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RESEARCH ARTICLE

Building Cartographic Models to Evaluate the Water Quality of the Euphrates River Stream Extending Between the Al-Shinafiya and Al-Nasiriyah cities in Southern Iraq Relying on GIS Technology and Water Quality Indices

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ABSTRACT

The current study aimed to evaluate the water quality of the Euphrates River in the area extending from Al-Shinafiyah to Al-Nasiriyah by studying the qualitative characteristics of the river and knowing the quality of its water, and that's using the model Canadian(CCME WQI) and Weighted Arithmetic Index, the origin of the water is then classified according to the Piper and Schuler- Solen methods, and it turns out that all elements of the physical and chemical properties are high. As for the Canadian model, the index values range between (62.2–74.7), the highest value recorded for site (4), which is It is located within fair waters, and the lowest was for site (1), while the values of (Wi*Qi) for the weighted mathematical model ranged between (0.072–60.939). The highest value recorded was for the characteristic (PO_4), while the lowest was for the characteristic (TDS), As for the classification of water quality, according to the Piper method, it was found that (3) of the water samples of the study area are classified as alkaline earth water, and that sulfates and chlorides are dominant in them. As for the other six samples, three of them had water quality in the form of chloride, and the other three were within the category of water rich in calcium, while according to the Schuler- Solen method, all water samples of the Euphrates River are from the group of chlorides and include one family, the sodium chloride family.

Keywords: Assessing water quality, Euphrates River, Geographic information systems, Physical and chemical properties, Water quality indicators

Introduction

Freshwater sources and their quality are of utmost importance in every country around the world,[1] for this water quality monitoring is considered an essential tool used by environmental agencies to measure water quality to make management decisions to improve or protect the water resource to achieve the desired goal, in addition to the fact that monitoring water quality is very necessary to determine the state of pollution in the water,[2] as it is since the physical, chemical, and biological properties of water as well as the degree of its acceptability for usage are referred to as its quality,[3] and several attempts have been made to assess the quality of the water, and the investigation of qualitative features is one of these techniques is the study of water's physical and chemical characteristics, as well as that of positive and negative ions, secondary and heavy elements, and so forth. According to the above, the study had several axes.

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The first dealt with studying the qualitative characteristics of the Euphrates River. The study's second axis was devoted to assessing river water quality using the CCME WQI model and the Weighted Arithmetic Index, these two international methods can be explained as follows:-

A- The Canadian Council of Ministers of the Environment water quality index CCME WQI: The Canadian model is characterized by its widespread use globally by researchers to evaluate the quality of water resources and determine their quality. The widespread use of it is attributed to the precise results that this index gives. It is concerned with weighing the characteristics that deviate, even with one test, from the standard limits beyond the weight of every measurement that deviates from the standard limits, which gives highly accurate and reliable results.
B- Weighted Arithmetic Index: This model is the preferred scientific method among many researchers because it uses variables to rephrase them as a descriptive numerical expression to clarify the quality and quality of the water resource.

As for the third axis, it studied the classification of river water quality according to the Piper method and the Schuler-Solen method.

It is worth noting that the study aims to evaluate the water quality of the Euphrates River between the cities of Shinafiya and Nasiriyah using cartographic methods and global models to demonstrate the suitability of the river's water for various human uses,this method (use of water quality models) is the most methods important scientific commonly used in the field of environmental assessment of water and indicating its suitability for uses, various studies that used these models in evaluation can be mentioned, including, but not limited to, the following studies: Salman et al.,[4] Mohammed et al.,[5] Majeed et al.,[6] Abdul-Ahad,[7] Sabeeh et al.,[8] Mahdi et al.,[9] Aljanabi et al.[10]

Materials and methods

The work method included three basic stages, which are as follows:

1- The first phase focused on field work and collecting water samples, where nine water samples were collected from the river. The sampling period was in 2022, Table 1, Fig. 1, and the collection method was followed according to international environmental protocols, as water samples were collected from the middle of the river using the boat because the water in the middle of the river is a true expression of the natural state of the river, and it is worth noting that all water samples were collected in bottles designated for collection, and then the bottles were placed in black nylon bags for fear of exposure to the sun, and then is stored in a temperature 28°C and sent to the laboratory.

Table 1. Geographical information for Euphrates River samples in the study area 2022.

Sample code	Geographical location	Longitude X	Latitude Y
E1	Thi-Qar	46.300770°	31.029032°
E2	Thi-Qar	46.067145°	31.116212°
E3	Thi-Qar	45.837034°	31.154755°
E4	Al-Muthanna	45.638079°	31.185635°
E5	Al-Muthanna	45.485488°	31.296973°
E6	Al-Muthanna	45.234736°	31.354186°
E7	Al-Muthanna	45.087216°	31.416730°
E8	Al-Qadisiyah	44.848481°	31.480112°
E9	Al-Qadisiyah	44.643477°	31.559863°

2- The work then moved to the second stage, the laboratory analysis of samples, where pH were measured laboratoryly using the Milwaukee pH/EC MW801 PRO, and the positive ions (calcium and magnesium) were measured in water samples according to Titritric Method,[11] In contrast, sodium and potassium concentrations were measured using the flame spectrometer.[12] For negative ions, chloride and bicarbonate were calculated by calibration,[12] At the same time, the Turbidimetric method was used to estimate sulfur using optical spectrometer,[12] while for nitrate, the reduction method was used using the cadmium column, where nitrate was converted to nitrate using the optical spectrometer.[12] In contrast, the concentration of phosphate was calculated by tin chloride using the optical spectrometer.[12] In contrast, the TSS and TDS in water samples were estimated according to the drying method,[12] and according to the above, 11 elements were measured (pH-TSS-TDS- Ca-Mg-Na-K-SO_4-Cl-PO_4-NO_3).
3- The third phase of the work focused on performing calculations for the models and indicators used in the study, as follows:
3-1- The Canadian Council of Ministers of the Environment water quality index CCME WQI: The index values are found by calculating three factors: range, frequency, and amplitude. These factors combine later to produce an index value ranging between 0–100. This number represents the overall water quality,[13] and the model was calculated as follows:
Scope F1: It represents the percentage of variables exceeding the standard limits compared to

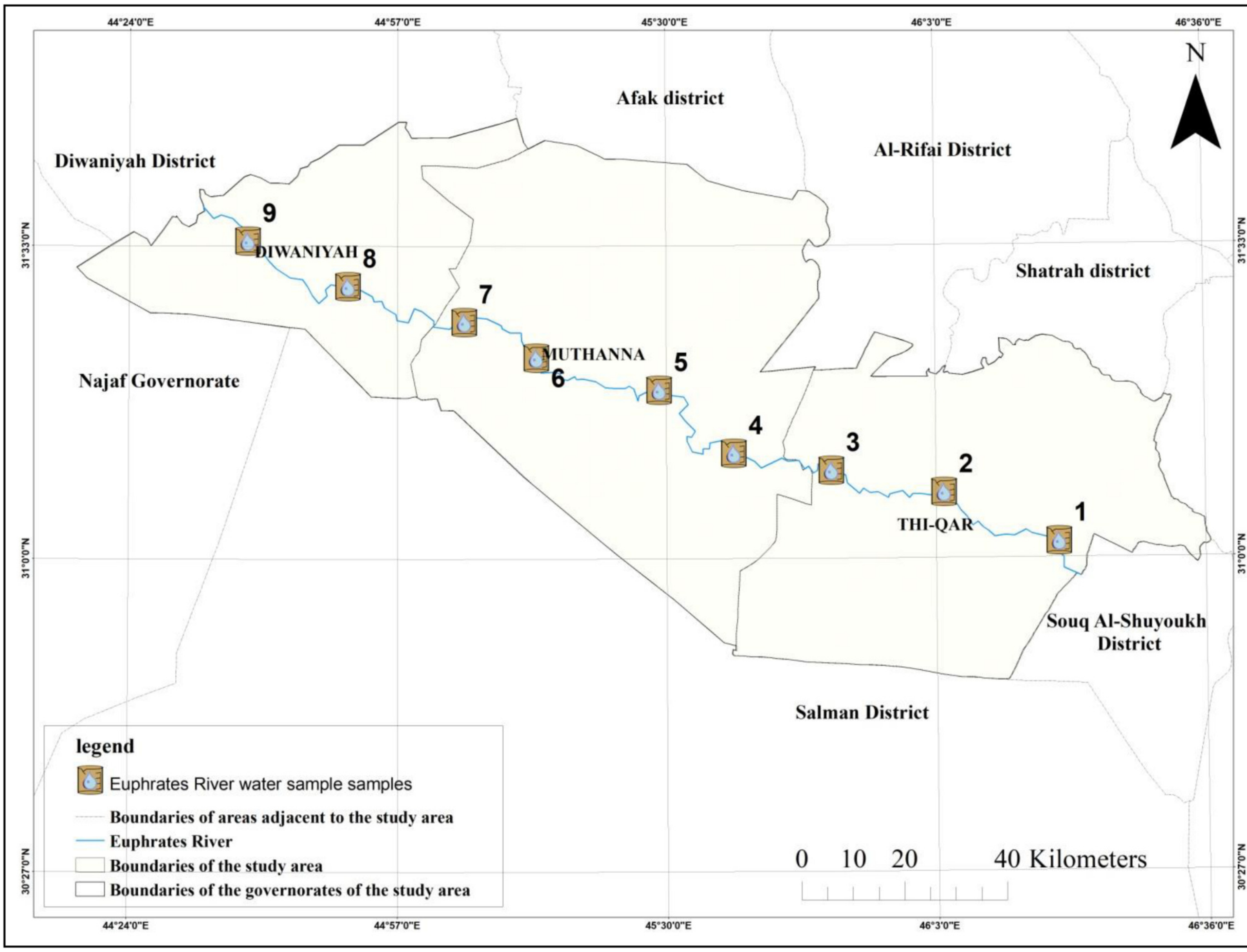

Fig. 1. Geographical locations of Euphrates River water samples in the study area. Source: The field study using a GPS device and the ARC MAP 10.8 program.

