Journal of Learning on History and Social Sciences
Homepage : https://journal.antispublisher.id/index.php/EJLHSS
Email : admin@antispublisher.com

e-ISSN : 3031-7347
JLHSS, Vol. 2, No. 9, September 2025
Page 527-546

Use of Groundwater in Selected Areas (Al-Rashidiya and Southern region's Baghdad) of Eastern Baghdad Oil Field: A Study in Sustainable Development

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DOI : https://doi.org/10.61796/ejlhss.v2i9.1411

Sections Info

Article history:
Submitted: June 30, 2025
Final Revised: July 09, 2025
Accepted: July 30, 2025
Published: August 18, 2025

Keywords:
Groundwater
Oil
Agriculture
Sustainability
Eastern baghdad
Al-rashidiya

ABSTRACT

Objective: *This study aims to evaluate the suitability of groundwater for multiple uses, including agricultural irrigation, human consumption, animal drinking, and poultry farming, in selected areas of the East Baghdad oil field (Rashidiya and the southern region of Baghdad), with a focus on sustainable water resource management.* ***Method:*** *Laboratory analyses were conducted based on international water quality standards to assess key physicochemical elements, and Geographic Information System (GIS) techniques were employed to transform raw spatial data into a digital database for mapping and generating hydrological tables.* ***Results:*** *The findings indicate spatial variation in groundwater quality across the study area, with certain zones exhibiting acceptable standards for agricultural and livestock use, while other zones were unsuitable for direct human consumption due to elevated concentrations of specific elements.* ***Novelty:*** *The study provides an integrated approach combining laboratory assessment with GIS-based spatial analysis, offering a practical framework for monitoring, mapping, and managing groundwater resources in oil field regions under environmental stress, thereby contributing to long-term sustainability strategies.*

INTRODUCTION

Sustainable development depends mainly on the preservation and sustainable use of various resources, including water resources, which are considered the basis for food or economic development, especially agricultural ones. Sustainable water management is the process of meeting current water needs without compromising future water needs in order to improve living conditions on the one hand and develop means and methods of production on the other hand, hence this study came to achieve the goal of sustainability and investment of groundwater in selected areas of the East Baghdad oil field through its investment for various sectors, especially agriculture [1].

The problem of the study is characterised by the question: What is the extent of the suitability of groundwater in the East Baghdad Oil Field (Rashidiya - Southern Region) for investment in different sectors? [2]

The hypothesis of the study was: The quality of groundwater in the East Baghdad Oil Field (Al-Rashidiya - Southern Region) has an impact on determining the type of optimal investment [3].

The study aims to demonstrate the importance of groundwater quality for different investments in the study area and clarify the impact of different oil operations on it through spatial analysis of groundwater distribution and determining the amount of consumption for each sector in order to achieve sustainable water development in this area [4].

The study area’s location determined by lines of longitude and latitude, as the study area, represented by the East Baghdad Oil Field, is located between latitudes (330 35̅0 00 ̿0-33°0 00̅0 00̿0) north and longitudes (450 00̅0 00̿0-440 20̅0 000̿) east.

Geographical Location of the Study Area (Spatial): The East Baghdad Oil Field is located in central Iraq, approximately 10 km east of Baghdad Governorate. It extends in a northwest–southeast direction, from the Taji area in the northwest of Baghdad to the northern part of the Sawira area. The field stretches over an estimated length of 120 km and varies in width from 10 to 20 km. As illustrated in Map (1), the field encompasses two main zones within its boundaries: the Southern Region and Al-Rashidiya. The total area covered by the region is approximately 1,269 km² [5], [6].

RESEARCH METHOD

Geography of the Study Area

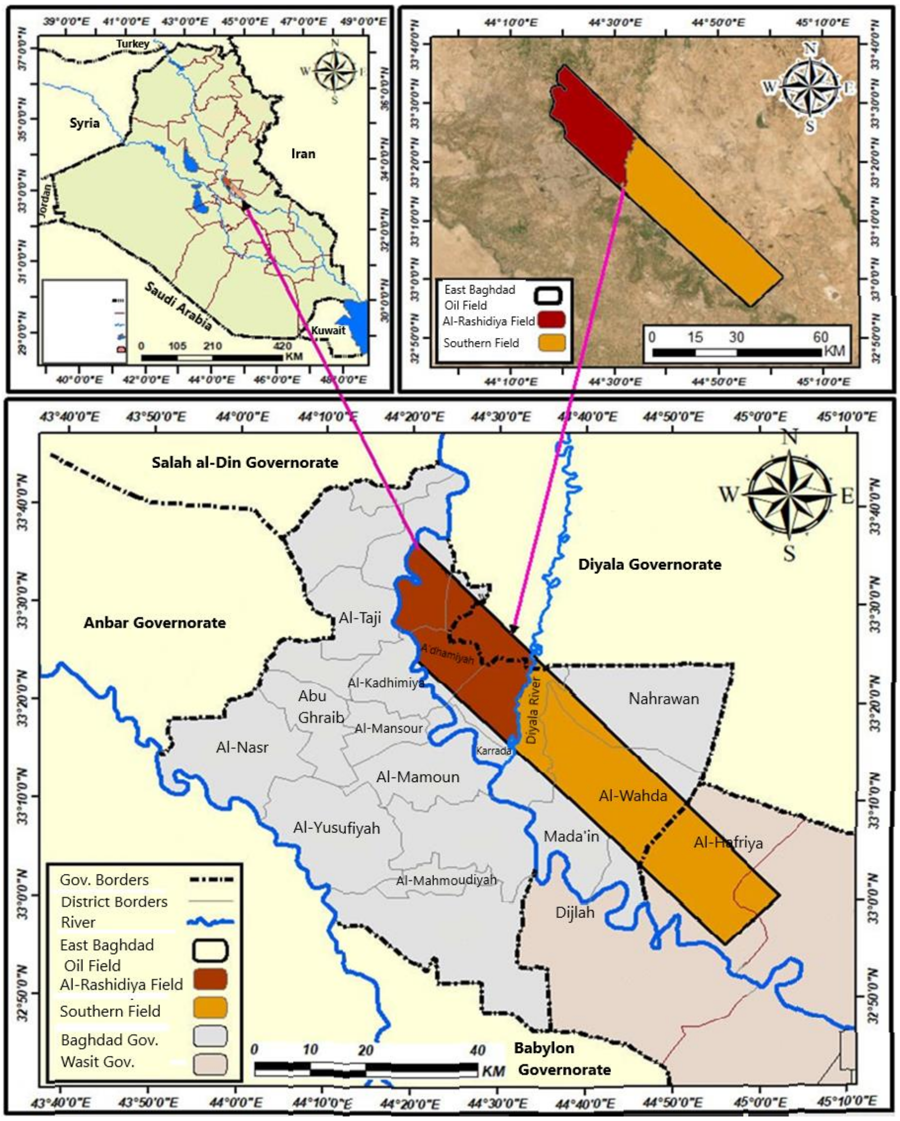
The natural characteristics are one of the most important factors through which the characteristics of the rock layers and the quality of the aquifer and the quality, movement and quantity of groundwater are studied, while the surface factor has a prominent role in determining the amount of groundwater through the degree of permeability, porosity, slope and slope, as well as the natural vegetation that plays a role in obstructing and flowing surface water during rainfall the climatic factors (solar radiation, temperature, humidity, wind, evaporation, rainfall) also contribute to replenishing the amount of groundwater and its impact on the aquifer, as well as the soil factor appears to play a role in influencing the volume of groundwater by determining the characteristics of the soil if it is low or high permeability.

