

Evaluating waters of Al-Jabbab River east of Wasit government for drinking and agricultural purposes

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ABSTRACT:

This research is concerned with identifying the natural characteristics of the region and the climate factor and its impact on water resources and their seasonal and annual fluctuations. It is also interested in revealing the qualitative water characteristics of AL Jabbab River and its suitability for various usages, including drinking and agriculture. Therefore, water samples were collected from the studied area in January 2023, and laboratory tests were conducted to determine their suitability for the aforementioned purposes. On the other hand, it is suitable for irrigation and for irrigating animals. This was clearly reflected in the different human uses of the land and the completed and unfinished projects.

Keywords: Al-Jabbab, East Wasit, water quality assessment

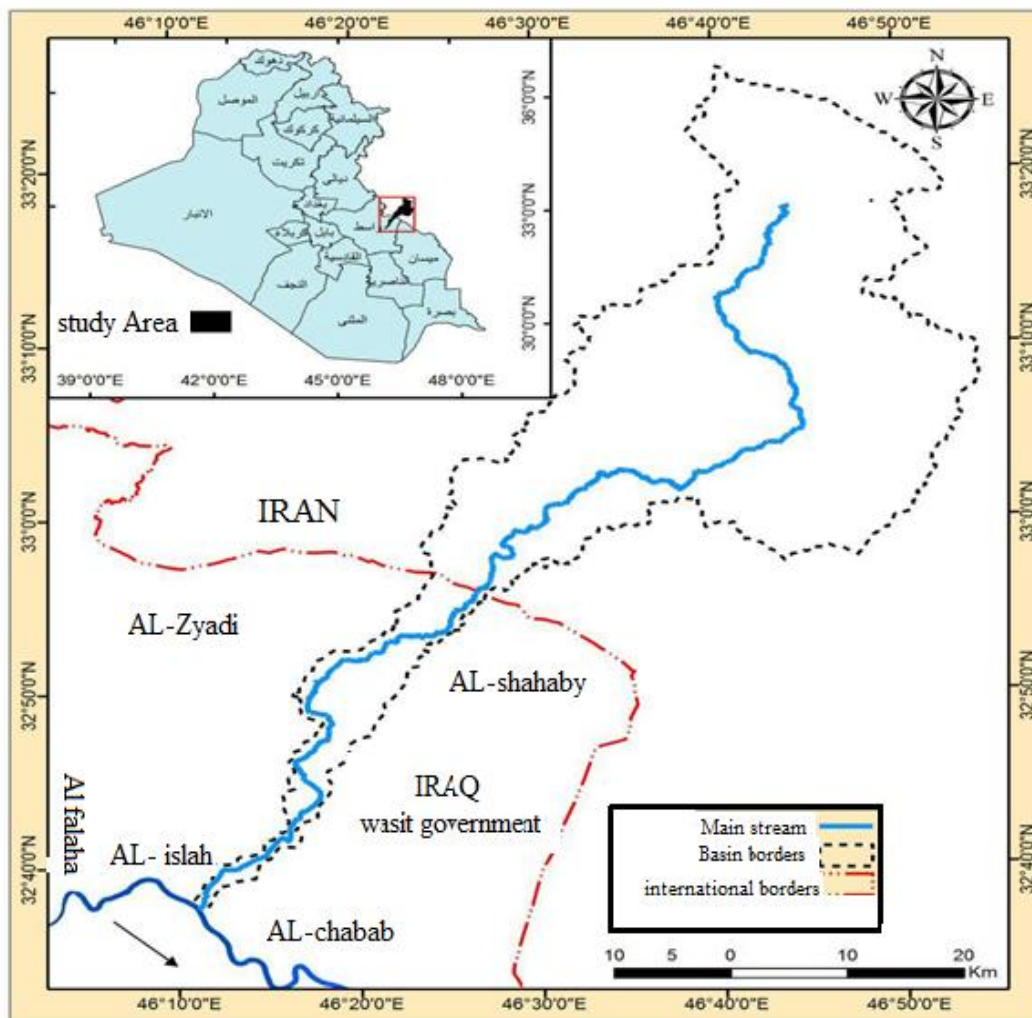
1. Introduction

Climate change and global warming are the most important threats to freshwater ecosystems on the planet in the 21st century. Recent seasons have shown climate change and global warming in the form of extreme temperatures and weather patterns, as climatic conditions cause droughts and floods that can have significant impacts on agriculture, natural resources, the general ecosystem, and livelihoods. To overcome water-related problems, extensive care should be directed to the operation of and river basin management, but in many cases, poor land use planning and land management practices during rapid development adversely affected the runoff volumes of some basins.

2. Study area

The study area, Al-Jabbab River, is located in the eastern part of Iraq within Wasit Governorate and extends into Iranian territory, the upstream region. Its area is (1454.93) km². It is astronomically confined between two latitudes (33° 62' 10" - 32° 37' 4") north, and two longitudes. (50" - 32° 37' 4" 46° 53') to the east, the part located within Iraqi territory includes the administrative borders of Wasit Governorate, specifically in the Sheikh Saad district. From the villages on both sides of the river, as it supplies the areas and villages through which it passes with water and participates in supplying the Tigris River with water in the rainy season, Map (1).

Map (1) The location and borders of the study area



Source: Ministry of Water Resources, General Commission for Survey, Iraq map, administrative scale 1:1,000,000, 2014, using ArcGIS 10.8

