Environmental Study in Assessing the Water Quality of the Al-Gharraf River for Agricultural Purposes

Studi Lingkungan dalam Menilai Kualitas Air Sungai Al-Gharraf untuk Tujuan Pertanian

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Abstract. General Background: *The Al-Gharraf River in Thi Qar Governorate, Iraq, is crucial for agricultural irrigation and livestock sustenance.* ***Specific Background****: However, the river's water is suspected of being polluted with physical and chemical contaminants, which may adversely affect soil properties, crop growth, and the health of livestock and poultry in the region.* ***Knowledge Gap****: Limited research exists on the extent of pollution in the Al-Gharraf River and its impact on agricultural and livestock practices.* ***Aims****: This study aims to assess the pollution levels of the river's water by evaluating key physical and chemical parameters, determining its suitability for agricultural purposes, and understanding the implications for livestock and poultry consumption.* ***Results:*** *The water quality, assessed using the American Salinity Laboratory classification, placed the river in the C3-S2 category, indicating third-degree salinity (very salty) and second-degree sodium (medium). Most physical and chemical measurements exceeded permissible limits for irrigation water, except for pH and Sodium Adsorption Ratio (SAR), which remained within acceptable bounds. The water, while within the premium class for low salt levels, posed significant risks to livestock and poultry due to high salinity and other pollutants.* ***Novelty:*** *The study provides a comprehensive analysis of the river's water quality, highlighting the critical need for regular monitoring and the implementation of modern irrigation practices to prevent further soil salinization.* ***Implications:*** *These findings emphasize the urgency of adopting sustainable water management strategies and raising awareness to prevent harmful discharges into the river, ensuring the long-term viability of agriculture and livestock in the region.*

Keywords *– Al-Gharraf River, water pollution, salinity, irrigation, livestock health*

Abstrak. ***Latar Belakang Umum:*** *Sungai Al-Gharraf di Kegubernuran Thi Qar, Irak, sangat penting untuk irigasi pertanian dan sumber makanan ternak.* ***Latar Belakang Khusus****: Namun, air sungai tersebut diduga tercemar oleh kontaminan fisik dan kimia, yang dapat berdampak buruk pada sifat tanah, pertumbuhan tanaman, dan kesehatan ternak dan unggas di wilayah tersebut.* ***Kesenjangan Pengetahuan****: Penelitian terbatas mengenai tingkat polusi di Sungai Al-Gharraf dan dampaknya terhadap praktik pertanian dan peternakan.* ***Tujuan:*** *Penelitian ini bertujuan untuk menilai tingkat polusi air sungai dengan mengevaluasi parameter fisik dan kimia utama, menentukan kesesuaiannya untuk tujuan pertanian, dan memahami implikasinya terhadap konsumsi ternak dan unggas.* ***Hasil:*** *Kualitas air, yang dinilai menggunakan klasifikasi Laboratorium Salinitas Amerika, menempatkan sungai tersebut dalam kategori C3-S2, yang mengindikasikan salinitas tingkat tiga (sangat asin) dan natrium tingkat dua (sedang). Sebagian besar pengukuran fisik dan kimiawi melebihi batas yang diizinkan untuk air irigasi, kecuali untuk pH dan Rasio Adsorpsi Natrium (SAR), yang masih berada dalam batas yang dapat diterima. Air tersebut, meskipun berada dalam kelas premium untuk tingkat garam rendah, menimbulkan risiko yang signifikan bagi ternak dan unggas karena salinitas tinggi dan polutan lainnya.* ***Kebaruan:*** *Studi ini memberikan analisis komprehensif tentang kualitas air sungai, menyoroti kebutuhan penting untuk pemantauan rutin dan penerapan praktik irigasi modern untuk mencegah salinisasi tanah lebih lanjut.* ***Implikasi:*** *Temuan ini menekankan urgensi penerapan strategi pengelolaan air yang*

berkelanjutan dan meningkatkan kesadaran untuk mencegah pembuangan limbah berbahaya ke sungai, sehingga menjamin kelangsungan jangka panjang pertanian dan peternakan di wilayah tersebut.