Geological structure

Through the study of the geological structure, it is possible to determine the locations of groundwater storage sites, their vertical and horizontal extension and the amount of water present in them, through which the aquifers are identified and the nature of the rocks and knowledge of their properties through their area, chemical properties, the location of their layers and their inclination Modern structural activities have shown that the floodplain is a convex structural fold in which numerous transverse and longitudinal faults extend, and that these faults divide it into separate and independent sections and contain water and oil at different levels, and that each reservoir has its own geological structure [1], [7], [8], [9].

RESULTS AND DISCUSSION

The study area is located in the area of the unstable continental shelf in the floodplain, which is called the Mesopotamian range, which is divided by (rbaday) into the secondary Euphrates region and the secondary Tigris region. The geological structure of the study area consists of deposits in the fourth time that consist of a succession of clay, gravel, silt, and shale layers. These deposits have economic importance as they form the topsoil that is used for agriculture in the study area and are the source of many subsurface water bodies.



Source: The author based on the Ministry of Oil's East Baghdad Oil Field, Geology Department, 1:5000 for the year 2024, using Arc GIS 10.8.

Map 1. Geographical Location of the Study Area.

The presence of geological sediment types in the region is shown in Table (1) and Map (1) as follows :

1. **Marsh deposits:** This type of deposit is formed in some depressions characterized by the presence of layers of clay and organic materials important for plants such as shells and very fine snails that give the marshes a black colour; this is due to the exposure of the surface layers to dryness as a result of high temperatures and is found in the northwestern part of the region and is estimated at (5.58231) km2 and its percentage is (0) %.
2. **Residual soil deposits:** They are multi-generational deposits dating back to the Holocene-Pleistocene stage, and their area in the study area reached (14.86243) km2 (14%) and consist of clay, silt, sand, and a mixture of iron, sand, large rocks and gravel.

3. **Man-made deposits:** These are deposits formed by various human activities, and most of these deposits are formed from the remains of the opening of ancient irrigation channels, which represent prominent morphological features in flat natural areas, and their area in the study area is (38.89032) km2. Its percentage is(3) % .
4. **Deltoids and extrusions:** They are river deposits formed when the river changes its course at an almost high angle or the river breaks natural or artificial dams and deposits in the form of alluvial fans beside the river also called alluvial fan deposits and these deposits are large-grained sand and silt and a little alluvial clay, which are found in the north of the central region beside the Tigris River and are modern to semi-modern as an area in the two study areas (7.945935) km2 and its percentage (1%).
5. **Depression fill deposits:** These deposits are formed in the area of depressions and originate from the deposition of materials found with the remains of decaying organisms and plants. These deposits are spread in the centre and south of the study area and their area in the two study areas is (127.9639) km2 and their percentage is (10).
6. **Floodplain deposits:** Floodplain deposits include river deposits, which consist of rock fragments carried by the Tigris and Diyala rivers and part of the Al-Azim River, and these deposits are widespread in the region, and the floodplain deposits are natural reservoirs for groundwater and consist of complex combinations of sand, clay, silt and varying proportions due to river deposits.

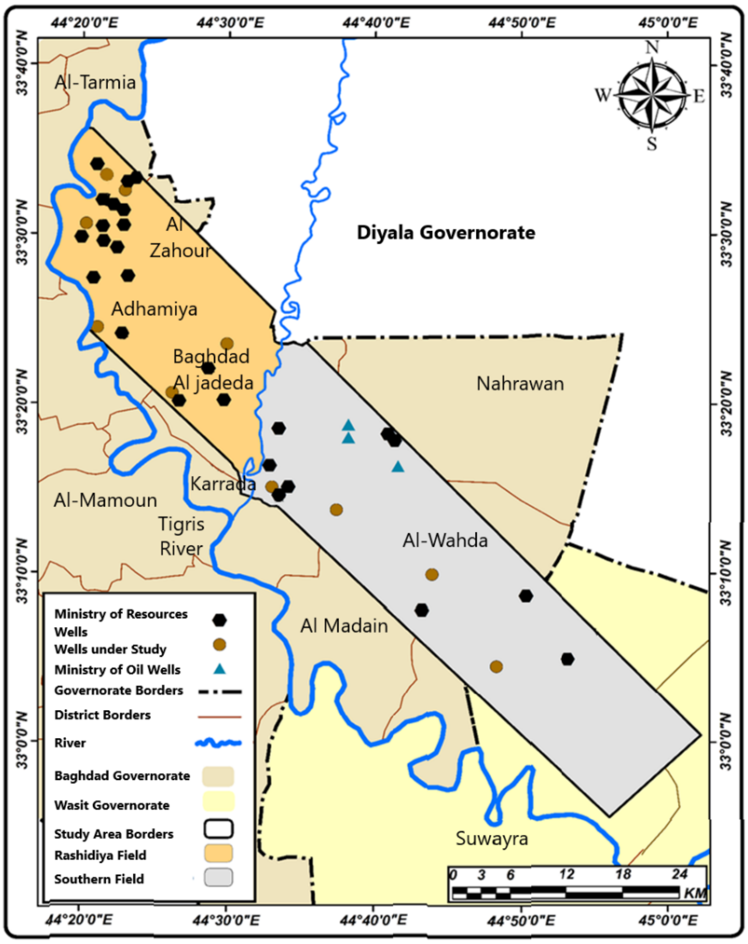
These deposits are spread over most of the region with an area of (1055.848) km2 and a rate of (83%).

Topography

Topography is considered one of the important factors affecting water resources—both surface and groundwater—by influencing their levels and their infiltration into the subsurface. The study area lies within the unstable shelf, which is regarded as one of the most favorable zones for hydrocarbon accumulations. The instability of this part of the alluvial plain is attributed to various geological factors, most notably the presence of subsurface faults that sometimes extend into deep weak zones and reach the crystalline basement [10].

Table 1. Area and percentage of geological regions.

