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Environmental Assessment of Al-Sudair River Water

Israa G. AL-Kafaji [1], Safaa M. Almudhafar [2], Basim A. Almayahi [3*]

[1] Department of Geography, Faculty of Arts, University of Kufa, Najaf, Iraq.
E-mail: israag.hantoosh@uokufa.edu.iq

[2] Department of Geography, Faculty of Arts, University of Kufa, Najaf, Iraq.
E-mail: safaa.almudhafar@uokufa.edu.iq

[3*] Department of Physics, Faculty of Science, University of Kufa, Najaf, Iraq.
E-mail: basim.almayahi@uokufa.edu.iq

Abstract

The studies dealt with an environmental evaluation of the characteristics of Sudair water in order to know its suitability for various uses (drinking water -irrigation - animal drinking). The study relied on the analysis of the chemical and physical properties of the water of the Sudair table, including (10) models of (10) sites and one model from each site (winter if summer). An element and a compound were also analyzed, and then these results were matched with international and Iraqi specifications to find out their suitability for various uses. It dealt with the abstract and the introduction, the problem of the study, its hypothesis, its importance and its limits, while it dealt with an analytical study as well as the qualitative characteristics of the waters of the Sudair table, which include (the physical and chemical characteristics of the Sudair table). Evaluation of Sudair water for various uses (represented by (civil use of drinking water, agricultural use (for irrigation and drinking animals). The study relied mostly on field work by collecting water models and using a set of tools and supplies such as a mercury thermometer, a GPS device and a camera, as well as water model analysis devices, as well as the adoption of maps to represent the phenomenon studied.The study has reached some main conclusions, namely that the physical and chemical properties of Sudair stream water vary spatially according to the variation of natural and human conditions. The study also found that Sudair water varies in its suitability for drinking water and agricultural use according to global and Iraqi environmental determinants and that this variation is spatial.

Keywords:

Sudair lake water, environmental assessment, chemical and physical properties, suitability for various uses, international and iraqi standards.

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*Corresponding Author: Basim A. Almayahi, E-mail: basim.almayahi@uokufa.edu.iq

Introduction

Water is the secret of life, as life began with it, and it is necessary and indispensable to all living beings about it and despite the large quantities of water surrounding man, they differ in terms of quality and quality. The volume of water on the planet reaches about 1400 million km^3, of which the volume of fresh water is about (35 million km^3), that is, by only 2, 5% (Al-Khoury, 2005) of this quantity, and this quantity includes all fresh water (lakes, rivers, ice, soil moisture, groundwater, springs, and eyes), while the recoverable part of human workers available about 200,000 km^3, that is less than 1% of the total fresh water (Radhakrishnan et al., 2024; Ministry of Water Resources, 2014; Almudhafar, 2020; Almudhafar & Alattabi, 2019; Almudhafar, 2018; Almudhafar & Abboud, 2018). Hydrological studies are concerned with studying rivers because of their great importance in dry and semi-arid regions, and determining the validity of these waters for multiple purposes. The aim of the study is to study the chemical and physical properties of the waters of the Sudair stream, which is 28 km long within the governorate and passes through population centers and agricultural land. Therefore, this study came to evaluate the environmental characteristics of the waters of the Sudair stream, which suffers from the impact of the waste of agricultural and civil activities for the purpose of determining the qualitative characteristics of these waters and indicating their suitability for drinking for humans, animals and irrigation, to cultivate and compare these results with global and regional determinants (Kadhim et al., 2023; Alattabi et al., 2023; Almudhafar, 2020; Abdil-Ameer Noor et al., 2022; Jayapriya, 2021). Water is a vital resource for all living beings, as it is the source of life (Abyss et al., 2022; Kadhim et al., 2023; Abdil-Ameer et al., 2023; Wahhab et al., 2023; Almudhafar et al., 2023). However, the availability and quality of water varies greatly around the world. While the total volume of water on the planet is around 1,400 million km3, only about 2.5% of this is fresh water (Almudhafar et al., 2023; Almudhafar et al., 2023; Almudhafar et al., 2023). Furthermore, the recoverable portion of fresh water that is accessible to humans is less than 1% of the total (Hassan et al., 2023; Almudhafar et al., 2024). Hydrological studies are crucial, especially in dry and semi-arid regions, to understand the characteristics of water bodies and assess their suitability for various purposes such as drinking, agriculture, and livestock. In this regard, the current study aims to evaluate the environmental characteristics of the Al-Sudair River in Najaf Governorate, Iraq (Partal & Özdilek, 2022). The Al-Sudair River is approximately 28 km long and flows through populated areas and agricultural lands, making it an important water source for the region. The main objectives of this study are: To detect the physical and chemical properties of the Al-Sudair River and build an integrated database system to aid in the preservation of water resources. To assess the suitability of the river water for various human uses. To achieve these objectives, the study will analyze the spatial variation in the physical and chemical properties of the Al-Sudair River water and evaluate its suitability for drinking, irrigation, and animal consumption based on international and Iraqi standards (Al-Jashaami et al., 2024; Robles et al., 2015; Al-Jashaami et al., 2024).