Kata Kunci – *Sungai Al-Gharraf, polusi air, salinitas, irigasi, kesehatan ternak*

I. INTRODUCTION

Water is an environmentally important substance and one of the necessities for the life of living organisms and this depends on the quantity and quality of water through its physical, chemical and biological properties, as these variables impact each other [1]

The availability of water resources is critical to global agriculture, particularly given their scarcity. To achieve the highest levels of quality of use feasible, appropriate attention must be paid to all parts of assessment, study, and research that would support the growth of those resources and their protection. Given that studies and research conducted globally and in the Arab world have shown the extent of which salt water may be used in agriculture, the pace of population growing has coincided with an increase in the amount of water consumed, Good water and soil management must be given utilizing washing needs ranging from 40–10% or by mixing, alternating irrigation, or irrigation, regardless of whether the water comes from rivers and streams or wells.Unplanned and additional usage will cause salt buildup [2].

Like other nations, Iraq has river pollution levels that are higher than what is safe to drink because water supply and distribution do not meet standards. The Al-Gharraf River's declining water quality and deficiency of an efficient self-control system, shown by the utilization of around 700,000 hectares of mostly agricultural land, pose a severe threat. [3]. The waters of Iraqi rivers are under increasing threat due to increased industrial and agricultural pollution, salinity, and low water levels due to climate change, as well as numerous dams built in Turkey, Syria, and Iran, as well as inadequate irrigation planning [4]. The problem of water quality in Iraq takes two dimensions. The first is the amount of water received from the source. The second dimension is the pollution of water after it enters Iraqi territory, and this pollution is the result of agricultural, industrial, and sanitary drainage to the riverbed. In light of this, indicators of water quality are methods for condensing data on water quality in order to deliver reports to the public in an accurate manner. They are also frequently used to evaluate the quality of water by contrasting observed values with established benchmarks. [5] .There are many studies that have been interested in investigating the suitability of water for use for various industrial, agricultural, and domestic purposes and comparing them with global and local determinants to develop appropriate solutions to reduce its pollution.

Many research studies have been conducted to assess the water quality in Iraq, including those by [6], [7], [8], [9] and [10] on the water of the Al-Gharraf River. And other studies on the water of the Euphrates River and the Tigris River, including [11], [12], [13], [14], [15],[16] and [17]; and a study by [18]; and [19].These studies have adopted either the application of different statistical models or comparison with some standards and have concluded to identify significant increases in the concentrations of some pollutants in the waters of the rivers studied, The water quality varied from very bad to poor to unfit for different purposes.

The assessment of irrigation water quality is contingent upon many criteria., the most important of which is the total content of salts and their ionic composition, and this results in variation in its quality as it depends on the type and quantity of dissolved salts resulting from the dissolution or weathering of rocks such as gypsum and lime, which in turn are transmitted with irrigation water. Water quality is the subject of research and study in many countries, and the most important quality specifications of irrigation water must be studied and agreed upon by most standards [20].The USDA noted in its 1954 manual [21] that the most important determining properties of water quality are the value of electrical conductivity, the percentage of sodium adsorption, and the concentration of boron and bicarbonate.

Water quality is of great importance, depending on the purpose of water use. Good-quality water must have several specifications and standards. As drinking water requires high standards, the water required for irrigation purposes requires specifications with lower standards than drinking water, while the specifications of water for animal husbandry, cows, sheep, poultry, and fish require specifications and standards approaching the standards of drinking water for humans. In light of the advanced necessity of water for agricultural uses, it is assumed that the study area suffers from water scarcity due to climate change and an increase in environmental pollutants.

The aim of this study was to determine the environmental level around the waters of the Al-Gharraf River in Thi Qar governorate, identify the quality of water and classify it according to international standards, know the validity of its use for agricultural and animal purposes, and give the necessary recommendations.

