American Journal of Physical Chemistry
2025, Vol. 14, No. 2, pp. 17-22
https://doi.org/10.11648/j.ajpc.20251402.11

Research Article

Irrigation and Its Impacts on the Water Resource of Lake Kankossa in Mauritania

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Abstract

The aim of this study is to assess the physico-chemical quality of water from Lake Kankossa in Mauritania, used for irrigation and agricultural re. Sampling campaigns were carried out during February and 2024. The sampling sites are: E1:Kankoussa, E2: Elhachai, E3:Elmaghtaa 1, E3:Elmaghtaa2. In this work, we studied the hydrochemistry of the waters of Lake Kankossa, in Mauritania. The aim of the study was to assess the physico-chemical quality of the lake's water for human consumption and irrigation. To this end, we carried out physico-chemical analyses to assess the risks of contamination on the lake's water quality. Samples were taken during the 2024 summer season at four stations located on the shores of Lake Kankossa. Physico-chemical parameters measured included: temperature, pH, turbidity, electrical conductivity, total dissolved solids, total hardness, calcium, magnesium, sodium, potassium, chlorides, nitrates, nitrites, ammonium, sulfates, total copper, iron, oxidizability, alkalinity and total alkalinity. These analyses were carried out using techniques such as volumetric analysis, spectroscopy and flame atomic absorption spectrometry. Statistical analysis of the results, compared with WHO standards for drinking water, revealed a significant deterioration in water quality in Lake Kankossa. The results showed that the concentration of most physico-chemical parameters complied with WHO standards. However, all parameters studied comply with WHO criteria for drinking water, with the exception of certain parameters, such as turbidity (486.25 NTU), potassium (24.5 mg/L) and nitrite (0.4 mg/L), which do not meet WHO standards. Appropriate treatment is recommended to render these waters potable. The graphical representation of the results of the Kankossa lake water analyses on the Riverside and Wilcox diagram shows that Kankossa lake water is of good quality for irrigation.

Keywords

Water, Quality, Physicochemical, Lake, Irrigation, Kankossa, Mauritania

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Received: 5 April 2025; **Accepted:** 28 April 2025; **Published:** 26 May 2025

1. Introduction

The waters of Lake Kankossa in Mauritania are an essential element for the existence of life on earth, and also play a vital role in socio-economic development [1]. Water supply, in sufficient quantity and acceptable quality, is one of the Millennium Development Goals [2].

Population growth, human activities and climate change are major contributors to water quality deterioration worldwide [3]. In fact, according to the WHO [4].

The aim was to assess the water quality of Lake Kankossa, an area classified as a regional agricultural hub. We chose 04 sampling points on the main canal along the edge of the lake. These stations were chosen according to their accessibility and proximity to sources of pollution. Taking into account that gardens and farms are spread throughout the region along the lake. The study was carried out over two climatic seasons in the years 2023-2024, with the aim of gaining an idea of the advantages and disadvantages of using water from Lake Kankossa as irrigation water.

The lake is an area of intense agricultural activity. Unfortunately, these agricultural activities, combined with tillage techniques and the use of fertilizers and phytosanitary products, can lead to excessive soil degradation and the release of nitrates, phosphates and phytosanitary products into aquatic environments.

The main aim is to study the quality of lake water used for irrigation, with a view to assessing its suitability for irrigation. Irrigation water quality is generally judged by a few determining factors, such as electrical conductivity (EC) and Sodium Adsorption Ratio (SAR) [4].

2. Materials and Methods Study Area

Lake Kankossa is a vast depression that collects rainwater from the heights of Assaba and Hodh El Gharbi. It is one of the largest permanent bodies of water in Mauritania, with a width of almost 300 meters and a length of up to 25 km, depending on the season. Located in the commune of Kankossa (15 °50'N, 11 °33'W), 100 km south of the town of Kiffa, the lake is linked to the Senegal River by a major wadi, the Karakoro. Its waters are widely used by local populations for their domestic needs, as well as for watering livestock [5].

The lake's water supply comes mainly from three wadis: the Kouroudjel to the northeast, the Lihraj to the northwest and the Niakhl é to the southeast. Several secondary tributaries, such as the Talhaya and Aghorat Ledkhan wadis, also contribute significantly to the water supply, particularly in the northern part of the lake [5].

