, 2015.

[4] K. Aziz, Munaf , "Evaluation of Ground water at West Karbala City". *Unpublished master's* thesis from Baghdad University, College of Science, 2018.

[5] Al-Khafaji, R. M. Nasif and A. J. Hammady , "Environmental Assessment of the Quality of Water and the Hydrochemical Formula Used for Some Groundwater Wells in Karbala Governorate".*Indan Journal of public Health Research,* 2018.

[6] S. Muhi, A. Jassam, "Water quality of ground water in selected wells in Zuber area ,Basra city". *Iraqi Journal of Science*, vol. 61, issue 6, 2019.

[7] M. K. Al-Jafar1, M. H. Al-Jaberi, "Determination of clay minerals using gamma ray spectroscopy for the Zubair Formation in Southern". *Iraq Journal of Petroleum Exploration and Production Technology,* 2021.

[8] A. A. Al-Ziyadi, H. A. Nasser, *Geography of DhiQar Governorate,* 2018.

[9] R.M. Owen ,S.N. Nasser, "The stratigraphic of Kuwait- Basra area". In Week L.G. (editor):Habitat of oil ,*asymposium.Am.Assos.petr.Geol.,Tulsa,* 1958.
[10] S.Z. Jassim, J.C. Goff, " Geology of Iraq". *Puplished by Dolin, Prague and Moravian Museum, Berno*.p.341, 2006.
[11] R.C. Bellen, ,V. Dunnington, H.V.,Wetzel,R.and Morton,D.," Lexique stratigraphic international. Asia". *Fasc.10a, Iraq ,paris,*333pp., 1959.
[12] V.K. Sissakian, "Geological Map of Iraq". Scale 1: 1000 000, *3rd edit. GEOSURV,* Baghdad, Iraq, 2000.
[13] M. Rashid, "A geomorphological and sedimentary study of the Hawizeh Marsh and its adjacent areas". Ph.D. thesis, College of Science, University of Baghdad, p.91. (In Arabic), 2008.
[14] D. Langmuir, "*Agueus environmental geochemistry". Prentice-Hall USA,* 600P, 1997.
[15] Collins, "Geochemistry of oil – field water development in petroleum Science", *No .1, Elsevier, Amsterdam, Holland,* 496p., 1975.
[16] G. Faure, "*principles and application of geochemistry*" *(2nd ed .),* 1997.
[17] Hughes, Jocelyn, "Hydrology & Hydrochemistry of British *Wetland, UK, Csiro land and water technical* Report". 42p., 2000 .
[18] J.D. Hem, "Study and interpretation of the chemical characteristics of natural water". U.S.G.S. Water supply, *Washington D.C*., 363P., 1985.
[19] V.V. Lvanov, "The main genetic type of the Earth crust mineral water and its distribution in the USSR". *Inter.Geol. Cong. of 23ndsessions. Czechoslovakia*,vol.12.33p., 1968.
[20] S.N. Davis, R.J.M. Dewiest, "*Hydrogeology". John Willy and Sons Inc. , New York,* 463p., 1966.
[21] G. Phillip., "Mineralogy of recent Sediments of Tigris and Euphrates River and some of the Older detrital deposits". *first edition,* 1966.
[22] M. Detay, "*Water wells implementation, maintenance and restoration*". *John Wiley &Sons, London,* 379 p., 1997.
[23] C. E. Boyd, *Water Quality An Introduction". Klumer Academic Publishers, USA,*330 P., 2000.
[24] D. Khalifa, *Groundwater Hydrology. National Library, Jordan*. (in Arabic), 1988.
[25] M.P.D. cooperation, Central Organization for Standardization and Quality Control ," Standard Specifications", *page (417) Drinking Water, page 9. (in Arabic),* 2009.
[26] WHO, " Guideline for drinking water quality. health criteria and other Supporting information". vol 2.2nd.*General,* 2017.
[27] H. Nash , M.C. call, G.J.H., *Groundwater Quality. Chapman & Hall comp.,London,*204 p. ,1995.
[28] M.E. Altoviski, *Handbook of hydrogeology Goegoelitzet, Moscow, USSR (IN Russian*), 614 p., 1962.
[29] R.S. Ayres , D.W. West Cat, "Water Quality for Agriculture, FAO, *Irrigation and drainage paper"*,29rev.Rome, 174p., 1985.