Al-Muthanna J. For Agric Sci | Print ISSN: 2226-4086 | Online ISSN:2572-5149
Vol. 10 , Issue. 01. 2023
https://muthjas.mu.edu.iq/ http://doi.org/10.52113/mjas04/10.1/3

SPATIAL ANALYSIS OF GROUNDWATER IN EAST WASIT REGION

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Received on 15/11/2022 Accepted on 28/12/2022 Published on 15/6/2023

Abstract

The East Wasit region is of particular importance in studying the reality of investing in water resources, especially groundwater in it. where (28) wells were selected to collect water samples to study the characteristics of wells water in the region. The spatial distribution maps were prepared using the Arc GIS program, and the study found that the fixed levels of the wells of the study area varied between (2.5-36) m, while the moving levels were (0-37) m and the depths of the wells ranged between (52-67) m. The data available from the spatial analysis maps of groundwater properties can be used directly in the data feed easily and accurately to simulate the behaviour of the hydrological system in the water basins. Where the study of the characteristics of well water is one of the important aspects because it is the most important factor to show the composition of the ground that appeared in the region through the demolition and construction processes. The results showed that the study area is one of the promising areas that are suitable for investing groundwater in economic quantities that can contribute to the revitalization of various sectors, especially agricultural ones.

Keywords :Spatial analysis, Groundwater , GIS . Wasit region

Introduction

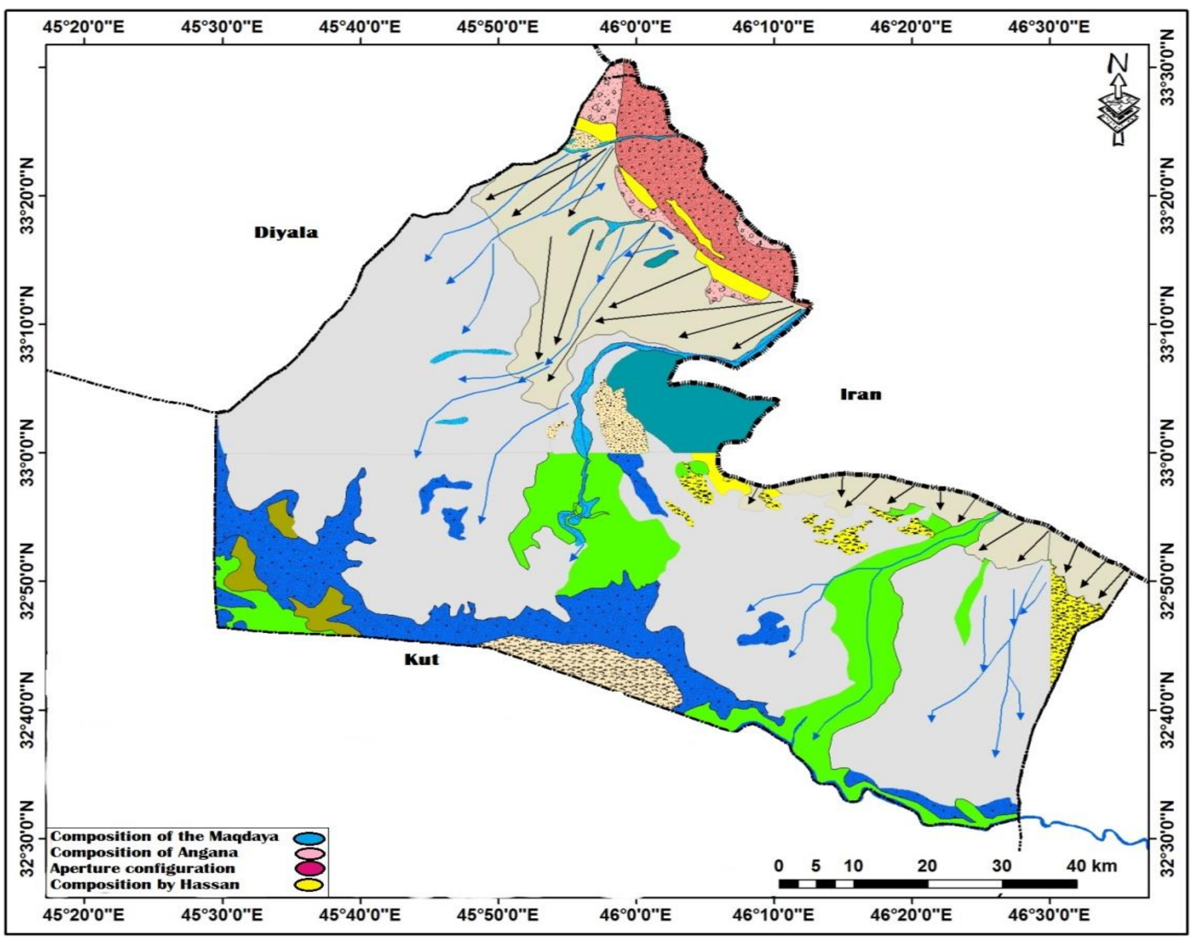
The study of water resources is of great importance to researchers from ancient times to the present. Finding water in any area is a necessary condition for human survival and life. Despite of the great development that the world is witnessing in technological techniques, the issue of water is still facing modern human, and the search for new sources of water is no less important than the search for oil and gas sources ... Hydrological studies and groundwater exploitation have expanded at present as a result of the increase in demand rates and their importance in filling the shortage of surface water resources due to dry seasons on the one hand and the deterioration of their quality on the other and the population(Intawech,1982). especially since the field of agriculture has witnessed in recent years demand for the application of geographic information systems (GIS) techniques, the East Wasit border area between Iraq and Iran is witnessing torrential seasons in most rainy years(Bouwer,1978), but it is also witnessing seasons of drought with long periods, due to the deterioration and lack of surface water in it on the one hand and the weakness of development projects and planning for torrential water on the other hand.

Geology of the study area

The study area is located in two parts, the first part is represented by the eastern and northeastern section of Wasit Governorate, which is represented by the area adjacent to the Hamrin Hills, and the second part is represented by the southern part within the sedimentary plain area of Iraq. so the first part of the region was characterized by geosyncline folds from the east and northeast, which are with deep folds in the Zagros Mountains, and the impact of the tectonic situation on this part is the continuation of the change,

which is reflected in the most sediments in this region, either in terms of Synthetic The area lies within the central part of the unstable pavement of the Arab-African Shield, i.e. within the low folds and Mesopotamia, and thus falls within the hill footing zone (Al-Jubouri, 2008). The study area is located on ancient rocks dating back to the third geological time and modern rocks dating back to the fourth time, vary in the study area from one place to another in terms of structure and geological time, which is from the oldest to the newest, and as shown in map 1.