The Problem of the Study

The problem represents the basic essence of the research around which thetopic revolves. The main problem of the study is the following question:

1. Do the chemical and physical properties of the Sudair table vary?
2. Is the quality of the Sudair table suitable for different uses?

The Hypothesis of the Study

The hypothesis of the study is a preliminary solution to the problems between things and causes or is the interpretation of the phenomena studied and, on this basis, it was developed for the following main hypothesis:

1. The physical and chemical properties of the Sudair table vary.
2. The quality of Sudair water varies in its suitability for various uses.

The study aims at the following:

1. Detecting the physical and chemical properties of Al-Sudair stream in Najaf Governorate, and building an integrated database system for it so that specialists can take the necessary measures to preserve water resources.
2. Knowing the suitability of this water for various human uses.

Boundaries of the Study Area

The study area is part of the deposition plain,and the Sudair table branches off from the right side of the Jahat table in the center of Abu Sakhir district, which is one of the branches of the right side. It is one of the main tables in the study area and empties into the Najaf Sea. Its discharge rate is (28) m^3/s, where its length is (28) km, and its discharge rate is (3.28) m^3/s. The area of agricultural land benefiting from this table is (8000) dunums. These lands are based on the method of irrigation by pumping and flowing. The objective limits were represented by the study of physical and chemical properties for Sudair (Figure 1).

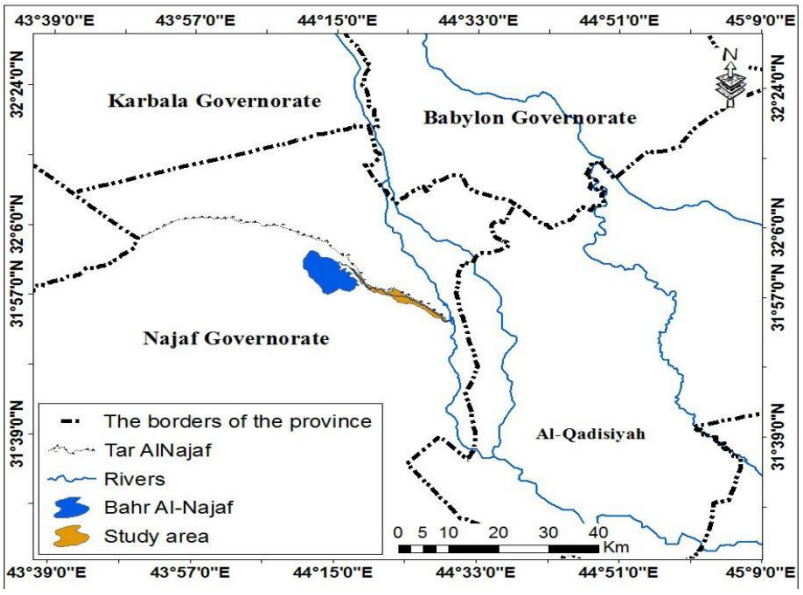

Figure 1. The location of the study area in the governorate

Materials and Methods

The researcher began her research work on a date based on the means and methods of several agencies:

1. Access to (books, researches, letters, and theses) related to hydrology on the one hand and pollution seeker on the other hand,
2. Relying on the Internet to obtain research and articles related to the study.
3. Conducting a field survey of the study area in order to identify all activities in the study area.

4. Due to the lack of studies on the subject in Najaf Governorate, this study relied mostly on field work, which is as follows:
   A. Carrying out exploratory tours to identify the polluted sources of water of Al-Sudair stream, the number of which is (5) tours.

   B. Collecting (10) samples of Sudair Creek water within the study area from (10)sites and by (1) model from each site, through a season, as (15) elements and a chemical compound were analyzed, and these samples were taken from a depth of (30cm) below the surface of the water and on a regular basis taking into account sampling from being free of impurities and leaves and collected with the direction of the flow of the table, and then the water models were placed with two types of different packages, namely (one liter plastic containers for the analysis of positive and negative ions) (as well as opaque glass containers for the analysis of oils and greases).