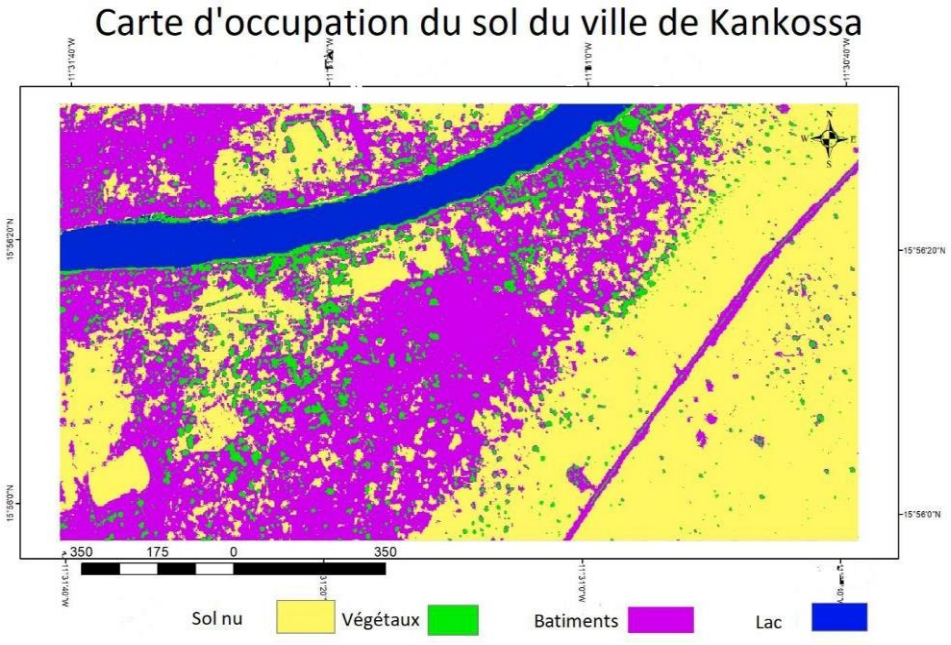

Figure 1. *Location of study area.*

Samples were taken during months 02 and 04/2024. Water samples were taken in 1-liter polyethylene bottles and stored at 4 °C. Analyses were carried out at the ISET water chemistry laboratory, the laboratory of the Water-Pollution-Environment unit of the FST of the University of Nouakchott, and the water chemistry laboratory at INRSP. These sites were selected on the basis of their:

1) Accessibility.
2) Proximity to potential sources of pollution.

All the work was carried out in the study area, spread over

the two shores of the lake. The aim was to analyze and better understand the physico-chemical characteristics of the waters of Lake Kankossa in Mauritania.

Figure 2. *Location of sampling sites.*

Table 1. *GPS coordinates of sampling sites.*

Sample	site	GPS coordinates
E1	Kankossa 1	15°56'20.2 "N 11°31'14.9 "W
E2	Elhachia (Kankossa 2)	15°56'22.7 "N 11°31'17.0 "W
E 3	Elmaghtaa1	15°56'10.2 "N 11°32'05.1 "W
E4	Elmaghtaa2	15°56'15.7 "N 11°31'44.5 "W

Parameters studied include temperature, PH, electrical conductivity, chloride, bicarbonate, alkalinity, total alkalinity, carbon dioxide, calcium, magnesium, sodium, potassium and SAR.

pH and temperature were determined using a Hanna HI 9024 pH meter fitted with a temperature probe. Electrical conductivity was measured with a Hanna HI 8733 conductivity meter. Chlorides were measured by Mohr's volumetric method in the presence of silver nitrate. Calcium and magnesium ions were determined by complexometry using a disodium salt of ethylenediamine tetraacetic acid (EDTA) solution. Bicarbonates are analyzed by volumetric determination with HCL 0.1 N. For sodium and potassium ions, we used a Corning flame atomic emission photometer. The Sodium Adsorption Ratio by Jiménez and Chavez is defined by the following relationship: SAR= (Na^{+}) / (RACNE CARRE(Ca^{2+} + $Mg^{2+)/}$2) with the concentrations of Na^{+}, $Ca^{2+}$and Mg^{2+} ions expressed in meq/L.