Map (1) Geology of the study area



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- Composition of Muqdadiya: The formation of Muqdadiya is revealed in the wings of the Hamrin fold, the age of the formation dates back to the era of the upper Miocene, which consists of several sedimentary cycles consisting of one cycle of sandstone, gravel, clay stone and alluvial which is characterized by increasing the size of the granules towards the top of the brown colour

, the thickness of the composition is about 50 m (Barwari, 1991).

2- Composition of the opening: The formation of the opening is revealed in large areas of Iranian territory, which consists of the upper areas of the basins and valleys of the study area, Also, it appears within the Iraqi territory parallel to the extension of the Hamrin mountain range towards northwest-southeast, this formation dates back to the Middle Miocene era, The lower section of this formation consists of thick layers of fine-grained gypsum, limestone, and clay stone, and its layers tend to be green, the thickness of this part is 20 meters, While, the upper section consists of a succession of sedimentary cycles of gypsum and clay stone with red crumbs and the thickness of this formation is 237 m, and the sedimentation environment for this formation is a marine environment within closed ponds (Shatner et al., 2008) .

3- Formation of Anjaneh: This formation is revealed in the headwaters of the valleys inside Iranian territory and appears at the southwestern end of Hamrin in specific areas, especially in the north of the district of Zarbatiya, The age of this formation dates back to the Upper Miocene era, which It consists of a layered sequence of red clay stone and silt with thin layers of fine sand of light grey colour and greenish lead and is of medium hardness and the thickness of the composition is 618 m. (Hamza, 1989).

4- Formation of Bay Hassan: This formation is revealed in the upper sources of the basins of the study area, as it appears in the northeastern wing of the Hamrin fold This formation dates back to the Pliocene era, and the rocks of the formation consist of conglomerates of sandstone, gravel, clay stone, alluvial and sandy silt, and its upper borders are often covered with quadruple time sediments The thickness of the formation is 580 m, and its sedimentary environment is a continental environment (Barwari, 1992).

Materials and methods

1.1 Fieldwork:

(28) wells were selected by Random method to collect water samples distributed geographically on the boundaries of the study area, their locations were determined using a GPS device to identify them on the map according to the coordinates of (UTM-WGS84), Through five field visits to the study area during October, November, and December of the year 2021. water samples were collected using plastic bottles, and a rope (50) meters long tied to a bucket to extract water from wells that do not have pumps.

2.2 Chemical analyses

2.2.1 Electrical Conductivity (EC)

. The electrical conductivity in the extract of saturated soil paste was measured using meter EC according to (Intawech ,1982).

2.2.2 (pH) degree

The pH was measured in saturated soil paste extract using a meter PH device as reported by (Intawech ,1982).

2.2.3 Cations

The concentration of potassium K^+ and Na^+ ions was calculated by Photometer Flame, while the concentration of magnesium ions Mg^{+2} and calcium Ca^{+2} was calculated by the method of improvisation with EDTA solution at 0.02.

2.2.4 Anions

Chlorine concentrations were calculated by flushing method with concentrated sulfuric acid (0.025) standard solution using phenolphthalein index and orange methyl index. As for the sulfate $SO4^{-2}$, its concentration was calculated by spectrophotometer.

2.2.5 Turbidity

Turbidity was measured using the Nephelometric Turbidity Unit (NTU) measuring unit.

Results & Discussion

1- Wells depths

The depths of the wells are determined by the quality of the aquifer rocks, the permeability of the water-bearing layer and the amount of water to be invested. The layers of sandstone, gravel, and sand have a good ability to pass through the water tank and are considered productive layers because of their high permeability. Clay and silt layers are non-productive and cannot store and pass-through water and will be responsible for the low productivity of wells (Thamer et al., 2014). shows that the depths of the wells ranged between (52-67) m, and it is noted from Map (2) that their data were classified into a group of ranks, namely as a below: :

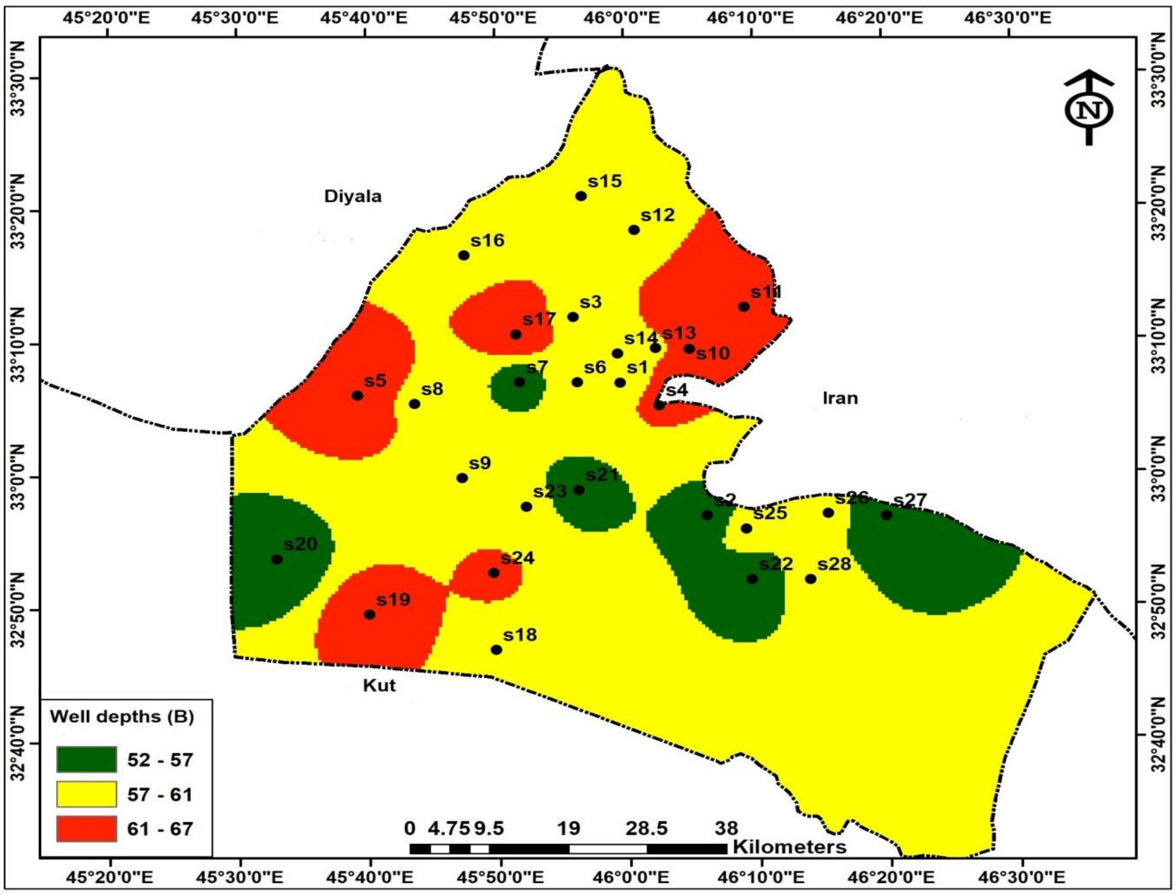
1- The first rank (52 - 57) m: where the number of wells contained in this rank is (6) wells.

