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Assessment of ^{40}K and Heavy Metal Levels in Euphrates River of Al-Qadisiyah Governorate

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ABSTRACT

The objective of the current research is to measure the specific activity of ^{40}K and heavy metals in the water samples collected from the Al-Diwaniyah River in Al-Qadisiyah Governorate, Iraq. The activity of ^{40}K in water samples was ascertained using High Purity Germanium Spectrometer (HPGe) detector technology, which is based on a high-resolution gamma spectrometry system, and by using an atomic absorption spectrometer (A.A.S.) to determine the heavy metals of Ni, Cd and Pb, as well as measure some of the physical properties of water samples. The results indicated the concentration of ^{40}K in the water was presented in different concentrations. The lowest value was 2.6±0.5 Bq/L Al-Muhanawiyah, while the highest value was in Al-Diwaniyah center 24.6± 4.0Bq/L. On the other hand, the highest results of Pb, Cd and Ni have been 0.1247, 0.0652 and 0.157 ppm, respectively. While, the results of physics properties were from 7.05 to 8.3 for total dissolved solids (T.D.S.) values were from 2100 to 756.6 mg/L, electrical conductivity values were between 1140 and 3500 μs/cm, and turbidity values were between 7.0 and 54.5. Based on the results, the concentrations of the ^{40}K and heavy metals indicated that the results are almost slight compared to internationally accepted values.

INTRODUCTION

Water is a vital resource that nature has given to people and all other living things. However, due to human usage of pollutants, clean water is becoming increasingly scarce in many regions of the world (Usharani et al. 2010). Water serves as a vehicle via which radionuclides are transported and interact with many troposphere compartments. Soils, sediments, crustal rocks, biota, and even air constantly exchange radioactive elements with water (Mas et al. 2006). There are two sources that can contribute to increased radioactivity concentrations in water: anthropogenic radiation and natural radiation (Aswood et al. 2020). The long-lived radionuclides ^{238}U, ^{235}U, ^{232}Th, and ^{226}Ra, as well as the single ^{40}K, have been present since the Earth's formation. They are found in trace amounts in both nature and the human environment, the exposure to natural radiation being more significant than that of industrial radioactive sources (Aswood et al. 2022, UNSCEAR 2014). As a result, they account for the vast majority of human exposure to radiation from natural terrestrial sources, and there will be a risk for both cancer and non-cancerous diseases (Salih et al. 2019). Around the world, nuclear technology is being more widely used, and radionuclides are being used more often in industry, agriculture, medicine, and other atomic and radiological applications. This would be coupled with an increase in accidents, which would raise the possibility of human ionizing radiation exposure from the outside and radionuclide contamination of internal organs (Aswood et al. 2019). Several factors, such as the river basin's geological makeup, atmospheric inputs, industrial, agricultural, and urban activity, as well as the heavy metal present in water resources and rainfall amounts, all contribute to the degradation of river water quality (Kareem & Shekha 2016). Many health hazards have been linked to exposure to high levels of heavy metals, including lead, copper, nickel, zinc, cadmium, and others, which is a reflection of both natural and human influences working together (Alhous et al. 2020). Therefore, information on the possible chemical and radiological danger of ingestion and cutaneous absorption may be obtained by measuring the quantities of heavy metals and radionuclides in water. The environment contains both heavy metals and radioactive elements, although the amounts of each vary depending on the geologic formation (Kadhim et al. 2020, Li et al. 2020).

As a result, radionuclides can exist as molten minerals, dust, or particles in water. They enter the body by inhalation or digestion. They emit internal radiation when they come into contact with the body (Salih & Aswood 2024). These water sources have higher levels of natural radioactivity due to sedimentation, dissolution, and transport. Furthermore, dust and other particles in water raise the concentration of heavy elements and radioactivity, primarily when water naturally transports radioactive materials over the surface of the Earth (Salman et al. 2020).

However, this transport process is affected by factors in the physical of the water, such as the constant change in pH, temperature, turbidity, dissolved solids content, etc. (Rahim 2020). Therefore, the purpose of this study was to determine radionuclides, including ^{40}K, and measure some heavy metals in surface water that were collected from the Euphrates River in the Governorate of Al-Qadisiyah.