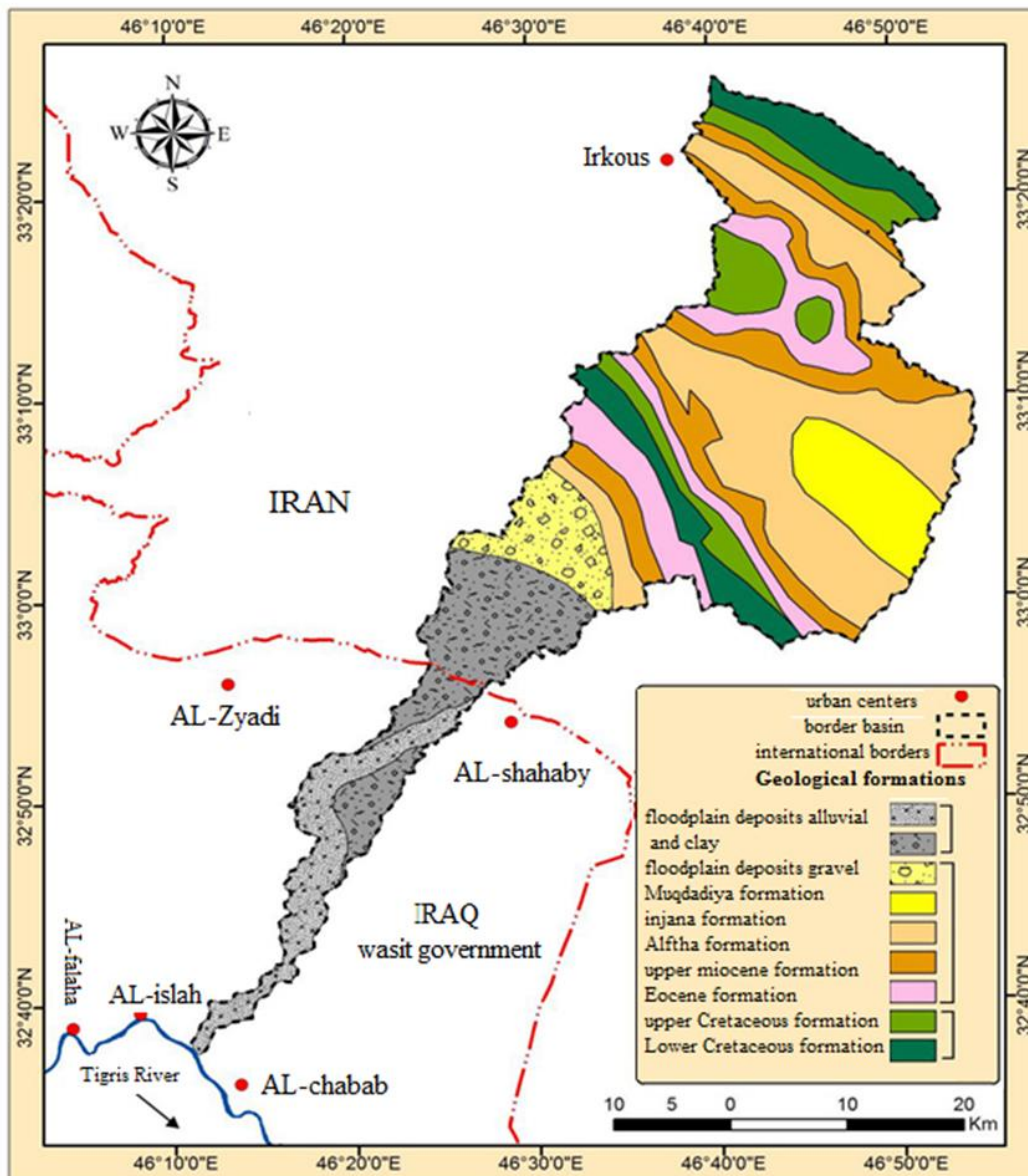
3. Natural characteristics

The geological composition has a significant impact on the volume of surface water, as the rainwater that falls on the ground flows in the form of tributaries and rivers towards the slope of the land

(Mohammed Youssef Hassan et al., 1983), and this depends on the type of rocks, the degree of their porosity and permeability, and the joints and cracks in the study area. The study area is located within the unstable pavement of the Arab-Nubian shield and includes one of the tectonic belts, the Zagros belt, which heads to the northwest and represents the most deformed part of the region.

The eastern ones, while the flat zone occupied its western parts (Bolton, C.M.G., 1958). As there are a number of known and unknown faults in the studied area, cutting the course of the river and extending in a northwest-southeast direction, as well as cutting the course of Wadi Kalal Badra, a fault near the Iraqi-Iranian border, and another fault near the downstream area and extending in a northwest-southeast direction (Abdulnaby, 2018), Map (2).

Map (2) Geology of the study area



Source: Using ArcGIS 10.8 and based on the sources below:

From the rock point of view, geological formations are revealed in the study area, the oldest of which dates back to the Mesozoic Era, which appears in the upper parts of the river basin in Iran, represented by the lower and middle Cretaceous formations until the end of the Middle Era, while the Cenozoic Era begins with the formation of the Eocene, which marks the beginning of the Tertiary Period, and ends with the formation of Pi at the end of the Tertiary Period.

The deposits of the Quaternary period were represented by the Pleistocene and Holocene deposits at the end of the Cenozoic Era (Dia Kharbat Shather et al., 2008).

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4. The climate

The climate of the study area is continental in the sense that it is characterized by a high annual temperature range, low marine influences, and high frequencies of continental air masses. Because it is located in the arid and semi-arid climate ranges, wet marine influences are minimal.

The climatic data of three weather monitoring stations (Khanaqin, Badra, and Ali al-Gharbi) were relied upon because they are located within the study area's nutrients, reflect the nature of its climate, and cover a unified period of time (1994–2022).

In general, the annual averages are higher than (18) C, and in all study stations the annual average temperature is higher than that, so the general average for the study area is (24.8) C, and it exceeds that in Ali Al-Gharbi station to reach (25.7) C, to (24.9) C. m in Badra, and to (23.8) C. m in Khanaqin. The difference in temperature rates made it characterized by a long hot season and a cold season, which contributed to raising the annual temperature range to (26.8) m in Badra, (26.6) m in Khanaqin, and (26.5) m in Ali al-Gharbi, and this significant increase in the annual temperature range It is the most important climatic indicator to know the nature of the continental or marine influences, and on this basis, this disparity has made the region have a dry continental climate.

