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ASSESSMENT OF IRRIGATION WATER QUALITY FOR CROP PRODUCTION IN OMI (KAMPE) IRRIGATION FIELD, YAGBA WEST LOCAL GOVERNMENT AREA, KOGI STATE, NIGERIA

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ABSTRACT

The Omi Dam irrigation area represents a significant agricultural opportunity in Kogi State, Nigeria. Crop production in this area is heavily reliant on water from Omi reservoir, during the dry season. The purpose of the research was to determine whether this irrigation water is suitable for use for crop production. Sampling was conducted monthly from three sites within the irrigation field from January 2025 to May 2025. A number of physicochemical properties were examined in the water samples, including pH (6.31-6.54), electrical conductivity (Ec) (87.66-105.06 µohms/cm), total dissolved solids (TDS) (73.0-55.20 mg/L), major cations such as sodium ($Na^{+)}$) (1.84-3.68 mg/L), potassium ($K^{+)}$) (4.34-5.17 mg/L), calcium (Ca^{2+}) (2.22-3.70 mg/L) and magnesium (Mg^{2+}) (1.97-2.37 mg/L), and major anions such as carbonate ($CO3^{-}$) (50.62-97.62 mg/L), bicarbonate ($HCO3^{-}$) (5.39-10.12 mg/L), phosphate (PO_4^{2-}) (3.87-4.50 mg/L), sulphate (SO_4^{2-}) (63.98-78.29 mg/l), chloride (Cl^{-}) (58.14-69.76 mg/L) and nitrate (NO_3^{-}) (2.84-5.52 mg/L). The levels of the analyzed samples fall within the standards limits required for irrigation water rating except for phosphate. The water is considered chemically acceptable for irrigation based on the computed chemical index values with respect to SSP (53.73-65.45 %), SAR (1.14-2.72 meq/L), MAR (40.12-48.54 %), PI (61.31-74.08 %), KR (0.36-1.009), SCAR (1.05-2.87 meq/L) and ESP (1.64-3.80 meq/L) except for RSC (51.81-101.68 meq/L), RSBC (3.16-6.42 meq/L) and PS (87.52-92.11 meq/L). The Wilcox diagram suggests that every water samples is in good state. The irrigation water was classified as "low salinity" by the United States Salinity Laboratory diagram, making it appropriate for crop production.

Keywords: Irrigation, Omi Dam, Salinity

INTRODUCTION

Irrigation is primarily necessary to increase agricultural output, particularly in the dry season where rainfall is inadequate to satisfy crop water requirements. Yet, a crucial element affecting crop growth and yield is the quality of irrigation water (Ingrao *et al.*, 2023, Anyango *et al.*, 2024, Al-Aizari *et al.*, 2024). Poor irrigation water quality can lead to a variety of issues that significantly affect agricultural yields and soil health, such as nutrient imbalances, soil salinization and the presence of hazardous substances (Demo *et al.*, 2025). Thus, determining the quality of irrigation water is crucial to maximizing crop yield and guaranteeing sustainable farming methods. The soil-plant-water system may be impacted by a number of physical, chemical, and biological factors that are commonly used to assess irrigation water quality (Chinasho *et al.*, 2023). Among these factors include pH, salinity, electrical conductivity (EC), sodium concentration and the existence of dangerous substances such as pathogens, pesticides or heavy metals (Barathkumar *et al.*, 2025).

Water has special chemical qualities that allow it to suspend, dissolve, absorb and adsorb a wide range of substances because of its polarity and hydrogen bonding (Kontogeorgis *et al.*, 2022). As a result of environmental pollution and other biological processes, this irrigation water is not naturally pure. Nonetheless, some dissolved salts are introduced by irrigated water and their sources determine the amount and quality of these dissolved salts. Sodium (Na^{+}), calcium (Ca^{2+}), magnesium (Mg^{2+}), chloride (Cl^{-}), carbonate (CO_3^{-2}) and bicarbonates (HCO_3^{-}) are often the most common chemicals that dissolve in water. The concentration of these dissolved ions in water determines whether it is suitable for irrigation (Pandian & Sashikkumar, 2016).