   C. Taking photographs of important phenomena.

5. Using maps to distribute phenomena.
6. Visits to state departments: A number of official departments in Najaf Governorate were reviewed by the Directorate of Water Resources in Najaf Governorate, the Directorate of Environment in Najaf, the Directorate of Agriculture in Najaf, and the Kufa Agriculture Division in the city of Kufa.
7. Laboratory Analysis: After completing the field study, the researcher collected many samples of water whose physical and chemical properties were analyzed in the Environment Laboratory in Najaf Governorate.
8. Data Tabulation Phase: It is the last stage of the study in which the data are disaggregated after being collected through desk work and field study. During the field study, several devices were used for the purpose of completing the requirements of the study, namely:

   A. A thermometer (mercury) device to measure the temperatures of the water.

   B. A camera in order to take photographs of important phenomena to enhance the study.

   C. Chemical and physical analysis devices

Structure of the study: The research was divided into the following axes:

1. Analysis of the qualitative characteristics of the waters of the Sudair River.

2. Evaluation of the qualitative characteristics of the Sudair River water (for evil, for irrigation and for industry).

3. Findings.

Table (1) showed that the temperature of the waters of Al-Sudair table varied spatially along the length of the table, as it recorded the highest temperatures in the sites (6-10), reaching (29,29,29,28,28) m and decreasing at the sites (1-5), reaching (25,24,24,21,19) m, respectively. Temperature is one of the main factors affecting the metabolic processes of all living organisms. Any change in this factor from the usual limit leads to a change in the activity and effectiveness of these organisms, as well as the impact of temperatures on the speed of chemical reactions and the process of dissolving gases in water, and thus affects its natural qualities

It is clear from the above that the reading of the water temperature was in the normal and environmentally permissible position, as it did not exceed (35 °C), but its impact remains important in the

evaporation processes, the speed of chemical reactions, the dissolution of gases, the decomposition and activity of bacteria, and the speed of consumption of dissolved oxygen (Do), which changed many of the natural qualities of water.

Turbidity

Turbidity is one of the water quality standards that determine the content of the sample of clay and silt suspended in the water column as well as for organic and inorganic microflora. Plant wanderers and other organisms perform an important function in determining turbidity. High turbidity affects the health of water and its environment by impeding the permeation of light in the water column, which helps in the photosynthesis of plants and hinders them in the process of breathing organisms, especially fish. Table (1) shows that the concentration of turbidity in the stream water varies spatially, as it recorded the highest concentrations at the sites (1-4, 8-10), reaching (147-60-43,4-31,5-65,1-57,2-40,3), while the lowest concentrations were recorded at the sites (5-7), recording (8,6-5,01-5,37) NTU. The rise in turbidity is due to the increase in suspended materials in the water column resulting from the role of rainwater and soil erosion and its arrival into the stream through the sewage waste from the water of agricultural trocars, which helps to increase the density of plant and animal wanderers that raise the turbidity of water.

Table 1. Chemical Characteristics

Forms	Temperature	Turbidity	Dissolved oxygen (DO) mg /l
1	19	147	4
2	21	60	2.8
3	24	43.4	2.6
4	24	31.5	2.4
5	25	8.6	3.6
6	28	5.01	17
7	28	5.37	6.2
8	29	65.1	2.6
9	29	57.2	2.4
10	29	40.3	2.7

Dissolved Oxygen

It is the concentration of oxygen molecules (O_2) dissolved in water, which is the mainstay of the life of aquatic organisms, and its lack constitutes a great environmental pressure on the aquatic system, and its measurement is essential in evaluating the health of water and its free of organic pollutants, as it is consumed by microorganisms. The presence of dissolved oxygen lies in the fact that it regulates the vital actions of aquatic groups and is indispensable even in the case of a decrease in its concentration below a certain level in order to sustain aquatic life, and a decrease in its concentration in water resulting from the introduction of pollutants that help to accumulate aerobic bacteria that live on it and consume it during breathing, which reduces plant life in that environment and then animal life dependent on plant life, for example, fish need it first at a high rate, followed by aquatic invertebrates, then bacteria and aquatic plants. Temperature with dissolved oxygen is determined by an inverse relationship, as the higher the temperature, the lower the concentration of dissolved oxygen in the water and vice versa, especially since the solubility of oxygen in the water is low. Therefore, the validity of the analysis of the water of the Sudair stream shows from Table (1) that the concentrations of dissolved oxygen of the stream water in the study area vary spatially , as it recorded the highest concentrations

of it in the sites(7,6,1) , as it recorded (4-17-6,2), while the lowest concentrations were recorded in the sites (10,9,8,5,4,4,3,2), as it recorded (2.7-2,4-2,6-3,6-2,4-2,6-2,6-2,8) mg/liter.

Chemical Characteristics

Basal or Acidic (pH)

It is clear from Table (2), that the pH values of the table water vary spatially, if all ten sites record a modified increase in the pH values. The increase in their values is due to the high temperatures that cause the high density of plant rodents, which leads to an increase in the effectiveness of photosynthesis, which leads to the consumption of carbon dioxide gas and the increase in the pH degree. Most natural water falls between the values (4-9) and the decrease or increase in the value of (pH) resulting from the arrival of pollutants to river water. In general, most Iraqi river water tends to the basic characteristic because it contains bicarbonate. The variation in the values of (pH) in Sudair water is due to its effect on the phosphate fertilizers used by the farmer, represented by ((mono-superphosphate, triple-superphosphate)) and as a result of the use of these materials, they contribute to raising the pH values in Sudair water.

