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Study of Physical, Chemical and Microbiological Properties of Irrigation Water in the Northern Region of the Governorate of Laghouat, Algeria

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ABSTRACT

This study evaluated the physico-chemical and microbiological quality of irrigation water from seven wells in northern Laghouat province: Aflou, Gueltat Sidi Saad, Ain Sidi Ali, Hadj Mechri, Oued Morra, El Ghicha, and Brida. Results showed that most wells are suitable for agricultural use, with moderately alkaline pH and low turbidity. However, high salinity and electrical conductivity were recorded in Aflou and El Ghicha, which could affect sensitive crops. Major ions (Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, NO_3^{-}) varied but generally remained within acceptable limits. Microbiological analyses indicated sporadic coliform presence, while Clostridium sulfito-reducers were detected only in Oued Morra, signaling potential fecal contamination. Overall, irrigation water quality is acceptable, though attention is needed for areas with high salinity or microbial contamination. The study highlights the importance of regular monitoring, proper water management, and farmer awareness to ensure sustainable and safe irrigation practices in arid regions.

Keywords: Irrigation water, Salinity, Microbial contamination, Physico-chemical analysis, Laghouat

First: Introduction

The importance of irrigation water in arid and semi-arid regions

Irrigation water is central in arid and semi-arid regions due to harsh climatic conditions characterized by scarce rainfall and high rates of evaporation, making it impossible to rely on rainfall for agricultural

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production[1]. In such environments, groundwater and surface water resources for irrigation become the basis on which various agricultural practices are built, as it is the element that guarantees the continuity of agricultural activity and guarantees minimum food security for the population. Irrigation water also helps to stabilize the rural population and support the local economy. It allows the cultivation of crops that require a regular supply of water that cannot be replaced by rain. The importance of this resource is even more pronounced with regard to water quality, as any increase in salinity, a change in chemical composition or microbial contamination can lead to a deterioration in soil fertility, a reduction in crop productivity and increased risks of salinization threatening the sustainability of agricultural land. Monitoring the quality of irrigation water and assessing its characteristics is therefore an essential step in ensuring the development of efficient and climate-resilient agriculture in these ecologically sensitive areas.

Location of the Aflo Zone

Risks associated with high salinity and water pollution on agricultural production

High salinity in irrigation water is one of the most significant challenges that agriculture faces in arid and semi-arid environments, as the accumulation of salts in the soil disrupts the natural uptake of water and nutrients by plants, leading to stunted growth, a noticeable decrease in crop productivity, and even the death of plants in advanced stages of salinization[2]. High levels of sodium also affect soil structure through granular degradation and loss of structural cohesion, which reduces permeability Soil increases the risk of erosion and loss of fertility. In addition to the problem of salinity, water pollution – whether chemical or microbial – poses an additional threat to agricultural systems, as the presence of nitrates, heavy metals or faecal spores deteriorates soil quality, deteriorates the safety of agricultural products

[1] Anyango, G. W. (2024). *A critical review of irrigation water quality index and assessment methods.* **Science of the Total Environment**.

[2] Ding, B., Bai, Y., Guo, S., He, Z., Wang, B., Liu, H., Zhai, J., & Cao, H. (2023). Effect of Irrigation Water Salinity on Soil Characteristics and Microbial Communities in Cotton Fields in Southern Xinjiang, China. **Agronomy**, 13(7), 1679.

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and the risk of transmitting harmful pollutants to the consumer[1]. Pollution also reflects on plant health due to fungal and bacterial diseases associated with a high microbial load in irrigation water, which increases production costs and reduces land productivity. Controlling salinity levels and monitoring pollution indicators is a crucial step in ensuring sustainable and safe agricultural production, especially in areas that rely heavily on groundwater as a primary resource for irrigation.

The danger of microbial contamination for humans, soils and crops

Microbial contamination in irrigation water poses a multidimensional risk that extends to humans, soils and plants alike. When irrigation water contains pathogens such as coli faeces, clostridium and streptococcus, the likelihood of their transmission to agricultural products remains high, especially in crops eaten fresh, which can lead to intestinal infections and diseases caused by bacteria that are resistant or harmful to public health. At soil level, a high microbial load contributes to changing the biological balance of soils. Pathogens outperform the beneficial microorganisms responsible for breaking down organic matter and stabilizing nutrients, leading to deterioration in biofertility and reduced soil ability to support proper plant growth. At the crop level, the use of water contaminated with microbes increases the likelihood of plant diseases that spread through the root or surface system, reducing plant vigour, decreasing yields, and increasing agricultural losses due to the need for additional controls[2]. This type of pollution is more dangerous in arid regions, where the soil's ability to regenerate is limited due to low bioactivity and low humidity, making monitoring the quality of water for irrigation imperative to ensure consumer safety and protect the agricultural environment.