3. Results and Discussion

3.1. Kankossa Lake Water Quality for Irrigation

Table 2. *Physico-chemical characteristics of water from Lake Kankossa used for irrigation, compared with International Irrigation Water Standards [6].*

ANALYSIS RESULTS				FAO IRRIGATION WATER STANDARD,			
Parameter	**Min**	**Avg**	**Max**	**No problems**	**Growing problems**	**Serious problems**	**Limit values**
CE (µs/cm)	553	566,25	590	< 750	750 - 2000	> 3000	8700

ANALYSIS RESULTS				FAO IRRIGATION WATER STANDARD,			
Parameter	**Min**	**Avg**	**Max**	**No problems**	**Growing problems**	**Serious problems**	**Limit values**
		<6		6 - 9	> 9		
SAR	1,63	<8		8 - 16	> 16	--	
		<16		16- 24	> 24		
Ca2+ (mg/l)	24,05	28,453	33,66	--	--	--	--
Mg2+ (mg/l)	15,06	20,863	26,2	--	--	--	--
Na+ (mg/l)	44	47	50	--	--	--	69
K+ (mg/l)	22	24,5	27	--	--	--	--

Analyses of the physico-chemical parameters of Kankossa lake water show that, overall, it meets the standards set by the FAO for irrigation. These results confirm their suitability for agricultural use, subject to regular monitoring to prevent environmental impacts and maintain soil sustainability.

3.2. Riverside Diagram and Wilcox Log

Soil salinization and alkalinization are the main risks associated with the use of irrigation water. These phenomena, caused by high concentrations of dissolved salts or sodium, can alter agricultural productivity and soil structure [7].

To assess these risks, the results of physico-chemical analyses of the waters of Lake Kankossa were projected onto the Riverside and Wilcox log diagram.

Salinity is measured by electrical conductivity (EC) in µS/cm.

Alkalinization: This is characterized by the SAR index, which expresses the ratio between the main cations present in water (Na^+, Ca^{2+}, Mg^{2+}). The SAR index is calculated according to the following formula: $SAR = [Na^+]\sqrt{([Ca^{2+}]+[Mg^{2+}])^2}$ [7].

3.2.1. Irrigation Water Classifications Based on Conductivity

Table 3. Irrigation water quality scale based on electrical conductivity [9].

Conductivity (EC)	Water classes
EC < 250µS/cm	C1
250µS/cm < EC <750µS/cm)	C2
750µS/cm < EC <2250µS/cm)	C3
2250µS/cm < EC <5000µS/cm)	C4

The waters are low-salinity, medium-salinity, high-salinity and very high-salinity respectively.

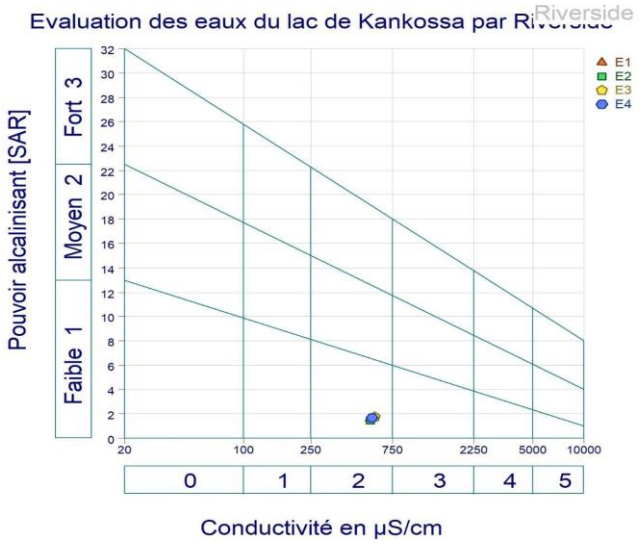

Figure 3. Riverside diagram for Lake Kankossa.

3.2.2. Irrigation Water Classifications in Relation to SAR

Table 4. Irrigation water quality scale according to SAR [8].

SAR	water classes
SAR< 10	S1
10 < SAR	S2
18 < SAR	S3
SAR>	S4

These different SARs indicate that the waters are respectively "excellent to low alkalization hazard", "good to acceptable alkalization hazard", "medium to high alkalization hazard" and "poor to very high alkalization hazard".

The US Salinity Laboratory analysis results show that the irrigation water from Lake Kankoussa is class C2S1, i.e. low-salinity irrigation water with excellent alkalinity [10].