Abdurraheem *et al*. (2020) investigated the drainage features of the Omi (Kampe) Dam basin which dwell on the connections between the various morphometric factors and drainage terrain characteristics. Furthermore, Adeniran *et al*. (2010) have examined the water needs of a few chosen crops in the Kampe dam irrigation project. The ecological risk of heavy metals and their temporal and spatial levels in irrigation water from Omi Dam were evaluated by Isah *et al*. (2025). Nevertheless, no research has been conducted to evaluate the physicochemical characteristics of the irrigation water so as to assess if it is suitable for irrigation.

Therefore, the purpose of this study is to use the United States Salinity Laboratory diagram, the Wilcox diagram, and irrigation water quality indicators to assess the irrigation water quality in Omi Dam irrigation field.

MATERIALS AND METHODS

Study Area

The Kampe (Omi) Dam Irrigation Project (KODIP) is located in Yagba West Local Government Area of Kogi State, Nigeria. It is almost 146 kilometers away from Ilorin, the Kwara State capital. It is located between longitudes 6° 37' and 6° 42' E and Latitudes 8° 34' and 8° 38'. Despite the fact that the project was first conceived in 1979, building did not start until 1983. A 42-meter dam was constructed that could hold about 250 million cubic meters of water. The irrigation system consists of a 39-kilometer main canal, approximately 300-kilometer feeder canals and supplementary drainage lines. Upon completion of all phases, the dam will have the capacity to irrigate approximately 4,100 hectares. Presently the completed phase 1 irrigates about 2,000 hectares of arable land. This stage enables year-round agricultural production of rice, sorghum, vegetables, and maize (Adeniran *et al*. 2010, Isah *et al.*, 2025).