Electrical Connection (EC)

The electrical connection is an indicator of water pollution, especially with salts and dissolved solids, as the greater their values in water, the greater the pollution of that water. The main determinant of the electrical current in water is the ions dissolved in it , so natural water is a good conductor of electrical current and is determined on these ions in a direct relationship depending on their concentrations in it. It is clear from Table 2 that the concentration of the electrical connection of the table water varies spatially, if high concentrations are recorded at the sites (6-7-8-9), as it reaches (5,73-4,15-4,35-4,16) decimons/ m, while the sites (1-2-3-4-5-10) have the lowest concentration, as it recorded (2.56-2,84-2,96-3,70-3,72-2,64) deci/ m.

Total Dissolved Salts (T.D.S)

Table (2) shows that the concentrations of total dissolved salts of table water are spatially high, as they recorded the highest concentrations in all sites (1720-1670-1850-1930-2410-2420-3730-2700-2836-2710) mg /liter. The high concentrations of total dissolved salts are due to the flow of salt water from the adjacent trocars to the stream.

Total Hardness

Hard water: It is water in which soap is not frothy or hardly frothy because it contains calcium, magnesium and sodium salts. It is not considered safe to drink when the ratio of hardness-causing salts reaches 200-300 mg /liter. There are two types of hardness: - Temporary hardness: It is the result of the presence of calcium bicarbonate and magnesium salts. Permanent difficulty: It is caused by the presence of sulfate salts, chlorides, calcium nitrate, magnesium and sodium, and the water is alkaline. It is clear from Table (2) that the concentrations of the total hardness of the water of the table vary spatially, if the highest concentration rate is recorded at the sites (2-9) as it reached (1020-1090-1420-1620-2950-1290-1350-1040) mg/liter and the lowest concentration at the sites (1-10) as it reached (700-600) mg /liter. The reason for the high total hardness is due to what drifts to the water from the neighboring soils through rainfall and low drainage of the stream as well as agricultural and human waste. The reason for the change in the concentrations of total hardness is also due to the direct proportionality between it and magnesium and calcium.

Table 2. Chemical Characteristics

No.	pH	EC	T.D.S	T.H
1	7	2.56	1720	700
2	7.18	2.84	1670	1020
3	7.2	2.96	1850	1090
4	7.5	3.70	1930	1420
5	7.54	3.72	2410	1620
6	7.57	5.73	2420	2950
7	7.48	4.15	3730	1290
8	7.81	4.35	2700	1350
9	7.44	4.16	2836	1040
10	7.46	2.64	2710	600

Cations

- ***Magnesium (Mg)***

Magnesium is important in the aquatic ecosystem, as it is one of the basic components of the chlorophyll molecule, food making for plants, and an important element for the growth and reproduction of fish. Magnesium is a reducing element for the toxicity of some trace elements such as lead and zinc, but its high concentration in water affects human health, and the presence of magnesium with sulfates in drinking water leads to diarrheal disease.

Table (3) shows that the concentrations of magnesium for the table water in the study area vary spatially, as it recorded the highest concentration of magnesium in the site (6), reaching (253.7) mg /liter, while the sites (1-9) reached (29.28-86.32-70.76-65.88-78.08-70.76-82.98-80.52) mg/liter, while the site (10) recorded the lowest concentration, reaching (9.76) mg/liter. The spatial variation in the high concentrations is attributed to contamination with agricultural trophic water, which contains residues of fertilizers and agricultural pesticides, as well as their impact on wastewater, which affects the chemical, physical and biological properties of the water of the study area.

- ***Sodium [($^{1+}$ (Na)]***

Table (3) shows that the concentrations of sodium (Na) in the water of the table vary spatially, as all sites recorded their highest concentrations (150,8-165,4-199,7-241,7-228,7-406,8-301,4-334,8-215,5-219) mg /liter, while they recorded mg/liter. The higher concentrations in January were due to lower discharge rates resulting in an increased concentration of mg/L salts. The reason for the high sodium in the table is due to the process of puncturing from agricultural land or from household waste water. The high sodium is also due to the frequent dissolution of salt rocks, which affects its physical and chemical properties.

- ***Calcium [Ca^{+2}]***

Calcium is one of the most alkaline elements and the main cause of water hardness and is one of the necessary nutrients for plants and other aquatic organisms. It appears from Table (3) that the calcium concentrations of table water are high and spatially differentiated for all sites, as it reached (232-296-320-460-520-764-400-404-289-224) mg/liter.