MATERIALS AND METHODS

Study Area

Al-Qadisiyah Governorate is one of the Governorates of the Middle Euphrates region. It is located south of the capital, Baghdad, and away about 193 km. The study area site between latitudes 31.6858 -32.0451ºN and longitudes 45.0099- 44.7411ºE as shown in Fig. 1. It has a total area of 8,153m^2, which constitutes 1.9 % of the total area of Iraq, and the population was estimated to be 1,320,000 people, which constitutes about 2.73 % of the total population of Iraq. The Diwaniyah River passed through agricultural, commercial lands and industrial factories close to the river.

Sample Collection

The sampling spots were located using the Global Positioning device (G.P.S.), as shown in Table 1 coordinates for latitude and longitude. Additionally, twelve samples were collected from the surface water of the Euphrates River in Al-

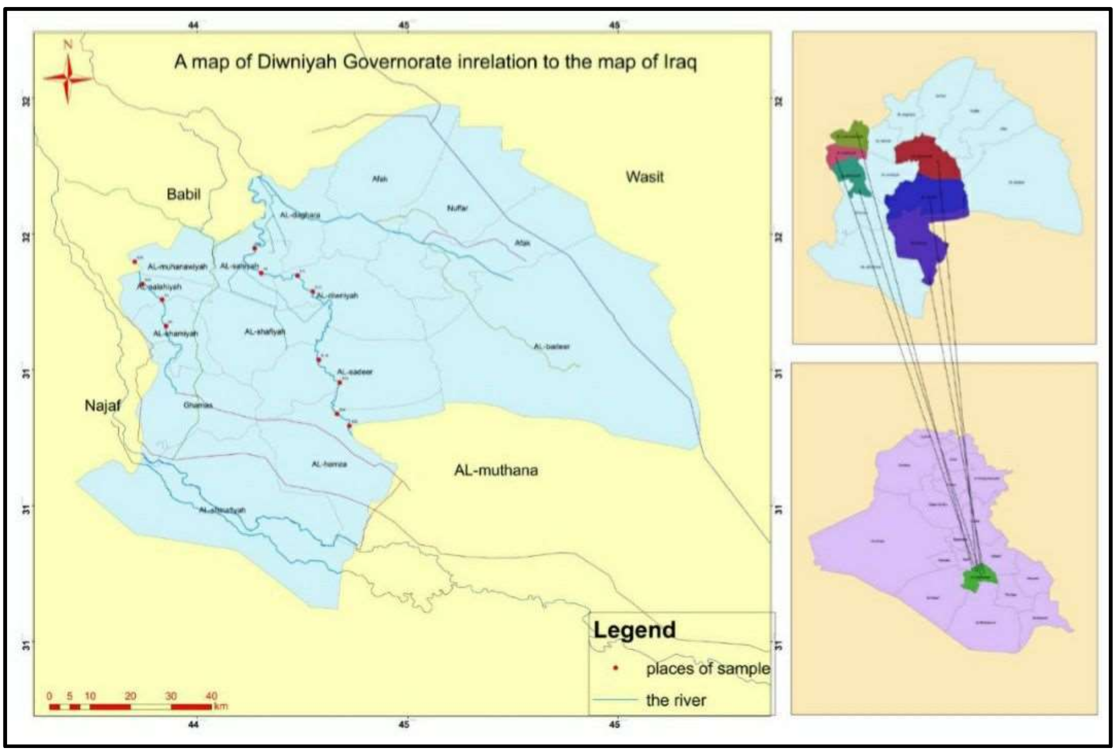

Fig. 1: The map of the study area.

Table 1: Water samples from Al-Diwaniyah River.

Sample codes	Regions	Location	Latitude (x)	Longitude (y)
S 1	Al-Siniyah	Al-jadwal	44.7411	32.0451
S 2		Omaltahab	44.7971	32.0321
S3	Al-Diwaniyah	Abu alfadhil	44.9077	32.0022
S 4		Sadr alyosfiyah	44.9232	31.9842
S 5	Al-shamiyah	Kasabatalshamiyah	44.5935	31.9658
S 6		AL-ain	44.5928	31.9181
S 7	Al-muhanawiyah	Aljajanalgharby	44.5334	32.0491
S 8		AL-kazaliyh	44.5711	31.9823
S 9	Al-sideer	AL-dahaya	44.9644	31.8022
S10		AL-milaha	44.9878	31.7809
S11	Al Hamza Al Sharqi	AL-shofa	45.0099	31.6858
S12		Azezallah	44.9712	31.7268

Qadisiyah governorate, Iraq, to measure the concentrations of radionuclides as well. Twelve samples of water were collected to measure physical and chemical properties.