II. METHODS

Description of the study area

The Gharraf River is the main branch of the Tigris River, and as such, it derives its characteristics from it. It is distinguished from other branches of the Tigris River by its length and by the population density of the districts and districts through which it passes. It flows from the right side of the Tigris River at the Kut dam to the Euphrates River, passes through Wasit and Thi-Qar governorates, and ends in the AL-Hammar marshes north of the city of Nasiriyah, with a length of about 230 km and branched-off channels for irrigation of agricultural lands scattered on both sides of the river. The study area is characterized by semi-arid climatic Properties such as high temperatures During the summer, low humidity, few annual precipitations of almost150 mm, a high rate of solar radiation,and a high evaporation rate [22]. It was planned to complete this study, as water samples were collected from three elected stations on the AL-Gharraf River at a distance of 15 km.

Samples were collected monthly and expressed quarterly, starting from the winter of 2023 until the spring of 2024. Figure (1). Using clean 1 liter polyethylene bottles, with three repeaters per station and at a depth of about 30 cm below the surface of the water to collect water samples for physical and chemical tests, the necessary information was recorded on each bottle.

Physical and chemical measurements

Estimation of water samples Electrical conductivity, total dissolved salts, and pH were transferred directly from the study stations to the laboratory using a Hanna-type device and expressed by measuring Electrical conductivity EC. by µs/cm unit and total dissolved salts TDS by mg/l unit.

According to [23], we estimated the chloride Cl concentrations of the water samples at mg/L. Sulfate SO4 was measured in mg/L according to the method described in [23] using a spectrophotometer at a wavelength of 420 nm. The total hardness, magnesium Mg values, and calcium Ca values were estimated according to the calculation method described by [24].The output is expressed in units of mg/L. Sodium Na was measured in mg/L units according to the method described in [23].

The Sodium Adsorption Ratio SAR was calculated from the concentrations of Na, Ca, and Mg according to the equation given in [21].