- ***Potassium [(K^{+1})]***

Table (3) shows that the concentrations of potassium in the water of the table vary spatially and have high concentrations for all sites, as it recorded (26.9-32.9-43-60.6-65.3-46.9-41.7-30.4-29.2-29) mg/liter. The high concentrations of potassium are due to the passage of the table in agricultural lands, where agricultural trocars are abundant, from the use of phosphate fertilizers that include potassium in their composition, such as compound fertilizers, as well as being affected by wastewater that contains chemical detergents or industrial products used at home, which affects the physical and chemical properties of water.

Table 3. Magnesium, Sodium, Calcium, and Potassium Concentrations (mg /l)

Samples	Magnesium (Mg)	Sodium (Na)	Calcium (Ca)	Potassium (K)
1	29.28	150.8	232	26.9
2	86.32	165.4	296	32.9
3	70.76	199.7	320	43
4	65.88	241.7	460	60.6
5	78.08	228.8	520	65.3
6	253.7	406	764	46.9
7	70.76	301.4	400	41.7
8	82.98	334.8	404	30.4
9	80.52	215.5	289	29.2
10	9.76	219	224	29

Anions

Chlorides [(CL_{4-2})]

The chloride ion has an impact on the germination process and the increase in the concentration of the ion affects the quality of water and causes damage to plant types such as grapes. It appears from Table 4 that the concentrations of chlorides in the table water vary spatially and have high concentrations for all sites, as it recorded (170-213-175-163-220-223-150-120-117-135) mg/liter. The reason for the rise in chlorides is due to the low rate of discharge and the climate factor, which is determined by high temperatures, evaporation rates, variation in rainfall quantities, and the impact of waste water and sewage in the region and abroad that are thrown into the stream without treatment, which affects the physical and chemical properties of water .

Table 4. Anions concentration

Samples	Cl	SO_4	PO_4	Oils & Greases
1	170	535	1.31	39.2
2	213	607	1.83	4.4
3	175	657	1.43	1.43
4	163	907	0.88	4.8
5	220	1028	0.67	14
6	223	1509	0.09	31.6
7	150	1026	0.67	0.8
8	120	609	1.77	1.2
9	117	462	1.37	0.4
10	135	404	1.19	0.2

Sulfates [(SO_4)]

Sulfates contribute to the formation of permanent difficulty in water, especially in the form of calcium sulfate or magnesium, and are among the elements that cause salinity, as they give the salty taste when their concentration is more than (200) mg/liter, which causes diarrhea when they are in the form of magnesium sulfate and sodium sulfate, and their high concentrations in water contribute to killing fish and their eggs, damaging aquatic life, causing damage to water health and changing its natural characteristics. It appears from Table 4 that the concentrations of sulfates in the water of the table vary spatially,as they recorded the highest concentrations at the sites (5-6-7), amounting to (1028-1509-1026) mg /liter, in which the sites (1-10) amounted to (535-607-657-907-609-462-404) mg/liter.

Phosphate [(PO_4)]

The concentration of phosphates affects the quality and suitability of water through qualitative change in the preparation and type of organisms in the aquatic environment. Table 4 shows that phosphate concentrations of table water vary spatially, as the highest concentrations were recorded at sites (1-10), reaching (1,31-1,83-1,43-1,77-1,37-1,19) mg /liter, while the lowest concentrations were recorded at sites (4-5-6-7), reaching (0.88-0,67-0,09-0,67) mg/liter.The reason for the rise in phosphate. The reason for the spatial variation is due to the civil waste, puncture water, fertilizer water and pesticides dumped directly into the river and the other natural depending on the geological formations and the dredging of the soil that contains large quantities of it, which raises its concentrations if it is discharged to the rivers and then all affect the qualitative characteristics of the water.

Oils and Greases (Fat)

Table 4 shows that the concentrations of oils and greases for table water vary spatially, as they recorded the highest concentrations in the sites (1-5-6), reaching (39,2-14-31,6) mg /liter, while the lowest concentrations were recorded in the sites (2-10), reaching (4,4-1,43-4,8-0,8-1,2-0,4-0,2) mg/liter. The reason for the spatial variation from one region is that the contamination of this water with residues of fats and oils is due to the result of the excreta of these materials being excreted after being consumed for multiple purposes to sewage or to land through trocars or rainwater networks, where they take their way to the stream water without treatment, which affects the physico-chemical properties of water.

Evaluation of the Validity of Sudair Water for Various Uses (Civil – Agricultural)

After discussing and analyzing the physical and chemical environmental characteristics of Sudair stream water, the nature of this water can be evaluated to know its suitability and quality for various uses, as the quality of water is the measure in different human uses, so the quality is important as the availability of water itself is important, because water may be suitable for certain workers, but it may not be suitable for other workers. Therefore, this came to evaluate the validity of the water of Al-Sudair stream for civil workers (drinking water), and agricultural workers in Shaqia (vegetable and animal).