Experimental Methods

The samples of surface water were collected from 12 different locations along the Euphrates River in Al- Qadisiyah governorate during 5 months (8-12) in 2023. The radionuclide concentrations were collected using a container volume of one liter made of polyethylene. A pure germanium reagent, HPGe (GC4020), was used to measure the radionuclide concentrations. The reagent used in the analysis is of the type (PNP). It has a separation ability of up to 2.0 keV at energy (1332 keV) peer back (^{60}CO). It was operated by using liquid nitrogen within a Dewar container to reach a temperature of (-176). To minimize the radiation background, layers of lead coated in copper were placed around the detector, making a thick shield that measured 10 cm.

This system operates using the program (Genie 2000) to determine the peaks, their energies, and the net area beneath each peak by analyzing the observed spectra. It is manufactured by the company (Canberra) (Riyadh & Al-Hamzawi 2023). Therefore, this system was chosen as the effective measurement technique. It is the most popular due to its desirable qualities, such as its high density (5.3 g/cm^3), which makes it have a high ability to stop nuclear radiation in a small way. Thorium ^{232}Th activity was measured through its daughters ^{212}Pb and ^{228}Ac with energy 583.1 and 911.1 keV, respectively.Radium^{226}Ra activity was measured through its daughters ^{214}Bi ^{214}Pb with energy 609.3 and 351.9 keV, respectively. Potassium ^{40}K activity was measured at single energy 1460.8 keV, as well as 12 measured Ni, Cd, and Pb content was also determined using Atomic Absorption Spectrophotometer A.A.S. Model A.A. - 7000, Company SHIMADZU, Origin Japan (Rice et al. 2012). T he physical properties of water measured by pH meter were used to measure the pH Model SD300pH, Company Lovibond, Origin Germany. A conductivity (E.C.) meter Model Cond 7110, Company W.T.W., Origin Germany, was used to measure the total dissolved solids in water (mg/L) and electrical conductivity (μS/cm). Turbid meter, Model 2020wi, Company LaMotte, Origin U.S.A., and mg/L units were used to express the results.

Calculations

Specific Activity of Radionuclides

To estimate the radionuclides' particular activity (As) determined by equation 1 (Chougaonkar et al., 2004).

$$As = Cn/\varepsilon \times I\gamma \times t \times m \quad \ldots(1)$$

When the activity is in Bq/L, Cn is the total sub-peak count rate per second, ε: Efficiency, Iγ: gamma-ray emission intensity per energy, t: time (s),m: mass of the specimen (kg).According to equation (2), parameters such as radium equivalent activity (Ra_{eq}) is used to calculate the radiological hazards associated with exposure to radiation ^{226}Ra, ^{232}Th, and ^{40}K in water (Zorer 2019).

$$Raeq = C_{Ra} x\ 1.43 + C_{Th} x\ 0.07 + C_{K40} \quad \ldots(2)$$

The radium risks, such as radium equivalent (Ra_{eq}), these indicators are used to obtain total activity (^{226}Ra, ^{232}Th, and ^{40}K) Bq/L in water and the risk assessment of materials containing.

Absorbed dose rates (D_R)are determined using the following method (3) (Alaboodi et al. 2023).

$$D_R = C_{Ra} \times 0.461 + C_{Th} \times 0.623 + C_{K40} \times 0.041 \quad \ldots(3)$$

Additionally, an equation was used to determine the external hazard index (Hex), and the parameter's value cannot be greater than the acceptable level's limit of unity (Heldal et al. 2021).

$$H_{ex} = \frac{C_{Ra}}{370} + \frac{C_{Th}}{259} + \frac{C_K}{4810} \leq 1 \quad \ldots(4)$$

Heavy Metals in Water

The concentrations of heavy elements were calculated from the calibration curve and according to the equations mentioned (Hnamte 2013) in:

Heavy elements dissolved in water, then:

$$E_{Con.} = \frac{A \times B}{C} \times 1000 \quad \ldots(5)$$

$E_{Con.}$: Water's dissolved element concentration (μg/L).