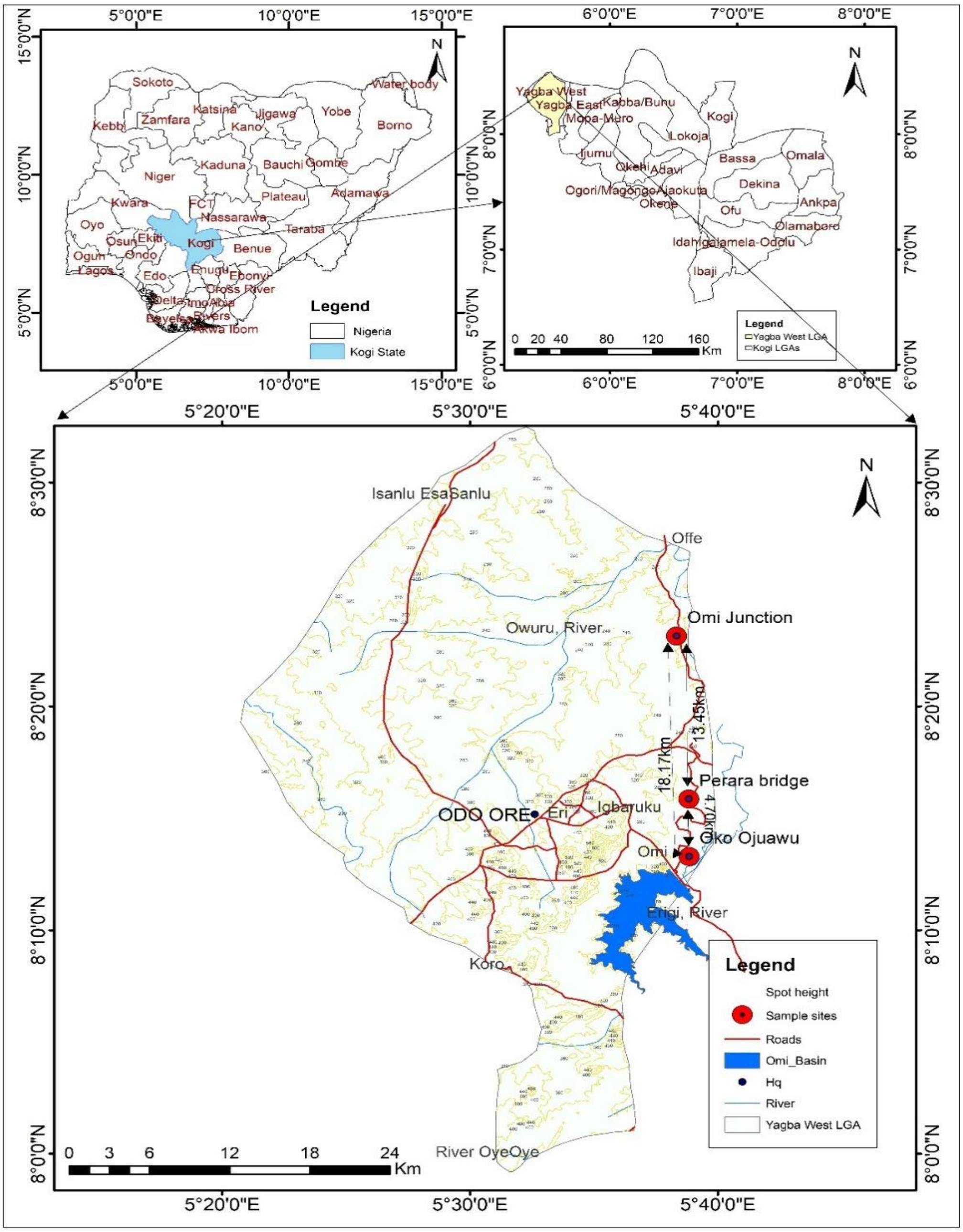

Figure 1: Study Area (Isah *et al.,* 2025)

Collection of Water Samples

The water samples were collected in accordance with Adeyemi *et al*. (2021). Ten distinct farm locations in each station provided irrigation water samples, which were then thoroughly mixed in a sterile plastic bucket to provide a representative sample. The water was kept in 200 ml reagent bottles that had been thoroughly cleaned with distilled deionized water. After collecting, tight-fitting corks were used to seal the containers. Samples were transported in a cooled icebox to the laboratory for physicochemical analysis. The samples were collected for five months (January – May 2025) and were analyzed in triplicate.

Analysis of Water Samples

The water sample was analyzed in accordance with Adegbola *et al*. (2019). Portable pH/EC/TDS meters were used to analyze pH, TDS, and EC in-situ. Water sample analysis of the irrigation water were done for the major cations (sodium (Na^+), calcium (Ca^{2+}), potassium (K^+), magnesium (Mg^{2+}) using Atomic Absorption Spectrometry and anions (nitrate (NO_3^-), chloride (Cl^-), carbonate (CO_3^-), bicarbonate (HCO_3^-), sulphate (SO_4^{2-}), and phosphate (PO_4^{2-})) using conventional titration methods (Adegbola *et al.,* 2019).

Determination of Irrigation Water Quality Criteria

A number of widely used water quality indices, such as Soluble Sodium Percentage (SSP), Magnesium Adsorption Ratio (MAR), Sodium Adsorption Ratio (SAR), Residual Sodium Carbonate (RSC), Residual Sodium Bicarbonate (RSBC), Kelly Ratio (KR), Permeability Index (PI), Sodium to Calcium Activity Ratio (SCAR), Potential Salinity (PS) and Estimated Exchangeable Sodium Percentage (ESP) were employed to evaluate the quality of the irrigation water (Table 1).

Table 1: Water Quality Indicese

S/N	Water Quality Indices	Reference
1	$SSP = \frac{Na^+}{Na^+ + K^+ + Ca^{2+} + Mg^{2+}} X\,100$	(Al-Aizari *et al.*, 2024)
2.	$SAR = \frac{Na^+}{\sqrt{\frac{Ca^{2+}+Mg^{2+}}{2}}}$	(Anyango *et al.*, 2024)
3.	$MAR = \frac{Mg^{2+}}{Ca^{2+}+Mg^{2+}} \times 100$	(Hakami *et al.*, 2024)
4.	$RSC = (HCO3^- + CO3^{2-}) - (Ca^{2+} + Mg^{2+})$	(Moges & Dinka, 2023)
5.	$RSBC = HCO3^- - Ca^{2+}$	(Sahu *et al.*, 2022)
6.	$PI = \frac{Na^+ + \sqrt{HCO3^-}}{Na^+ + Ca^{2+} + Mg^{2+}} X\,100$	(Subbarao *et al.*, 2018)
7.	$KR = \frac{Na^+}{Ca^{2+}+Mg^{2+}}$	(Adegbola *et al.*, 2019)
8.	$SCAR = \frac{Na^+}{\sqrt{Ca^{2+}}}$	(Abou El-Defan *et al.*, 2016)
9.	ESP = [1.475 × SAR] / [1 + (0.0147 × SAR)]	(Walche *et al.*, 2024)
10.	$PS = Cl^- + \frac{1}{2\,SO_4^{2-}}$	(Taşan, 2023)