the total number of variables and is calculated as in the following equation[14]

$$F1 = \left(\frac{NO.\ of\ faild\ variables}{Total\ no.\ of\ variabls}\right) \times 100$$

Frequency F2: It represents the percentage of individual examinations exceeding the standard limits over the total number of examinations and is calculated as in the following equation[15]

$$F2 = \left(\frac{NO.\ of\ faild\ tests}{Total\ no.\ of\ tests}\right) \times 100$$

Amplitude F3: represents the amount of tests passed and is calculated in two stages:

– The first stage: - The number of times individual concentrations exceed the standard limits, which is called "excursion" and is calculated as follows[16]

$$\text{Excursion} = \left(\frac{\text{failed test value}}{\text{guideline value}}\right) - 1$$

– The second stage: - The sum of the individual tests passed. It is calculated by summing the individual deviations and dividing them by the total number of tests, this variable is called the sum of the modified deviations and is symbolized by the symbol nse, It is calculated according to the following equation:-[17]

$$nse = \frac{\sum_{i=1}^{n} excursion}{Number\ of\ tests}$$

After calculating the first and second stages, the capacity F3 is calculated according to the following equation:-[18]

$$F\,3 = \frac{nse}{0.01\,nse + 0.01}$$

After finding the previous three factors F1, F2, F3, the Canadian Water Quality Index is calculated according to the following equation:-[19]

$$CCME\ WQI = 100 - \left(\frac{\sqrt{f1^2 + f2^2 + f3^2}}{1.732}\right)$$

The constant 1.732 is to modify the result of the value of the model, which is limited to between 0–100, to express through it the quality of the water. If the value is limited to between 0–44, the water is classified as poor, and between 45–64 it is classified on the marginal. Between 65–79 is fair, but if the value is limited to between 80–94 then the water is good and between 95–100 the water is classified as excellent.[20]

3-2- Weighted Arithmetic Index: The weighted arithmetic index was calculated in three steps as follows:-[21]

$$WQI = \sum_{Qi}^{Wi} / \sum WI$$

The results of this model range between 0–100, where if the value is limited to between 0–25 the water is classified as excellent, between 26–50 it is classified as good, and between 51–75 is bad, either the value is limited to between 76–100, so the water is very bad. However, if it is above 100, it is unsuitable and not appropriate to use.[22]

3-3- Piper method: - The Piper diagram is a graphical representation of chemistry used to classify water and compare chemical elements. It consists of two triangles, one showing positive and the other negative ions. The dominant ions are identified by projecting percentages on a chart and intersecting them at a point. This determines water quality based on sample location from the upper rhombus, water is divided according to Piper's diagram into seven types A.B.C.D.E.F.G Table 2.

The results of laboratory analyses were plotted on a Piper chart using the Aq·QA Version 1.1.RockWare program.

3-4- The Schuller-Solen method: This scheme includes the Schuler and Solen classifications in terms of meq% for the concentrations of the main positive and negative ions, through which the group of waters, their families and their types are distinguished, in addition to the environment affecting the concentrations of the main ionic components in it. Graphically, the diagram for this method consists of Schuler's tripartite diagram by adding a line representing the 15% of the limits of concentrations that fall within the Solen classification thus, water quality is determined based on: ionic components. The number to the left represents the positive and negative ionic components of the Schuler classification, while the one to the right is the Solen classification.

Results and discussion

1- Qualitative characteristics of the Euphrates River: Water quality depends on a set of physical, chemical variables, including pH, turbidity, salinity, and concentration of positive and negative ions, etc. These variables are of particular importance for assessing the quality of water bodies,[23] and therefore the study relied on the following determinants:-

pH: - It is clear from Table 3 and Fig. 2 that the pH values in the water of the Euphrates River for all samples ranged between 7.1–7.9, during the summer, the values ranged between 7.1–7.5, the highest value was recorded for sample 6, while the lowest value was recorded for sample 4, In the winter, the values ranged between 7.5–7.9, the highest value was recorded for sample 8, while the lowest value was recorded for sample 3. The average pH level has reached 7.7, an average of 7.5 for the summer and 7.9 for the winter.

Suspended solids:- It is clear from Table 3 and Fig. 3 that values of suspended solids in the Euphrates River water for all samples during the summer range between 54.2–79.3, The highest value was recorded for sample 8, while the lowest was recorded for sample 3, In the winter, the values ranged between 13.1–34.7, the highest value recorded for sample 9, while the lowest value was recorded for sample 6.

Dissolved solids: - It is clear from Table 3 and Fig. 4 that the values of dissolved solids in the Euphrates River water for all samples during the summer range between 1527.2–1778.5. The highest value was recorded for sample 2, while the lowest was recorded for sample 2 3, while in the winter season, the values ranged between 1179.7–1608.1; the highest value was recorded for sample 2, while the lowest value was recorded for sample 3, these values vary spatially, Site 2

Table 2. Piper chart sections and water quality according to the Langguth method.

Category	Water quality
A	Ordinary alkaline earth water contains predominant bicarbonate
B	Ordinary alkaline earth water contains bicarbonate, sulfate or chloride
C	Ordinary alkaline earth water contains predominant sulfate or chloride
D	Alkaline earth water with increasing fractions of alkali with predominant bicarbonate
E	Alkaline earth water with increasing fractions of alkali with predominant sulfate and chloride
F	Alkaline water with predominant bicarbonate
G	Alkaline water with predominant sulfate or chloride

Table 3. Concentration values of physical and chemical qualitative characteristics in the Euphrates River for the summer and winter seasons year 2022.

Summer 2022	Unites	E1	E2	E3	E4	E5	E6	E7	E8	E9
pH	-	7.3	7.4	7.2	7.1	7.4	7.5	7.3	7.3	7.4
TSS	mg/l	73.4	77.1	54.2	58.3	72.1	65.9	66.4	79.3	62.8
TDS	mg/l	1643.1	1778.5	1527.2	1693.7	1754.3	1653.2	1596.9	1648.8	1673.4
Ca	mg/l	267.1	308.2	323.2	334.9	295.4	352.2	285.8	262.3	347.9
Mg	mg/l	28.9	41.5	53.1	60.5	13.1	67.6	42.2	55.9	32.4
Na	mg/l	395.8	414.1	420.7	325.9	408.4	433.6	404.1	393.6	431.7
K	mg/l	8.07	9.47	9.47	3.27	6.93	4.80	8.53	4.87	1.93
SO_4	mg/l	278.7	267.5	247.9	295.4	283.1	264.3	215.1	280.6	263.1
Cl	mg/l	549.3	683.2	595.6	605.3	572.7	619.5	564.7	545.3	616.1
PO_4	mg/l	3.76	3.21	6.09	5.83	3.29	4.34	7.21	5.97	6.76
NO_3	mg/l	23.9	42.6	21.5	16.7	23.4	17.8	15.9	13.4	15.1
Winter 2022		**E1**	**E2**	**E3**	**E4**	**E5**	**E6**	**E7**	**E8**	**E9**
pH	-	7.7	7.9	7.5	7.8	7.6	7.7	7.8	7.9	7.8
TSS	mg/l	24.9	33.5	15.2	21.5	18.2	13.1	23.3	14.3	34.7
TDS	mg/l	1350.9	1608.1	1179.7	1402.3	1589.5	1495.6	1340.9	1197.2	1456.5
Ca	mg/l	191.2	178.2	138.7	122.0	146.5	114.5	177.4	160.2	195.6
Mg	mg/l	75.9	87.6	84.5	92.9	88.1	97.7	78.4	72.1	92.3
Na	mg/l	218.5	229.3	227.3	149.0	172.1	162.9	151.7	296.5	151.2
K	mg/l	1.57	2.41	2.61	2.92	1.09	2.83	1.59	1.37	2.23
SO_4	mg/l	479.0	487.9	486.3	632.0	650.8	643.3	634.2	852.3	301.7
Cl	mg/l	495.4	505.1	503.4	442.0	562.7	654.5	544.4	473.8	413.1
PO_4	mg/l	7.44	5.65	3.51	6.28	4.24	7.67	5.56	6.23	5.71
NO_3	mg/l	18.2	15.4	12.7	28.4	13.1	25.7	27.7	19.6	14.4

recorded the highest percentage for both seasons, as for site 2. It recorded the lowest percentage for both semesters.

Calcium: It is clear from Table 3 and Fig. 5 that the calcium concentration values in the water of the Euphrates River for all samples range between 114.5–352.2. The highest value recorded during the summer was for sample 6, while the lowest was for sample 6. In the winter, and from looking at the same table, its cab be showed that the values of calcium concentration in the Euphrates River during the summer range between 262.3–352.2. The highest value was recorded for sample 6, while the lowest value was recorded for sample 8. In the winter, the values ranged between 114.5–195.6, the highest value was recorded for sample 9, while the lowest value was recorded for sample 6.