A: The element's concentration (mg/L).

B: The filtered sample's final volume (ml).

C: The filtered sample's initial volume (ml).

Statistical Analysis

Microsoft Office Excel 2013 and Graph Pad Prism 9.2.0 were used to gather, analyze, and present the data. Numbers were used to represent categorical data, while mean Standard Error Mean was used to convey numerical data. An unpaired one-way ANOVA was used to compare the mean values across the different groups for variables that were regularly distributed. When the P-value was less than 0.05, it was deemed significant.

RESULTS AND DISCUSSION

Specific Activity

Using HPGe gamma spectroscopy, the activity and amounts of naturally occurring radionuclides (^{226}Ra, ^{232}Th, and ^{40}K) in each of the water samples were ascertained. We assessed the activity concentration in unit Bq/L.

Table 2 shows the concentrations of radionuclides in all the drawn water samples that appeared. The naturally occurring radionuclide ^{40}K activity concentrations are in water only, and no results are displayed for other radionuclides. According to this table, the activity concentration of Potassium ^{40}K was measured with a maximum value of 24.6± 4 Bq/L in the S4 Al-Diwaniyah River. The minimum concentration 2.6±0.5, in S8 Al-muhanawiyah river, as tabulated in Table 2. The findings reveal that the natural radionuclide activity concentrations in the water samples are within the allowed limits. To ascertain the radiation threat from naturally occurring radioactivity associated with the water, the radiological parameters were evaluated, and the resulting values were compared with globally accepted safety limits.

Table 3 shows the external hazard indicators (H_{ex}), gamma dose rates (D_R.), and radium equivalent activity (Raeq) were sampled to (0.182 Bq/L) found in the (S8) sample. All of the (Re_{aq}) readings in the examined samples were discovered to be below the 370 Bq/L standard limits. Table 4 shows The (S4) sample's absorbed gamma dose rate (D_R.) varied from 1.009 nGy/h. The mean value of 0.7341 nGy/h of the rate of absorbed dose in the studied area is slightly more than the global limit of 55 nGy/h (Elewee & Aswood 2022). Regarding the external hazard index (Hex), the indicators' values ranged from 0.0051 Bq/L in the sample from S4andS7 to0.0005 Bq/L in sample S8, with an average value of 0.0037 Bq/L, which is somewhat less than the allowable limit $H_{ex} \leq 1$ (Heldal et al. 2021).

This indicates that the study's water samples will not harm the population as seen in Table 4. To discussion about the presence of radionuclides, the ^{40}K alone without other nuclides in water slightly varied from one site to another in the Euphrates river sampling in the Governorate of Al-Qadisiyah due to river water flow and dilution and lack of bioaccumulation led to a lack the concentration of radionuclides in the water being low or slight compared in the aqueous sediment based on the physical, chemical, and geochemical characteristics of the aquatic environment (Fallah et al. 2019). ^{40}K is more prevalent than the other isotopes in the samples under study due to its high rock abundance and abundance of heavy metals. This could be the result of runoff during the rainy season, which washes potassium fertilizers and stream forms into the river (Hamza et al. 2019). The external hazard indexes were within allowable levels, indicating that there are no significant radiation health concerns for those who use the water in their daily lives.

Concentration of Heavy Metals

Table 5 shows that the concentrations of heavy metals in water, such as lead, amounted to (0.1247-0.0002) parts per million, where the highest value was in sample 7 in Al-Mahnawiyah and the lowest value in sample 8 in Al-Salihiyah, while the values of cadmium ranged between (0.0652-00) parts per million, where the highest value was recorded in sample 11 in Al-Hamzah and the lowest value in sample 1 in Al-Suniya. Nickel concentrations ranged between (0.1571-0.0) parts per million, where the highest value was in sample 4 in Diwaniyah and the lowest value in sample 9 in Al-Sudair, as well as in sample 11 in Al-Hamzah was 0.0. The poor solubility of heavy metals in river water is due to their tendency to adsorb on suspended particles (Ahmed et al. 2021).