$$SAR = Na^{+} / \sqrt{[\,(Ca^{+2}+Mg^{+2}) / 2\,]}$$

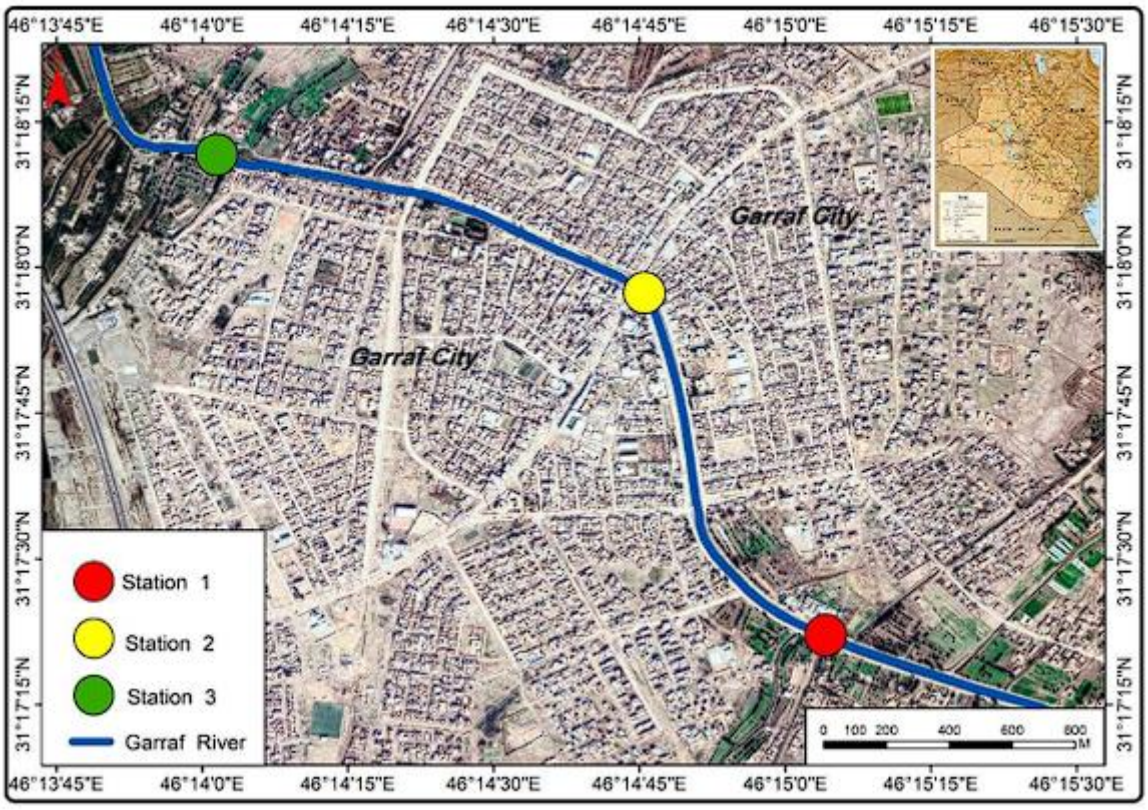

Figure 1. Shows the three study stations on the Gharraf River within in Thi Qar Governorate, Iraq. red circle: station 1; yellow circle: station 2; green circle: station 3.

III. RESULT AND DISCUSSION

Physical and chemical measurements of the selected stations on the Al-Gharraf River showed some different changes from each other in values during the study seasons. Table 1. All factors also recorded values higher than the permissible limits in the irrigation water classification standard, except pH and SAR, which were within the acceptable limits of Table 2. An assessment was made to indicate the suitability of the waters of the AL-Gharraf River for various agricultural purposes as follows :

pH The results of the current study showed high concentrations of alkalinity in water of the AL-Gharraf River under study , which is a characteristic feature of Iraqi water [19]. The reason may be due to the quantities of fertilizers and pesticides that reach the river water along with the water of the agricultural lands, in addition to the nature of the surrounding lands, as the study recorded the highest pH values during the spring season, followed by the winter season, where the numbers of vagrants and aquatic plants flourish and increase [25]. Which consumes carbon dioxide in the form of carbonates and bicarbonates through the process of photosynthesis , where bicarbonate ions HCO3 are converted to carbonates CO3 and CO2, and in the presence of algae, the carbonate decomposes into OH ion and CO2, which cause to an increase in pH value and thus an increase in alkalinity, but the decrease in pH values during the hot seasons may be due to two important things, the first the other is the decomposition of organic substances by decomposing organisms, which leads to the release of CO2 into the water and the formation of H2CO3 acid, causing a decrease in the pH value of [13]. This is consistent with what was mentioned by [15] and his statement [25]

Table 1: presents the study's results and rates during the winter and spring seasons, measured in the specified units

Parameters / Stations	pH	EC.	TDS	Cl	So4	TH	Ca	Mg	Na	SAR
	-	µs /cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	-
	Winter season									
Sta1	7.83	1204	921	198	260	530	39	23	55	7.7
Sta2	7.67	1291	917	210	252	510	52	28	49	8.53
Sta3	7.65	1322	905	225	290	541	36	18	57	6.71
	Spring season									
Sta1	7.71	1201	895	192	291	524	40	19	62	10.66
Sta2	8.12	1211	914	203	299	512	51	22	66	10.43
Sta3	7.62	1182	878	210	298	532	44	24	61	10.73
	Important values in this study									
Max	8.12	1322	921	225	299	541	52	28	66	10.73
Mini	7.62	1182	878	192	252	510	36	18	49	6.71
Total	7.76	1235	904.5	206	281.5	524.5	43.5	22.5	58.3	9.13

Table 2:Compares the results of this study with the classification of irrigation water according to [26].

This study (total values	Units	Range in irrigation water	Present study
pH	-	6.0 -8.5	7.76
EC	ds /m	0 -3	1.235
TDS	mg/l	0 -2000	905
Cl	mg/l	0 -30	206
So4	mg/l	0 -20	282
TH	mg/l	-	525
Ca	mg/l	0 -20	44
Mg	mg/l	0 -5	22
Na	mg/l	0 -40	58
SAR	-	0 -15	9.13

Electrical Conductivity EC. is a measure of the number of positive and negative ions in water, reflecting the TDS of sulfates and chlorides, as well as changes in calcium and magnesium ions. There is a correlation between EC and total solids dissolving values, with higher values observed in winter seasons compared to spring. This may be due to increased water levels during agricultural seasons, increased use of fertilizers and pesticides, and precipitation. High rates of dissolved solids values in river water also increased during winter months, impacting mitigation factors. This study supports [15] findings.