Data Analysis

The raw data was analyzed by the use of Microsoft excel (version 14.0). The Statistical Package for Social Sciences (SPSS), Version 20 for analysis of variance (ANOVA) were used to calculate the mean and standard error of the physicochemical values. The analytical results were compared with the standard specifications (Al-Aizari *et al*., 2024).

RESULTS AND DISCUSSION

Physicochemical Properties of the Irrigation Water of Omi (Kampe) Reservoir

The means distribution ranges of pH, Total Dissolved Solids (TDS), Electrical Conductivity (Ec), Sodium (Na^+), Calcium (Ca^{2+}), Potassium (K^+), Magnesium (Mg^{2+}), Nitrate ($NO3^-$), Chloride (Cl^-), Carbonate ($CO3^-$), Bicarbonate ($HCO3^-$), Sulphate ($SO4^{2-}$), Phosphate ($PO4^{2-}$) for all sites compared with FAO guidelines was shown in Table 2.

All three sites (Omi Junction - A, Perera Bridge - B, Oko-Ojuawo - C) had similar pH values (6.54-6.39) (Table 2) which fall within the FAO recommended guideline of 6.0–8.5. This ensures nutrient availability and prevent soil degradation suggesting its suitability for irrigation. Deviations below 6.0 could mobilize toxic metals, while pH above 8.5 might reduce nutrient solubility (Jackson *et al.*, 2018). Adegbola *et al.* (2019) recorded similar values (6.40-7.02) in irrigation water from Ikose River in Ogbomoso, Nigeria.

Electrical conductivity in this study ranged within 87.66 – 105.06 µohms/cm (Table 2). The highest EC was observed in Site B (105.06 ± 8.71 µS/cm) with significant variation. EC measures salinity, with FAO thresholds of <750 µS/cm for sensitive crops, 750–2,250 µS/cm for moderately tolerant crops, and >2,250 µS/cm indicating severe restrictions (Balachandar *et al*., 2010). The EC at Site B (105.06 µS/cm) is very low, indicating excellent suitability for all crops, including sensitive ones like vegetables grown at Omi Dam irrigation field. The high variation suggests potential seasonal or spatial fluctuations, possibly due to runoff or upstream inputs. This study compares with Solomon *et al*. (2020) who recorded EC range of irrigation water between 220.6 – 367.0 µS/cm in Wamba Shett 210, North Central, Nigeria.

The highest TDS was observed in Site B (73.00 ± 7.94 mg/L) with notable variation. TDS reflects dissolved salts and minerals. FAO classifies TDS <450 mg/L as low risk for irrigation (Ayers & Westcot, 1985). Site B TDS is well below this threshold, confirming suitability for irrigation. The variation at Site B may indicate inconsistent water sources or contamination events, requiring regular monitoring. Adegbola *et al*. (2019) recorded similar values (29.50-54.53 mg/L) in irrigation water from Ikose River in Ogbomoso, Nigeria.

A key determinant of irrigation water quality is the amount of sodium (Na+). In this study, Site C had the lowest sodium (1.84 ± 0.37 mg/L) and site A had the highest sodium level of 3.68 ± 0.55 mg/L. Low sodium levels reduce the risk of soil sodicity, which affects soil structure. Sulphate levels range between 58.78 mg/L in site C and the highest value of 78.28 in site B. The levels of sodium and sulphate fall within the FAO guidelines of 200 mg/L and 578 mg/L respectively (Ayers & Westcot, 1985), but the high variation of sulphate suggests potential contamination from agricultural runoff (e.g., fertilizers) or geological sources, which should be investigated to prevent long-term soil impacts. The levels of phosphate (3.87– 4.50 mg/L) however exceeded the FAO maximum tolerable limit of 2 mg/L. Phosphate levels >2 mg/L may cause algal blooms (Fipps, 2003).