Presentation of the research problem

The need to assess the quality of irrigation water in the northern province of Laghouat The northern regions of Laghouat province are experiencing increasing agricultural expansion that is almost entirely dependent on groundwater, requiring monitoring of this vital resource and assessing its suitability for agricultural use. However, available data on the characteristics of irrigation water in this region remain limited and scattered, especially in light of climate change and increasing pressures on water resources. With the high salinity indices in several wells and the frequency of local reports of possible contamination of certain points by bacteria associated with human activities, there is an urgent need to carry out a systematic study that accurately determines the true state of the quality of irrigation water[3]. This problem is compounded by farmers' direct dependence on this untreated water, making any exceedance of physical, chemical or microbial standards a threat to agricultural production, soil sustainability and consumer safety[4]. Thus, the essence of the research problem lies in the lack of a comprehensive scientific assessment that clarifies the level of quality of irrigation sources in the northern part of the state, reveals potential risks, and provides reliable data that helps farmers and relevant authorities make appropriate decisions to protect agricultural and environmental resources.

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[1] Jeong, H., et al. (2016). Irrigation Water Quality Standards for Indirect Wastewater Reuse. **Water** (MDPI).

[2] Boukalova, Z. (2025). Irrigation water quality in a framework of sustainable development. **Frontiers in Agronomy**.

[3] "Water Quality for Irrigation and General Water Uses: Background Information" (2024). Australian & New Zealand Guidelines (ANZG).

[4] Suvendran, S., et al. (2025). Evaluating the Effects of Irrigation Water Quality and Sodium Adsorption Ratio on Soil Properties. **Water** (MDPI).

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The general objective of the article

to determine the agricultural and healthy viability of this water. the main objective of this article is to carry out a comprehensive assessment of the quality of irrigation water used in the northern province of Laghouat, analysing its physicochemical and microbiological properties in accordance with national and international standards[1]. The purpose of this assessment is to determine the suitability of this water for agricultural use, particularly with regard to the concentration of salts, the level of ionic elements affecting soil structure and crop productivity, in addition to monitoring microbial indicators that may pose a risk to human health through its transfer to agricultural products. The main objective of this article is to conduct a comprehensive assessment of the quality of irrigation water used in the northern province of Laghouat, analyzing its physicochemical and microbiological properties in accordance with national and international standards. To provide an accurate scientific reading that helps to understand the current situation of irrigation resources in the region, identify potential imbalances and propose practical guidelines that contribute to improving the management of these resources, strengthening the sustainability of agricultural activity and ensuring consumer safety.

Second: Study Methodology (Materials and Methods)

1. Study Area

- Description du Mojaz La'maqat al-Abar al-Saba'ah : (Aflo – Gueltet CD Saad – NCD Ali – Hadaj Mechari – Oud Mora – El Ghicha – Brida)

  The wells studied are located in the northern strip of Laghouat province, an area of slight geographical and climatic diversity, with a predominance of arid and semi-arid conditions in which agriculture depends mainly on groundwater. The scope of the study includes seven main communes: Aflou, which is the highest region in the state and is characterized by a prevalence of agricultural fields dependent on well water;   Ain Sidi Ali, where the cultivation of cereals and fodder is concentrated; Hadj Mechri, located in a semi-plateau area with limited agricultural activity; Wadi Morra, adjacent to a local valley stream that may contribute to changes in water quality; El Ghicha, known for the presence of several agricultural wells with varying levels of salinity; and finally Brida. Located south of the northern mountain range, which depends on medium-depth groundwater. These sites represent a relatively diverse view of irrigation resources in the northern part of the state, making them suitable for a comprehensive assessment of groundwater quality used in agriculture.

- **Nature of the region**: dry climate, groundwater resources essential for irrigation

  The study area, located in the agricultural north of the province of Laghouat, is characterized by a dry to semi-arid climate, where very low rainfall rates are recorded, in contrast to a significant increase in temperatures and evaporation, especially during the hot periods of the year. This climate pattern contributes to the limitation of surface water resources, making groundwater dependence a fundamental and necessary option to meet irrigation needs. The region draws its water from underground reservoirs that vary in depth and the quality of their geological composition, which is reflected in the concentration of salts and the level of mineralization in these resources. Dry climatic conditions also accelerate evaporation and salt concentration in the upper layers of the soil, which can affect the quality of the extracted water and explain variations in some conductivity and salinity indices. The climatic and hydraulic characteristics of the region are therefore essential to understand the dynamics of groundwater resources and to determine their suitability for agricultural uses.