Magnesium: It is clear from Table 3 and Fig. 6 that the concentration values of magnesium in the water of the Euphrates River for all samples ranged between 13.1–97.7. In the summer, the values ranged between 13.1–67.6, the highest value recorded for sample 6 and the lowest value recorded for sample 5. In the winter, the values ranged between 72.1–97.7; the highest value was recorded for sample 6, while the lowest value was recorded for sample 8. It can be shown that there is a temporal variation in the concentration values of the study samples during the two seasons. The magnesium concentration values in the summer do not exceed 70 mg/L, in contrast to the winter season, which recorded the lowest concentration value of the magnesium element, which was more than 70 mg/L. As for the spatial variation, it was recorded at 6, The highest percentage for both classes.

Sodium: It is clear from Table 3 and Fig. 7 that the values of sodium concentration in the water of the Euphrates River during the summer range between 325.9–433.6, the highest value was recorded for sample 6, while the lowest value

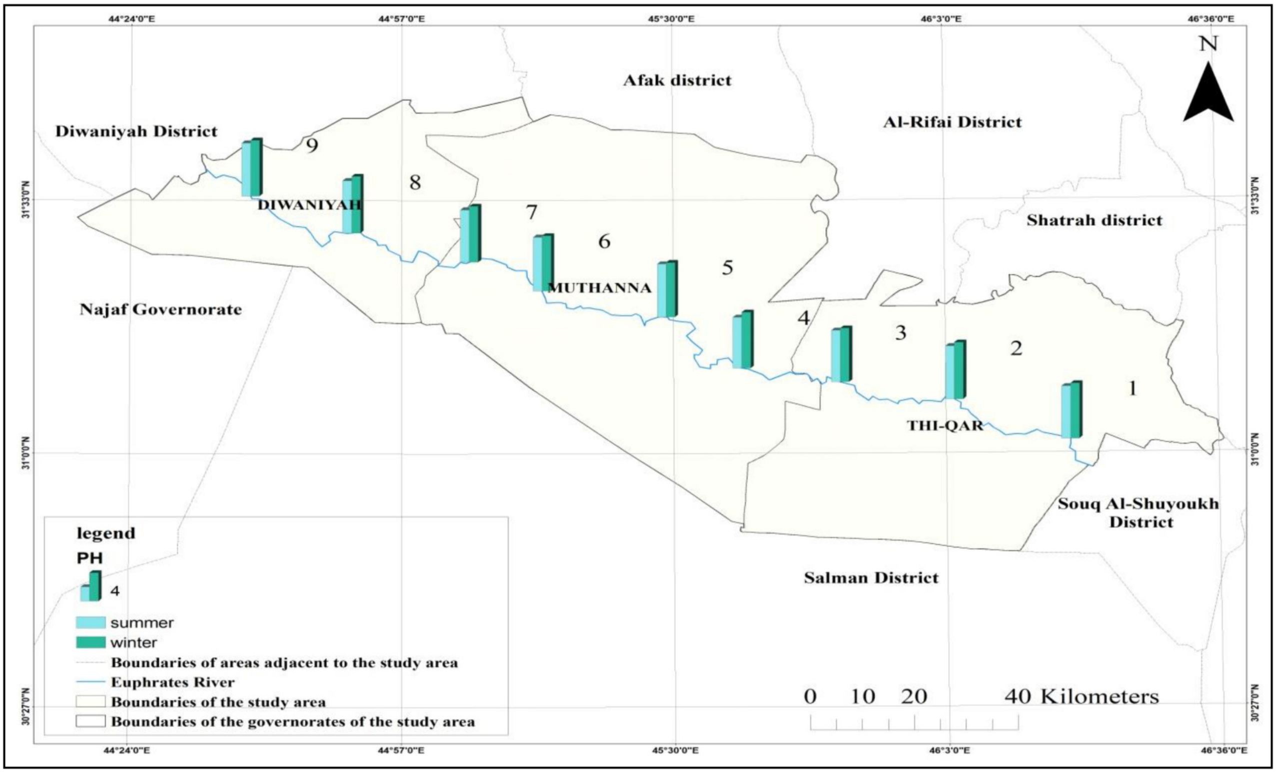

Fig. 2. Geographical distribution of pH concentration values in the Euphrates River in the study area.

area.

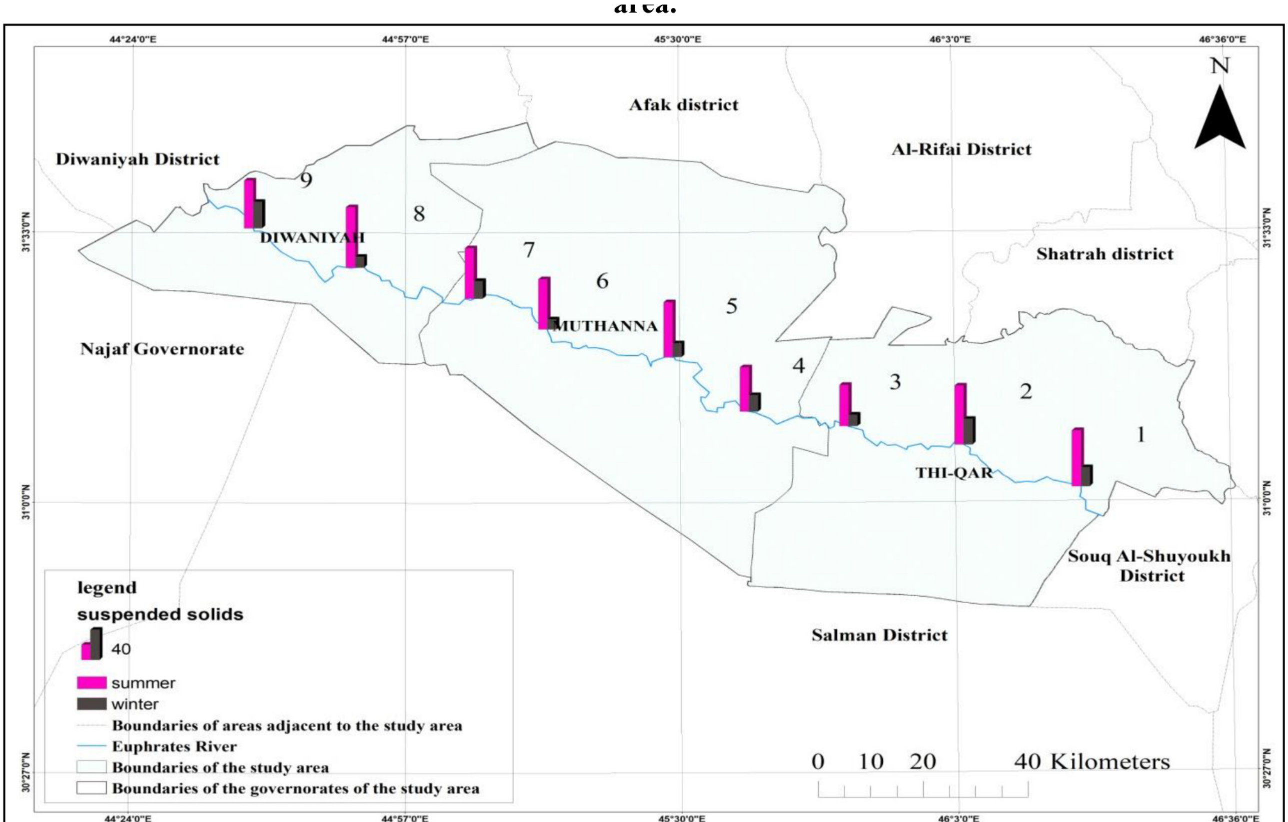

Fig. 3. Geographical distribution of concentration values of Suspended Solids in the water of the Euphrates River in the study area.

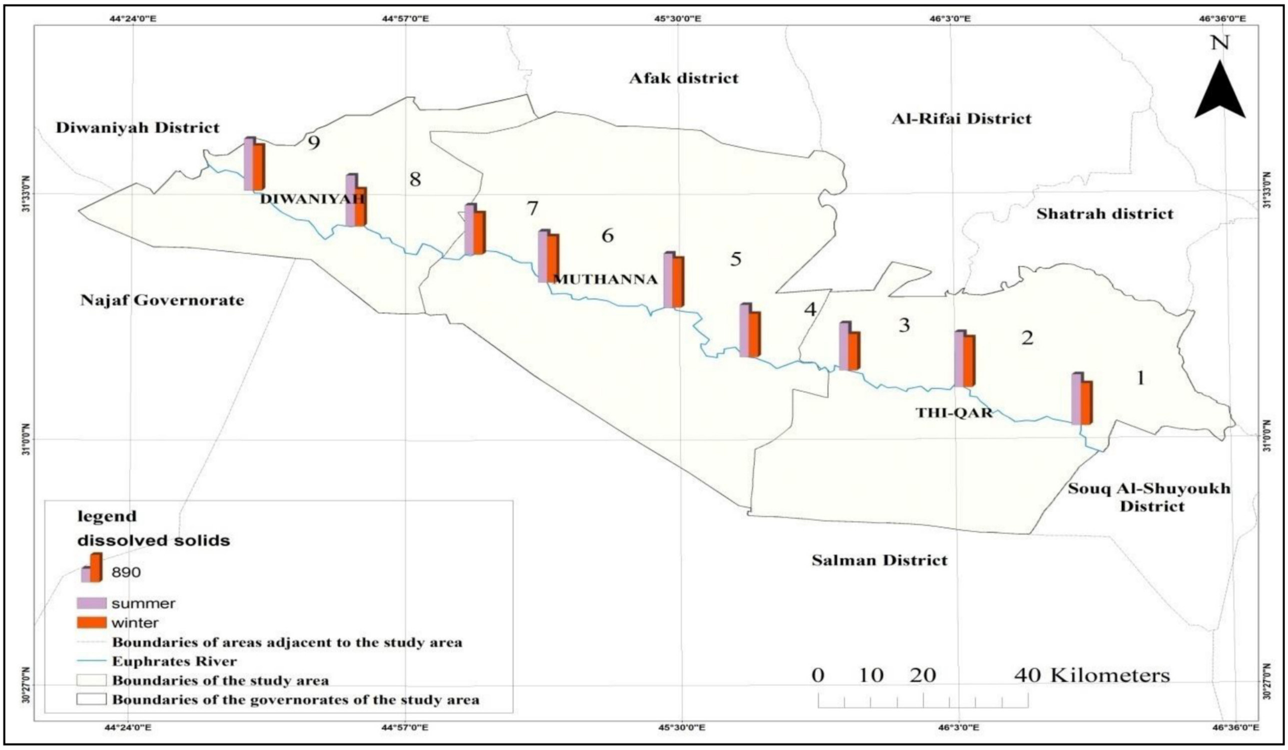

Fig. 4. Geographical distribution of the concentration values of Dissolved Solids in the water of the Euphrates River in the study area.