Name	Area	%
Marsh Sediments	5.58231	0%
Residual Soil Sediments	14.86243	1%
Anthropogenic Sediments	38.89032	3%
Delta Slope Sediments	7.745935	1%
Depression Fill Sediments	125.9639	10%
Floodplain Sediments	1055.848	83%
Total	1265.386	100%



Source: The author based on Table 1 and ArcGSI 0.8, Density program.
Map 2. Geology of the study area.

The floodplain can also be considered in the aging stage, which is one of the geomorphic stages, which is characterised by the flatness of the land and rivers with wide channels, and the flat land is devoid of heights with some low elevations in the region, The height is low (40) metres above sea level and a small to medium height in the southern, central and western eastern parts of the region, and it appears from the map of equal heights (3) that the region is characterised by complete flatness, as its height above sea level ranges between (40) metres in the northeastern part of the Rashidiya area and (25) metres in the southwestern parts of the Al-Suwayrah district in the study area, in addition to the presence of some heights that are with the extension of the sedimentary plain from the northeastern sides towards the southern and southwestern sides of the region. As shown in table 2 and map 3.

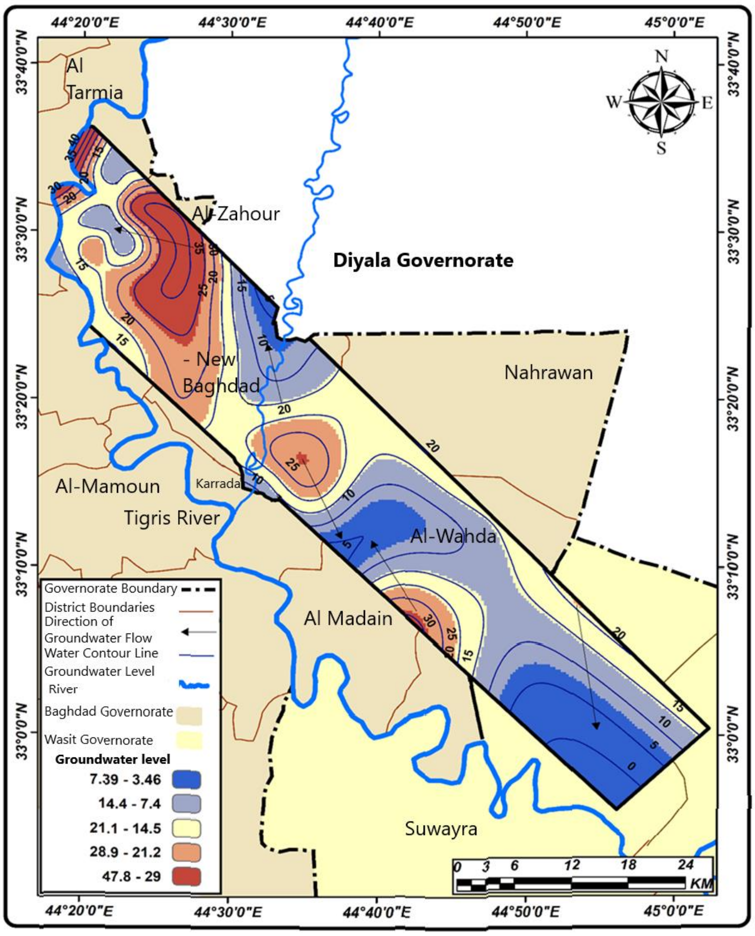
Numerical distribution of wells in the region

The spatial analysis of groundwater is done by estimating and measuring the value of groundwater because it has a fundamental role in water management because it gives a clear idea about the volume of groundwater, its productive capacity, its level, the number of wells and their depths in the region. The groundwater system is the changes in its level, chemical composition, temperature, flow and other factors affecting the system. The numerical distribution of wells in the area (Rashidiya) is variable, while in the east and south of the area, the wells are few because the wells in this area are saline, as well as this part of the study area where there are sanitary landfill areas that negatively affect groundwater and through the review of the relevant authorities represented by the Ministry of Water Resources and the General Authority for Groundwater in Baghdad, as well as the field study, which was distributed by (40) wells. We were provided with (37) samples from the Ministry of Water Resources, the Groundwater Resources Authority and three wells from the Ministry of Oil/East Baghdad Oil Field, and ten groundwater wells were analysed by the author.

Table 2. Degrees of elevation.

Height categories	Good evening	Ratio
22.98-28.18	180.2481	14%
28.19-31.17	271.6648	21%
31.18-34.27	232.4829	18%
34.28-37.03	374.745	30%
37.04-51.2	206.2454	16%
Total	1265.386	100%

Source: The author based on Map (2) and ArcGIS 10.8 program.



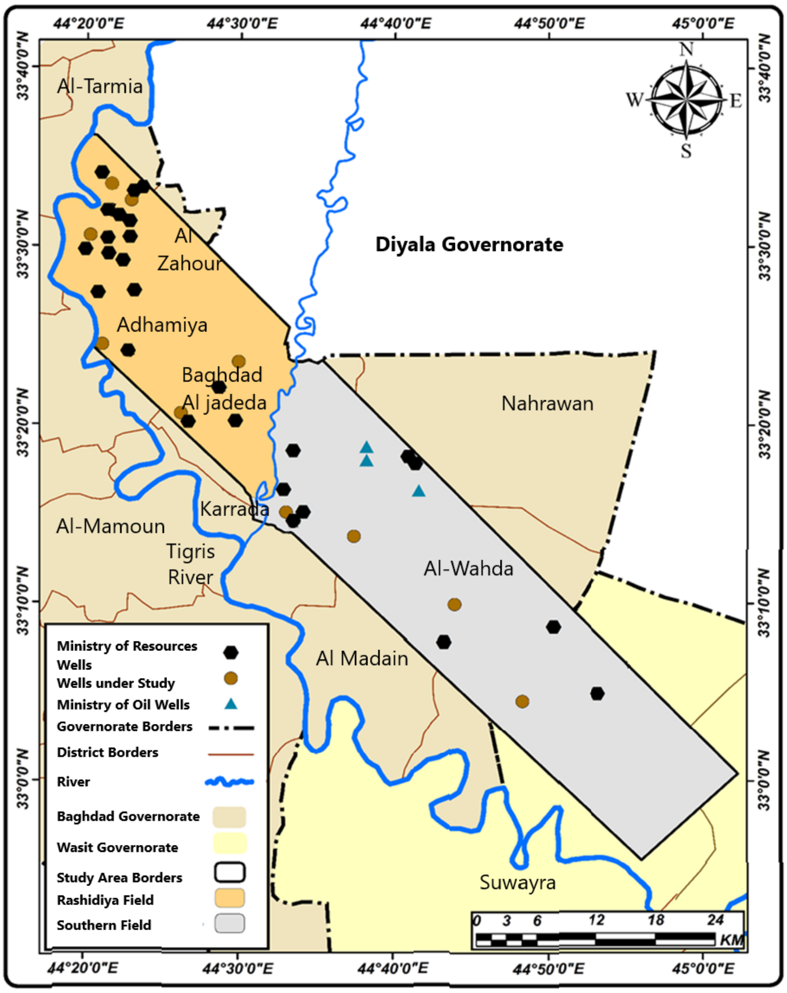
Source: The author based on data from Table 1 and Arc GIS10.8, Density program.

