

QUALITY ASSESSMENT OF WATER FROM THREE SELECTED RIVERS IN JALINGO METROPOLIS, TARABA STATE

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ABSTRACT

This study is poised to investigate the physicochemical and bacteriological parameters of three rivers (Karofi, Nukkai and Donga) in Jalingo Metropolis, Taraba State. The parameters under study were determined following standard methods: The pH (7.20 ± 0.70 - 7.98 ± 2.40), temperature (24.5 ± 1.30 - 25.3 ± 1.30 °C), dissolved oxygen (7.38 ± 0.70 - 8.72 ± 0.56 mg/L) and key ionic indicators such as alkalinity (40 ± 3.33 - 80 ± 6.76 mg/L), total suspended solids (25 ± 0.00 - 45 ± 0.00 mg/L), electrical conductivity (102.4 ± 10.0 - 390 ± 11.32 µS/cm), chloride (101 ± 6.79 - 112 ± 9.20 mg/L), nitrite (0.00 ± 0.00 - 0.10 ± 0.00 mg/L), sulphate (4.00 ± 0.50 - 6.00 ± 0.52 mg/L) and ammonia (0.00 ± 0.00 - 0.01 ± 0.00 mg/L) were within permissible limits of World Health Organization. However, turbidity levels (46.0 ± 3.4 - 77.6 ± 4.07 NTU) were significantly elevated across all samples an indication of high particulate contamination. Phosphate concentration (17.97 ± 0.98 - 51.39 ± 4.50 mg/L) exceeded the recommended limits, suggesting nutrient loading likely linked to faecal contamination. Urea concentration was in the range of 0.16 ± 0.00 - 0.21 ± 0.00 mg/L, biochemical oxygen demand values (50 ± 1.24 - 82.5 ± 7.72 mg/L) were notably high, depicting sustained organic pollution. Total and dissolved organic carbon (TOC and DOC), BOD and COD values were also found to be above the permissible limits. Oil and grease levels were within the safe limit. Nitrate values were within the safe limit except for river Karofi that had a high value of (17.97 ± 1.24 mg/L). While arsenic, cobalt, lead and selenium were not detected, metals such as iron and aluminium were present in concentrations that may pose health risk. Chromium levels were within the safe limits except for river Karofi (2.10 ± 0.00 mg/L) value that was above the safe level. Nickel and zinc concentrations for water from the three rivers were found to be within the permissible safe limits. Manganese levels were within the safe limit except for river Donga with high value (2.10 ± 0.00 mg/L) and above the safety limit. Result of bacteriological analysis showed elevated coliform and Escherichia coli counts, with rivers (Nukkai and Donga) depicting unquantifiable levels of coliform, an indication of faecal pollution. The Canadian Council of Ministers of the Environment Water Quality Index indicates that the water from the three rivers are significantly impaired (Donga river = 31.10 %, Karofi river = 28.25 % and Nukkai river = 19.77 %) and ranked as poor. Water from any of these sources needs treatment before it can be safe for domestic use or drinking purposes.

1. Introduction

The pollution of aquatic environments by heavy metals and other contaminants has emerged as a pressing concern for both environmental and public health researchers. In urban areas such as Jalingo Metropolis in Taraba State, the degradation of river water quality can be traced to various anthropogenic sources including industrial discharges, domestic sewage, agricultural runoff, and atmospheric deposition (Ibrahim & Musa, 2022). These pollutants

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compromise the integrity of freshwater ecosystems, posing ecological threats and significant public health risks.

Water bodies play an indispensable role in sustaining life and supporting socio-economic activities such as agriculture, domestic use, fishing, and recreation. However, when contaminated by hazardous substances like trace metals, their capacity to support life and development becomes severely undermined. Heavy metals such as lead (Pb), chromium (Cr) and Mercury (Hg) in particular, are non-biodegradable and tend to accumulate in aquatic organisms and sediments, thereby posing chronic risks to both aquatic ecosystems and human populations who depend on these rivers for drinking, irrigation, and other daily needs.