2- The second rank (57-61) m: where the number of wells contained in this rank was (16) wells.

2- Electrical Conductivity

The electrical conductivity values of the water models of the samples of the study area ranged between (3.1-.79) dc. m^{-1} Table (1) and Map (3) show that the electrical conductivity values increase in the northern and northeastern parts of the study area with the beginning of the course of Kalal Badra and the Shuwaija marsh area due to the increase in the concentration of salinity and decreases towards the southern and southwestern parts of the region, which

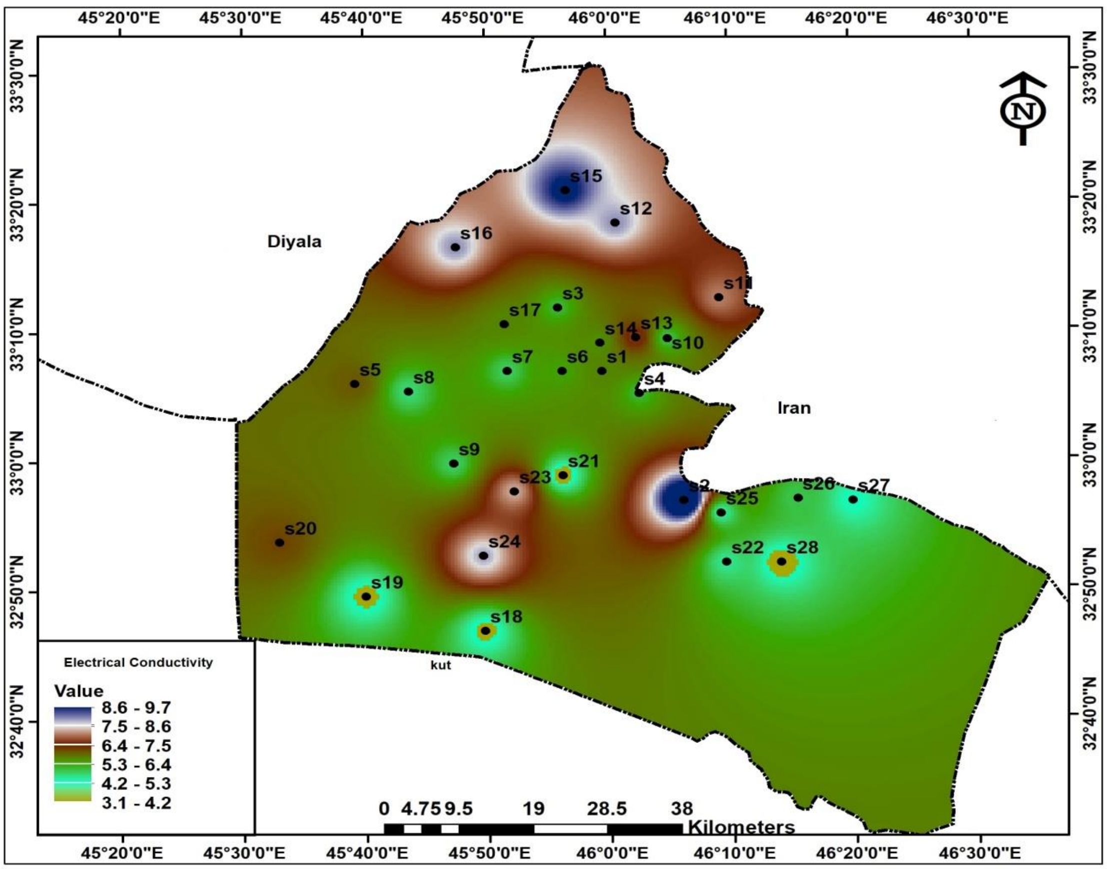
Map (2) Spatial variation of good depths in the study area



affects the water

quality and the extent of Map (2) Spatial variation of good depths in the study area Suitability for human, animal, and plant uses in the region if samples (S2, S15, S12, S16, S24, S23, S11, S13, S20) recorded the highest rate of electrical conductivity, which indicates an increase in the concentration of ions in water such as calcium, sodium, and potassium, and also due to poor management of irrigation and puncture networks in the study area, as well as the high percentage of evaporation in the study area.

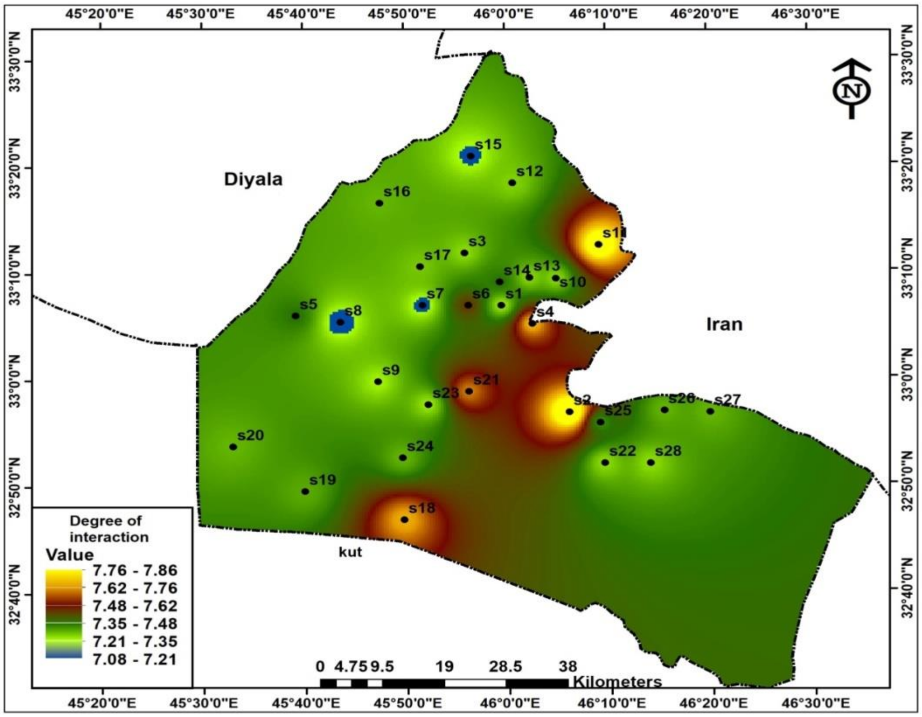
Map (3) Spatial variation of the electrical conductivity of the water of the wells of the study area



3- Degree of reaction

From observing the pH value of the water samples of the study area samples in Table (1) and Map (4), it was found that all these models represent basic samples, but in different proportions, where the highest concentration of basal was recorded at the area of Karmashiya, east of Zarbatiya, which represents an area for the deposition of gypsum rocks that Klal Badra passes through, whether in Iran or Iraq (Talal and Zarzis, 1977). This is reflected in the effectiveness of physical weathering in the region, especially samples (S2, S4, S18, S21) for basal rate. The other samples recorded lower values than the mentioned samples, but they were all recorded as basic and not acidic, and some of them are close to the neutralization between acidity and basic.