Map 3. The Groundwater movement in Study area.

The unstable shelf is the result of favorable geological conditions that facilitated the formation of hydrocarbon deposits. The surface of the region is characterized by flatness and minimal slopes. Since the study area forms part of the alluvial plain, particularly during the glacial period when heavy rainfall occurred, these rains had a significant impact on the surface.

Physical and chemical properties

Water is a colourless, tasteless and odourless liquid at the surrounding temperature and pressure, as one water molecule contains two hydrogen atoms covalently bonded to one oxygen atom, and groundwater has its physical properties, which vary according to the aquifer's surroundings from different formations and substances dissolved in it, which affect the physical properties of groundwater such as colour, taste, odour, temperature and percentage of dissolved substances. This affects the physical properties of groundwater such as colour, taste, odour, temperature, TDS, dissolved salts and electrical conductivity (EC), which leads to a wide variation in the quality and properties of this water and hence the appearance of different pollutants according to the different and varying proportions of these properties as follows [10], [11], [12], [13], [14], [15]:



Source: The author based on Arc GIS 10.8, Density.

Map 4. Geographical distribution of wells in the study area.

Physical properties

Color Odor Taste

The colour of the water results from increased concentration of magnesium ion, concentration of dissolved iron, lack of dissolved oxygen and humic compounds, while the taste results from increased dissolved solids (TDS), increased carbonate hardness, dissolved oxygen varieties and excessive bacterial activity, As for the smell, it usually results from the presence of decaying substances and fungi, as organic substances when mixed with water cause decomposition and by taking samples from the wells of the region and analysing them, it was found that their colour is reddish due to the high sodium sulphate and other elements that give the well water a bitter taste.

Temperature

Temperature is one of the important characteristics of groundwater and means the increase or change in the temperature of the water in a way that differs from the natural temperature, and the temperature affects the characteristics of the density and therefore the water and is related to internal factors in terms of the degree of depth of the interactions that occur with the rocks and the nature of the rocks and the structure containing the water as it affects a surface thermal system the closer it is to the surface and vice versa, the less the amount of increase the deeper the depth towards the subsoil, and water temperature is a factor that affects the ability of the extent of chemical pollutants and inorganic components.

Salts (Total Dissolved Solids): (TDS) mg/L

It is the sum of dissolved solids in aqueous solution, whether ionised (salt) or non-ionised, remaining in the dried aqueous form. Salinity is also expressed in mg/L (parts per million (ppm) myl Lcppnm) and is considered a general indicator of water quality. The concentration and type of salts depends on the origin and environment of the basin and the system of water movement in the aquifer and is also a general indicator of the amount of salinity and the classification of groundwater, and depends on the type of rock and the time duration of the contact process between the reservoir rock and water and the proportion of dissolved substances, and the amounts and distribution of dissolved salts (T.D.S) vary according to geological conditions [16].

The highest value of dissolved substances in the Rashidiya area was (11,600-7,720) mg/litre with an area of (30,60014) km2 and a percentage of (7) %, indicated in red. The lowest value was (4.280-1.510) mg/litre with an area of (47.30573) km2 (8%), indicated in cyan colour, while the highest value was (4.280-1.510) mg/litre with an area of (47.30573) km2 (8%). In the southern region, the highest value was (11.600-7.720) mg/L with an area of (29.91638) km2 (4%) indicated in red, and the lowest value was (4.280-1.510) mg/L with an area of (148.738) km2 (18%) indicated in cyan.

Table 3. International salt concentrations.

Water Type	TDS value mg/L
Fresh Water	Less than 100
Brine Water	Between 1,000 and 3,000

Moderately Brine Water	Between 3,000 and 10,000
Salt Water	Between 10,000 and 35,000
Very Brine Water	Greater than 35,000

Source: Obaid Majeed, Ali Develop ment of turbine system for pumping Deep Under, erg round Water, Iraq journal of desert, Studies, vil,2, no2010-p32.

This is in addition to measuring the dissolved solids (TDS), electrical conductivity (EC), and hydrogen ions (PH), which are shown in the tables below, which show the highest and lowest levels in the study area, as follows :

Table 4. Concentrations of dissolved substances mg/L.

Region	Color	Concentration (mg/L)	Area (km²)	Percentage (%)
Al-Rashidiya	Sky Blue	1,510–4,280	37.20573	8%
	Green	4,290–5,500	62.94037	14%
	Yellow	5,510–6,450	150.1997	34%
	Orange	6,460–7,710	165.6277	37%
	Red	7,720–11,600	30.60014	7%
Total			446.5737	100%
Southern	Sky Blue	1,510–4,280	148.738	18
	Green	4,290–5,500	302.1135	37
	Yellow	5,510–6,450	193.1615	24
	Orange	6,460–7,710	145.433	18
	Red	7,720–11,600	29.31638	4
			818.78237	
Total			1265.336	100

Source: The author’s work using Excel and Appendix 1.

Table 5. Electrical conductivity/mm/L.

Region	Color	Concentration (mg/L)	Area (km²)	Percentage (%)
Al-Rashidiya	Brown	2,310–6,240	31.06361	7%
	Light Brown	6,250–8,150	56.31237	13%
	Green	8,160–9,810	113.2499	25%
	Olive	9,820–11,600	202.8282	45%
	Dark Olive	11,700–18,000	44.13846	10%
Total			447.5926	100%
Southern	Brown	2,310–6,240	109.0134	13%
	Light Brown	6,250–8,150	154.9213	19%
	Green	8,160–9,810	298.1785	36%
	Olive	9,820–11,600	199.4774	24%
	Dark Olive	11,700–18,000	56.12354	7%

	817.71412	
Total	1,306.71265	100%

Source: The author's work using Excel and Appendix.(1)

Chemical properties

The chemical properties of water varied between the positive chemical properties that include calcium, magnesium, sodium and potassium, and the negative chemical properties represented by chlorides, sulphates, nitrates and bicarbonates ions, which varied in the study area, as shown in Appendix 1, which includes all these elements and includes the highest and lowest value for both negative and positive chemical properties.

Table 6. PH concentration.