In terms of rainfall, the region is characterized by seasonal rainfall; that is, its precipitation is limited to the actual rainy season that extends between the months of October and ends in the month of May, and it begins with small quantities and ends as well. The

concentration of rain varies between the months of the rainy season according to the different study stations, so the month of November is the rainiest in all stations, as measured by the amounts reached in the three stations. They are Khanaqin, Badra, and Ali Al-Gharbi (54, 42.7, and 37.9) mm, respectively, and the rains are of high amounts during the months of December, January, and February, then gradually decrease to reach their lowest amounts during the month of May, which amounted to rain amounts of In the three stations, the values were (6, 11.1, 10.2) mm.

5. Evaluation of the validity of Al-Jabbab River water

Water quality is the determining factor in investing in water and using it for drinking purposes, watering animals, and in the fields of agriculture and industry. Therefore, water samples were collected from the Jabbab River in January 2023 (photo 1), and laboratory tests were conducted on them to determine their suitability for the aforementioned purposes and to compare them with specifications for Iraqi and international standard waters, with the aim of deciding on the appropriateness of using them for various aspects of use, as follows:

The validity of the valley water for drinking

The evaluation of water quality for the purpose of drinking depends on indicators, the most important of which are total dissolved salts and positive and negative ions. The qualitative characteristics of river water have been compared (table 1) with the standards of the World Health Organization (WHO) for 2011 and the Iraqi Standard Standards (IQS) for 1996 to infer their suitability for drinking purposes. Table (2)

Table 1: Qualitative characteristics of the waters of the Al-Jabab River

N	Elements	Al- Jabab River
1	PH	7.78
2	EC	6.01
3	NTU	3.52
4	TDS	3648
5	Na ⁺¹	280.5
6	K ⁺¹	14.6
7	Mg ⁺²	152
8	Ca ⁺²	362
9	SAR	17.49
10	Cl ⁻¹	414.2
11	No3 ⁻¹	26.6
12	SO4 ⁻²	712

Source: Adopting the results of water analyzes in the Central Laboratory for Soil, Water Plant Analysis, College of Agricultural Engineering Sciences, University of Baghdad.

Table (2) Iraqi and international specifications for potable water

N	Elements	Iraqi Standard (WHO) mg/L	World Standards (WHO) mg/L
1	PH	6.5-8.5	6.5-8.5
2	EC	-	18
3	NTU	5	5
4	TDS	1000	1000
5	Na ⁺¹	200	200
6	K ⁺¹	-	10
7	Mg ⁺²	150	150
8	Ca ⁺²	200	200
9	Cl ⁻¹	250	250
10	No3 ⁻¹	50	50
11	SO4 ⁻²	400	500

1-WHO, International standard for drink water, world health organization, 4 Edition Switzerland, 1999, P.36.

2- The Central Agency for Standardization and Quality Control, Iraqi specifications for drinking water, No. (417), first update 2001

Photo (1) Collecting water samples from the Jabbab River



Source: Field study dated 1/17/2023

From the comparison of the physical and chemical properties of the water, it was noted from Table (1), that the values of the hydrogen ion (PH) are 7.78 mg/ liter in the water of the Al-Jabbab River, and therefore its concentrations fall within the Iraqi and international standard limits allowed for drinking purposes. As for the values of electrical conductivity E.C. (), it was 6.01 $\mu\text{M}/\text{cm}$ in the river water. As for the turbidity of the NTU, its value was 3.52, and this indicates

that the river water is within the limits of water suitable for use for drinking purposes. Table (2) shows that the total dissolved salts T.D.S values were (3648) mg / liter, reflecting the salinity of the water, which exceeded the natural drinking standards.

As for the common ions in the water of the study area, whose effects are reflected on the suitability of the water for various uses, including drinking, they are:

Positive ions) Cations): Calcium element Ca^{+2} Gypsum rocks are sources of water enrichment with this element, and the results of the chemical analysis of the water of the Jabbab River show that the values of calcium are 362 mg/liter, and in general, they exceed the normal limit in the specifications of drinking water of 200 mg/liter.