Map (4) Spatial Distribution of PH of Study Area Well Water



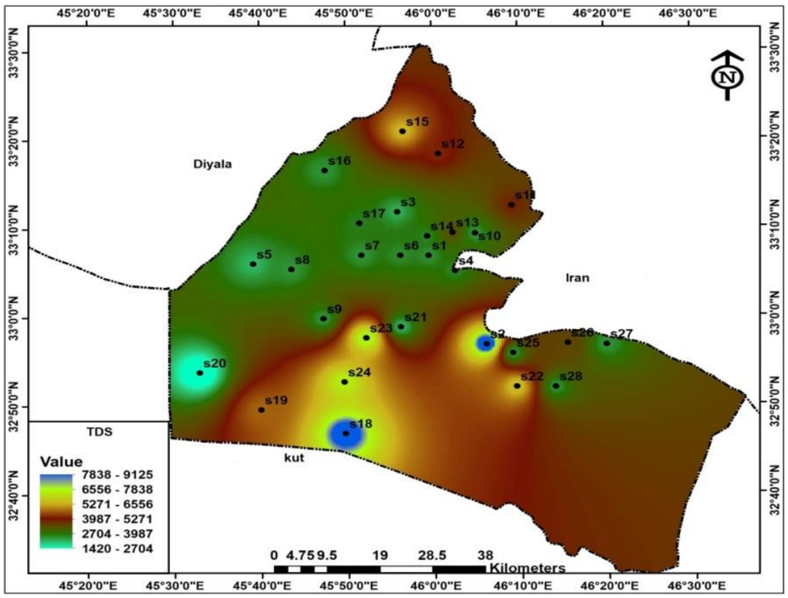
4. Total dissolved solids (TDS)

It is clear from Table (1) that the values of (TDS) in the wells of the study area ranged between (1420-9125) mg L^{-1}, where the highest concentration was recorded in the wells (S2, S18, S23, S24, S22, S15, S19) and their values were (9125, 8921, 7800, 7350, 6405, 6190, 5342) respectively. This is because the values of (TDS) increase with the movement of groundwater and its friction with the rocks of the region through which it passes, as well as the high temperatures which increase with the percentage of salts so the total dissolved solids rise as we advance south and southwest, This was a major reason for burying many wells within the south of the province (Akhchev, 2016). As for the samples (S20, S21, S5, S3, S25), they recorded a lower concentration than the previous samples, and this is because the water did not travel long distances in its movement, so the percentage of water friction with rocks and solubility in them decreased.

5-Calcium ion

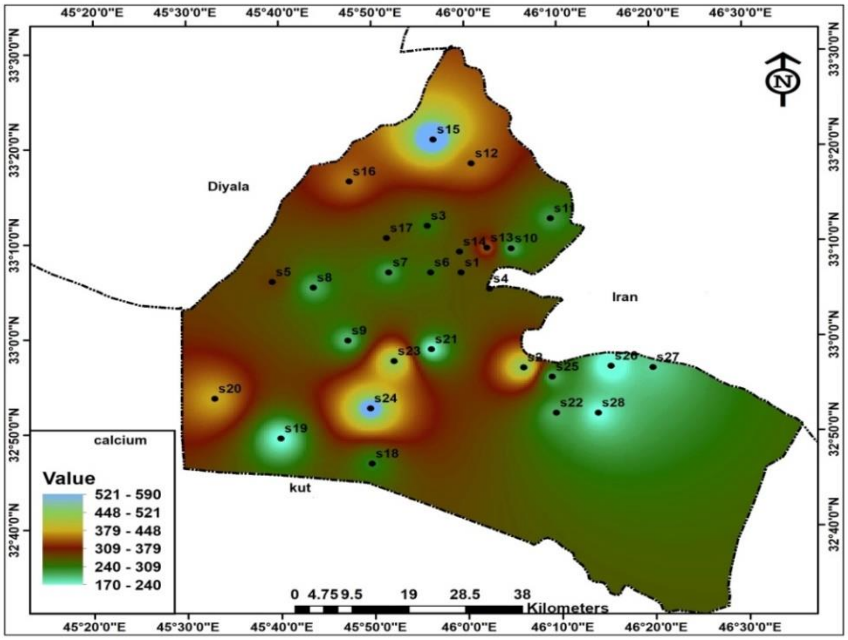
Limestone and dolomite limestones are among the most important sources of positive calcium ions, as well as evaporative rocks such as gypsum and anhydrite, which can dissolve in water quickly, leading to a high concentration of dissolved calcium in well water (Al-Mawazni, 2008), This shows the reason for the high concentration of region in Zarbatiya and the western and southwestern parts of the Jassan region. The samples (S26, S21, S28, S19) within the southeastern part had a lower calcium concentration than the rest of the samples due to the lack of electrical conductivity in these parts, whereas (Al-Naama et al., 2010) indicated that the concentration of calcium

Map (5) Spatial Distribution of Total Dissolved Solids of Well Water Study Area



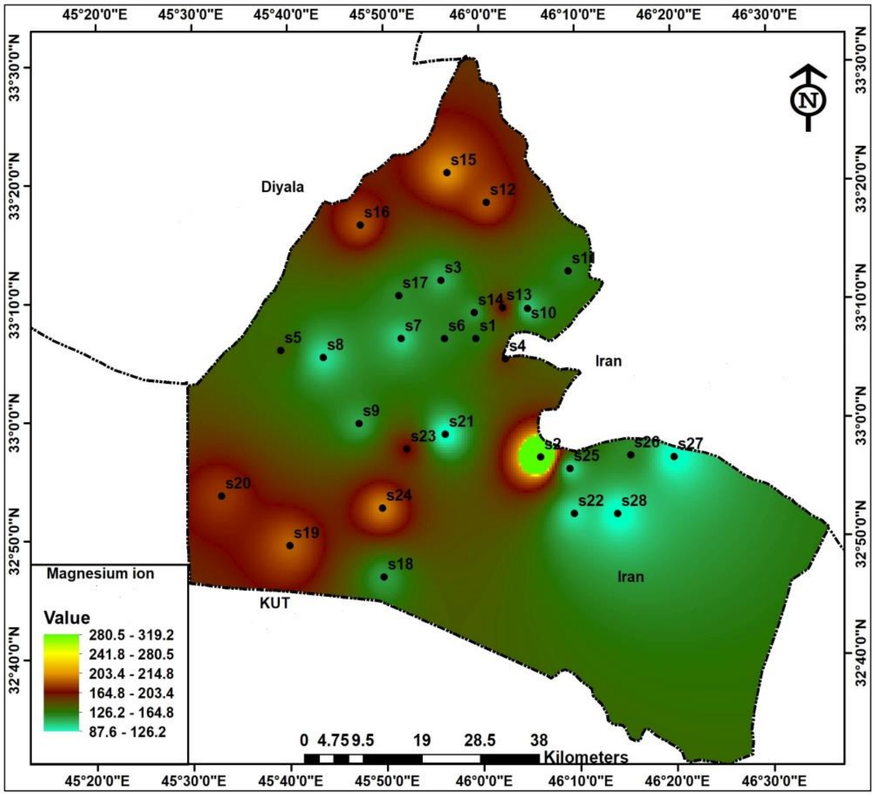
calcium in samples (S15, S24, S23, S20, S12, S16, S13) as shown in Table (1) and Map (6) located in the northern parts of the ion in water is significantly related to electrical conductivity.