The mean nitrate concentration in the samples ranged from 2.84 mg/L (site A) to 5.52 mg/L (site B). The values fall below the maximum tolerable limit of 30 mg/L safe for irrigation (Ayers & Westcot, 1985). A low nitrate concentration indicates minimal risk of over-fertilization or eutrophication in runoff, making it ideal for irrigation. Site C had the highest carbonate (97.62 ± 12.36 mg/L) and bicarbonate (10.12 ± 1.24 mg/L). High carbonate and bicarbonate can increase water alkalinity, potentially raising soil pH and affecting nutrient availability (Barathkumar *et al.*, 2025). FAO suggests bicarbonate <120 mg/L to avoid precipitation of calcium/magnesium, reducing soil permeability. Site C values are within safe limits but warrant monitoring to prevent long-term soil alkalinity issues.

The most common ions in a high saline water are chloride ions (Abou El-Defan *et al.*, 2016). In this study, chloride ions levels range from 58.14 mg/L to 69.76 mg/L and are considered suitable for irrigation purpose. More than 350 mg/L of chloride can be harmful to crops that are susceptible (Ayers & Westcot, 1985). The levels of magnesium (1.97 – 2.37 mg/L), potassium (4.24-5.17 mg/L) and calcium (2.22 – 3.70 mg/L) in this study are below their respective FAO maximum tolerable limits which contributes to a good quality irrigation water. This elements contribute to soil fertility but must be balanced to avoid nutrient imbalances (Xie *et al.*, 2024).

Table 2: Summary of Water Quality Parameters of Irrigation Water from Omi (Kampe) Reservoir from January 2025 to May 2025

Water Quality Parameter	Unit	Site A (Omi Junction)	Site B (Perera Bridge)	Site C (Oko-Ojuawo)	FAO Standard*
pH	-	6.54 ± 0.13	6.39 ± 0.03	6.31 ± 0.11	6.0-8.5
Electrical Conductivity (Ec)	µohms/cm	90.30 ± 8.68	105.06 ± 8.71	87.66 ± 8.98	<750
Total Dissolved solid (TDS)	mg/l	54.40 ± 6.07	73.00 ± 7.94	55.20 ± 4.05	0-2000
Sodium (Na^+) (mg/l)	(mg/l)	3.68 ± 0.55	3.60 ± 0.71	1.84 ± 0.37	<200
Sulphate	mg/l	63.98 ± 4.51	78.28 ± 7.20	58.76 ± 4.25	<576
Phosphate	mg/l	4.07 ± 0.29	4.50 ± 0.53	3.87 ± 0.34	<2
Nitrate (NO_3^-)	mg/l	2.84 ± 0.43	5.52 ± 1.51	5.35 ± 1.53	<30
Carbonate (CO_3^{2-}) (mg/l)	(mg/l)	50.62 ± 8.17	81.36 ± 9.78	97.62 ± 12.36	<510
Bicarbonate (HCO_3^{2-}) (mg/l)	(mg/l)	5.39 ± 0.87	8.65 ± 1.04	10.12 ± 1.24	<120
Chloride (Cl^-)	mg/l	60.12 ± 8.51	69.76 ± 14.51	58.14 ± 8.46	<350
Magnesium (Mg^{2+}) (mg/l)	(mg/l)	1.97 ± 0.05	2.22 ± 0.09	2.37 ± 0.16	<60
Potassium (K^+) (mg/l)	(mg/l)	4.34 ± 0.24	4.79 ± 0.53	5.17 ± 0.16	<78.2
Calcium (Ca^{2+}) (mg/l)	(mg/l)	2.22 ± 0.21	3.45 ± 0.47	3.70 ± 0.35	<400

Determination of Irrigation Water Quality Criteria

The mean distribution ranges of Soluble Sodium Percentage (SSP), Magnesium Adsorption Ratio (MAR), Sodium Adsorption Ratio (SAR), Residual Sodium Carbonate (RSC), Residual Sodium Bicarbonate (RSBC), Kelly Ratio (KR), Permeability Index (PI), Sodium to Calcium Activity Ratio (SCAR), Potential Salinity (PS) and Estimated Exchangeable Sodium Percentage (ESP) compared with FAO guidelines are shown in Table 3.