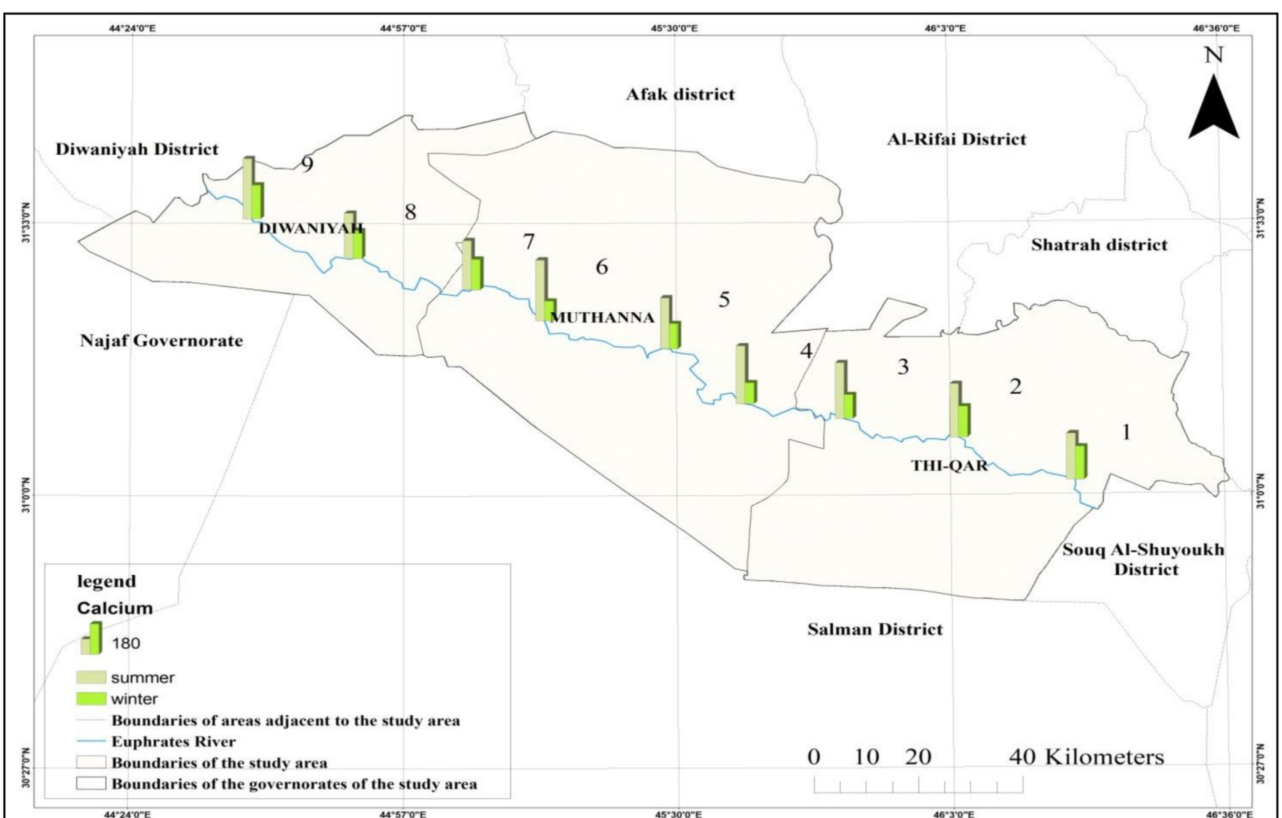

Fig. 5. Geographical distribution of Calcium concentration values in the Euphrates River in the study area.

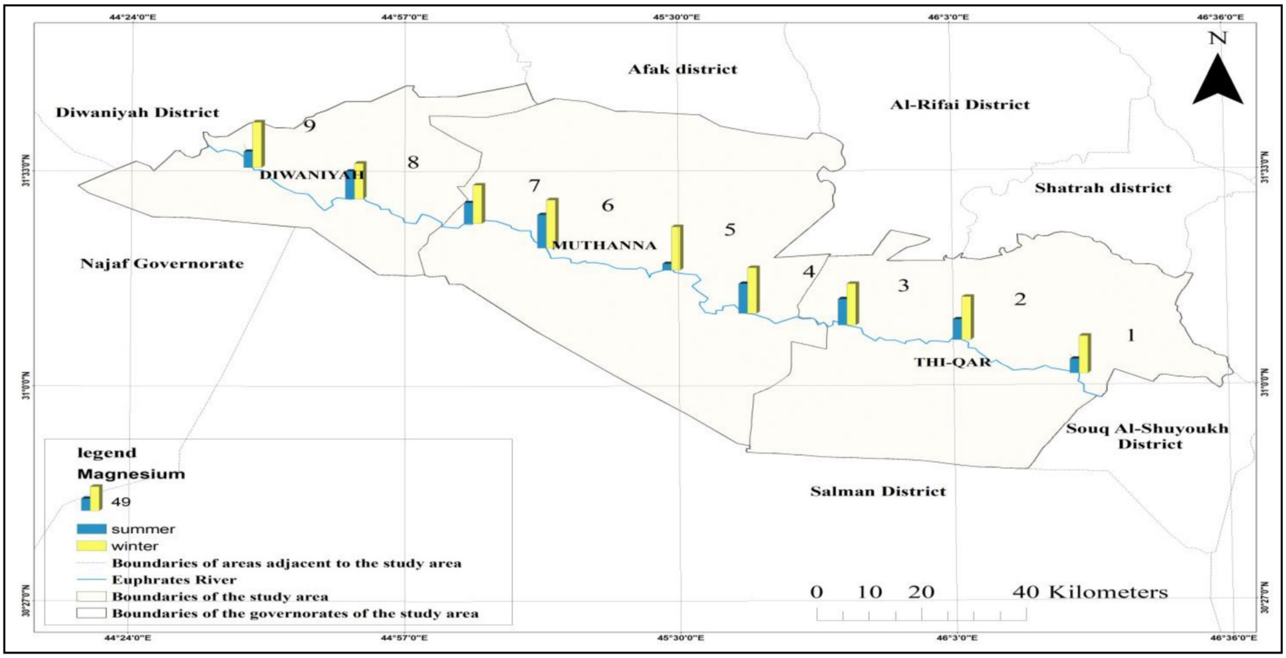

Fig. 6. Geographical distribution of Magnesium concentration values in the water of the Euphrates River in the study area.