Map(6) Spatial variation of calcium ion for well water in the study area



6- Magnesium ion

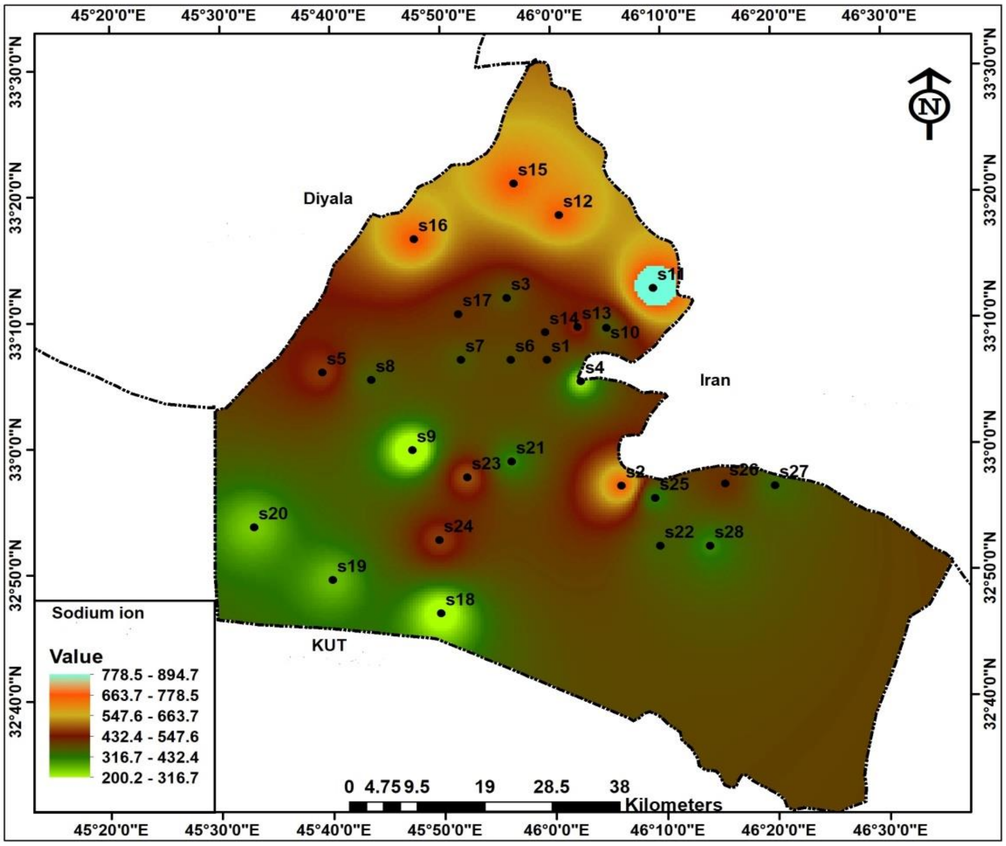
Magnesium ion is produced by dissolving some rocks in groundwater such as dolomite, lime, clay, and calcareous minerals, and it is less concentrated than calcium in well water because magnesium is deposited in larger amounts of calcium (Al-Jubouri, 2015). In Karmashiya and Siha within the Jassan area, whose values were (319.2, 224.4, 218.4, 204.0, 194.4) respectively, due to the presence of carbon dioxide (CO2), which works to dissolve carbon and wire metals containing magnesium ion (Abdullah and Majeed, 2015). Well samples (S8, S21, S27, S22, S25,) recorded the lowest calcium concentration compared to other waters in the region and their values were (102.0, 90.0, 690.0, 99.6, 102.0) respectively, and this may be due to the lack of sources of magnesium ion in the water of these wells.



Map (7) Spatial Variation of Magnesium Ion for Study Area Well Water

7- Sodium ion

Table (1) and Map (8) show the spatial variation of sodium ion for the wells of the study area, where wells (S11, S15, S2, S12, S16, S23, S24, S5) recorded the highest concentration of sodium ion within the northern and eastern parts of the region and their values were (894.7, 742.9, 749.8, 742.9, 749.8, 535.9, 515.2, 510.6) respectively, This is due to the presence of clay minerals resulting from weathering processes, as clay minerals contain a high percentage of Sodium, as well as frequent irrigation, which works to dissolve sodium salts, especially if their concentrations are high in the soil, transporting them to groundwater, and with increasing irrigation, the concentration of sodium increases (Akhchev, 2016), While wells (S18, S4, S20, S19, S28, S21) recorded the lowest concentration of sodium ion in the southern and southwestern parts compared to other samples, whose values were (236.9, 259.9, 285.2, 294.4, 324.3) respectively, due to severe sodium dissolution in these parts, where (Al-Shammari, 2006) indicated that the sodium ion does not precipitate easily in water .