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[1] Chellali, R., et al. (2015). Evaluation of irrigation water quality of dam Dahmouni: physicochemical and bacteriological assessment. **JMES – Journal of Materials and Environmental Science**.

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2. Sample collection

- **Number of samples:** 7 samples from seven wells

During this study, seven (07) water samples, each representing an independent well in the northern strip of the governorate of Laghouat, were taken in order to cover the geographical and hydrological differences between the different irrigation areas. The sampling points included seven main municipalities:

- Aflou
- Gueltat Sidi Saad
- Ain Sidi Ali
- Hadj Mechri
- Wadi Murra (Oued Morra)
- The Ghicha
- Buraidah
- Period: February – May 2023

The sampling was carried out between February and May 2023, a period that is part of the agricultural season when the need for irrigation water increases. This period was chosen because it allows the physicochemical and microbiological properties of the water to be monitored at a stage when agricultural use is relatively intense, reflecting the true state of the water quality of the wells used in the field.

- **Method of Withdrawal and Storage**

Water samples were taken from all seven wells using clean, sterile tools to prevent secondary contamination. The water was drawn directly from the well after the pump was opened for about a minute to ensure water was renewed in the pipes and to reduce sediment. Sterile plastic bottles with a capacity of 1 litre per sample were used, and they were fully filled to minimize the presence of air voids that could influence chemical or microbiological indicators.

After removal, the containers were hermetically sealed and placed in thermally insulated boxes containing ice cubes to maintain a low temperature (~4°C), which helps prevent the growth of bacteria during transport. Samples were transported to the laboratory within 4 hours of collection and refrigerated at 4°C until physicochemical and microbiological analyses were performed, in accordance with internationally approved standards to ensure the accuracy and scientific validity of the results.

3. Physicochemical analysis

Measurement criteria:

- Temperature, pH, conductivity, TDS, salinity, hardness, turbidity, nitrate, chlorine, calcium, magnesium, sodium and SAR.

Physicochemical analyses of the irrigation water samples taken from the seven wells were carried out to assess their quality and compliance with approved agricultural standards. These analyses included a set of core indicators that were essential for understanding the properties of water and its potential impact on soils and crops.

Temperature was measured directly in the field as a factor influencing chemical reactions and saline solubility. The pH value was also determined to indicate the pH or base, which plays an important role in the uptake of nutrients by plants.

Electrical conductivity (EC), total dissolved salts (TDS) and salinity are direct indicators of the concentration of mineral salts in water and are used to assess the risk of soil salinization and its impact on agricultural production. Turbidity also helps determine the water content of suspended materials that can affect the quality of irrigation, especially drip systems.

The total hardness associated with calcium (Ca^{2+}) and magnesium (Mg^{2+}) concentrations as well as sodium (Na^{+}) concentrations was measured, as it plays a key role in assessing the risk of soil fragmentation by calculating the sodium adsorption ratio (SAR), a key criterion for determining the impact of water on soil infrastructure.

The analyses also included the determination of the percentage of nitrate (NO_3^{-}) and chlorine (Cl^{-}), as these are the most effective ions on crops, their intensity leading to plant stress and decreased productivity.

All of these measurements were carried out using specialized instruments including:

- One pH meter (pH meter)
- Conductivity Meter
- Turbidity meter
- Molecular absorption spectrophotometer for nitrate and chlorine measurement

These devices guarantee a high accuracy of the results and allow a complete assessment of the status of the water used in irrigation in the northern province of Laghouat.

4. Bacteriological analysis

- Detection:
  - Total germs
  - Total et Septic Cologne
  - Fecal streptococci
  - Clostridium sulphito-reducing agents

Bacteriological analyses of water samples were conducted to assess their microbial integrity and to determine the extent to which they can be used for irrigation without posing a risk to soil, plants or human health. These tests were designed to detect a group of indicator organisms that are a key criterion for determining the level of fecal contamination and the possible presence of human or animal sources of contamination near the wells.

