Academia Open
Vol 9 No 1 (2024): June
DOI: 10.21070/acopen.9.2024.9848 . Article type: (Science)

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ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

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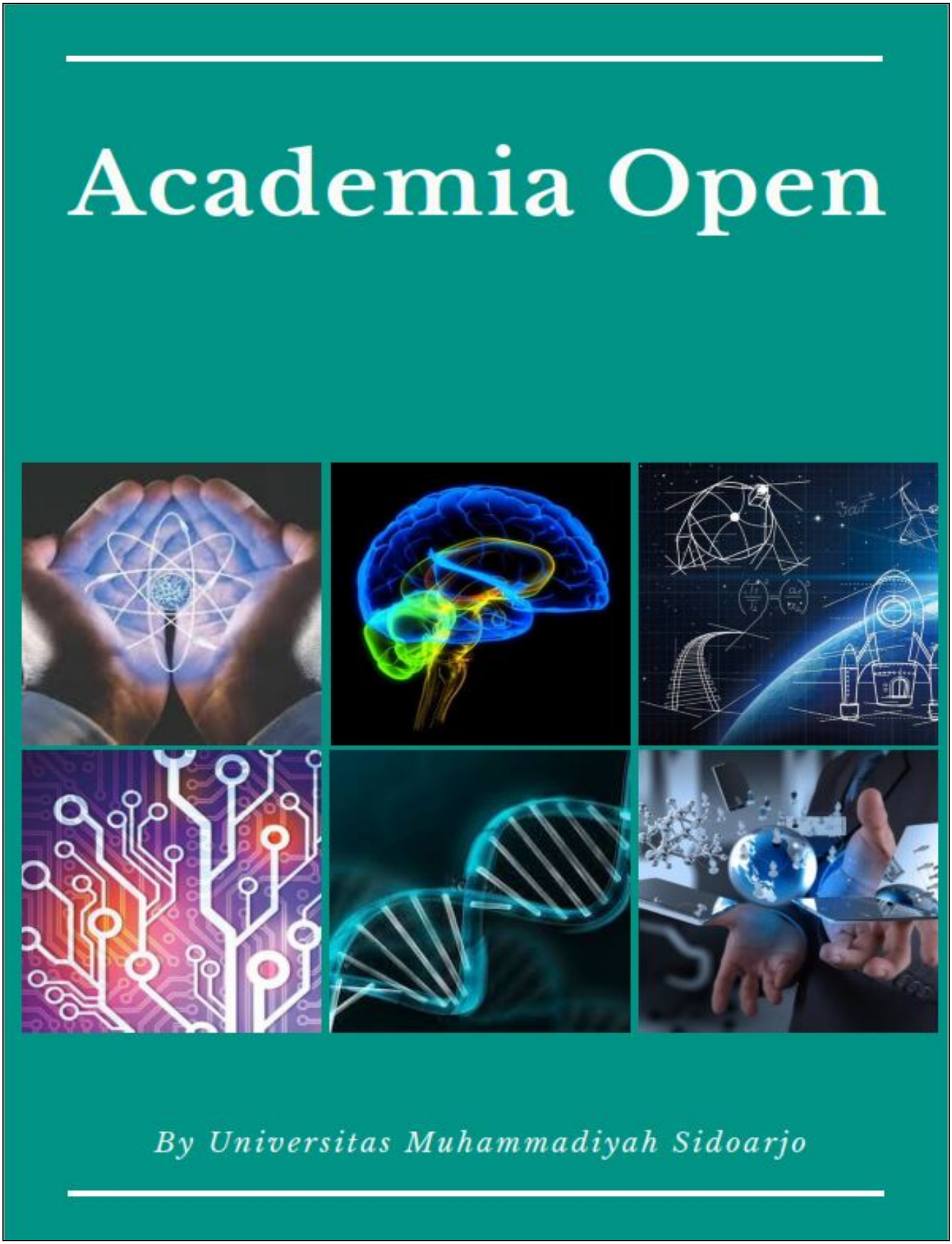
Vol 9 No 1 (2024): June
DOI: 10.21070/acopen.9.2024.9848 . Article type: (Science)