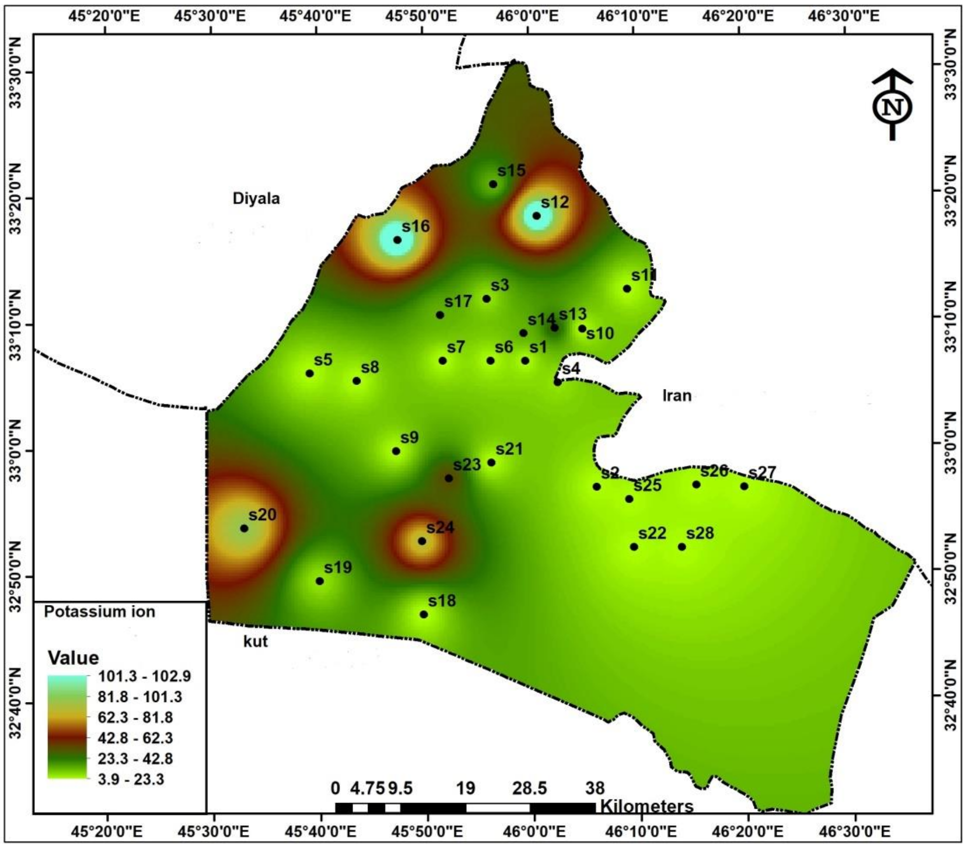


Map (8) Spatial Variation of Sodium Ion for Study Area Well Water

8- Potassium ion

Table (1) and Map (9) show the spatial variation of the potassium ion of the wells of the study area and it is clear that the wells (S12, S16, S20, and S24) recorded the highest concentration of potassium ions within the northeastern parts in Zarbatiya and the northwestern parts within the Badra area and some western and southwestern parts of the study area and their values were (120.9, 120.9, 93.6, 81.9) respectively, The reason for this is that this element is present within the group of minerals of the returning clay layers. In addition to the use of phosphate fertilizers in agriculture, potassium ion is found in conjunction with sodium ion in the earth's crust due to their high resistance and ease of absorption by clay minerals (Miqdadi, 2003). But in general, the concentration of potassium in the wells of the study area is reduced because it is slightly soluble in groundwater.

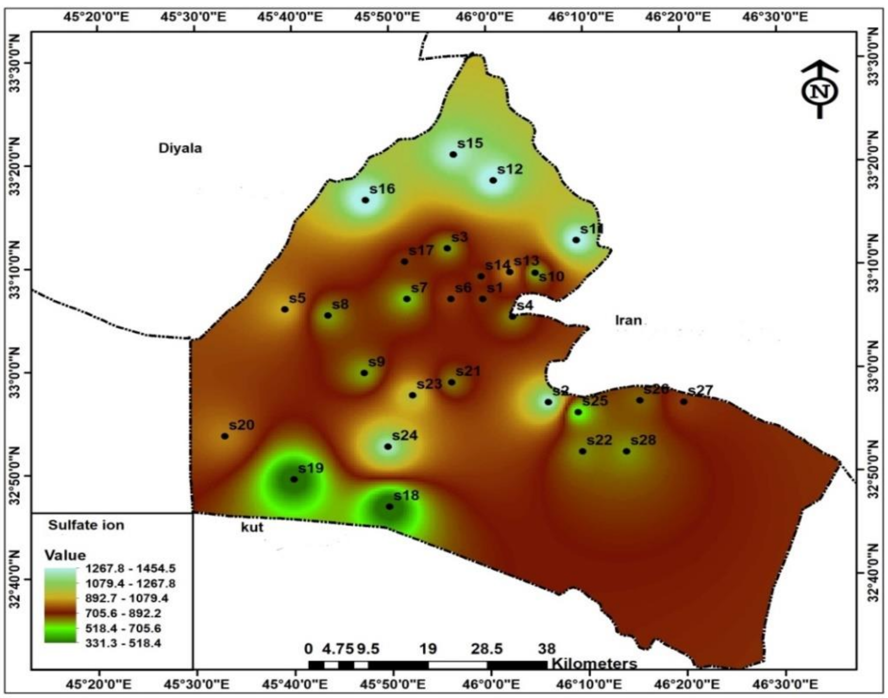
Map (9) Spatial Variation of Potassium Ion for Study Area Well Water



9- Sulfate ion

Table (1) and Map (10) show that the water models of site wells (S16, S12, S11, S2, S15, S24, S23, S5) recorded the highest concentration of sulfate ion, whose values were (1454.4, 1444.8, 1416, 1377.6, 1368, 1344, 1084.8, 998.4) respectively and the reason for the increase in the concentration of sulfate ion is due to the presence of sulfuric acid that comes from the atmosphere or from the decomposition of organic materials and chemical fertilizers used in agriculture(Akhchev, 2016), That the increase The sulfate ion in the water has a negative role on agricultural investment, as it leads to soil salinization as a result of the deposition of calcium sulfate, which in turn affects the sodium ion dissolved in water, In addition to the appearance of spots on the leaves of plants and hindering their growth due to the slow process of photosynthesis (Al-Zubaidi, 2011), the wells (S18, S19, S25, S7, S10, S9) recorded the lowest concentration of the sulfur ion, which amounted to (331.2, 532.8, 345.6, 600, 619.2, 633.6) respectively, due to the increased degree of reaction in them.

Map (10) Spatial Variation of Sulfate Ion for Well Water Study Area



10- Chloride ion

Table (1) and Map (11) show the spatial variation of the chloride ion in the wells of the study area. It is noted that the highest concentration of the chloride ion was recorded in wells (S2, S15, S24, S23, S12, S16, S13, S11, S20, and S5), which values were (1934.4, 1675.6, 1402.25, 1380.95, 1359.65, 1299.3, 1256.7, 1015.3, 986.9, 930.1) respectively within the northern and northwestern parts of Zurbatiya and Badra and also in the southern parts of the study area, and the reason is attributed to the presence of a mineral Halite, which is characterized by its rapid decomposition and solubility in water, forming dissolved salts, and that the high concentration of chloride ion in water has harmful effects on humans and crops (Thamer, 2014). Wells (S21, S27, S28, S22) recorded the lowest concentration of chloride ions, which amounted to (415.35, 493.45, 536.05, and 663.85), respectively. The reason for the difference in the concentration of chloride ions in well water is attributed to the presence of halite minerals from organic waste and irrigation water(Akhchev, 2016).