Region	Color	Concentration (pH range)	Area	Percentage (%)
Al-Rashidiya	Red	7.101–7.244	311.8116	70%
	Light Brown	7.245–7.415	117.8514	26%
	Gray	7.416–7.729	11.5103	3%
	Blue	7.73–8.278	4.61594	1%
Total			445.7892	100%
Southern	Red	7.101–7.244	635.6702	78%
	Light Brown	7.245–7.415	157.4166	19%
	Gray	7.416–7.729	24.33453	3%
	Blue	7.73–8.278	1.956436	0%
			819.29016	

Source: The author using Excel and Appendix 1

Use of groundwater for various purposes and evaluation of its suitability

The environmental impact of the oil industry is widespread and expandable as it produces large quantities of toxic waste, the effects of oil and gas extraction, refining and transportation, some volatile organic compounds, nitrogen and sulphur compounds and spilled oil can pollute the air, water and soil at harmful levels when improperly managed and after fossil fuel extraction is the largest contribution to the continuous accumulation of carbon in the Earth's atmosphere. Through what has been mentioned, the effects of environmental pollution of the extractive oil industries in the East Baghdad Oil Field (Rashidiya, Southern Region) will be clarified for the various sectors in the region on the one hand and the use of groundwater for different purposes on the other hand according to the results of the laboratory analyses that have been adopted and the distribution maps for the values of the different elements, and after determining this, the suitability of this water for uses will be evaluated as follows:

Use of groundwater for agricultural purposes

Agricultural activity is one of the activities that consume water resources, especially groundwater within the study area (as most of the water used for this purpose will be lost either by evaporation of that water or by transpiration from the plant, and the amount of water used in this area depends on major factors, including: The type of plant grown, the nature of the prevailing climate within the cultivated area, and the quality of the prevailing soil.

The exploitation of groundwater to irrigate agricultural crops is evidence of insufficient rainfall to meet the requirements of those crops, this exploitation determines the total concentration of dissolved salts in groundwater in its suitability for irrigation and all the methods followed by farmers during cultivation and the extent of the effects resulting from those methods, among those methods is the excessive use of pesticides and fertilisers for chemical fertilisers, the increase in their use serves to increase agricultural production, forgetting the negative impact resulting from them. Another wrong method used by farmers is unregulated irrigation, which leads to a large depletion of groundwater, as excessive irrigation causes a reduction in high groundwater levels, which results in issues such as increasing soil salinity as a result of wrong irrigation, which requires the preservation of groundwater by using a specific model of drainage irrigation in the subsurface layer of the land .

Hence, it is necessary to determine the consumption for each sector of water to determine the adequacy of water for this sector and its suitability for this use and through the data collected from agricultural crops, as shown in Table (7) and Figure (1), which shows the water needs of summer and winter crops during the agricultural season, From Table (8), it is clear that the volume of water needs for winter agricultural crops in metres/cube/year for cereal crops reached (9,020,00) m3/year, while the water needs for vegetables and fruits crops reached (73. 495,200 m3/year, i.e. 200 m3/year of the water requirement for the agricultural season in Rashidiya.

Table 7. Areas planted with winter and summer crops (dunums) in Al-Rashidiya for the agricultural season.

Crop	Total Area (Dunam)	Irrigated Area by Wells (Dunam)	Water Quota (m^3/year)	Water Requirements (m^3/year)
Grains	3,500	2,200	4,100	9,020,000
Vegetables and Fruit Trees	6,540	5,420	13,560	73,495,200
Total	10,040	7,620	17,660	82,515,200

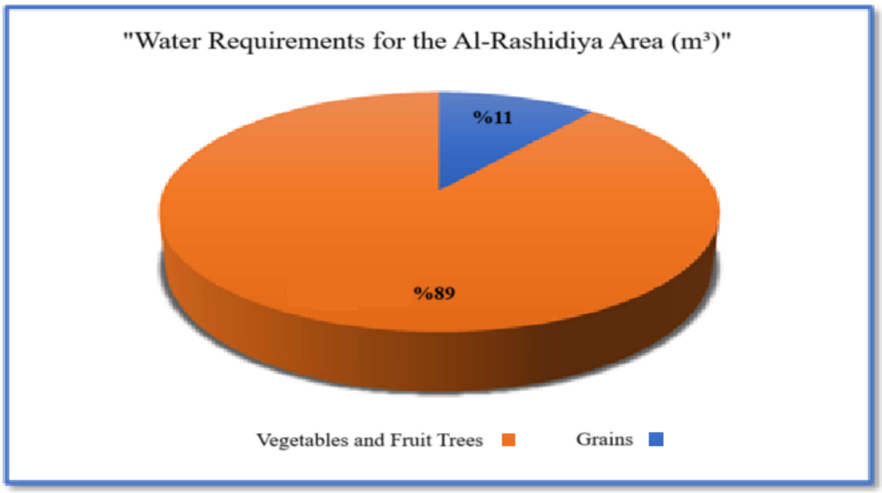
Source: The author based on: Ministry of Planning, Directorate of Agricultural Statistics, unpublished data; Mahdi Al-Sahhaf, Water Resources in Iraq and Their Protection from Pollution, 2023, p. 113; Ministry of Agriculture data, Directorate of Agriculture, Al-Rashidiya /Al-Nahrawan**.**

As for the southern region of the study area, it is clear from Table (7) and Figure (2), which show the water needs for winter and summer agricultural crops (in cubic metres/year), which amounted to (67,217,000), of which the water needs for vegetable and fruit crops for the same region and the agricultural season amounted to (63,723,000) m3/year. (63,723,000) m3/year, the total water requirement for all crops in the southern region, while cereals amounted to (3,485,000) m3/year for the agricultural season, and the reasons that push farmers to dig and use groundwater wells are the division of water distribution quotas of the Tigris or Diyala River by the concerned authorities, which are very few hours are not sufficient to irrigate their agricultural lands as required [17].

Table 8. Areas planted with winter and summer crops in Southern region for the planting season.

Crop	Total Area (Dunam)	Irrigated Area by Wells (Dunam)	Water Quota (m^3/year)	Water Requirements (m^3/year)
Grains	1,510	850	4,100	3,485,000
Vegetables and Fruit Trees	58,200	4,700	13,560	63,732,200
Total	7,330	5,550	17,660	67,217,000