Total Dissolved Salts TDS values have taken the same pattern as the values of electrical conductivity, being a reflection of the water content of positive and negative salts, as their values increased during the cold months due to a high water level due to seasonal agricultural activity and increased water releases of the agricultural season, which caused an increase in the concentrations of sulfates, chlorides, calcium, and magnesium ions resulting from the use of fertilizers and pesticides, as well as precipitation and soil drift, and this is consistent with [27]

Table 3: compares electrical conductivity values and total dissolved salts with irrigation water classification according to the American salinity laboratory [21].

Classification of water (Salinity Hazard)	EC. µs/cm	EC. µs /cm In this study	TDS mg/L	TDS mg/L in Present study
C1 Low salinity	0 -250		0 -160	
C2 Medium salinity	250 -750		160 - 480	
C3 Very salty	750 - 2250	1235	480 - 1440	905
C4 Very severe salty	2250 - 5000		1440 - 3200	

Chlorides Cl are more abundant in water due to their easy solubility and difficulty in adsorption on natural minerals [28]. In Iraqi waters, chloride concentrations are higher than in other aquatic environments.The study found a significant increase in chloride concentrations in winter due to agricultural season and increased water levels in riverbeds, saturated with high concentrations of fertilizers and pesticides. The decrease in chloride concentrations in spring may be due to low water levels, slow runoff, high temperatures, and increased nutrient consumption. However, this study disagrees with previous research by [29] and [30].
Sulfate SO_4 , a common form of sulfur compounds in water, is derived from the decomposition of gypsum minerals and aluminum sulfate fertilizers [31]. It is also a source of sulfates from the atmosphere through acid rain containing industrial pollutants , including sulfur [19]. High concentrations of sulfate can cause diarrhea, dehydration, and intestinal irritation. The current study found high concentrations of sulfates exceeding national and international limits, particularly during the spring season. High levels of sulfur compounds in river water may be from trocar water, organic compounds, and untreated sewage discharged to the river. The decrease in sulfate values may be due to the dilution factor of rain, which reduces the concentration of sulfate in the water. This agrees with [15] and does not agree with what he explained [13].

Calcium Ca is a crucial ion in water, essential for plant growth and agricultural soils. It plays a crucial role in chlorophyll synthesis and soil permeability [25]. A study found that calcium values were superior to magnesium at all stations during different seasons. In the spring, calcium values decreased due to high temperatures and low water levels, resulting in insoluble compounds in water [31].In winter, calcium values were highest due to temperature changes or the remains of fertilizers washing the soil during the agricultural season. This suggests that calcium is a vital ion in maintaining soil health.This is agreed upon [5].

Magnesium Mg is a crucial nutrient for aquatic plants, as it plays a significant role in chlorophyll synthesis. However, it is found in aquatic environments in smaller quantities than calcium due to its soluble form. The study found that magnesium levels are highest in spring due to point subtractions and chemicals, or due to the decomposition of algae and other organisms. The lowest magnesium levels are observed in winter due to insoluble compounds in water or consumption by aquatic plants, particularly submersible algae, which enters the partial synthesis of chlorophyll in algal cells [25].The study agreed with the mention [13], while it did not agree with [32].

Sodium Na ions are highly soluble salts, including sodium bicarbonate, sodium carbonate salt, and sodium sulfate salt, which are affected by temperature due to their presence in cold atmospheres [33].These ions are abundant in lakes and rivers, often ranking as the most abundant ions in the binary rank [34].Sodium ions are crucial in agriculture, as they affect water and salt exchange in agricultural soils.
The study recorded the highest values during spring and the lowest values during winter, which aligns with [29].study, but differs from [5].findings. Sodium ions are also essential for causing water salinity and play a significant role in agriculture by affecting water and salt exchange. Overall, sodium ions play a crucial role in maintaining water quality and promoting agricultural growth.

Total Hardness TH is the concentration of positive ions in water, primarily composed of calcium and magnesium ions. When hardness values exceed 180 mg/L, it is considered very hard according to the American Manual Table 4. The study found high hardness values, indicating the presence of ions other than calcium and magnesium, such as sulfates and chlorides, contributing to non-carbon hardness. The river water returned very hard, consistent with previous studies indicating a rise in total hardness values in Iraqi water. The lowest hardness values were recorded during spring due to high pH, which may lead to the insolubility of calcium carbonate in the water. The highest

hardness values were recorded during winter due to the concentration of pollutants from point sources released into the river. This is consistent with what he mentioned [13].and did not agree with the study [5] and [29].