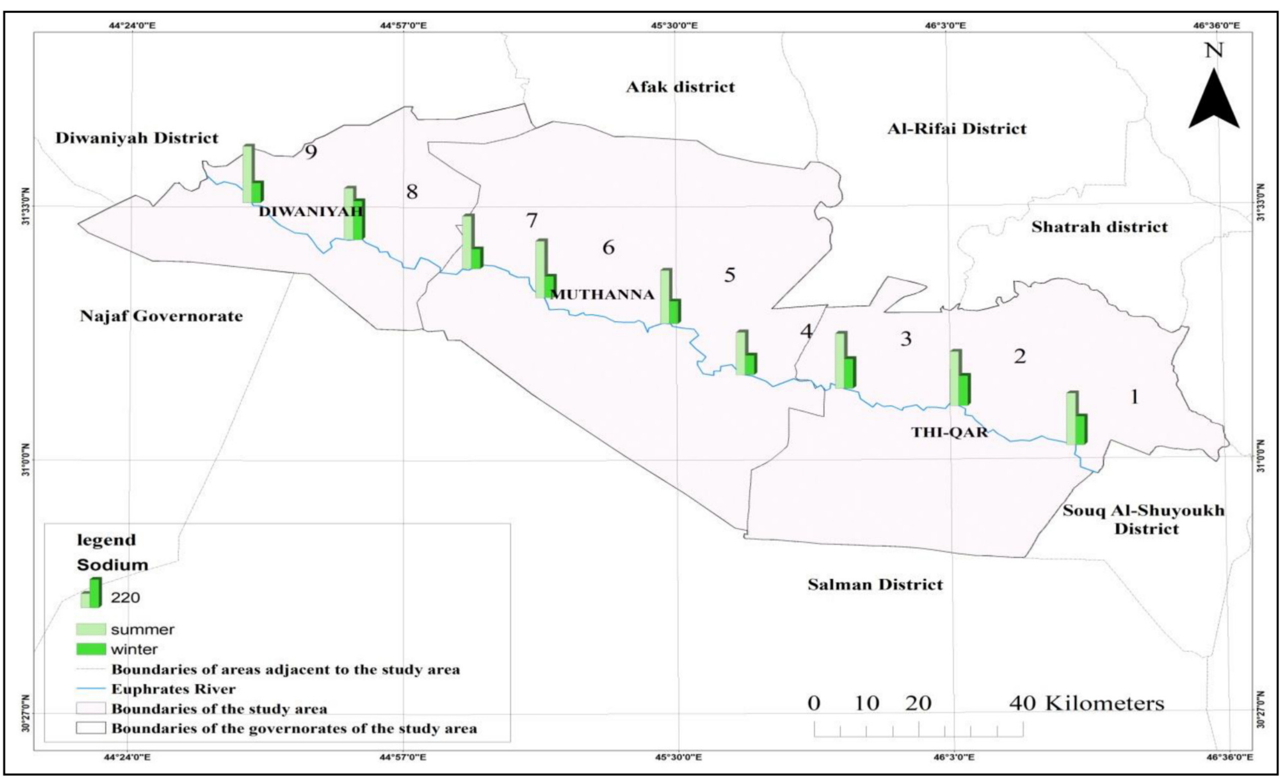

Fig. 7. Geographical distribution of Sodium concentration values in the water of the Euphrates River in the study area.

was recorded for sample 4, at a seasonal average It reached 403.1 mg/L, while in the winter the values ranged between 149.0–296.5, the highest value was recorded for sample 8 while the lowest value was recorded for sample 4, with a rate of 195.4 mg/L.

Potassium: It is clear from Table 3 and Fig. 8 that the concentration values of potassium in the

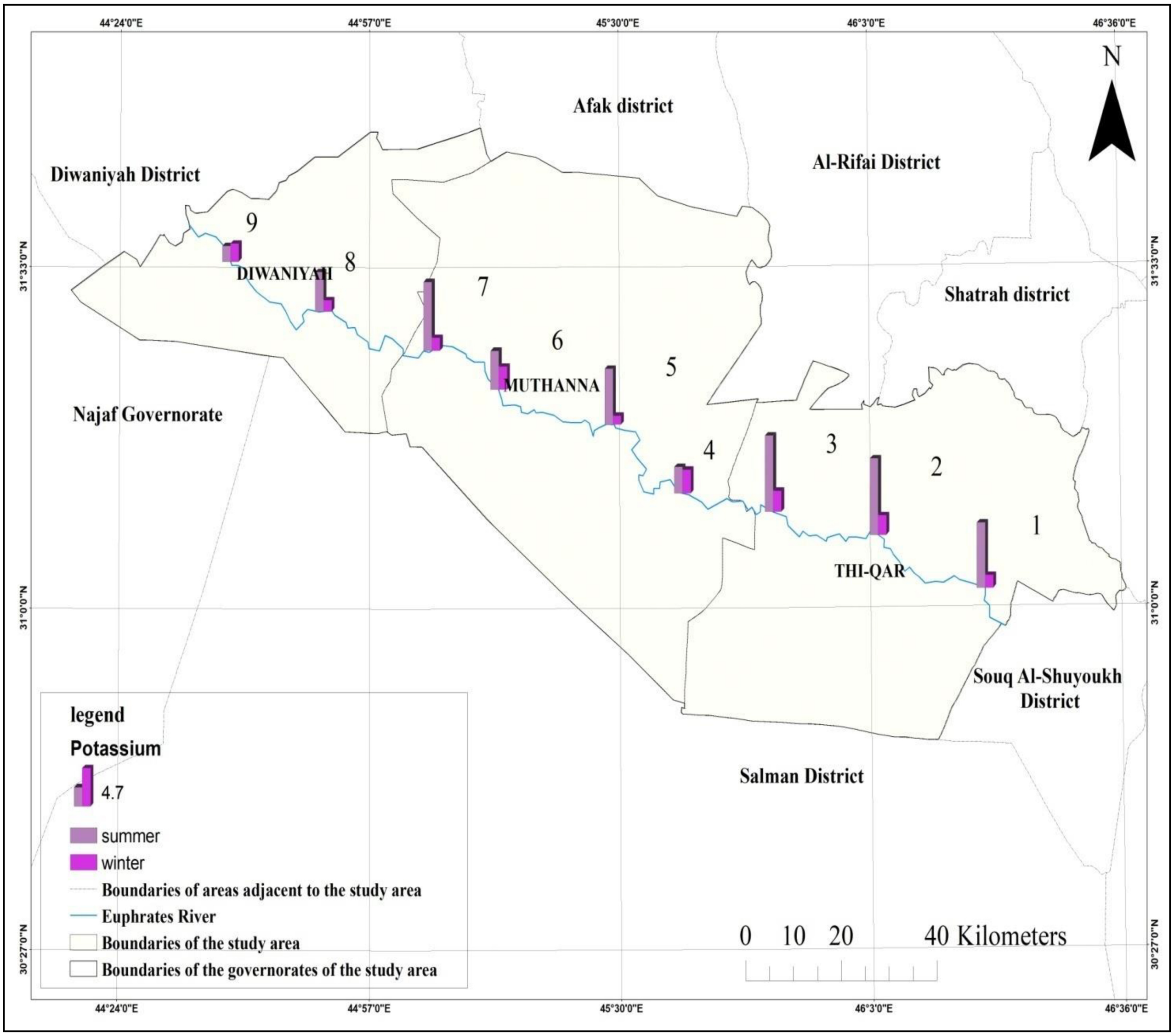

Fig. 8. Geographical distribution of Potassium concentration values in the water of the Euphrates River in the study area.

water of the Euphrates River during the summer range between 1.93–9.47. The highest value was recorded for sample 2–3, while the lowest value was recorded for sample 9, the general average of potassium reached 6.37 mg/L, while in the winter the values ranged between 1.09–2.92, the highest value recorded for sample 4 and the lowest recorded for sample 5, for a seasonal rate amounted to 2.07 mg/L.

Sulfates: It is clear from Table 3 and Fig. 9 that the concentration values of sulfates in the water of the Euphrates River for all samples ranged between 215.1–852.3. During the summer, the values ranged between 215.1–295.4, the highest value recorded for sample 4. The lowest value was recorded for sample 7, and in the winter the values ranged between 301.7–852.3, the highest value was recorded for sample 8 and the lowest for sample 9.

Chloride: It is clear from Table 3 and Fig. 10 that the chloride concentration values in the water of the Euphrates River during the summer range between 545.3–683.2. The highest value was recorded for sample 2, while the lowest was for sample 8. During the winter season, the values ranged between 413.1–654.5, the highest value recorded for sample 6, while the lowest value was recorded for sample 9.

Nitrates: - It is clear from Table 3 and Fig. 11 that the concentration values of phosphate in the water of the Euphrates River for all samples ranged between 12.7–42.6 with a general average

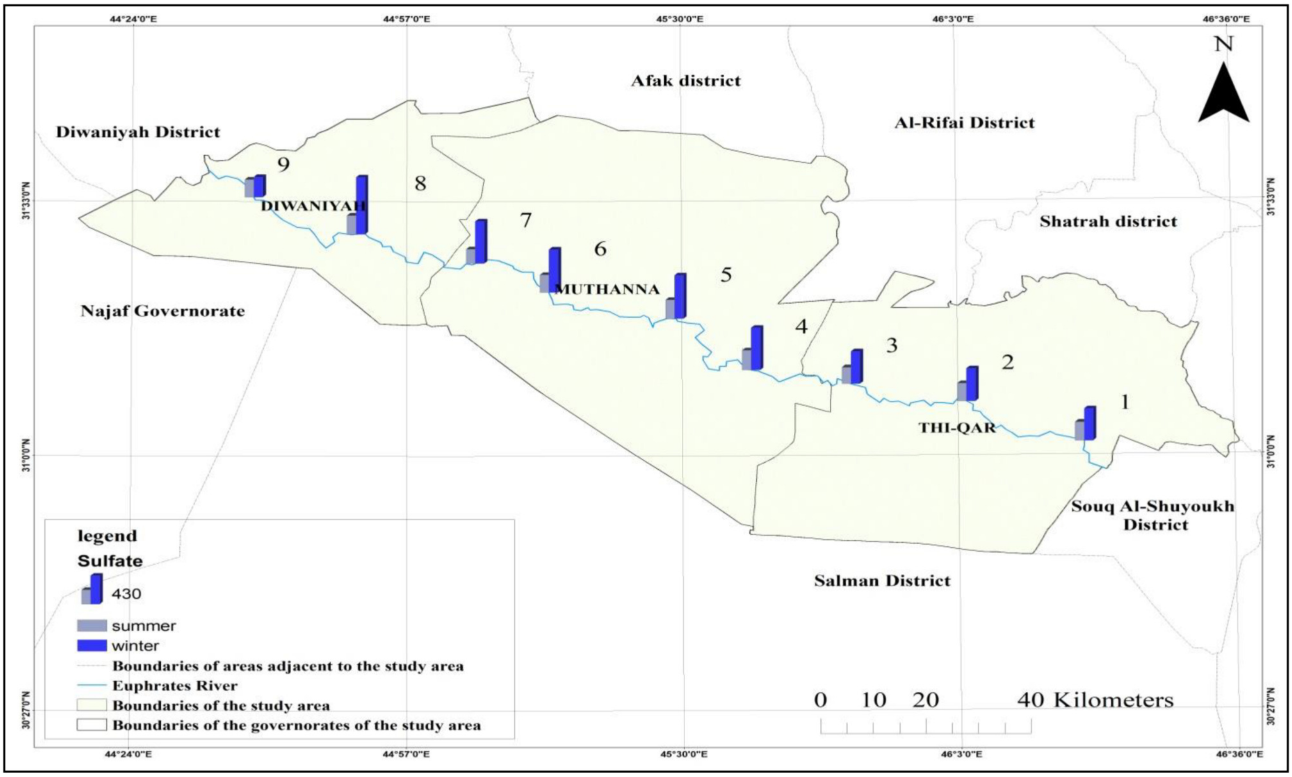

Fig. 9. Geographical distribution of Sulfate concentration values in the water of the Euphrates River in the study area.