Surface water pollution often leads to notable changes in the physicochemical and biological properties of aquatic systems. For instance, increased nutrient concentrations may result in eutrophication, while thermal pollution can alter water temperature and substrate composition, degrading aquatic habitats. Furthermore, the presence of toxic substances, particularly trace metals, can have acute and chronic impacts on aquatic organisms (Adewumi *et al.*, 2020; Okonkwo & Eze, 2023). The toxicity and bioavailability of these metals are further modulated by environmental variables such as pH, temperature, water hardness, dissolved oxygen, and organic matter content (Yakubu *et al.*, 2021). The situation is particularly critical in developing regions like Jalingo metropolis, Taraba State where the lack of effective waste management systems, inadequate environmental regulations, and poor public awareness contribute to the continuous degradation of water bodies. Despite various national efforts to monitor water quality in Nigeria, the data is often generalized and fails to reflect localized realities. Many studies focussed on more industrialized areas or larger river systems, while smaller but yet highly impacted rivers within urban centres remain under-investigated. This study therefore aims to assess the quality of water from three selected rivers (Karofi, Nukkai and Donga) in Jalingo Metropolis, Taraba State.

2. Material and Methods

2.1 Study Area

The study was carried out in Jalingo, the state capital of Taraba State, North-Eastern Nigeria. It is nestled in the Savannah-covered foothills of the Shebshi Mountains, about 40 km South-East of the Benue River. Jalingo has an annual average temperature of 33 °C and rainfall of 1,624,004 mm with high rainfall intensity in August. It is a moderate-sized settlement with an estimated population of about 439,059 people (Jalingo Demographic Database, 2025). The people of Jalingo are mainly farmers, civil servants, petty traders and few business owners. They are regarded as advantaged with some of the settlers having water and sanitation access. Meanwhile, a lot of the residents get their water either directly or indirectly from the three major rivers passing through the city.