Evaluation of the Validity of the Water of Al-Sudair Table for Civil Workers

Evaluating the Physical Characteristics and Suitability of Water for Drinking

There are many human water workers, but the most important impact of water quality is on the water intended for drinking. The quality of the Kufa Shatt water can be evaluated to know its suitability for drinking according to the World Health Organization (W.H.O) standard, which determined the concentration of ions allowed in

human drinking water table (), according to the elements that have been analyzed and shown their concentrations and from comparing the values of the physical and chemical properties of Sudair water with those standards as follows:

Temperature

We note from Table (1) according to the World Health Organization (W.H.O) standard (Table 5) of (35 °C), that the temperatures of all the studied sites are safe to drink, and their degrees range between the lowest and highest sites (19-29) °C. It is clear from the above that the temperature reading varies spatially, although the temperature of the water was in the normal and environmentally permissible position, as it did not exceed (35°C), but its impact remains important in the processes of evaporation, the speed of chemical reactions, the dissolution of gases, the decomposition and activity of bacteria and the speed of consumption of Dissolved Oxygen (Do), which changed many of the natural qualities of water.

Turbidity

It is clear from Table 1 according to the World Health Organization (W.H.O) standard (Table 5), which is (5-25) mg /liter, that all sites are non-potable, ranging from the highest to the lowest sites (65-147) mg /liter.

Table 5. Water Suitability for Drinking According to W.H.O Standard (Khalil, 2010; W.H.O., 1971)

S/N	Items	Allowed percentages
1	Temperature	35 ºC
2	Turbidity	5-25 mg/l
3	Dissolved solids (T.D.S)	1000 mg /l
4	Dissolved Oxygen (DO)	Not to fall below (4) mg /liter
7	Basophilic or acidic (pH)	(6.5-8.5)
8	Electrical Conductivity (EC)	2 Deci / m
9	Total Difficulty (T.H)	500 mg /l
10	Sodium (Na+)	200 mg /l
11	Magnesium (Mg)	50-150 mg/l
12	Calcium (Ca)	(75-200) mg /l
13	Potassium (K+)	(12) mg /l
14	SO_4	(200-400) mg /l
15	Chlorides (CL)	(200-650) mg /l
17	PO_4	(0.4) mg /l
18	FAT	It must be free of oil and grease

Dissolved Oxygen Concentrations (DO)

It is clear from Table 2 according to the World Health Organization (W.H.O) (Table 5), which is (not less than 4 mg/liter), that all sites are safe to drink in terms of concentrations of dissolved oxygen (DO), which range between (4-6.2) mg/liter. Evaluation of chemical properties and the suitability of water for drinking

pH

It is clear from Table 2 that (pH) according to the World Health Organization (W.H.O) (Table 5), amounting to (6.5-8.5), that all sites are safe to drink in which the pH values range between (7.57-7.81).

Electrical Conductivity (EC)

It appears from Table 2 that the concentrations of electrical conductivity according to the World Health Organization (W.H.O) (Table 6), amounting to (2) dc/m, and that all the studied sites are non-potable and have EC concentrations ranging between (2,56- 5,73) dc/m.

Dissolved Solids (T.D.S)

Table 2 shows that the concentrations of dissolved solids according to the standard of the World Health Organization (W.H.O) (Table 6), amounting to (1000mg/liter),that all sites are higher than the permissible limits (T.D.S)as it reached (1720-3730) mg /liter and are not drinkable due to the contact of puncture water with surface water, which is rich in agricultural waste and low water levels, which leads to the unpalatability of water and its inability to drink .

Total Hardness (TH)

We note from Table 2 that the concentrations of total hardship according to the standard of the World Health Organization (W.H.O) (Table 6) of (500mg/liter), that all sites are higher than the permissible limits in terms of (TH) and are not suitable for drinking, as it reached (600-2950) mg /liter.

Magnesium (Mg)

It appears from Table 3 that the concentrations of magnesium, according to the World Health Organization (W.H.O) standard (Table 5), amounting to (50-150mg/liter), that all the studied sites are not drinkable in terms of (Mg) except for the site (), which amounted to (9,08).

It is clear from Table 3 that sodium concentrations according to the World Health Organization (W.H.O) in Table 5 of (200mg /liter), that all sites are not drinkable in terms of (Na) except for the site () as it amounted to (150,8) mg / liter drinkable .

Calcium Ca

It is clear from Table 3 that the calcium concentrations according to the World Health Organization (W.H.O) (Table 5), amounting to (75-200mg/liter), that all the studied sites are not drinkable in terms of (Ca), whose concentrations range between (224-764) mg /liter.

Potassium - K

We note from Table 3 that potassium concentrations according to the World Health Organization (W.H.O) (Table 5), amounting to (12 mg/liter), that all the studied sites are not drinkable in terms of (k), whose concentrations range between the lowest and the highest (26.9-65.3) mg /liter.