Table 4: Compares hardness values with irrigation water classifications as per [35].

Classification of water	Hardness values in water mg/L	Present study
Soft	0 – 17	
Slightly Hardness	17.1 – 60	
Moderately Hardness	61 -120	
Hardness	121 – 180	
Very Hardness	> 180	524.5

Sodium Adsorption Rate SAR is the ratio of the amount of Na in the water to Ca and Mg ions. The accumulation of Na in the soil causes the compression of clay particles and humic substances that clog the pores of the upper soil, which restricts the movement of water to and from the soil [36]. Depending on the SAR value, water is classified for agricultural purposes [37]. The results of the current study showed that the highest value of the sodium adsorption ratio was in spring season Table 1, which indicates that the validity of the water in the Al-Gharraf river under study has an average effect on watering crops based on the classification of American salinity laboratory [21] Table 6 .These waters are generally unsatisfactory in their use unless the salinity is low or medium, taking into account the care of drainage and washing. While they are less valuable during the winter season, Based on this value, the water in the riverbed is not suitable for long-term use for irrigation purposes. The results of the study agreed with [29] and did not agree with the study [5].

The suitability of water of the Al-Gharraf River for agricultural uses :

- **The suitability of river water for irrigation purposes.**

The standards that are adopted to assess the quality of water for various agricultural purposes should be determined for variables that have the potential to cause harmful changes. For example, the effect of irrigation water on soil properties or on crop growth. Or their impact on livestock and poultry. In this study, the assessment of irrigation water in the Al-Gharraf River was based on salinity and sodium hazards.

Salinity Hazard is mainly due to the osmotic pressure and its effect on crop growth; salinity is more related to the components of these salts. This study was based on the classification [21], for irrigation water, which is one of the most widespread classifications in the world and consists of four classification grades based on electrical conductivity and concentration of total dissolved salts. Table 3 . Explained by [38] that the irrigation water for the study stations is based on the electrical conductivity that it is within the second class and has a good salinity class Table 5

Table 5: Compares electrical conductivity (EC. µs/cm) with the classification of irrigation water according to [38].

Classification of water (salinity Hazard)	Electrical conductivity EC. µs /cm	Present study
None (Excellent)	≤ 750	
Some (Good)	760 - 1500	1235
Moderate (Acceptable)	1510 - 3000	
Severe (Unacceptable)	≥ 3000	

Table 6: Compares electrical conductivity values and sodium adsorption ratio with irrigation water classification according to [21].

Classification of water (Sodium Hazard)	Electrical Conductivity (EC. µs /cm)				Present study
	100 - 250	250 - 750	750 - 2250	> 2250	1235
	Sodium Adsorption Ratio SAR				
S1 Low	0 - 10	0 - 8	0 - 6	0 - 4	
S2 Moderate	10 - 18	8 - 15	6 - 12	4 - 9	9.13
S3 Severe	18 - 26	15 - 22	12 - 18	9 - 14	
S4 Very severe	> 26	> 22	> 18	> 14	

Using the American salinity laboratory scheme, which is widely used globally in determining the quality of irrigation water by dividing four degrees of salinity (EC) and four degrees of sodium SAR , giving sixteen common degrees of salinity and sodium, according to Salinity Hazard, the study found that the water rate of the Al-Gharraf River at the stations was within the limits of the Third Class (C3), that is, the river water is very salty. As for the sodium hazard in irrigation water based on SAR, the study recorded an average of SAR values within the limits of Second Class (S2); that is, the water has a moderating effect of sodium. Therefore, the water of the river during the study stations, based on the American salinity laboratory scheme for classifying irrigation water and applying it to the water quality of the Al-Gharraf river during the study period, is within the category (C3-S2), meaning the third degree in terms of salinity (very salty) and the second degree in terms of sodium (medium), and for the entire study period, see Figure 2.