The sodium content in relation to the total cations (Na^+, Ca^{2+}, Mg^{2+}, and K^+) is measured by SSP (Al-Aizari *et al.*, 2024). In this study, Site A had the highest SSP (65.446%) and site C had the lowest SSP (53.733 %), with Site B showing the highest variation. Values >60% indicate potential sodicity risks, as sodium can displace calcium and magnesium in soil, reducing permeability and fertility (Naganna Mohanavelu *et al.*, 2021). Site A SSP (65.446%) exceeds this threshold, suggesting a high risk of soil sodicity, which could impair crops like maize and vegetables grown at Omi reservoir irrigation field. Site B high variation indicates inconsistent sodium levels, possibly due to seasonal runoff or upstream inputs, requiring regular monitoring.

SAR assesses sodium impact on soil structure relative to calcium and magnesium (Sahu *et al.*, 2022). The ratio of sodium to calcium and magnesium influences the quantity of water available for crops (Ayers & Westcot, 1985). FAO classifies SAR <10 as "excellent", 10-18 as "good", 18-26 as "fair" and >26 as "unsuitable" (Olurin *et al*., 2022). Site C had the lowest SAR (1.141 meq/L) while site A has the highest SAR (2.717 meq/L) which indicates excellent suitability for irrigation, with minimal risk of sodicity. This aligns with the low sodium concentration (1.84 mg/L) reported for Site C (Table 2), making it ideal for sensitive crops. MAR assesses magnesium impact, with values >50% potentially reducing soil permeability. Magnesium Adsorption Ration (MAR) in this study ranged from 40.119 % (Site C) to 48.352% (Site A) which falls within the standard guideline (<50 %) rendering the water suitable for irrigation (Ayers & Westcot, 1985). Water infiltration and root growth are negatively impacted by high MAR because it creates imbalance that can result in defects in the soil structure, decreased permeability, and increased compaction (Barathkumar *et al.*, 2025). PI evaluates long-term soil permeability effects, with PI >75 % indicating suitability for irrigation (Subbarao *et al.*, 2018). High-quality irrigation water is indicated by PI values between 25 and 75 %. The water becomes unsuitable for irrigation if the PI levels are less than 25 %. The water samples in this investigation appear to be acceptable for irrigation, as shown by the PI values, which range from 61.312 % (Site C) to 74.078 % (Site A).

SCAR focuses on sodium competition with calcium and lower values are preferred to avoid sodicity (Abou El-Defan *et al.*, 2016). The SCAR values in this investigation fall between 1.048 (Site C) to 2.866 (Site A), all of which fall under the prescribed irrigation water guideline (<9). RSC calculates how much bicarbonate and carbonate is present in excess of calcium and magnesium (Adegbola *et al.*, 2019). Sites B and C had extremely high RSC values (84.337 meq/L and 101.676 meq/L, respectively). Values >2.5 meq/L are hazardous, as they can precipitate calcium/magnesium, increase soil alkalinity and reduce fertility. The extremely high RSC at Sites B and C (far exceeding 2.5 meq/L) indicates severe risks of soil alkalinity, potentially displacing essential nutrients and reducing yields of crops like paddy rice (Murtaza *et al.*, 2021). This aligns with Site C high carbonate (97.62 mg/L) and bicarbonate (10.12 mg/L) concentrations (Table 2). Sites B and C had high RSBC values (5.204 meq/L and 6.424 meq/L, respectively). RSBC focuses on bicarbonate role in alkalinity. Values >5 meq/L can increase soil pH, affecting nutrient availability. The high RSBC at Sites B and C is in tandem with the RSC values, indicating a significant alkalinity risk that could lead to poor crop performance if not managed with amendments like gypsum (Davis & Bush, 2025).

Kelley's ratio (KR) is a measure of the level of Na^+ in relation to Ca^{2+} and Mg^{2+}. KR of irrigation water less than 1 is considered suitable. KR > 1 indicates an excess level of Na^+ in water (Sahu *et al*., 2022). In this study, site C had the lowest KR (0.361) while site A KR (1.009) is marginally above the ideal threshold but still suitable, supporting its low SAR and sodium concentration. ESP measures sodium proportion in soil cation exchange capacity, influenced by irrigation water (Barathkumar *et al.*, 2025). Site C had the lowest ESP (1.635 meq/L) while site A had the highest ESP (3.798 meq/L). Values <15 are safe, while >15 indicate sodicity risks. The values of ESP in this study confirms its suitability for irrigation.