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ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

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A Comparative Study to Analyze the Validity of Well Water for Some Areas of Eastern and Western Diyala Governorate

Studi Perbandingan untuk Menganalisis Validitas Air Sumur untuk Beberapa Daerah di Kegubernuran Diyala Timur dan Barat

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Abstract

General Background: Groundwater is a critical resource for many regions, particularly in arid and semi-arid areas, where surface water is scarce. **Specific Background:** In Diyala Governorate, Iraq, reliance on groundwater is high, especially in the northeastern and western regions, which use it extensively for domestic and agricultural purposes. **Knowledge Gap:** Despite its importance, there is limited comprehensive analysis comparing the quality and suitability of groundwater across different areas within the governorate. **Aims:** This study aims to analyze the chemical and physical properties of groundwater from selected wells in the northeastern (Khanaqin and Saadia) and western (Khalis and Dali Abbas) regions of Diyala Governorate to determine its suitability for use. **Results:** The analysis revealed a significant increase in nitrate concentrations, particularly in the western regions, with a value of 26.3 mg/L, and higher nitrite levels were also observed. The pH levels indicated a tendency toward acidity in the northeastern regions (7.1-7.2), whereas the western regions showed values closer to the acidity standard (7.05-7.45). The dissolved salts were notably lower in Khalis (575 mg/L). **Novelty:** The study uniquely highlights the variation in groundwater quality across different regions of the governorate, revealing critical discrepancies in water composition and well depth that have not been previously documented. **Implications:** These findings underscore the need for region-specific water management strategies in Diyala Governorate, particularly in the eastern regions where groundwater characteristics align more closely with international standards, making them more suitable for sustainable groundwater investment and utilization.

Highlights:

1. Significant regional differences in groundwater quality were observed.
2. Higher nitrate/nitrite concentrations found in western regions.

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Eastern regions' groundwater closer to international standards.

Keywords: Groundwater quality, Diyala Governorate, nitrate concentration, pH levels, water suitability

Published date: 2024-06-22 00:00:00

Academia Open
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Introduction

The residents of the study areas suffer from severe water shortages, which prompted the residents to maximize the use of available water resources (ALtimimi, 2020), especially groundwater, by digging wells in their homes.

The study of the physical and chemical properties of water in general is important in determining the quality of water in terms of purity and pollution to assess its suitability for drinking, agriculture and other uses, as groundwater varies in terms of chemical and physical properties according to its location and geological and climatic conditions, which play an important role in determining the quality of that water and the possibility of using it for various purposes (Hussein, 2017), and groundwater is located in the ground under pressure equal to or greater than atmospheric pressure (Al-Sultani, 2017) The scarcity of water and the shortage in the provision of liquefied water in the required quantity and quality that the Iraqi individual aspires to have pushed towards water in the ground by digging wells to meet the shortage of liquefied water (Razouki, 2013).

Methods

Used Materials and Equipment Table (1):

Origin	Materials and devices used	
Chinese	Becker	1
Iraqi	distilled water	2
Chinese	Taxdeducted atsource	3
Romanian	Multiparameter photometer	4
Chinese	Dissolverd oxygen analyzer	5
Us	ATOMAC ABSORPTION SPECTOR PHOTOMETER	6

Table 1. *Materials and devices used.*

-Methods:

During the study, 12 wells were randomly selected for sampling and the depths of the wells and their uses in the studied areas were determined by 6 wells in the northeastern regions of the governorate (Saadia and Khanaqin), and 6 wells in the western regions, EC temperature governorate (Khalis and Deli Abbas), and electrical conductivity measurements were made for different samples.

In water, total salts, Nitrite concentration NO2, nitrate concentration NO3,dissolved oxygen percentage DO, Temperature T, and Chromium Cr,the concentration of iron Fe, soluble in water TDS , acidic function Ph and EC.