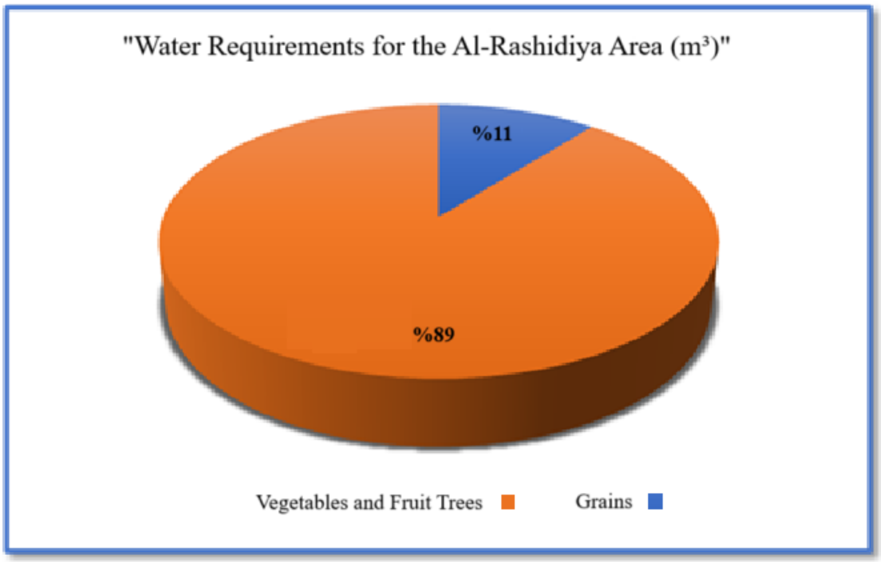
Source: The author based on: Ministry of Planning, Directorate of Agricultural Statistics, unpublished data; Mahdi Al-Sahhaf, Water Resources in Iraq and Their Protection from Pollution, 2023, p. 13; Data from the Ministry of Agriculture, Rashidiya Agriculture Directorate, Nahrawan Agriculture Directorate.



Source: The author based on Table (8) and Excel program

Figure 1. Water requirement for agricultural crops in cubic meters/year, Al-Rashidiya area.

From the previous table, it is clear that the agricultural areas in the study area vary for the summer and winter seasons, which results in a variation in the needs of these crops for water. As for palm groves, they reached (16096) dunums for the year (2024), as shown in Table (9), which shows a palm grove in the study area, and the diversity of palm trees was observed within the Rashidiya region, with higher production than the southern region.



Source: The author's work based on Table (8) and Excel program**.**
Figure 2. Water requirements for agricultural crops in the southern region.

Table 9. Number of palm trees in the two study areas.

Al-Barhi	**Osta Omran**	**Al-Khadrawi**	**Al-Tabarzil**	**Al-Maktoum**	**Al-Buraim**	**Al-Khastawi**	**Al-Zahdi**	**Region Name**
10,000	18,600	23,000	15,600	7,800	15,600	184,000	2,900	Central Region
						500		

Source: The author based on data from the Ministry of Agriculture, Rashidiya Agriculture Directorate and Nahrawan Agriculture Directorate**.**

The irrigation of agricultural crops relied on covered vegetables (greenhouses) and on groundwater by digging wells near them, as shown in Table (10) and Table (11).

The total number of tunnels is (1600) tunnels in an area of (120) dunums in the Rashidiya area and there are no tunnels in the southern area as shown in Table (11).

Table 10. Number of greenhouses and irrigation methods adopted in the two regions.

Region	**Houses**	**Covered Houses**	**Area Used for Houses**	**Total Number of Houses**	**Drip Irrigation**	**Flood Irrigation**	**Other Irrigation**
Central Region	Rashidiya	12	12	51	51		
Southern Region	2	2	4				

Table 11. Number of plastic tunnels and irrigation methods adopted in the two regions.

Region	Tunnels	Covered Tunnels	Area Used for Tunnels	Total Number of Tunnels	Drip Irrigation	Flood Irrigation	Other Irrigation
Central Region Rashidiya Southern Region	40	120	1,600	1,600			

Source: The author based on data from the Ministry of Agriculture, Rashidiya and Nahrawan Directorate, 2024, and the ArcGIS program**.**

The expansion of these greenhouses and plastic tunnels contributes to reducing the underground storage in the region, and the traditional irrigation method contributes to the accumulation of salts near the soil surface, causing soil salinisation and leakage of salts during rainfall into the groundwater, causing a change in its qualitative characteristics, so the soil must be washed of salts at close intervals to prevent their accumulation and increase their concentrations and their impact on groundwater.

Use of groundwater for animal drinking:

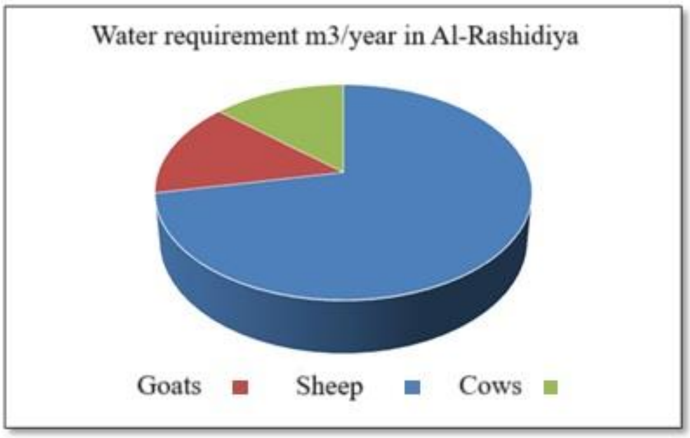
Livestock represents the second dominant pattern within the study area and is less important than field crops, relying on groundwater for livestock consumption. As shown in Table (12) and Figure (3).

From the analysis of the table and figures below, we notice the diversity of animals in the study area and thus the percentage of groundwater consumption varies and the total consumption per season for the totals of animals in the study area amounted to (249,018.00) m3/year for different species, which numbered (84,420 heads) in the study area in the region, which depends on water projects, the river and artificial ponds that farmers dug and piped from groundwater wells (12).

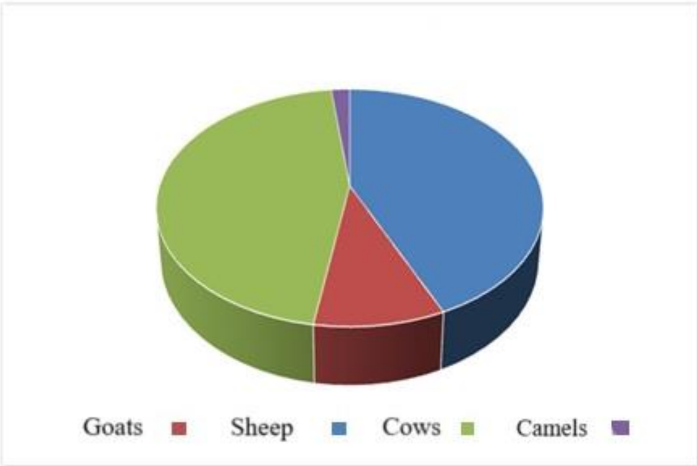
Table 12. Animal numbers and water requirements for the year 2024 for the two regions (Rashidiya and Southern).