In soil solutions with a moisture content below 50%, potential salinity (PS) may raise the osmotic potential. PS calculates the risk associated with elevated salt concentrations caused by Cl^- and SO_4^{2-} (Taşan, 2023). High PS implies greater risk of salt accumulation in the soil after irrigation, which can affect plant growth (Demo *et al.*, 2025). In Salinity potential (PS) was divided into two groups: safe (less than 3) and unsafe (more than 3) (Al-Aizari *et al*., 2024). The mean value of PS for all samples in the study area ranged between lowest value of 87.52 meq/L in site C and highest value of 108.90 meq/L in site B. All the studied samples were unsafe for irrigation due to the dominance of chloride concentrations. Al-Aizari *et al.* (2024) reported more than 92% of water samples as unsafe due to high chloride concentration in ground water from Doukkala region in Morocco.

Table 3: Statistical Summary of Calculated Indices

Site	Descriptive Statistics	SSP (%)	SAR (meq/L)	MAR (%)	RSC (meq/L)	RSBC (meq/L)	PI (%)	KR (-)	SCAR (meq/L)	ESP (meq/L)	PS (meq/L)
A	MIN	52.409	0.715	38.731	16.700	0.660	49.647	0.213	0.655	1.044	35.360
	MAX	74.152	4.757	61.059	115.410	8.730	84.778	1.850	5.313	6.558	132.430
	MEAN	65.446	2.717	48.544	51.813	3.162	74.078	1.009	2.866	3.798	92.111
	MEDIAN	64.802	2.175	45.000	44.350	2.390	79.909	0.760	2.069	3.108	105.970
	SD	8.187	1.753	9.419	34.621	2.970	12.828	0.713	2.052	2.381	35.794
B	MIN	33.130	0.626	26.598	31.180	-2.580	32.469	0.150	0.517	0.915	41.700
	MAX	77.213	5.835	61.772	136.030	11.940	97.674	2.076	6.673	7.927	201.280
	MEAN	58.570	2.431	42.352	84.337	5.204	68.519	0.833	2.496	3.384	108.904
	MEDIAN	62.454	1.063	41.919	84.070	5.200	68.132	0.306	0.955	1.544	95.150
	SD	15.621	2.087	12.064	42.674	5.176	22.896	0.782	2.407	2.816	50.456
C	MIN	44.978	0.010	25.063	34.420	1.190	35.292	0.003	0.010	0.014	41.720
	MAX	69.036	3.023	52.338	174.150	13.610	89.083	1.068	2.888	4.269	134.510
	MEAN	53.733	1.141	40.119	101.676	6.424	61.312	0.361	1.048	1.635	87.516
	MEDIAN	50.995	0.854	36.797	95.985	7.425	54.452	0.230	0.740	1.244	96.380
	SD	8.422	1.038	8.337	51.922	4.229	19.625	0.379	1.004	1.460	31.907
*MTL		<60	<26	<50	<2.5	<5	25-75	<1	<9	<15	<3

Maximum Tolerable Limits (Adegbola *et al* 2021; Al-Aizari *et al* 2024)

Wilcox Diagram

Soluble sodium percentage (SSP) values against respective values of electrical conductivity (EC) gives the Wilcox Diagram (Figure 2) and it is used to rate the quality of irrigation water (Singh *et al.,* 2009). Based on the Wilcox's diagram of EC and SSP, water from all the locations at sites A, B, and C fall within the "Excellent to good" classification. This means that waters from these sites are good for irrigation. The low EC values at all sites align with FAO guidelines (<700 µS/cm) for sensitive crops), indicating negligible salinity risks. This supports the "Excellent to good" classification, as low EC ensures water availability for crops like paddy rice, maize, and vegetables grown at Omi Dam irrigation field. Despite Site A high SSP (65.446%), which exceeds the typical threshold of 60% for sodicity risk. The Wilcox diagram classification suggests that the combination of low EC and SSP is still within acceptable limits for most crops. Site B high SSP variation indicates potential fluctuations, but the "Excellent to good" rating implies these are not currently limiting. However, the high RSC and RSBC at Sites B and C suggest significant alkalinity risks, which could lead to soil pH increases and nutrient imbalances, potentially contradicting the Wilcox diagram optimistic classification. The diagram focuses on salinity and sodicity but does not account for alkalinity (RSC/RSBC), which may limit its application for long-term soil health.