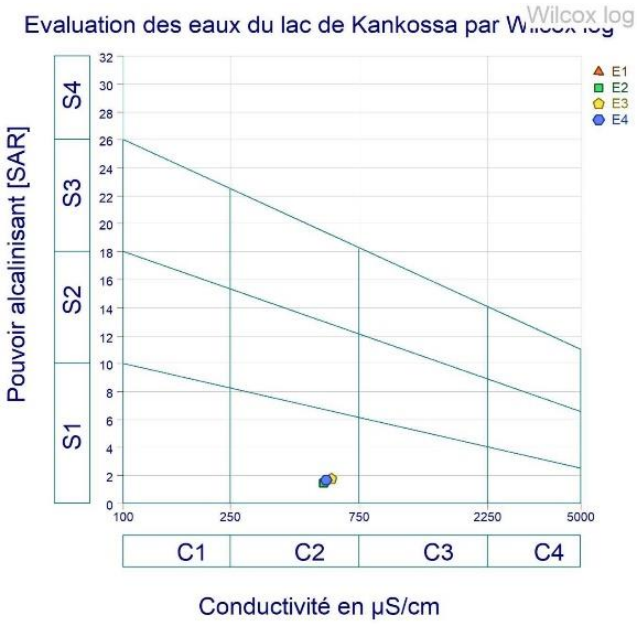

Figure 4. *Wilcox log plot of Lake Kankossa waters [11].*

According to the Riverside and Wilcox log diagram, all samples fall into the C2-S1 class, indicating water quality suitable for irrigation. It can be used without special controls to irrigate plants with a slight tolerance to salts.

3.3. Wilcox Diagram

In agriculture, plants do not tolerate sodium-rich water. The Wilcox diagram proposes a classification of irrigation waters based on electrical conductivity and the proportion of sodium in the water (expressed as a percentage, % Na^+). Sodium content is defined by the relationship: $\%Na = ( )Na+K*100Ca+Mg+Na+K$ [12].

Physico-chemical analyses of Kankossa lake waters, combined with the use of the Wilcox diagram, indicate that these waters belong to the "excellent" class for irrigation, according to the cross index % Na^+ / conductivity. This result underlines their suitability for agricultural use, while minimizing the risks associated with salinity and sodium [13].

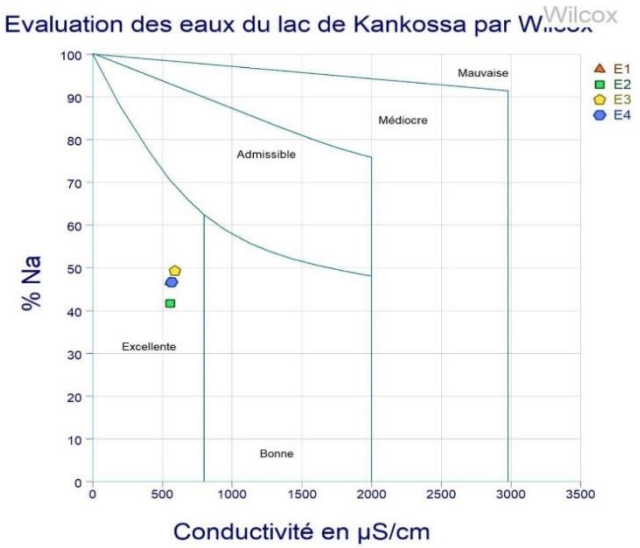

Figure 5. *Wilcox diagram of Lake Kankossa waters [14].*

4. Conclusion

The results of the physico-chemical analyses of Kankossa lake water were also compared with the FAO guide values for irrigation water, and evaluated using the Riverside and Wilcox methods. These comparisons show that the waters of Lake Kankossa are classified in the "No problem" category, particularly with regard to the risk of salinity and their impact on soil permeability. However, this permeability can be affected by sodium, particularly during the winter period.

According to Riverside and wilcox log, kankossa lake waters belong to class C2-S1, which means they are particularly suitable for slightly salt-tolerant plants, with periodic monitoring of salinity evolution. and according to the Wilcox classification, they are rated as "excellent" [15].

For irrigation, the Reverside and Wilcox diagram of water analyses for Lake Kankossa shows that the water in the study area poses no risk to crops, and is of good quality for irrigation.

Abbreviations

WHO	World Health Organizatio
EC	Electrical Conductivity
SAR	Sodium Adsorption Ratio
ISET	Higher Institute of Technological Education
INRSP	National Institute for Public Health Research
EDTA	Ethylene Diamine Tetraacetic Acid
HCl	Hydrochloric Acid
FAO	Food and Agriculture Organization of the United Nations

Conflicts of Interest

The authors declare no conflicts of interest.

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