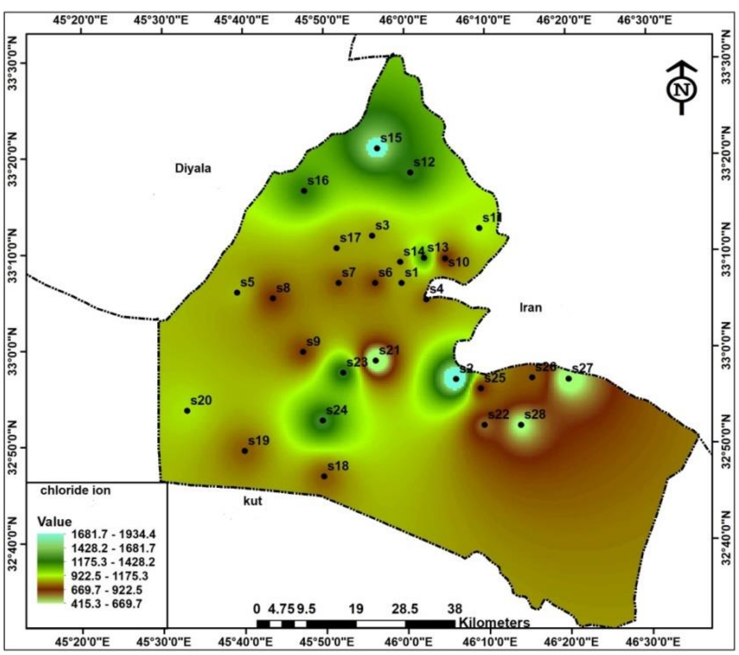
11- Bicarbonate ion

Table (1) and Map (12) show the spatial variation of the bicarbonate ion for the wells of the study area, where it was found that the highest value recorded for the bicarbonate ion was in wells (S2, S15, S21, S16, S20), whose values were (372.1, 323.3, 217.2, 280.6, 280.6) respectively in the northern parts of Zurbatiya and Badra and the eastern and western parts of Jassen, while wells (S13, S26, S8) whose values were (30.5,

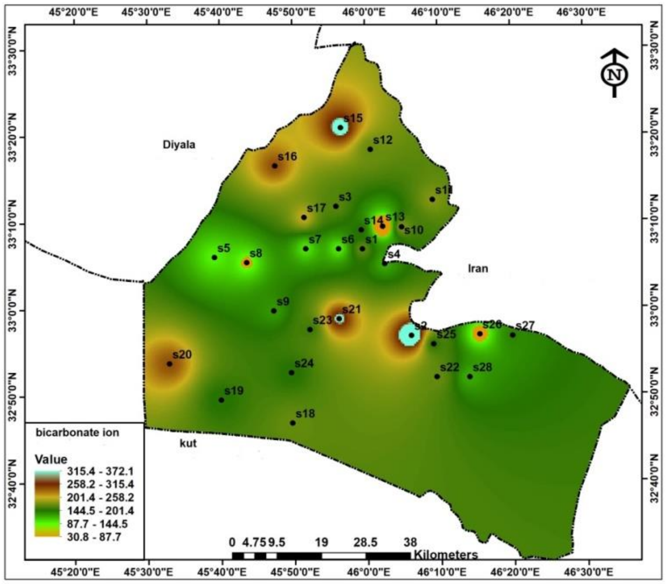
91.5, 100.8), respectively, recorded the lowest concentration of the bicarbonate ion. (Thamer, 2014)\

The main source of the bicarbonate ion is the dissolution of carbon materials and carbon dioxide resulting from the organic activities that occur in the soil or the saturated zone of the soil, in addition to the carbon dioxide gas present in the air(Akhchev, 2016), and when it comes into contact with groundwater, the reaction of the two components of dilute carbonic acid will occur, which It interacts with carbonate rocks, leading to their dissolution, and thus increases the percentage of carbonate and bicarbonate ions in groundwater

Map 11 Spatial Variation of Chloride Ion for Study Area Well Water



Map (12) Spatial Variation of Bicarbonate Ion for Well Water in the Study Area



13- Turbidity

Table (1) shows that the turbidity values in the water of the wells of the study area were close, and from Map (13) it is noted that the highest values of turbidity were in the northwestern parts of the region towards the southwestern parts in wells (S7, S2, S8, S26, S27) and their values were (14.32, 14.26, 13.06, 12.62, 12.53) respectively, This is due to the damage in these wells due to their age while the lowest value of turbidity was recorded in wells (S1, S14, S13, S19) and their values were (11.3, 11.3, 11.4, 11.4) respectively within the eastern regions, due to the presence of suspended matter and specific types of microorganisms (Mohammed, 2017).