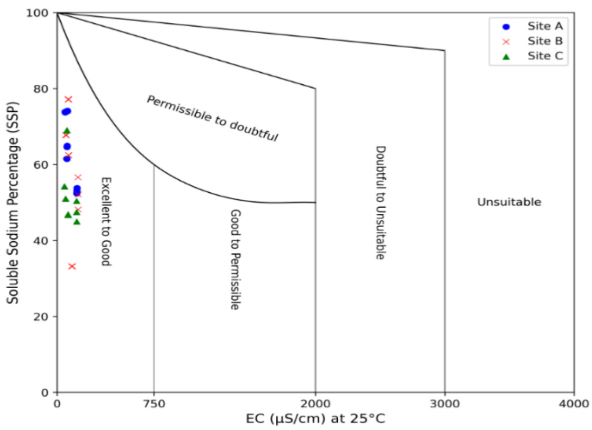

Figure 2: Wilcox Diagram

US Salinity Laboratory Diagram

Sodium adsorption ration - SAR (sodium hazard) against respective values of electrical conductivity - EC (Salinity hazard) (Figure 3) gives the US Salinity Laboratory Diagram used in rating the quality of irrigation water (Offiong & Edet, 1998). Based on the US Salinity Laboratory diagram of EC and SAR, water from all the locations fall within the "C1 (low salinity) – S1 (low sodium hazard)" category. This suggests that overall salinity and sodium levels are low, therefore water from all the sites are safe for irrigation. The C1-S1 classification indicates that Omi Dam irrigation water is safe for irrigating sensitive crops like maize, paddy rice, and vegetables, with low risks of salinity (osmotic stress) or sodicity (soil structure degradation). Site C low SAR (1.141 meq/L), KR (1.068), ESP (1.635), and sodium (1.84 mg/L) strongly support its suitability, aligning with the C1-S1 rating.

However, Site A high SSP (65.446%) suggests potential sodicity risks, as SSP >60% can reduce soil permeability, despite the S1 classification. Site B high SP and EC variation indicate long-term salinization risk. The high RSC and RSBC at Sites B and C (far exceeding FAO's safe thresholds of 2.5 meq/L and 5 meq/L, respectively) indicate severe alkalinity risks, which the USSL diagram does not address, potentially overestimating water suitability.

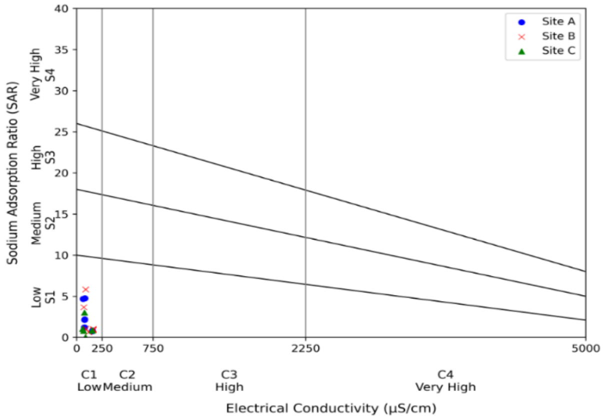

Figure 3: US Salinity Laboratory Diagram

CONCLUSION

The findings from this study showed that, the irrigation water from Omi reservoir is safe to use for crop production because the majority of quality indices fell between good and excellent. The water could be utilized on practically all soils because the ionic concentrations for the key cations and anions were within FAO limits. Wilcox diagram and US Salinity Laboratory Diagram indicate that the water is safe for production of important crops like maize, paddy rice, and vegetables, with low risks of salinity and sodicity. However, the parameters studied (phosphate, RSC, RSBC, and PS) were above the FAO guidelines, indicating severe alkalinity risks.

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