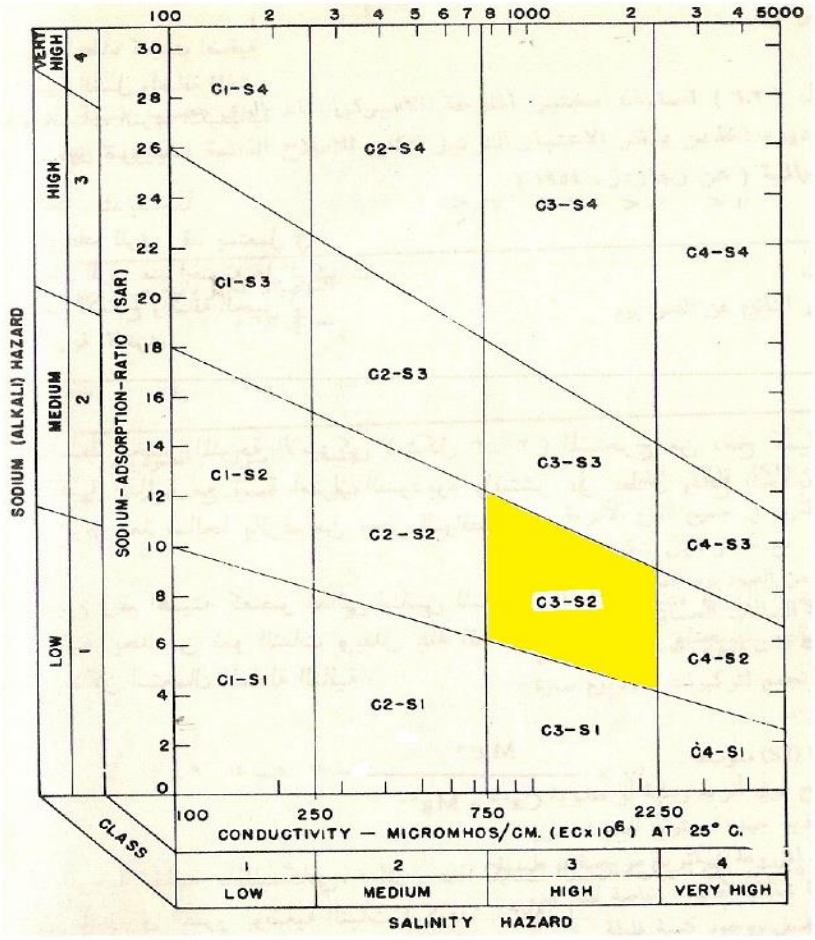

Figure 2 : Us salinity laboratory scheme for classification of irrigation water

- **The suitability of river water for drinking animals**

The results of this study, after comparing it with the [26] , showed in Table (2) that precautions were taken from the use of water by livestock and poultry due to exceeding some of the parameters indicated in the classification, while Table (7) classifies drinking water based on electrical conductivity values, which was good within the premium class with a low level of salts and acceptable for all types of livestock and poultry. As described by [38] potable water validity was based on the electrical conductivity values, which were good and allowed to be used as shown in Table 5.

Table 7 : Compares electrical conductivity values (EC. µs/cm) with the specification of drinking water for livestock and poultry, as per [26].

Classification of water (salinity Hazard)	EC. µs /cm	Present study
Excellent	< 1500	1235
Very acceptable	1500 – 5000	
Acceptable for animals and unacceptable for poultry	5000 – 8000	
Limited use for animals	8000 - 11000	
Very limited use	11000 – 16000	
Not recommended for use	> 16000	

IV. CONCLUSION

The study found that all coefficients in Al-Gharraf River water exceeded the permissible limits in the irrigation water classification standard, except for pH and SAR, which were within acceptable limits. The water was found to be very salty, with medium sodium levels, and should not be used for extended periods. The study also highlighted the importance of avoiding livestock and poultry water use. Due to exceeding the permissible limits within world standards,. To ensure the quality of agricultural water, regular river water checks are necessary. Modern irrigation methods are recommended over traditional ones to minimize water waste. Awareness should be raised to prevent trocars water discharge to the river and monitor soil salinity. The purpose is to monitor the salinity of the soil influenced by the river's water.

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