Table 6 shows the results that showed that the pH levels ranged between (7.05 - 8.3), where river water is

Table 2: Specific activity of ^{40}K in Euphrates River water samples.

Sample codes	Study area	^{40}K
S 1	Al-Siniyah(Al-jadwal)	14.4 ±1.4
S 2	Al-Siniyah(omaltahab)	17.2± 4
S3	Al-Diwaniyah(Abu alfadhil)	24±2
S 4	Al-Diwaniyah(Sadr alyosfiyah)	24.6± 4
S 5	Al-shamiyah(Kasabatalshamiyah)	18±1.3
S 6	Al-shamiyah(AL-ain)	14.9±1.5
S 7	Al-muhanawiyah(aljajanalgharby)	24.5± 4
S 8	Al-muhanawiyah(AL-kazaliyh)	2.6±0.5
S 9	Al-sideer(AL-dahaya)	19.7±1
S10	Al-sideer(AL-milaha)	17.9±3.3
S11	Al Hamza Al Sharqi(AL-shofa)	19.1±3
S12	Al Hamza Al Sharqi(Azezallah)	16.4±3

Table 3: Radioactive risks associated with water samples from the Euphrates River of Al-Diwaniyah Governorate.

Sample code	Raeq (Bq/L)	D.R. (nGy/h)	Hex
S1	1.008	0.590	0.0030
S2	1.204	0.705	0.0036
S3	1.68	0.984	0.0050
S4	1.722	1.009	0.0051
S5	1.26	0.738	0.0040
S6	1.043	0.611	0.0031
S7	1.715	1.005	0.0051
S8	0.182	0.17	0.0005
S9	1.379	0.808	0.0041
S10	1.253	0.734	0.0040
S11	1.337	0.783	0.0040
S12	1.148	0.672	0.0034
Mean ± SD	1.2440	0.7341	0.0037
global limits	370	55	▯ 1

considered slightly alkaline. Table 7 shows that the highest value was in sample 8 in Al Mahnawiyah with an average of 7.97, and the lowest value of 7.225 was in sample 9 in Al Sudair. Electrical conductivity recorded values that ranged between (1140-3500) micro Siemens/cm, and the highest value was in sample 7 in Al-Mahanawiya at 3402, and the lowest value was 1201 in sample 4 in Al-Diwaniyah, while the values of total dissolved solids in water ranged between 2100-746 mg/L. The highest value was in sample 7 in Al-Mahanawiyah, and the lowest value was in sample 1 in Al-Suniyah, and the turbidity ranged between (54.5 - 7.0) NTU. The highest value in the sample was in Al-Diwaniyah, and the lowest value in the sample was 5 in Al-Shamiya. Furthermore, the alkalinity of river water accelerates the adsorption process and reduces the solubility of heavy metals (Al-Asadi et al. 2020). Elevated levels of lead in river water are likely attributable to increased gasoline use, agricultural runoff, and the discharge of untreated pollutants into the river.

Table 4: Radioactive risks associated with water samples from the Euphrates River of Al-Diwaniyah Governorate.

Radioactive risks	Number of values	Minimum	Maximum	Mean	Std. Error of Mean	Global Limits
Raeq (Bq/kg)	12	0.1820	1.7220	1.2440	0.1201	370
DR (nGy/h)	12	0.1700	1.0090	0.7341	0.0662	55
Hex	12	0.0005	0.0051	0.0037	0.0004	< 1

Table 5: Heavy metals examined in water samples of Al-Districts of Al-Diwaniyah Governorate.