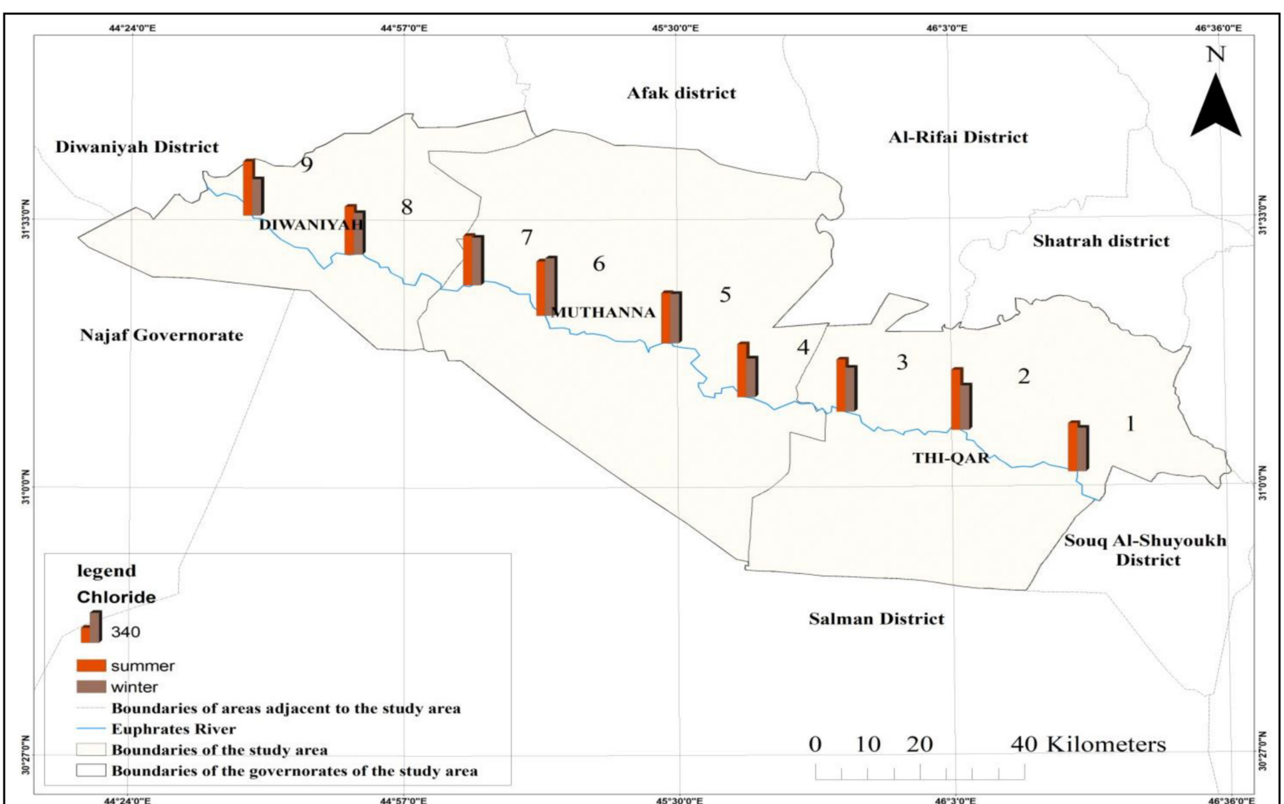

Fig. 10. Geographical distribution of Chloride concentration values in the water of the Euphrates River in the study area.

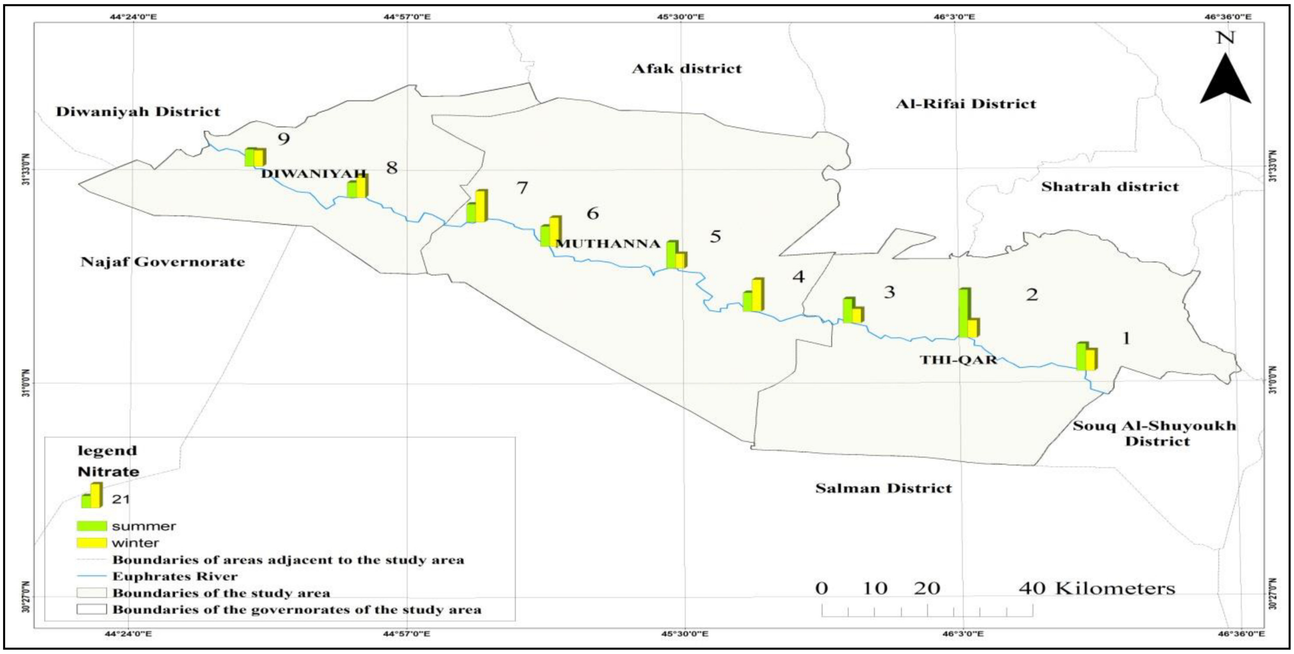

Fig. 11. Geographical distribution of Nitrate concentration values in the water of the Euphrates River in the study area.

of 20.3 mg/L. During the summer, the highest value was recorded for sample 2, the lowest value was recorded for sample 8, while in winter, the highest value was recorded for sample 4, and the lowest value was recorded for sample 3.

Phosphate: - It is clear from Table 3 and Fig. 12 that the concentration values of phosphate in the water of the Euphrates River for all samples range between 3.21–7.67, during the summer, the highest value was recorded for sample 7, while the lowest was recorded for sample 2. In winter, the highest value was recorded for sample 6, while the lowest was for sample 3.

2- Describing the water quality of the Euphrates River using international models: The study relied on two models to measure the water quality of the Euphrates River extending between the cities of Shinafiya and Nasiriyah, and they are as follows in terms of application:-

A- The Canadian Council of Ministers of the Environment water quality index CCME WQI: The water quality of the Euphrates River in the study area was classified using the above guide based on the Iraqi standards permitted within the Iraqi water environment for human use,[24] using 11 characteristics, namely (PO_4-Cl-SO_4-K-Na-Mg-Ca-TDS-TSS-pH-NO_3) It is clear from Table 4 and Fig. 13 that the water quality index values range between 62.2–74.7. The highest value recorded for site 4 is within fair water, while the lowest was for site 1 which is within water and whose quality is marginal, the same applies to sample 3, which is classified as water marginal, as it recorded a value of 62.3. All of the other six sites were within Fair water, and this deterioration in water quality is mainly due to the high concentrations of salts and pollutants thrown into the river, which led to a decrease in the index values.

Table 4. Evaluations and classification of the water quality of the Euphrates River in the study area according to the Canadian model CCME-WQI.