Result and Discussion

Result

During the study, (12) wells were selected for sampling from the northeastern areas of Diyala Khanaqin and Saadiya and west areas, represented by the areas of Khalis and Deli Abbas, map (1), (Al-Ajili, 2016).

Site	Use	Item	Depth (m)
Khanaqin	Watering	Farm	100
	Drink and water	Residential House	100
	Drink and water	Residential House	120
Saadia	watering	Farm	45
	Drink and water	Residential House	35
	Drink and water	Residential House	60
Alkalis	watering	Residential House	6
	watering	Residential House	6
	watering	Farm	6
Deli Abbas	Drink and water	Residential House	14
	Drink and water	Residential House	14

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	Drink and water	Residential House	12

Table 2. *Depth of wells in study areas.*

It is clear from the results of Table (2) that a number of wells are distributed in the study area characterized by their random spread and are not approved by the official authorities, and it was found through the study that the wells in the northeastern regions are at a great depth of more than 100 m due to the height of the land above sea level, as well as that the western regions (Khalis and Deli Abbas) where the groundwater is close to the surface of the earth due to low land and high groundwater levels where the depth of the well reaches Between 6-10 AD (Ibrahim, 2023).

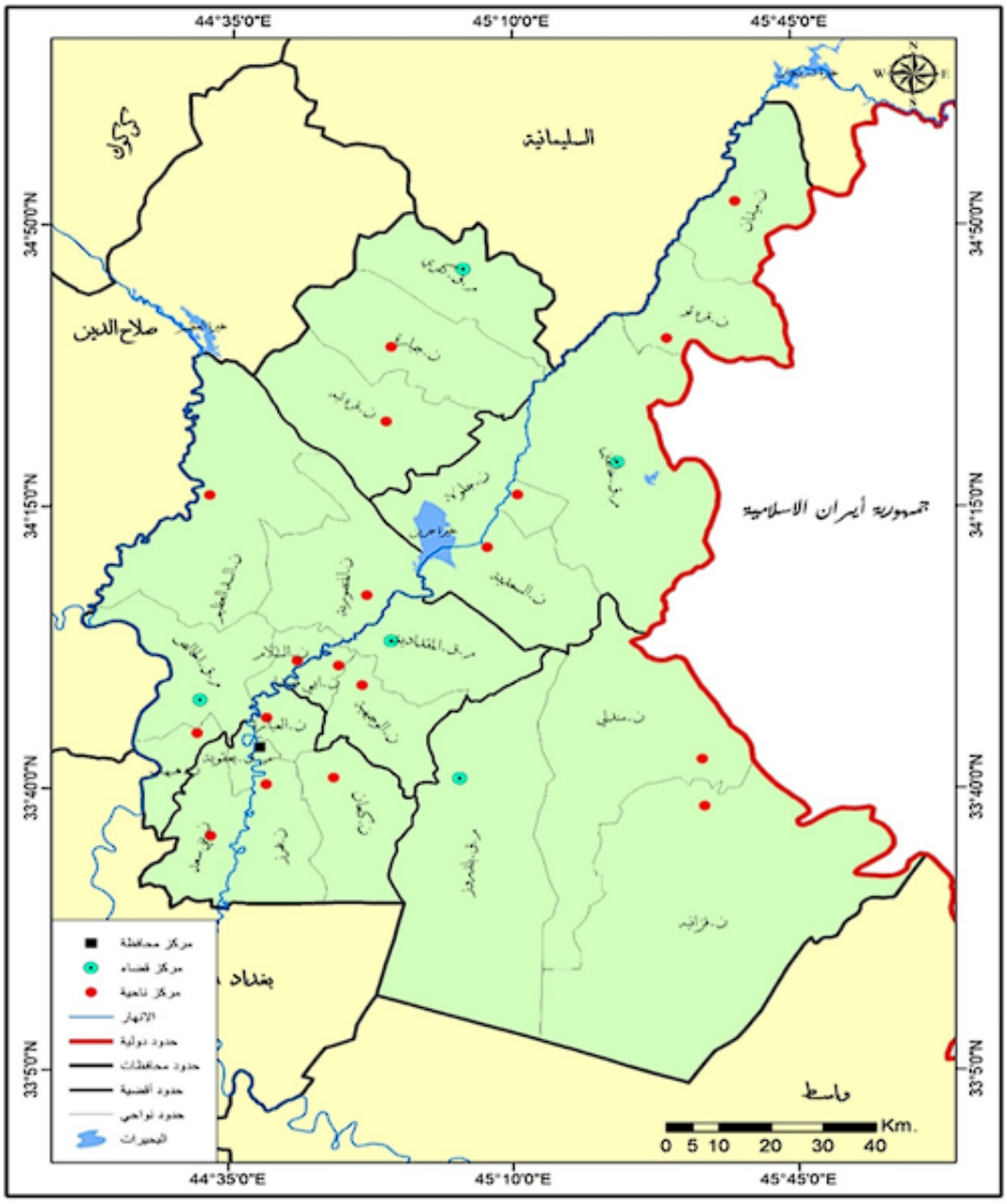

Figure 1. *Administrative Units in Diyala Province((Al-Ajili, 2016).*

The results of the analysis of the physical and chemical properties of the studied groundwater samples are seen in Table (3):

Region	Cr ppm	Fe ppm	Do mg/L	TDS ppm	T	EC	PH	Nitrite	Nitrates
Khanaqin	0.12	0.26	8.3	404	20.4	915	7.31	7.5mg/L	0.0 mg/L

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1									
2	0.008	0.08	8.1	841	20.4	2041	6.75	10.2mg/L	7.2 mg/L