Sequence	Names of rivers	Parameter		
		Pb (ppm)	Cd (ppm)	Ni (ppm)
S1	Al-Siniyah	0.0003	0.0	0.0032
S2	Al-Siniyah	0.0005	0.0024	0.0002
S3	Al-Diwaniyah	0.0051	0.0015	0.0509
S4	Al-Diwaniyah	0.0070	0.0007	0.1571
S5	AL-Shaamiyah	0.0004	0.0030	0.0001
S6	AL-Shaamiyah	0.1235	0.0046	0.0562
S 7	AL-Muhnawiyah	0.1247	0.0561	0.0031
S8	AL-Muhnawiyah	0.0002	0.0003	0.0002
S 9	AL-Seedir	0.0733	0.0314	0.0
S10	AL-Seedir	0.0061	0.0013	0.0252
S11	AL-Hamza	0.1012	0.0652	0.0
S12	AL-Hamza	0.0012	0.0001	0.0023

Table 6: Physical properties to taken water samples of AL-Diwaniyah River.

Sequence	Names of rivers	Parameter			
		P.H.	ECMs\cm	T.D.S.Mg\l	Turb.NTU
S1	Al-Siniyah	7.11	1243	746	10.60
S2	Al-Siniyah	7.8	1360	1092	28
S3	Al-Diwaniyah	7.54	1261	756.6	26.1
S4	Al-Diwaniyah	7.29	1140	812	39.6
S5	AL-Shaamiyah	7.12	1386	831.6	7.0
S6	AL-Shaamiyah	8.21	1322	793	14.6
S7	AL-Muhnawiyah	7.64	3500	2100	11.91
S8	AL-Muhnawiyah/AL-Salahiyah	8.3	1304	782.4	11.7
S9	AL-Seedir	7.05	1320	792	19.2
S10	AL-Seedir	7.4	1407	1110	23.6
S11	AL-Hamza	7.46	1304	786	11.1
S12	AL-Hamza	7.31	1198	938	54.5

The pH

An excellent measure of the extent of pollution and water quality is the pH of the aquatic systems. The pH values in the S8 AL-Muhnawiyah district's river (AL-Salahiyah) ranged from 8.3 to 7.05, with the AL-Seedir district having the lowest pH value. These findings indicated that the water samples' pH was relatively alkaline. A decrease in pH makes heavy metals more soluble and become more toxic. In contrast, an increase in pH leads to their precipitation in sediments as in pH values to AL-Muhnawiyah river in Table 7 & Fig. 2 (Thirumala 2012).

Table 7: A comparison of the pH values in the water of Al-Qadisiyah Governorate.

Names of places	Number of values	Minimum	Maximum	Mean	Std. Error of Mean	P value
Al-Siniyah	5	7.11	7.8	7.455	0.345	0.6346 ns
Al-Diwaniyah	5	7.29	7.54	7.415	0.125	
AL-Shaamiyah	5	7.12	8.21	7.665	0.545	
AL-Muhnawiyah	5	7.64	8.3	7.97	0.33	
AL-Seedir	5	7.05	7.4	7.225	0.175	
AL-Hamza	5	7.31	7.46	7.385	0.075	

ns: no significant p-value >0.05; *significant p-value ≤0.05; **significant p-value ≤0.001; ***significant p-value ≤0.0001.; **** significant p-value <0.0001.

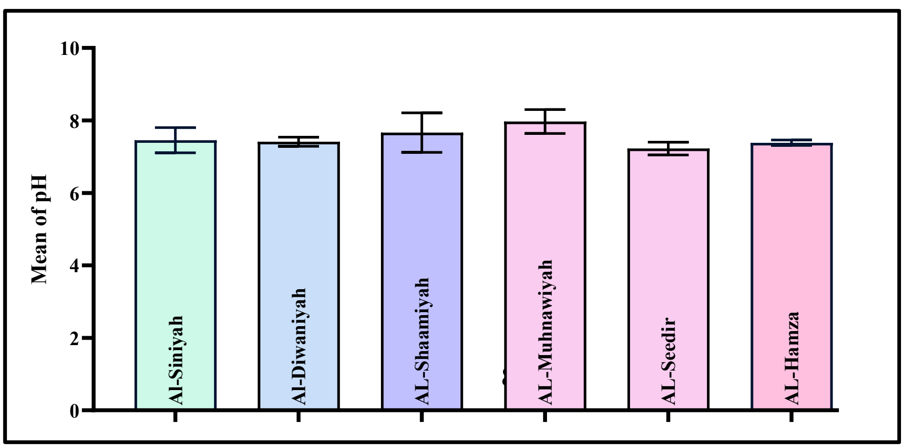

Fig. 2: Study locations' pH values.