F 1	F 2	F 3	the value	Category
75.1	58.2	51.1	62.2	Marginal
75.0	66.6	52.4	65.3	Fair
75.2	58.1	51.4	62.3	Marginal
83.3	62.5	76.9	74.7	Fair
83.1	62.5	56.3	68.2	Fair
83.0	66.7	66.7	72.5	Fair
83.3	62.5	75.3	74.2	Fair
75.0	58.3	73.7	69.5	Fair
83.3	62.5	76.0	74.4	Fair

B- Weighted Arithmetic Index: After applying the above model to water samples of the Euphrates River in the study area, based on the Iraqi standards permitted within the Iraqi water environment for human use,[24] Table 5, using 11 characteristics, which are (NO_3-PO_4-Cl-SO_4-K-Na-Mg-Ca-TDS-TSS-pH), It turns out that the values of Wi*Qi for the weighted mathematical

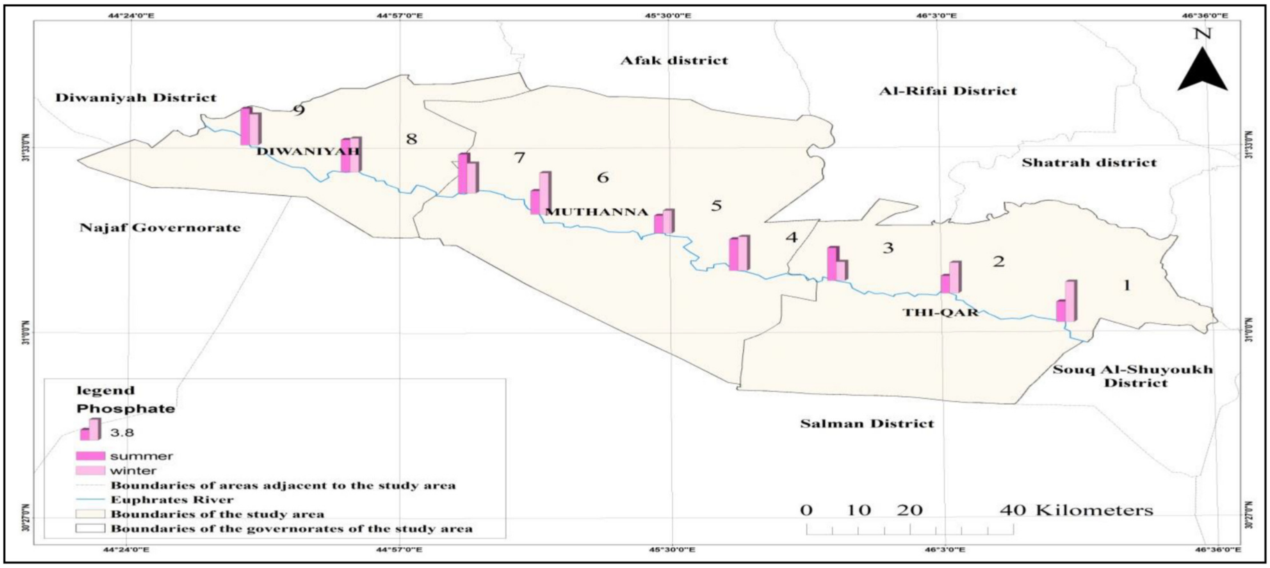

Fig. 12. Geographical distribution of Phosphate concentration values in the water of the Euphrates River in the study area.

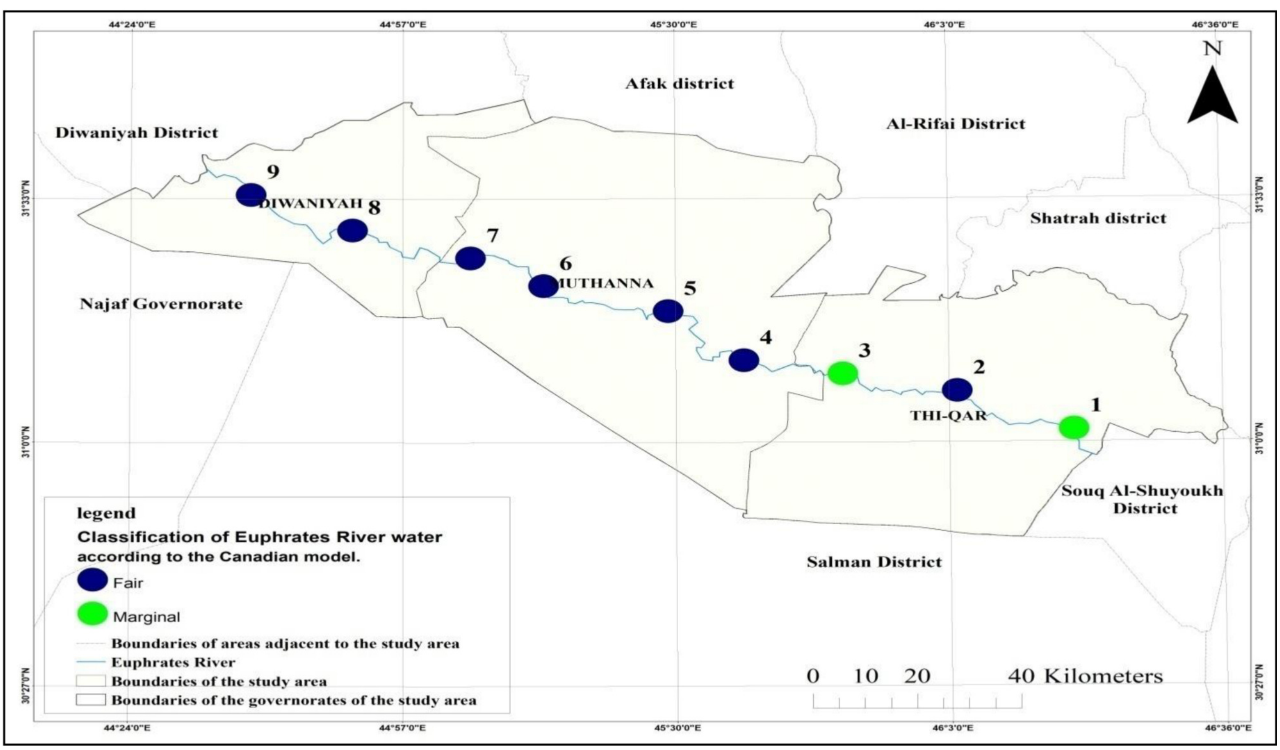

Fig. 13. Geographical distribution of the water quality classification of the Euphrates River in the study area according to the Canadian model.

model to indicate water quality range between 0.072–60.939, the highest value recorded for the characteristic PO_4, while the lowest was for the characteristic TDS, as for the two elements K-SO_4, they recorded close values of (1.050–1.051) for each of them respectively. As for the other attributes pH-TSS-Ca-Mg-Na-Cl-NO_3 they recorded values of 13.330-4.985-0.584-2.588-24.450-1.382 - Respectively, Table 5.

The value of the quality index for all the standards studied was 175.3, thus the water of the study area is classified as poor water, this is attributed to the high salt concentrations and pollutants that are thrown into the river, which

Table 5. Classification of the water quality of the Euphrates River in the study area according to the weighted mathematical model.

Elements	Unites	Ci	Si	Wi	Qi	Qi × Wi
pH	-	7.5	7.5	0.1333	100.0	13.330
TSS	mg/l	44.9	30	0.0333	149.7	4.985
TDS	mg/l	1532.8	1500	0.0007	102.2	0.072
Ca	mg/l	233.4	200	0.0050	116.7	0.584
Mg	mg/l	64.7	50	0.0200	129.4	2.588
Na	mg/l	299.2	35	0.0286	854.9	24.450
K	mg/l	4.2	20	0.0500	21.0	1.050
SO_4	mg/l	420.2	200	0.0050	210.1	1.051
Cl	mg/l	522.6	200	0.0050	276.3	1.382
PO_4	mg/l	5.49	3	0.3333	183.0	60.939
NO_3	mg/l	20.3	50	0.0200	40.6	0.812
SUM				0.6342	2183.9	111.2
WQI		175.3				

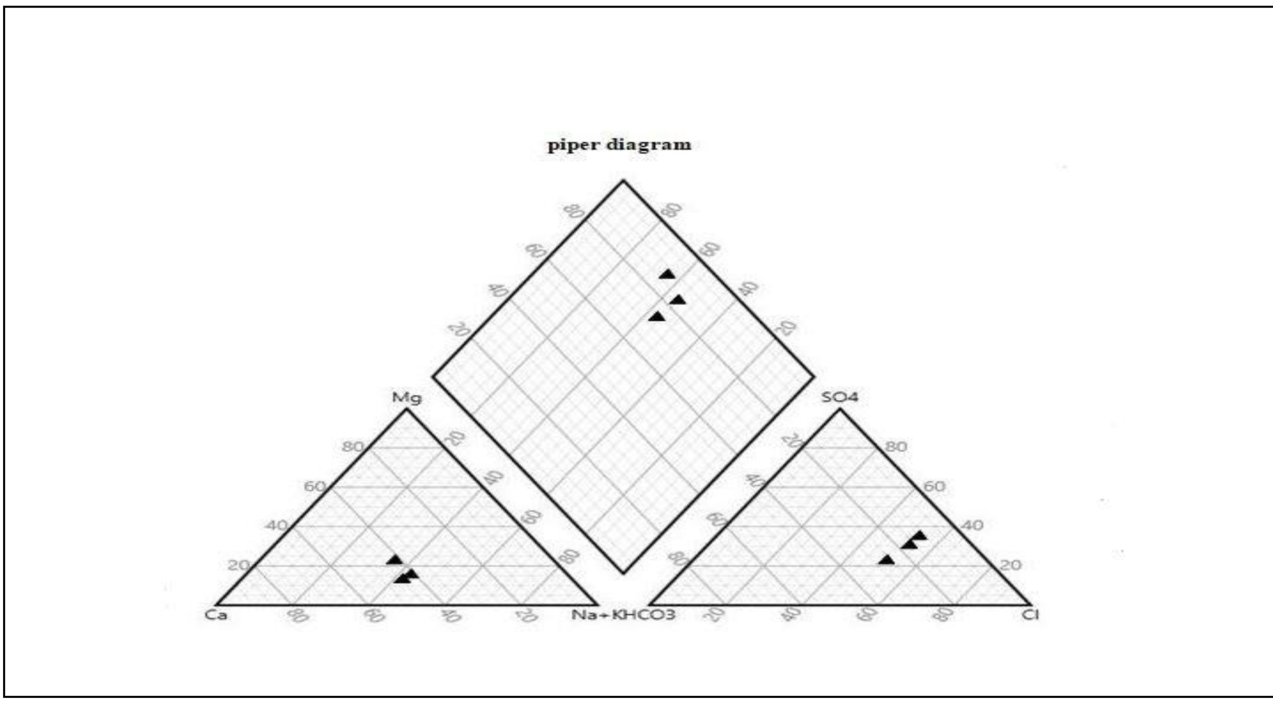

Fig. 14. Classification of the water quality of the Euphrates River in the study area according to the Piper diagram.

affected the decrease in the index values for the study samples.