3	0.009	0.11	8.5	1109	20.4	1985	7.8	7.2mg/L	11.9mg/L
Saadia 1	0.007	0.09	8.8	1105	20.4	1967	7.13	9 mg/L	10.1mg/L
2	0.009	0.17	9.7	1110	20.4	2710	6.97	15 mg/L	30.0mg/L
3	0.007	0.08	8.6	945	20.4	2850	7.2	17 mg /L	26.3mg/L
Alkalis 1	0.013	0.39	7.6	583	20.6	1053	7.8	16mg/L	0.0 mg/L
2	0.012	0.37	8.1	554	20.4	914	7.15	13mg/L	1.2 mg/L
3	0.011	0.24	8.4	588	20.4	1041	7.4	14mg/L	0.0mg/L
Deli Abbas 1	0.012	0.22	8.1	1023	20.3	1952	6.99	21mg/L	0.0mg/L
2	0.009	0.14	9.4	833	20.3	1399	6.97	15mg/L	0.0mg/L
3	0.003	0.04	9.6	833	20.4	2090	7.19	8mg/L	0.0 mg/L

Table 3. *Results of Physical and Chemical Properties Analysis of Studied Water Samples.*

Discussion:

Nitrates (NO3) represent the predominant form of inorganic nitrogen compounds in the aquatic environment (Alia et al., 2018).Table (3) shows that the average concentration of this ion in groundwater is 22.1 ppm for the city of Saadiya, which is the upper limit for the concentration of this ion in the water of the studied wells, while the minimum is 6.3 ppm for the city of Khanaqin.

Note that there are some wells that contain less ion No3 nitrates, as in Khalis and Deli Abbas, respectively, 0.4 ppm, 0.1 ppm, and the concentration of nitrates indicates the presence of pollution in groundwater (Ahmed and Ahmed,2023).While the rate of nitrite concentrations was higher in the western regions Khalis and Deli Abbas respectively (14.3, 14.6), and perhaps the reason for the high nitrite concentrations may be due to the proximity of wells to sources of water pollutants from domestic sewage and sewage in addition to agricultural activities a role in the high nitrite values (Abdul-Jabbar and Al-Obaidi, 2011), and the acidity function is considered the measure to know the quality of water if it is acidic or basic under normal conditions (Ahmed and Ahmed, 2023) and that the pH ratio was estimated between 6-9 for most water.