The Turbidity

Table 8 and Fig. 3, presented the turbidity ranged between (54.5-7.0) NTU; the highest value in the sample was 12 in Al-Hamzah, and the lowest value in the sample was 5 in Al-Shamiya. The results of the study indicated that the high turbidity values may be due to the presence of particles and suspended materials in the water, which consist of clay, silt, sand, organic and inorganic materials, as well as various human activities, which lead to an increase in turbidity and its association with heavy metals (Laghari et al. 2018).

Total Dissolved Solids (T.D.S)

Table 9 and Fig. 4 presented the T.D.S. levels ranging from 746 mg/L in the S1 Al-Siniyah River to 2100 mg/L in the S7 AL-Muhnawiyah River, which had the highest value. According to the present total dissolved solids levels, AL-

Table 8: A comparison of the Turbidity test in the water of Al-Qadisiyah Governorate.

Names of places	Number of values	Minimum	Maximum	Mean	Std. Error of Mean	P value
Al-Siniyah	5	10.6	28	18.23	2.514	<0.0001 ****
Al-Diwaniyah	5	26.1	39.6	32.67	1.917	
AL-Shaamiyah	5	7	14.6	10.66	1.048	
AL-Muhnawiyah	5	11.7	11.91	11.81	0.105	
AL-Seedir	5	19.2	23.6	21.47	0.6998	
AL-Hamza	5	11.1	54.5	32.05	4.289	

ns: no significant p-value >0.05; *significant p-value ≤0.05; **significant p-value ≤0.001; ***significant p-value ≤0.0001.; **** significant p-value <0.0001.

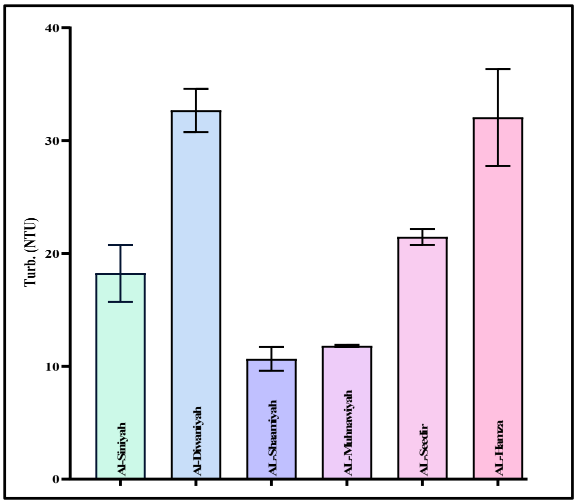

Fig. 3: Study locations' Turbidity values.

Table 9: A comparison of the T.D.S. test in the water of Al-Qadisiyah Governorate.

Names of places	Number of values	Minimum	Maximum	Mean	Std. Error of Mean	P value
Al-Siniyah	5	746	1092	919	173	0.0032 **
Al-Diwaniyah	5	756.6	812	784.3	27.7	
AL-Shaamiyah	5	793	831.6	812.3	19.3	
AL-Muhnawiyah	5	1782	2100	1941	158.8	
AL-Seedir	5	792	1110	951	159	
AL-Hamza	5	786	938	862	76	

ns: no significant p-value >0.05; *significant p-value ≤0.05; **significant p-value ≤0.001; ***significant p-value ≤0.0001.; **** significant p-value <0.0001.

Muhnawiyah is one of the study's salty sites. Fertilizers, high temperatures, and domestic sewage are the causes of the high concentration of total dissolved solids in the water (Laghari et al. 2018).

Conductivity of Electricity

Table 10 and Fig. 5, explain the capacity of a solution to conduct electric current is known as electrical conductivity, and it is influenced by temperature, ion valency, and concentration. According to the electrical conductivity data, AL-Diwaniyah had the lowest value at 1140 µs/cm, and S7 AL-Muhnawiyah had the greatest value at 3500 µs/cm. The current investigation yielded extremely high findings because it is closely correlated with both high temperature and the concentration of dissolved substances (T.D.S.) in water(Abowei 2010). Leaving waste during irrigation and