3- Classification of water quality according to the Piper and Solen methods.

A- Piper method: - After applying Piper's diagram to the study samples, it was found Fig. 14, that 3 of the water samples in the study area fall within type E, which waters are classified as alkaline earth waters, sulfates and chlorides are prevalent in it, and this is due to the original rocks that make up the area had a significant impact on the quality of the water, as the water was alkaline in nature because it contained a large amount of calcium and magnesium ions and small percentages of sodium and potassium ions, with a clear dominance of sulphate and chloride ions, As for the other six samples, three of them had water quality in the form of chloride, and the other three were in the category of calcium-rich water. Groundwater likely intermingled with river water in this area, which affected the results of the samples, and thus this effect was reflected in the quality of the classification.

B- The Schuller-Solen method: Based on this classification, the possible types of water are 63 types, and when applying the classification Schuler-Solen 1981 to water samples of the

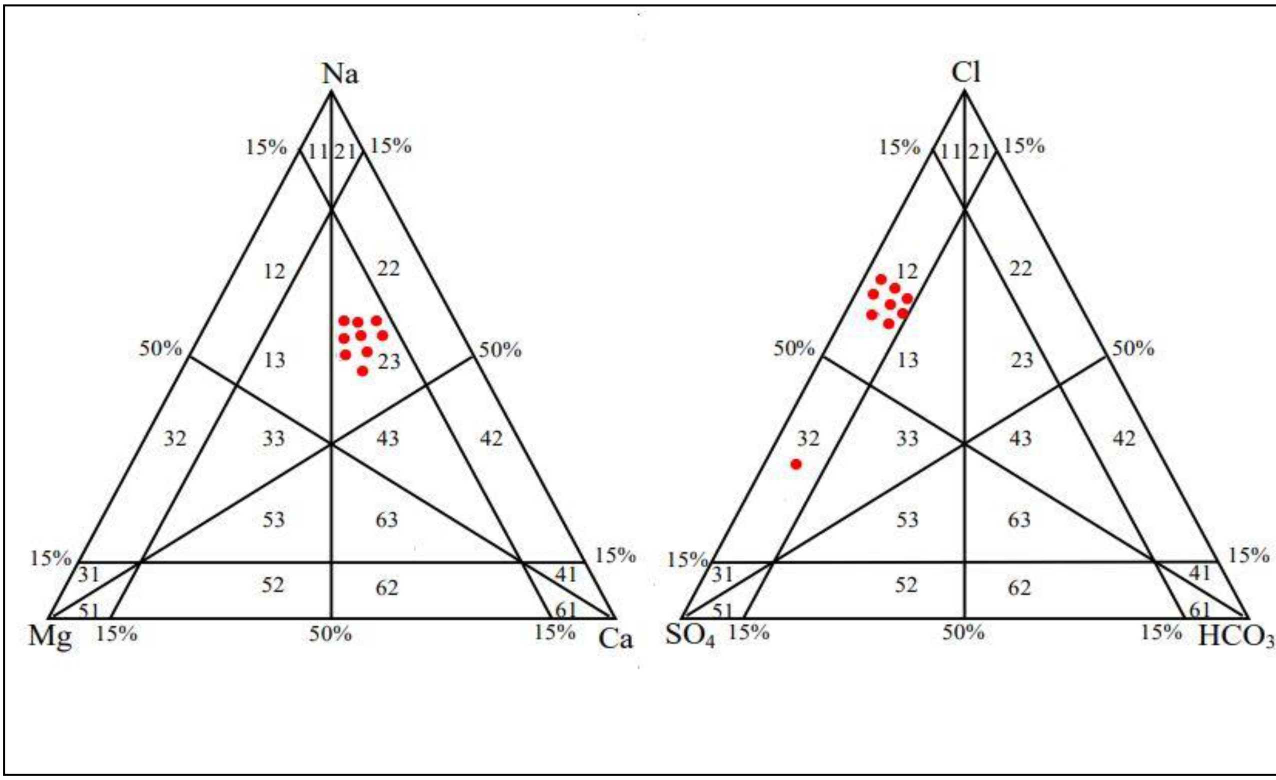

Fig. 15. Distribution of Euphrates River water samples in the study area to classify their quality according to the Schuller-Solen method 1981.

Euphrates River, it was found that concerning the concentration of the collected ions, all samples from the study area fell within the type r Na > r Ca > r Mg, which has the symbol 23. Regarding the negative ions, they can be divided into two categories: the first is r Cl > r SO_4 and has the symbol 12 and this type includes 8 samples. The second type is r SO_4 > r Cl and has the symbol 32 and includes only one sample.

It is worth noting that all the water samples of the Euphrates River are from the chloride group and include one family, the Chloride-Sodium family, Fig. 15, except one sample that was abnormal and recorded within the sulphate group and belonged to the calcium sulphate family and is attributed to this deviation of this value from its counterparts is due to the rocky nature of the area of that sample, in addition to its proximity to an agricultural area, which increased the concentration of sulfates in the sample's water.

Conclusion

The study reached a set of conclusions:

- That the concentration of physical and chemical elements in the Euphrates River is very high.
- International models for classifying water quality have proven their effectiveness in performing their role, as the water of the Euphrates River was classified according to the Canadian model into the water fair and marginal, as for the mathematical model Weighted, the index value for all criteria studied was (175.3) Thus, the water of the Euphrates River is classified as poor water.
- It was also shown that water samples of the Euphrates River are classified according to Piper's method into three types: The first is alkaline ground water and contains sulfates and chlorides, the second type was water in the form of chloride, the third type was water of the category Water rich in calcium, according to the Schuler-Solen method, all water samples of the Euphrates river are from the chloride group and include one family, the sodium chloride family, with the exception of one sample that was within the sulfate group and belongs to the calcium sulphate family.

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Authors' declaration

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are ours. Furthermore, any Figures and images that are not ours have been included with the necessary permission for re-publication, which is attached to the manuscript.
- No animal studies are present in the manuscript.
- No human studies are present in the manuscript.
- Ethical Clearance: The project was approved by the local ethical committee at the University of Thi-Qar.

Authors' contribution statement

H. S. D conduct the analysis and classification of the data, while R. H. A. is a supervisor of all theoretical and scientific aspects of the research.

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بناء نماذج خرائطية لتقييم نوعية مياه مجرى نهر الفرات الممتد بين مدينتي الشنافية والناصرية في جنوب العراق بالاعتماد على تكنولوجيا نظم المعلومات الجغرافية ومؤشرات نوعية المياه

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الخلاصة

هدفت الدراسة الحالية إلى تقييم نوعية مياه نهر الفرات في المنطقة الممتدة من الشنافية إلى الناصرية من خلال دراسة الخصائص النوعية للنهر ومعرفة نوعية مياهه وذلك باستخدام النموذج الكندي (CCME WQI) والمؤشر الحسابي الموزون، بعد ذلك تم تصنيف أصل المياه وفق طريقتي بايبر و شولير سولن، وتبين أن جميع عناصر الخواص الفيزيائية والكيميائية عالية، أما بالنسبة للنموذج الكندي فقد تراوحت قيم المؤشر بين (62.2-74.7)، أعلى قيمة سجلت للموقع (4)، وهو يقع ضمن المياه المقبولة، وأقلها للموقع (1)، في حين كانت قيم (Wi*Qi) للنموذج الرياضي الموزون تراوحت بين (0.072-60.939). أعلى قيمة سجلت للخاصية (PO_4) وأقلها للخاصية (TDS)، أما بالنسبة لتصنيف نوعية المياه وفق طريقة بايبر فقد تبين آن (3) من عينات مياه منطقة الدراسة تصنف على مياه أنها مياه قلوية أرضية وان الكبريتات والكلوريدات هي السائدة فيها ، أما العينات الستة الأخرى فثلاثة منها كانت نوعية المياه فيها على صورة كلوريد و الثلاثة الأخرى كانت ضمن فئة المياه الغنية بالكالسيوم ، أما حسب طريقة شولير سولن فإن جميع عينات مياه نهر الفرات هي من مجموعة الكلوريدات وتضم عائلة واحدة هي عائلة كلوريد الصوديوم.

الكلمات المفتاحية: تقييم نوعية المياه، نهر الفرات، نظم المعلومات الجغرافية، الخصائص الفيزيائية و الكيميائية، مؤشرات جودة المياه.