Map (13) Spatial variation of turbidity of the water wells of the study area

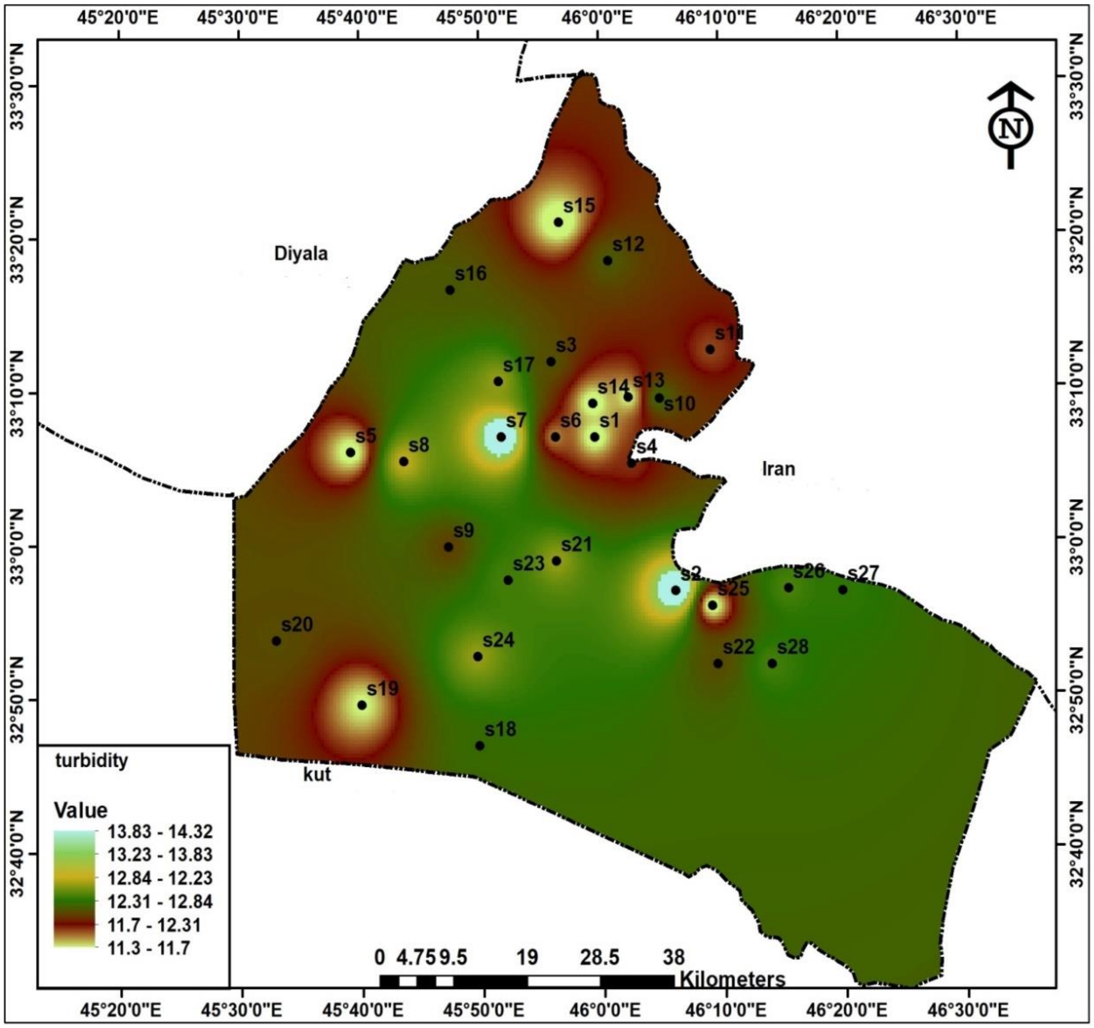


Table (1) Chemical Characteristics of the Water of the Well of the Study Area

			Tem	PH	EC	TDS	Ca	Mg	Na	K	CL	SO4	HCO3	Turb
	x	y	C°		ds.m	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	NTU
S1	592562	3664489	15.1	7.12	4.4	2655	292	130.8	427.8	3.9	901.7	748.8	195.2	11.3
S2	603046	3646059	15.3	7.9	9.7	9125	508	319.2	742.9	3.9	1934.4	1377.6	372.1	14.26
S3	586908	3673578	21.3	7.14	3.9	2419	256	114.0	400.2	7.8	904.8	643.2	189.1	12.24
S4	597300	3661346	21.6	7.63	3.9	2763	290	165.6	259.9	7.8	820.05	672	140.3	11.81
S5	560987	3662637	15.8	7.25	4.9	2365	310	141.6	510.6	3.9	930.1	998.4	110.4	11.34
S6	587442	3664508	15.3	7.36	4.1	2710	262	127.2	407.1	3.9	752.6	844.8	110.4	11.63
S7	580492	3664508	23.2	7.09	3.7	2614	230	105.6	388.7	3.9	788.1	600	115.2	14.32
S8	567870	3661495	15.3	7.08	3.6	2624	226	102.0	379.5	3.9	734.85	643.2	100.8	13.06
S9	573640	3651210	23.2	7.12	3.7	2613	218	117.6	200.4	3.9	749.05	633.6	148.8	12.13
S10	600879	3669170	22.7	7.14	3.8	2626	224	106.8	381.8	3.9	713.55	619.2	207.4	12.4
S11	607447	3675009	22.7	7.82	6.1	4350	236	128.4	894.7	3.9	1015.3	1416	207.4	11.76
S12	594253	3685677	22.1	7.15	7.1	4670	390	204.0	742.9	120.9	1359.65	1444.8	195.2	12.3
S13	596838	3669289	18.1	7.14	5.6	3724	378	180.0	499.1	31.2	1256.7	969.6	30.5	11.4
S14	592292	3668548	17.6	7.25	4.3	2795	288	120.0	437	15.6	887.5	748.8	170.8	11.3
S15	587878	3690358	24.6	7.1	8.1	6190	590	224.4	749.8	15.6	1675.6	1368	323.3	11.28
S16	573838	3682150	23.1	7.18	7.1	2640	390	204.0	749.8	120.9	1299.3	1454.4	280.6	12.3
S17	580065	3671176	23.2	7.16	4.4	2837	294	126.0	443.9	15.6	898.15	748.8	231.8	12.9
S18	577708	3627338	23.3	7.61	3.2	8921	248	120.0	236.9	3.9	802.3	331.2	195.2	12.42
S19	562474	3632215	17.5	7.19	3.2	5342	190	208.0	294.4	7.8	805.85	345.6	164.7	11.4
S20	551394	3639925	24.6	7.18	5.1	1420	418	194.4	285.2	93.6	986.9	931.2	280.6	12.21
S21	587611	3649565	17.5	7.55	3.1	2363	190	90.0	324.3	3.9	415.35	681.6	317.2	12.9
S22	608492	3637193	19.7	7.14	3.5	6405	226	99.6	372.6	3.9	663.85	662.4	195.2	12.21
S23	581343	3647247	18.3	7.13	6.4	7800	502	181.2	535.9	39	1380.95	1084.8	176.9	12.6
S24	577425	3638032	18.9	7.18	7	7350	558	218.4	515.2	81.9	1402.25	1344	164.7	12.9
S25	607792	3644214	19.4	7.22	3.4	2536	224	102.0	326.6	3.9	713.55	532.8	170.8	11.32
S26	617596	3646371	22.6	7.18	3.8	3870	170	127.2	450.8	3.9	798.75	700.8	91.5	12.62
S27	624650	3646072	20.2	7.18	3.3	2630	212	90.0	361.1	3.9	493.45	835.2	158.6	12.53
S28	615492	3637193	16.6	7.14	3.1	2665	190	87.6	324.3	3.9	536.05	652.8	140.3	12.6

Conclusions

1. It is clear from the general characteristics of the water of the wells, that the depths of the underground wells ranged between (52 - 67) m while the fixed levels ranged between (2.5 - 36) m and the mobile levels (0-37) m and drainage (0-15) due to the presence of this water between sandstone and gravel, which is one of the permeable layers of water.
2. The results of the assessment of the qualitative characteristics of groundwater indicated that they are all unfit for human drinking, due to the high rates of salt concentrations in them by Iraqi and international standards, and in return, they are suitable for irrigation and irrigation of animals and their use in some industries, including construction industries.

Recommendations

1- Establishing a hydrological monitoring station to monitor river discharges to know the fluctuations in the amount of water as well as calculate the size of the suspended sediments.

2- Organizing the drilling of automated wells by competent official authorities and choosing the correct sites, and it is also forbidden to drill wells in sites near mines and to dig more monitoring wells to monitor groundwater accurately.

3- Continue to conduct laboratory tests of groundwater in the region to know the changes that will occur in the physical and chemical properties of dissolved salts.

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