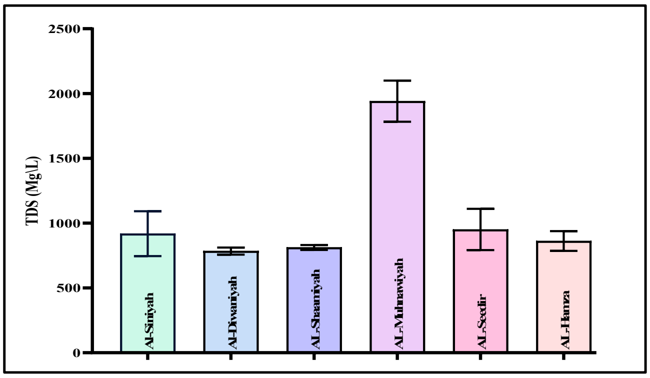

Fig. 4: The research locations' total dissolved solids values (mg/L).

Table 10: A comparison of the electrical conductivity test in the water of Al-Qadisiyah Governorate.

Names of places	Number of values	Minimum	Maximum	Mean	Std. Error of Mean	P value
Al-Siniyah	5	1243	1360	1302	58.5	<0.0001 ****
Al-Diwaniyah	5	1140	1261	1201	60.5	
AL-Shaamiyah	5	1322	1386	1354	32	
AL-Muhnawiyah	5	3304	3500	3402	98	
AL-Seedir	5	1320	1407	1364	43.5	
AL-Hamza	5	1198	1304	1251	53	

ns: no significant p-value >0.05; *significant p-value ≤0.05; **significant p-value ≤0.001; ***significant p-value ≤0.0001.; **** significant p-value <0.0001.

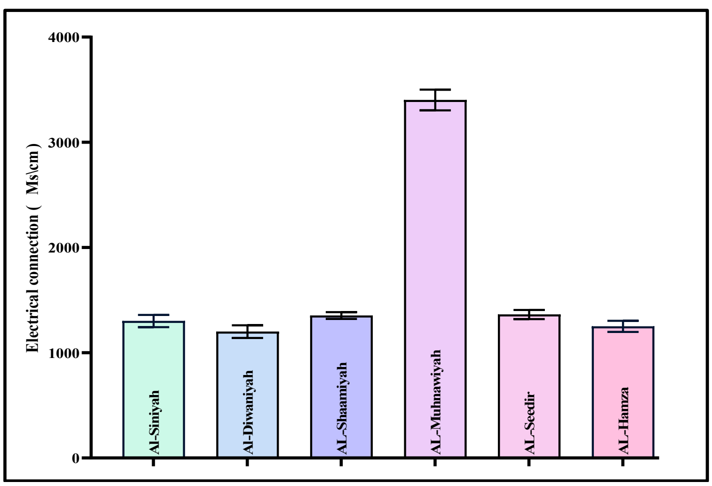

Fig. 5: Shows the research locations' electrical conductivity values (µs/cm).

river cleaning operations for long periods on the sides of the rivers, facilitates the return of large quantities of salts cumulatively, in addition to irregular fertilization operations in the soil, which add a percentage of salts to the soil that accumulate as a result of the phenomenon of continuous evaporation from the surface of the soil, and when watered and washed, the percentage of these salts returns to the streams. The river increases the values of conductivity and salinity together.

CONCLUSIONS

The radioactivity in water samples was collected from six regions of the Euphrates River in Al-Qadisiyah, Iraq, using pure germanium HPGe. The highest activity concentration of ^{40}K was 24.6 Bq/L, radium equivalent activity was 1.722 Bq/L as well as, and the absorbed dose was 1.00 nGy/h. The activity concentrations of ^{226}Ra and ^{232}Th were not found in the study area. The results of the radioactive test of ^{40}K are within permissible limits. On the other hand, the study demonstrated the concentrations of radionuclides and concentrations of heavy metals in water do not provide sufficient evidence of the occurrence of chemical and radioactive pollution due to their low concentration. The role of the competent authorities in protecting the river environment and preventing the dumping of pollutants into them is being activated by building units to treat liquid pollutant waste. The ongoing observation of the quality of the water to document any changes and minimize adverse effects on aquatic ecosystems, such as fertilizers and types of pesticides used in agriculture and overfishing in rivers.

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