Area	Type	Total	Needs M3/year	Needs liters/year	Need 1 liter/day	Water requirement m3/year
Al-Rashidiya	Sheep	18000	2	2000	5,47	36,000
	Goats	2900	2,5	2500	6,84	7,250
	Cow	850	8	8000	22	6,800
Southern region	Sheep	43108	2	2000	5,47	86,216
	Goats	7332	2	2500	5,86	18,330
	Cow	11364	8	8000	22	90,912
	Camels	918	4	2000	4,000	3,672
Total		84,420	29	27,000	72,62	249,18

Source: The author based on the Ministry of Agriculture, Directorate of Agriculture, Baghdad Governorate, Statistics Department, unpublished data, 2023, Mahdi Al-Sahhaf, Water Resources in Iraq and Their Protection from Pollution, p. 113**.**



Source: The author based on Table (12) in ArcGIS**.**
Figure 3. Water requirement m3/year in Al-Rashidiya.



Source: The author based on Table (12) in ArcGIS.
Figure 4. The amount of water needs of animals (southern).

Using groundwater for poultry

Poultry farms are one of the agricultural activities that have a direct impact on the properties of soil and groundwater, and through the residues produced by these fields and then enhance the elements harmful to the environment and groundwater, the most prominent of these elements are phosphorus potassium as well as heavy metals such as copper, nickel, zinc, lead and selenium resulting from the remnants of the toxic chemical substances. The toxic chemical element (phosphorus P) found in poultry waste is the most dangerous element that is also naturally present in the soil and is considered a water-soluble element as it is characterised by its ability to bind to soil grains and deposit them in the form of chemical inorganic compounds that can be chemically analysed very slowly so that the possibility of their leakage into the water table is very large. The poultry fields suffer from poor management by farmers, as they are often in quarry halls that do not accommodate the capacity of the field what is produced from those fields of waste outside the environmental standards, as the total number of wastes in the study area reached (136238) as in Table (13), if the total water need reached (11,867,670) m3/year (11,867,670).

1. **Use of groundwater for drinking purposes:** Through Table (15) and (16) and the map of the districts and the distribution of population and villages (6) and Figure (6), we can see the spatial distribution of the region's population and the spread of villages clearly, especially in agricultural areas and near the river, as well as the population spread in areas near the river, relying on groundwater and digging wells, with a total population of 88474 people in the Rashidiya area and 11329 people in the southern area**.**

Table 13. Water requirement for poultry farms m3/year.

Region	Number of fields	Number of chicks	Water requirement per year
Northern Region	16	6785	1,709,82
Southern Region	74	433169	109,158,588
Total	90	439954	11,867,670

Source: Ministry of Agriculture, Baghdad Governorate Agriculture Directorate, Statistics Department, unpublished data, 2023.

It is clear that the total water needed for the Rashidiya area is (5839284) litres3/year, while the water needed for the southern area is (747714) litres3/year, i.e. the total water need for the population of the area is (65869981) litres3/year, which is distributed in 47 villages spread across the districts of the study area.

Table 14. Number of villages in the study area.

Village	District/Subdistrict	X	Y	Governorate
1	Al-Mada'in District	481192.059451	3670582.885942	Baghdad
2	Al-Mada'in District	475088.817995	3675160.317034	Baghdad
3	Al-Mada'in District	466805.84745	3673852.479579	Baghdad
4	Al-Mada'in District	467895.711995	3684533.152125	Baghdad
5	Al-Mada'in District	461574.49763	3689328.556126	Baghdad
6	Tajaddin Subdistrict	487949.219634	3659684.240485	Wasit
7	Tajaddin Subdistrict	480756.113633	3663171.807031	Wasit
8	Tajaddin Subdistrict	482935.842724	3665351.536123	Wasit
9	Al-Aziziya District	492744.623635	3660556.132122	Wasit
10	Al-Aziziya District	493834.488179	3654452.890667	Wasit
11	Al-Aziziya District	499501.783817	3652927.080303	Wasit
12	Al-Aziziya District	494924.352725	3644862.082665	Wasit
13	Tajaddin Subdistrict	491654.75909	3650311.405394	Wasit
14	Tajaddin Subdistrict	485333.544725	3654888.836486	Wasit
15	Tajaddin Subdistrict	486641.38218	3667967.211032	Wasit
16	Al-Mada'in District	483807.734361	3670582.885942	Baghdad
17	Al-Mada'in District	471601.251449	3682135.450126	Baghdad
18	Al-Mada'in District	471601.251449	3671672.750488	Baghdad
19	Al-Rashidiya District	436788.5714	3707418.713642	Baghdad

20	Al-Rashidiya District	436864.489469	3715026.633733	Baghdad
21	Al-Rashidiya District	437071.740519	3711236.580283	Baghdad
22	Al-Rashidiya District	437723.133339	3716190.797591	Baghdad
23	Al-Rashidiya District	437864.974517	3714157.486734	Baghdad
24	Al-Rashidiya District	438077.203549	3711075.941577	Baghdad
25	Al-Adhamiya District	439612.42551	3705060.01737	Baghdad
26	Al-Adhamiya District	439658.732083	3712451.862151	Baghdad
27	Al-Rashidiya District	439886.586912	3711772.977914	Baghdad
28	Al-Rashidiya District	439949.724913	3713558.812997	Baghdad
29	Al-Rashidiya District	441749.367389	3712747.217846	Baghdad
30	Al-Rashidiya District	442425.34354	3709354.772649	Baghdad
31	Al-Rashidiya District	442459.625535	3710740.518314	Baghdad
32	Sadr City District	455062.53277	3697584.95244	Baghdad
33	Al-Zawraa District	455071.115926	3699432.034023	Baghdad
34	Al-Zawraa District	456561.838942	3686491.070184	Baghdad
35	Al-Rusafa District	456553.572442	3684642.916232	Baghdad
36	Al-Rusafa District	456561.838942	3686491.070184	Baghdad
37	Al-Mada'in District	456537.055444	3680947.731784	Baghdad
38	Al-Rusafa District	456528.799993	3679099.592622	Baghdad
39	Al-Rusafa District	456545.309624	3682794.767211	Baghdad
40	Al-Rusafa District	456692.256295	3692557.288528	Baghdad
41	Al-Rusafa District	457080.325204	3686703.850967	Baghdad
42	Al-Mada'in District	457190.227769	3694095.065862	Baghdad
43	Al-Rusafa District	458089.615879	3680940.919013	Baghdad
44	Al-Mada'in District	458600.086932	3691440.249128	Baghdad
45	Al-Mada'in District	461186.430287	3679079.906422	Baghdad
46	Al-Mada'in District	462746.357499	3680921.971071	Baghdad
47	Tajaddin Subdistrict	488138.706332	3648737.66673	Wasit

Source: Based on Map (6) in Arc GIS 10.8, Density.

Table 15. Population numbers for the two regions for the year 2024.