As for the concentration of magnesium ion $\text{Mg} + 2$, it reached 152 mg/liter, and by comparing the concentration of dissolved magnesium in the river water with a concentration in potable water of 150 mg/liter, it is clear that the water of the Jabab River has exceeded the maximum permissible limit for drinking. As for the sodium ion, Na^{+1} , the concentration of this ion in the river water was (280.5) mg/l. As for the potassium ion (K^{+1}), table (1) shows that the salt concentration of potassium in the river water is between (14.6) mg/liter, and compared with the upper limit allowed for drinking purposes (10 mg/liter, we notice that it exceeds the limit. The highest allowed for drinking purposes.

Negative ions Anions: sulfates (SO_4), resulting from the dissolution of gypsum soil components in rain and irrigation water, and sediments of the Quaternary. The concentration of sulfates in the studied water samples amounted to 712 mg/liter, which values exceed the permissible limits for drinking purposes of 500 mg/liter. With regard to the chloride element Cl^{-1} , it recorded values of 414.2 mg/liter, which are values that exceed the international and Iraqi permissible limits for drinking purposes. As for nitrate NO_3^{-1} , it is a complex pollutant whose concentration increases as a result of the excessive use of organic and inorganic chemical fertilizers, and it is a dangerous pollutant for humans.

These ions dissolve quickly in rainwater, floodwater, and irrigation water. The results of the chemical analysis of the concentration of nitrates in river water show that their values are 26.6 mg/L, and when compared to the permissible limits for drinking purposes (50 mg/L), it turns out that they are below the aforementioned limit

Table 2.

It is clear from the foregoing that the water of the Al-Jabbab River is not suitable for human drinking due to the high values of most of its dissolved ions above the upper limit allowed for the aforementioned purpose.

The suitability of water for animal consumption

Most animals have the ability to drink water of poor quality, in which the concentration of total salts reaches 1000 mg/liter. For the purpose of evaluating the water of the studied area, its characteristics in Table 1 were compared with the standard specifications for water for the purpose of animal consumption according to the classification of Altoviski, 1962 (Table3).

When comparing the T.D.S. element values with the water specifications for animal consumption (Table 3), we note that the river water is suitable for animal consumption and falls within the category of "good" water. As for the sodium element Na+1, it falls into the category of very good and good water. As for the element calcium, Ca+2, it falls within the category of good water. Magnesium, Mg+2, falls into the category of very good and good water. As for the elemental chloride, Cl-1, it falls into the category of very good and good water. As for the sulfate ion (SO4-2), it falls within the category of very good and good water. It is clear from this that the river water is suitable for irrigating animals due to the lower total salinity concentrations in it than the highest concentrations.

Table 3: Water specifications for the purpose of animal consumption according to the classification (Altoviski, 1962)

Maximum usage	Can be used	Usable	good water	Very good	Elements	N
15000	10000	7000	5000	3000	TDS	1
4000	2500	2000	1500	800	Na+1	2
1000	900	800	700	350	Ca+2	3
700	600	500	350	150	Mg+2	4
6000	4000	3000	2000	900	Cl-1	5
6000	4000	3000	2500	1000	SO4-2	6

Source: Altoviski. M. E. , Handbook of hydrogeology, Gosgeo litzdat, Moscow, USSR, in Russian,1962.