Chlorides (Cl)

It appears from Table 4 that the concentrations of chlorides according to the World Health Organization (W.H.O) standard of (Table 5) of (200-650mg/liter), that all the studied sites are safe to drink in terms of (CL), in which the concentrations range between (120-223) mg /liter.

Sulphates (SO_4)

It is clear from Table 4 that the concentrations of sulfates according to the World Health Organization (W.H.O) (Table 5) of (200-400mg/liter) that the sites are higher than the permissible limits in terms of (SO_4) and are not suitable for drinking, as they reached between the highest and lowest (404-1509) mg /liter as a result of agricultural waste and sewage waste that are thrown directly into the water table and contain organic materials.

Table 4 states that the concentrations of phosphates according to the World Health Organization (W.H.O) standard of (Table 5), amounting to (0.4mg/liter), are higher than the permissible limits in terms of (Po) and are not suitable for drinking at all sites (0.09- 1.83) mg /liter, due to civil waste, puncture water, fertilizer water, pesticides and soil dredging, which are directly to the table.

Oils and Greases (Fat)

It is clear from Table 4 that the concentrations of oils and greases and according to the World Health Organization (W.H.O) standard of Table 5 that all sites are higher than the permissible limits in terms of oils and greases, in which the concentrations ranged between (0.2-39.2) mg /liter, the water of the table is contaminated with fats and oils as a result of the excreta of these materials to the sewers or to the land through the trocars that pour into the water of the table without treatment.

It was found from the above and according to the standards of the World Health Organization that some elements and all sites are safe to drink and some sites have high concentrations of physical and chemical elements and thus are not safe to drink.

Evaluation of Chemical Properties and Water Suitability for Irrigation

pH

It is clear from Table 2 according to the standard of the Islamic Educational, Cultural and Scientific Organization (Table 6) that (ph), which is (6-8,5), that all sites are suitable for irrigation in which the values of pH range between (7,57-7,81).

Electrical Conductivity (EC)

It is clear from Table 2 according to the standard of the Islamic Educational, Cultural and Scientific Organization in (Table 6) that (EC) in sites (1-2-3-10) as it reached (2,56-2,84-2,96-2,64) dc/m suitable for irrigation, while the sites (4-9) as it reached (3,70-3,72-5,73-4,15-4,35-4,16) dc/m are not suitable for irrigation.

Dissolved Solids (T.D.S)

Table 2 shows that the concentrations of (T.D.S) according to the standard of the Islamic Educational, Cultural and Scientific Organization (Table 6) of (0-2000) mg/ L (1-2-3-4) are valid for irrigation as it reached (1720-1670-1850-1930), while the sites (5-6-7-8-9-10) reached (2140-2420-3730-2700-2836-2710) mg /liter and that all sites are above the permissible limits and are not suitable for irrigation.

Total Hardship (TH)

We note from Table 2 that the concentrations of total hardship according to the standard of the Islamic Educational, Cultural and Scientific Organization (Table 6) amounting to (more than 300mg/liter), that all sites fall within the limits of very hardship and are not suitable for irrigation as it reached (600-2950) mg /liter.

Magnesium (Mg)

It appears from Table 3 that the concentrations of magnesium according to the standard of the Islamic Educational, Cultural and Scientific Organization (Table 6), amounting to (0-50 mg/liter), that the sites (1-10) are suitable for irrigation as it reached (29,28.9,76), while the sites (2-9) are not suitable for irrigation more than (50) mg /liter. Table 7 shows water hardness classification.

Table 6. Validity of water for irrigation according to the standard of the Islamic Educational, Cultural and Scientific Organization (ISECL) (Water Resources Management, 1997)

Scale	Unit	That should be the legal limit	Max Allowed Bets
T. D. S.	mg/l	0	2000
pH	-	6	8.5
Electric conductivity	ds/m	0	3
Sodium (Na^{+})	mg/l	0	40
Magnesium Mg^{+2}	mg/l	0	50
Calcium Ca	mg/l	0	20
Potassium K^{+1}	mg/l	0	2
Sulfate SO^{4}	mg/l	0	200
Chlorine Hand Cl^{-1}	mg/l	0	30

Table 7. Water hardness classification (Todd & Mays, 2004)

Water Condition Description	Hardness limits (T.H) mg/l
Relief	0-75
Relatively hardship	75-150
Hardship	150-300
High hardship	>300

It is clear from Table 3 that sodium concentrations according to the standard of the Islamic Educational, Cultural and Scientific Organization (ISESCO) (Table 6) amounting to (200mg /liter), that all sites are not suitable for irrigation as it reached between the lowest and the highest degree as it reached (150.8-406.8) mg /liter.