Area Name	Males	Females	Total	Ratio	Per capita share	Total water needs
Rashidiya Area	45166	43307	88474	17.8	66	5839284
Southern Area	5736	5593	11329	26	66	747714

Source: The author's work based on data from the Ministry of Planning, Department of Regional and Local Development, Baghdad Planning Unit, data for the year 2023**.**

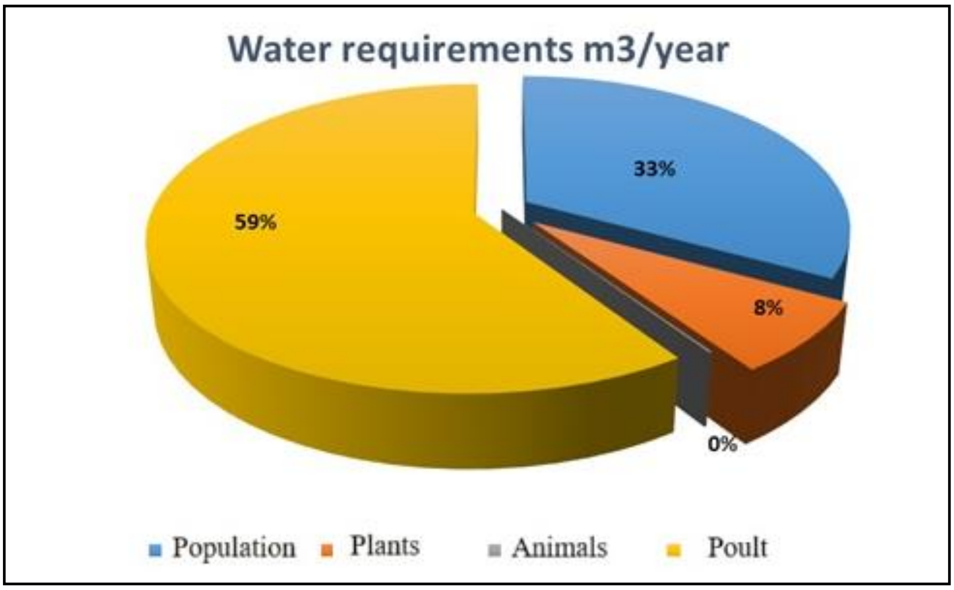
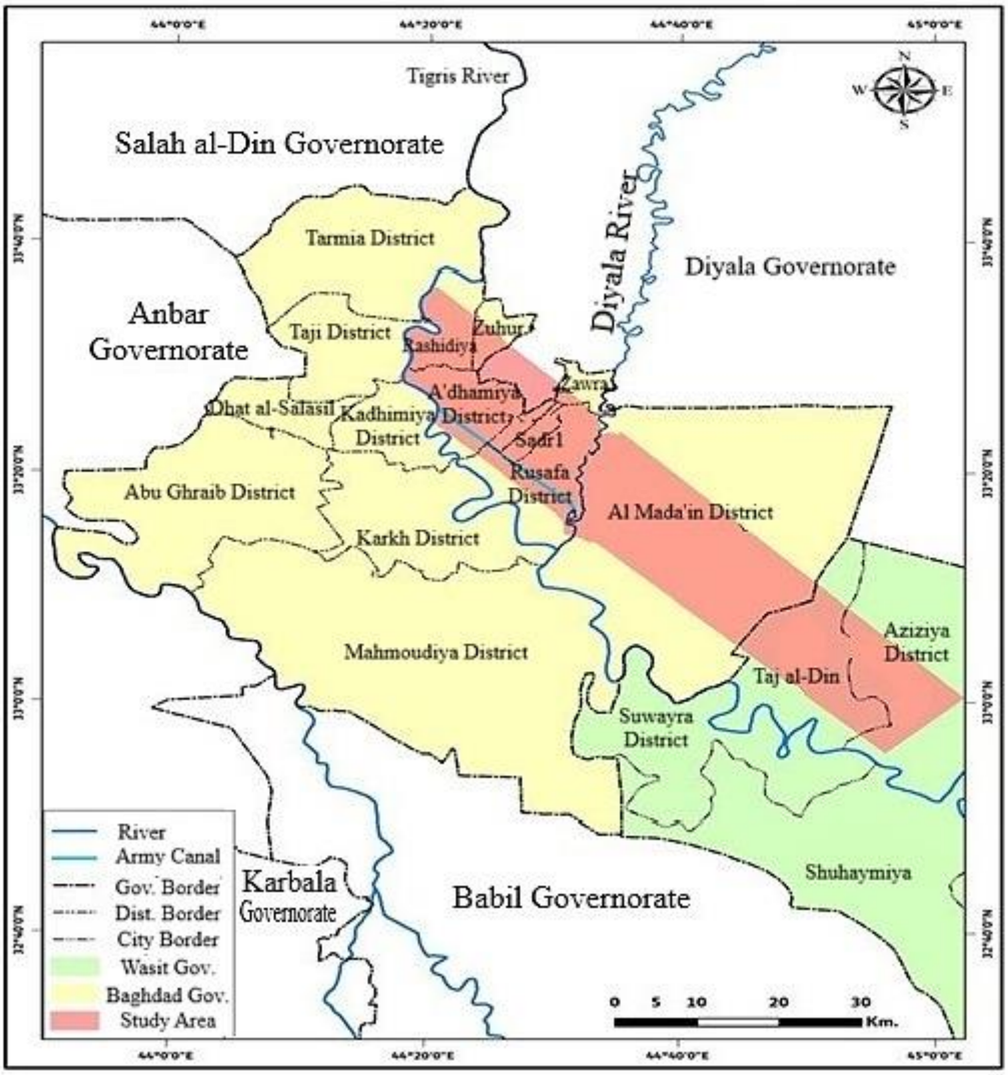


Figure 5. Total water requirement.



Source: The author based on Arc GIS 10.8, Geostatistical Analyst.
Map 5. Study area counties.

CONCLUSION

Fundamental Finding : The study confirmed significant disparities in groundwater quality across the East Baghdad oil field (Rashidiya and Southern regions), with variations in chemical and physical properties directly influencing its suitability for human consumption, agriculture, and livestock. While some wells are appropriate for cultivating salt-tolerant crops and limited fruit production, the majority exhibit elevated levels of chlorides, sulfates, and carbonates, rendering them unsuitable for sustainable agriculture and safe drinking. **Implication :** These findings highlight the urgent need for integrated groundwater management policies, improved irrigation practices, and community-based treatment solutions to ensure water sustainability and safeguard agricultural livelihoods in semi-arid oil field regions. **Limitation :** The study is constrained by its reliance on 30 samples, which may not fully capture seasonal or long-term fluctuations in water quality. **Future Research :** Further investigations should include broader temporal sampling, advanced geochemical modeling, and socio-economic assessments to design adaptive strategies that mitigate groundwater pollution while enhancing its usability across multiple sectors.

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