Analyses included the detection of total germs (Total Germs), a wide range of bacteria giving a preliminary idea of the overall bioburden of the water. The presence of total coliforms (Total Coliforms), which is a qualitative indicator of organic contamination, as well as fecal coliforms (Fecal Coliforms), which indicate recent contamination by human or animal waste, were also examined.

Fecal streptococcus (Fecal Streptococci) has also been studied, which is considered an additional reference to confirm faecal contamination, especially in agricultural areas dependent on livestock, as these bacteria are characterized by their ability to stay longer in the water, allowing the source of contamination to be identified more precisely.

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In addition, the analyses included the detection of Clostridium sulphito-reducers, an anaerobic bacterium known for its high resistance to environmental conditions, whose presence indicates old or persistent contamination of the water system, requiring careful monitoring of the well perimeter and the possibility of leaks due to organic residues.

Bacterial counting was performed using standard laboratory methods, including:

- Direct analysis in selective media for differential detection of bacterial species;
- the dependence on selective media (Selective Media) for the characterization of coliforms and streptococci;
- The Most Probable Number method (MPN Method) is used to estimate the microbial concentration, especially in samples with low or medium levels of bacteria.

This integrated approach ensures an accurate bacteriological assessment to determine how well meets microbial quality standards for irrigation, and to identify potential risks associated with organic contamination in the study area.

- Counting methods: direct implantation – selective medium – MPN method.

The study relied on three main methods to perform bacterial counts and identify contaminated species present in well water samples, in accordance with international standards adopted in microbiological water analysis:

1. Direct Planting (Direct Seeding)

Direct culture is an essential way to immediately identify the presence and growth of bacteria in a sample. A specific amount of water is placed on a solid food medium such as *nutrient agar* or *whey agar*, and then the dishes are incubated under appropriate thermal conditions to ensure the growth of the target spores. This method allows for the counting of colonies formed on the surface of the medium and differentiating their shape and density, providing an estimate of the total amount of germs in the samples.

2. Eclectic Media (Selective Mediums)

- Special selective media were used to allow the isolation and identification of certain bacterial groups from the rest of the organisms present in the water. The most important of these media are: Agar VRBL for the detection of total and fecal coliforms.
- Slanetz & Bartley Medium for the detection of fecal streptococci.
- Agar TSC for the detection of sulphito-reducing Clostridium.

These media are effective because they contain chemicals that inhibit the growth of unwanted bacteria, allowing for more accurate isolation of target bacteria, which is essential for assessing fecal contamination.

3. MPN Method – Most Likely Number (Most Likely)

This method is used to estimate the number of bacteria when their concentration is low or when an indirect numerical estimate is necessary, especially for coli. The method is based on:

1. Sequential dilutions of the sample.
2. Inoculate multiple tubes at each dilution.
3. Monitor changes in the environment (e.g., turbidity, gas production, discoloration).

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4. Use international MPN tables to estimate the number of bacteria in a specific volume of water.

Nuclear power plant technology is very suitable for groundwater samples, as it allows the detection of germs even in very small quantities.