Calcium Ca

It is clear from Table 3 that the calcium concentrations according to the standard of the Islamic Educational, Cultural and Scientific Organization (Table 6), amounting to (0-20mg / liter), that all the studied sites are not suitable for irrigation in terms of (Ca), whose concentrations range between (224-764) mg /liter.

Potassium (K)

We note from Table 3 that potassium concentrations according to the standard of the Islamic Educational, Cultural and Scientific Organization (Table 6), amounting to (0-2mg/liter), that all the studied sites are not suitable forirrigation in terms of (k), whose concentrations range between the lowest and highest (26.9-65.3) mg /liter.

Chlorides (Cl)

It appears from Table 4 that the concentrations of chlorides according to the standard of the Islamic Educational, Cultural and Scientific Organization (ISESCO) (Table 6) of(0-30mg/liter), that all the studied sites are suitable forirrigation in terms of (CL), in which the concentrations range between (120-223) mg /liter.

Sulphates (SO4)

It is clear from Table 4 that sulfate concentrations according to the standard of the Islamic Educational, Cultural and Scientific Organization Table 6 of (0-200mg/liter) that the sites are higher than the permissible limits in terms of (SO_4) and are not suitable for irrigation, as they reached between the highest and lowest (404-1509) mg /liter as a result of agricultural waste and sewage waste that is thrown directly into the water table and contains organic materials.

Table 4 states that phosphate concentrations according to the World Health Organization (W.H.O) standard of Table 6, amounting to (0-2/ mg /liter), are higher than the permissible limits in terms of (Po) suitable for irrigation at all sites (0.09- 1.83) mg /liter.

Oils and Greases

It is clear from Table 4 that the concentrations of oils and lubricants and according to the World Health Organization (W.H.O) standard (Table 6) that all sites are higher than the permissible limits in terms of oils and lubricants, in which the concentrations ranged between (0,2-39.2) mg /liter, the water of the table is contaminated with fats and oils as a result of the excreta of these materials being thrown into the sewers or to the land through the trocars that pour into the water of the table without treatment.

Evaluating the Validity of Water for Animal Drinking Purposes

It is clear from the chemical analysis of the water of the Sudair table compared with the quality of drinking water of the farm animals in the Table 8 and the extent of the possibilities of benefiting from the water of the Sudair table, that recording the temperature of the Sudair table is not suitable for drinking except for the sites (1, 2) suitable for drinking animals. Magnesium in the sites (1-10) is suitable for drinking animals and the rest of the sites are not suitable, and phosphates are suitable for drinking in the sites (4-7) and the rest of the sites are not suitable for the elements (turbidity –pH - hardness - Na-K - chloride - sulfate) according to the standard of the Food and Agriculture Organization (FAO) all sites are suitable for drinking animals as in Table 8. Table 9 shows quality of drinking water for farm animals

Table 8. Permissible limits for the quality of animal drinking water according to the FAO standard (Food and Agriculture Organization of the United Nations, 2010)

Parameter	Unit	Recommended Lower Limits	Recommended upper limits
Temperature	°c	12	25
Turbidity N.T.U	-----	1	2
pH	pH unit	6.5-8.5	6.5-9
Chloride Cl	mg/l	25	250
Sulfate SO_4	mg/l	25	250
Magnesium	mg/l	30	50
Sodium Na	mg/l	20	150
Potassium - K	mg/l	10	12
Hardship T.H.	mg/l	-	50
Phosphate (PO_4)	mg/l	0.4	5

Table 9. Quality of drinking water for farm animals (Mikhlif Shallal Mar'i, 1986)

Salts Dc/ m	Notes
Less than 1.5	Relatively low salinity and water is good for all animals
1.5 – 5	Very acceptable for all animals
5 – 8	Accepted for livestock at all times
8–11	Can be used for cows and sheep without pregnancy
11-16	Do not use during pregnancy and milk for all livestock
More than 16	It is not recommended for use because of the danger

Conclusions

The physical and chemical properties of the Al-Sudair River water vary spatially according to the variation in natural and human conditions. The quality of the Al-Sudair River water varies in its suitability for different uses (drinking, irrigation, animal consumption) based on international and Iraqi environmental standards. The study aimed to:

a. Detect the physical and chemical properties of the Al-Sudair River and build an integrated database system to aid in preserving water resources.

b. Assess the suitability of the river water for various human uses.

The study area is part of the deposition plain, and the Al-Sudair River is about 28 km long, with an average discharge rate of 3.28 m3/s. It provides water for about 8000 dunums of agricultural land.

The study relied primarily on field work, including water sampling, use of measurement instruments, and analysis of physical and chemical parameters, to evaluate the suitability of the Al-Sudair River water for different purposes. The water quality of the Al-Sudair River varies spatially and in terms of its suitability for various uses, which necessitates a detailed evaluation and management of this important water resource.

Author Contributions

All Authors contributed equally.

Conflict of Interest

The authors declared that no conflict of interest.

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