Water suitability for agricultural purposes

A number of criteria were adopted in the classification of water for the purpose of agricultural irrigation, namely:

Sodium Adsorption Ratio (SAR)

The sodium adsorption ratio (SAR) is important in determining the suitability of water for irrigation and its effect on the decrease in soil permeability, as an increase in the ratio of sodium ions in irrigation water over that of calcium and magnesium ions leads to the dissolution of soil particles, a decrease in its permeability, and an increase in salinity. The sodium adsorption ratio can be extracted from the following equation:

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}} \dots\dots\dots mep$$

If the value is less than 10, then the water is classified as excellent for irrigation purposes, and if it is from (10–18), then it is of good quality, and if it is from (18–26), then it is of the doubtful type, but if the water is greater than 26, it is of an inappropriate type. Through this, we notice that the values of the sodium adsorption ratio (SAR) in the water of the study area are listed in Table 1., and according to the above criteria, the water of the valleys falls within the category of "good" water when used for irrigation purposes.

Richard's 1954 classification of water suitable for irrigation

Richard developed a guide in which he determined the suitable water for irrigation based on two variables: the electrical conductivity value (EC) and the sodium adsorption ratio (SAR), as shown in Table (4):

(Richard’s 1954) Table (4) Iraqi and international specifications

SAR	index	Ec us/cm	index
0-10	S ₁	100-250	C ₁
10-18	S ₂	250-750	C ₂
18-26	S ₃	750-2250	C ₃
26 MORE	S ₄	2250 MORE	C ₄

: Richards, L.A. 1954 Diagnosis and improvement of saline and alkali soils

Table (5)

Types of water according to the classification (Richard's 1954)

water rating	index	water rating	index
allowed	C ₃ S ₁	excellent	C ₁ S ₁
It can be used	C ₃ S ₂	good	C ₁ S ₂
It can be used	C ₃ S ₃	allowed	C ₁ S ₃
poor	C ₃ S ₄	poor	C ₁ S ₄
poor	C ₄ S ₁	good	C ₂ S ₁
poor	C ₄ S ₂	good	C ₂ S ₂
so poor	C ₄ S ₃	allowed	C ₂ S ₃
so poor	C ₄ S ₄	poor	C ₂ S ₄

Richard. L.A. Diagnosis and Improvement of saline and Al kali soils, Agric. Hand book 60, US Dept of Agric, Washington, 1954.

According to the criteria found in Tables 4 and 5 of Richard’s classification, we conclude that the water of the Al-Jabbab River falls within the (good) water class (C1S2).

Conclusions: A number of conclusions were reached, the most important of which are:

The results of evaluating the qualitative characteristics of the water in the valleys indicated that they are all unsuitable for human drinking due to the high rates of salt concentrations in them according to Iraqi and international standards. On the other hand, they are suitable for irrigation and for irrigating animals.

The research also recommends paying attention to the application of modern irrigation methods that are more economical in water, such as sprinkler irrigation and drip irrigation, by introducing modern irrigation technologies that play a major role in rationalizing and raising the efficiency of water use to reduce the volume of water losses by evaporation and percolation into the soil to revive the largest possible amount of agricultural land in the region.

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تقييم مياه نهر الجباب شرق محافظة واسط لأغراض الشرب والزراعة

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(ملخص البحث)

اهتم هذا البحث في التعرف على الخصائص الطبيعية للمنطقة وعامل المناخ وتأثيره على الموارد المائية وتذبذبها فصلياً وسنوياً. كما اهتم في الكشف عن خصائص المياه النوعية لنهر الجباب ومدى ملاءمتها للاستعمالات المختلفة منها: الشرب والزراعة؛ لذلك جمعت عينات مائية من المنطقة المدروسة في شهر كانون الثاني ٢٠٢٣، وأجريت الفحوصات المختبرية عليها، لتحديد صلاحيتها للأغراض المذكورة، أظهر البحث أن نتائج تقييم الخصائص النوعية لمياه نهر الجباب وفقاً للمعايير العراقية والدولية، بأنها غير صالحة لشرب الإنسان؛ لارتفاع نسب معدلات تراكيز الأملاح فيها، وبالمقابل فهي صالحة للري ولإرواء الحيوانات. مما انعكس بشكل واضح في الاستعمالات البشرية المختلفة للأرض والمشاريع المنجزة وغير المنجزة فيها.

الكلمات المفتاحية: الجباب، شرق واسط، تقييم نوعية المياه.