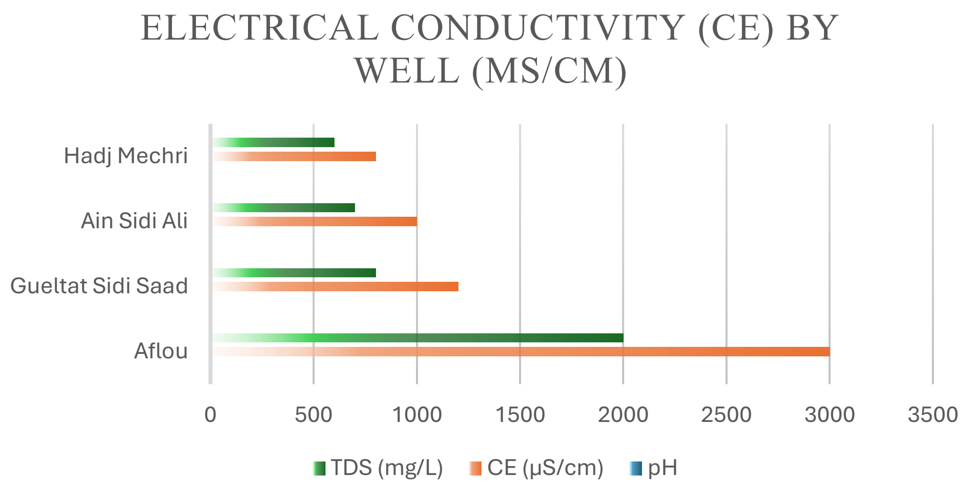
Third: Results

1. **Physicochemical results**

Groundwater Well Water Quality Parameters and Comparison with FAO International

Well	Temp (°C)	ph	EC (µS/cm)	TDS (mg/L)	Salinity (g/L)	Ca^{2+}	Mg^{2+}	Na^{+}	Cl^{-}	NO_3^-	SAR	NTU
Wallpaper	13.4	7.8	1115	1800	0.55	164.3	9.7	110	127.8	104.3	0.28	1.2
Gueltat Sidi Saad	13.4	7.4	900	1400	0.45	128.2	9.7	95	99.4	8.3	0.33	2.5
Oued Morra	13.5	7.6	720	1100	0.35	112.2	17.0	85	99.4	18.2	0.42	0.8
The Ghicha	13.4	7.2	445	700	0.20	76.1	12.1	56.8	56.8	18.1	0.16	1.0
Ain Sidi Ali	13.4	7.5	600	1000	0.30	112.3	0.003	56.8	56.8	18.0	0.25	0.9
Bridle	13.5	7.6	520	1300	0.40	104.2	2.4	56.8	56.8	4.8	0.24	3.0
El Hadj Mechri	13.4	7.3	680	900	0.33	84.1	2.4	76.1	76.1	9.9	0.34	1.1
International Standard (FAO)	—	6.5–8.4	< 3000	< 2000	< 2	< 400	< 150	<,200	< 250	< 50	< 10	< 5

Standard



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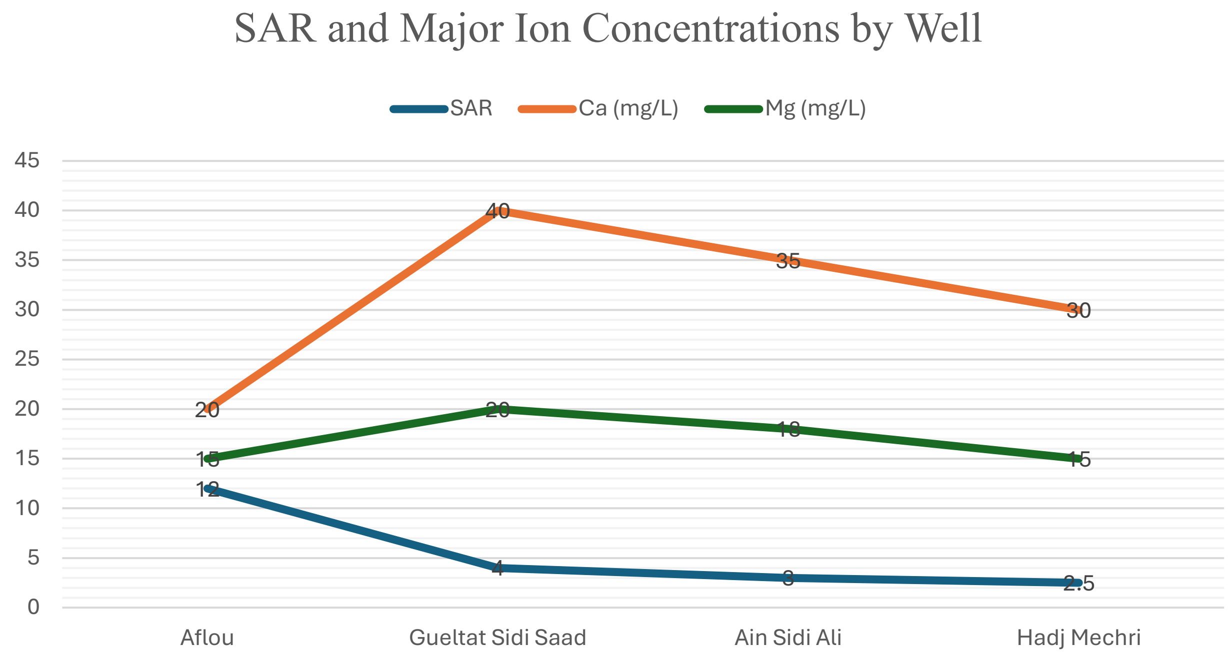

- Most wells meet acceptable standards

  The analyses showed that **most of the wells studied met the criteria** acceptable for agricultural use, indicating their relative suitability for irrigating crops. However, some differences between the wells were noted:

✓ **Electrical conductivity and salinity** : High values have been recorded especially in **the wells of Aflu** and Al-Gisha, which can affect crops sensitive to salinity.