The results of the study also show that the nature of the water tends to acidic in the northeastern areas of Diyala Governorate to spend Khanaqin and Saadiya district, respectively (7.1-7.2), and the reason may be due to the lack of sulfuric acid, carbonate and sulfate, which reduces the acidity of groundwater in the rocks, while the pH concentrations in the west of the governorate for the areas of Khalis and Deli Abbas respectively (7.45-7.05), and this indicates a convergence with the acidity standard, but at a lower rate than the northeastern regions of Khanaqin and Saadiya.

Through Table (3), it was found that the concentration of salts in the northeastern regions is higher than the western regions, as this was reflected in the high value of conductivity with a high value of (2509-1647) in the Saadiya and Khanaqin district, and its decrease in the areas of Khalis and Deli Abbas, where it decreased to (1002-1813). Water temperature adversely affects the solubility of gases such as oxygen gas and carbon dioxide (Al-Hamdani, 2018), and the results in Table (3) showed a slight variation in the temperature of the well water between the areas of Saadiya and Deli Abbas, where it reached in Dili Abbas (20.3) degrees Celsius and in Saadia (20.4) degrees Celsius, where the groundwater temperature remains stable for the depth of the wells and is not affected by air temperature (Kana et al., 2018).

It was found through Table (3) that the lowest value of dissolved salts was in Khalis 575 and the highest value was in the Saadiya area 1053, and the reason for the high salinity rate is attributed to several factors, including the floodplain sediments rich in navigator, as well as the great solubility in groundwater, as well as climate factors, (Ahmed and Star, 2021), and salts are represented by dissolved substances in water, whether as a result of industrial waste or through water weathering (Ahmed and Ahmed, 2023).

The low values of dissolved oxygen indicate damage to aquatic life (Al-Sarraj, 2019).The results of the study showed that the percentage of dissolved oxygen in the water samples of the eastern regions is higher compared to the western regions in the governorate, Table (3). During the study, the concentration of a number of heavy elements, including iron and chromium, was measured.

The results of the study showed that there is a slight increase in the concentration of heavy iron and chromium elements in the water of the studied wells on the western side more than in the wells of the northeastern side of the governorate due to the height of the northeastern lands above sea level and soil formations in them and the percentage of iron concentration in the western regions was Khalis, Deli Abbas respectively (0.33-0.13) ppm, while its percentage decreased in the northeastern regions Khanaqin and Saadiya respectively (0.11-0.15), as the height

above the surface level The sea and soil formations make the filtration ratio of well water higher than the soils in Khalis and Deli Abbas, which is characterized by a high percentage of salts due to the capillary property, and the results of the study showed that the concentration of chromium in the water wells of the northeastern regions reached in Khanaqin and Saadia respectively 0.045-0.007, either in Khalis and Deli Abbas respectively, the concentration of chromium reached 0.012-0.008, and the results of the study indicate that there is a variation in the concentration of heavy elements in the water wells such as iron and chromium, where the areas are characterized by Eastern with the presence of natural drainage due to being gravel sandy soils and the presence of natural puncture, (Todd, 2007).

Property	Iraqi Limiter	Universal Limiter
EC	1500	1530
PH	6.5-8.5	6.5-8.5
T.D.S	1000 mg/L	1000 mg/L

Table 4. *Global and Iraqi Groundwater Validity Criterion*

Conclusion

1- The results of the analysis of well water samples did not show a rise in the concentration of ions and salts, except for the Saadia area, where the concentration of salts was high and exceeded the global permissible limit.

2- The study showed a discrepancy in the depths of the wells in the study areas, as the wells in the east of the governorate range in depth by 77 m, unlike the western areas of the governorate, which range in depth of wells 10 m.

3- It was found that the best sites for groundwater investment are in the eastern part of the study area, due to the characteristics of groundwater that conform to the international standard.

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