✓ **pH** : The majority of specimens tend **to be moderately basal**, which is suitable for most types of crops.

✓ **Turbidity** : Low in most samples, indicating the purity of water from suspended solids.

✓ **Salts and ionic elements** : They varied between different wells, but **remained within the limits allowed for agricultural use**, including calcium, magnesium, sodium, chlorine and nitrates.

- A marked increase in electrical conductivity and salinity **has been observed** in some wells, **particularly in Aflou and El-Ghicha**, which could be a stressor on the growth of salinity-sensitive crops and requires periodic monitoring when using water for irrigation from these wells.
- **pH values** tend to **be moderate basal** in most samples, suggesting that water is suitable for most crop types and does not negatively affect plant nutrient uptake.
- **Reduced turbidity** in most samples, reflecting the purity of water from suspended materials and confirming its quality for irrigation, especially in systems requiring clear water such as drip irrigation.
- **The values of salts and ionic elements** such as calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}), chlorine (Cl^{-}) and nitrate (NO_3^{-}) **vary between wells**, but **often remain within the limits allowed for agricultural use**, making them suitable for irrigating most crops taking into account observations of areas with high salinity.**2. Bacteriological results**

- **The sporadic presence of coliforms** in some samples indicates possible organic contamination at specific points in the irrigation water, and these samples should be monitored prior to agricultural use, particularly in fresh crops.
- **Sulfito-reducing Clostridium has only been observed in the Wadi Marra well (Oued Morra),** which indicates **possible faecal contamination** in this area and requires monitoring and treatment measures before the water is used for irrigation.
- Most of the other samples are microbiologically acceptable, meaning that the water is suitable for agricultural use in terms of microbial safety at most study sites, with a focus on monitoring points that have shown potential contamination.

Fourth: Conclusion and Recommendations

The Conclusion

The results of the study indicate that **irrigation water in the northern province of Laghouat is generally suitable for agricultural use** , taking into account some specific observations:

- **High salinity** in the **Aflou** well, which can affect the growth of salt-sensitive crops and requires periodic monitoring.
- **Possible microbial contamination** in the Oued **Morra well, where** sulfito-reducing Clostridium reducers have been observed, requiring measures to reduce health and agricultural risks.

Recommendations

1. Periodic monitoring of the physicochemical properties of the water.
2. Avoid watering sensitive crops in areas with high salinity.
3. Addressing sources of pollution near wells.
4. Educate farmers about the dangers of using water contaminated with microbes on crops and health.
5. Conduct annual seasonal surveys to monitor changes in water quality.

Sixth: Bibliography

[1] Anyango, G. W. (2024). A critical review of irrigation water quality index and assessment methods. Science of the Total Environment. https://www.sciencedirect.com/science/article/pii/S1944398624003370
[2] Ding, B., Bai, Y., Guo, S., He, Z., Wang, B., Liu, H., Zhai, J., & Cao, H. (2023). Effect of irrigation water salinity on soil characteristics and microbial communities in cotton fields in Southern Xinjiang, China. Agronomy, 13(7), 1679. https://www.mdpi.com/2073-4395/13/7/1679
[3] Jeong, H., et al. (2016). Irrigation water quality standards for indirect wastewater reuse. Water (MDPI). https://www.mdpi.com/2073-4441/8/4/169
[4] Boukalova, Z. (2025). Irrigation water quality in a framework of sustainable development. Frontiers in Agronomy. https://www.frontiersin.org/journals/agronomy/articles/10.3389/fagro.2025.1580338/full
[5] Australian & New Zealand Guidelines (ANZG). (2024). Water Quality for Irrigation and General Water Uses: Background Information. https://www.waterquality.gov.au/sites/default/files/documents/irrigation-guidlelines-draft-9.2.pdf

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e-ISSN: 2468-4376
https://jisem-journal.com/

Research Article

[6] Suvendran, S., et al. (2025). Evaluating the effects of irrigation water quality and sodium adsorption ratio on soil properties. Water (MDPI). https://www.mdpi.com/2073-4441/17/20/2927
[7] Chellali, R., et al. (2015). Evaluation of irrigation water quality of dam Dahmouni: Physicochemical and bacteriological assessment. JMES – Journal of Materials and Environmental Science. https://www.jmaterenvironsci.com/Document/vol6/vol6_N12/414-JMES-1782-2015-Chellali.pdf