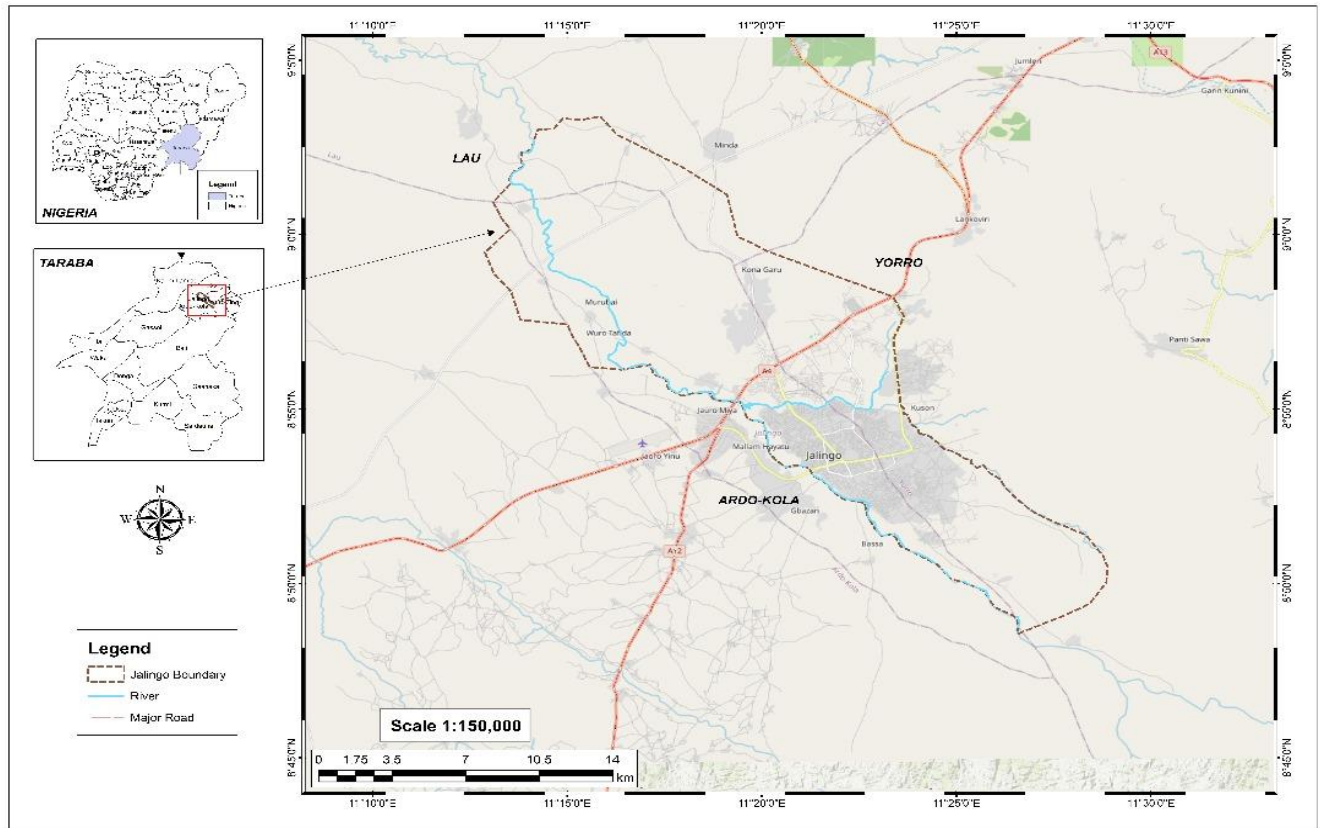


Figure 1. Map of Jalingo metropolis

2.2 Sample Collection

Water samples were collected directly from the three major rivers (Donga, Karofi and Nukkai) passing through Jalingo Metropolis, Taraba State by integrated sampling technique. The samples were collected into neatly washed 10 L containers from different points at the same time of the day. The collected samples from each of the rivers were properly mixed to obtain composite samples and then taken to the laboratory for analysis.

2.3 Laboratory Analysis

The water samples were analyzed by Spectrophotometric Technique using Modern Spectrophotometers DR 6000 HACH and DR 3900 HACH, following Standard Operational Procedures outlined by the Manufacturers' Kits.

2.4 Data Analysis

The results were analyzed using SPSS Statistical Package Version 21. All data were expressed as Mean \pm STD. The Canadian Council of Ministers of the Environment Water Quality Index was determined using Excel, version 16 following procedures adopted by CCME (2001).

3. Results and Discussion

3.1 Physicochemical Properties

The result of analysis of the levels physicochemical properties of water samples from the three rivers deployed in the study is presented in Table 1.

Table 1. Result of Analysis of the levels of Physicochemical Properties of Water Samples from the three Rivers used in the Study

S/N	Parameter	K	N	D	W.H.O(2014)/NSDWQ (2007)
1	pH	7.77 ± 2.40	7.98 ± 0.45	7.20 ± 0.70	6.5 - 8.5
2	DO (mg/L)	8.72 ± 0.56	8.6 ± 0.50	7.38 ± 0.70	7.5
3	Temperature (°C)	24.5±1.30	24.8 ± 0.98	25.3 ± 1.30	Ambient
4	Turbidity (NTU)	49.6 ± 3.05	77.6 ± 4.07	46.0 ± 3.41	5
5	Alkalinity(CaCO ₃ mg/L)	50 ± 3.65	80 ± 6.76	40 ± 3.53	120
6	TSS (mg/L)	30 ± 2.33	25 ± 0.00	45 ± 0.00	500
7	E. conductivity (µS/cm)	271 ± 10.78	390 ± 11.32	102.4 ± 10.0	1000
8	Chloride(mg/L)	110 ± 9.12	101 ± 6.79	112 ± 9.20	250
9	Ammonia(mg/L)	0.01 ± 0.00	0.0 ± 0.00	0.0 ± 0.0	0.5
10	Phosphate(mg/L)	17.97 ± 0.98	40.80 ± 3.75	51.39 ± 4.50	1
11	Nitrite (mg/L)	0.01 ± 0.00	0.0 ± 0.00	0.1 ± 0.00	3
12	Nitrate (mg/L)	52.1 ± 4.63	5.1 ± 0.20	2.2 ± 0.20	50
13	Sulphate (mg/L)	5 ± 0.46	6 ± 0.52	4 ± 0.50	200
14	Urea (mg/L)	0.16± 0.00	0.21 ± 0.00	0.19 ± 0.00	10
15	BOD (mg/L)	50 ± 1.24	66 ± 2.53	82.7 ± 7.72	6
16	COD (mg/L)	64 ± 4.54	75 ± 7.45	91 ± 6.92	10
17	TOC (mg/L)	3.92 ± 0.40	4.03 ± 0.50	3.78 ± 0.40	2
18	DOC (mg/L)	9.3±0.78	10.1±0.98	8.9±1.00	5
19	Oil and Grease (mg/L)	0.156 ± 0.00	0.2 ± 0.00	0.152 ± 0.00	10
20	Zinc (mg/L)	0.23 ± 0.00	0.30 ± 0.00	0.07 ± 0.00	5
21	Manganese (mg/L)	0.0 ± 0.00	0.0 ± 0.00	2.1 ± 0.00	0.05
22	Iron (mg/L)	0.97 ± 0.00	0.82 ± 0.00	0.49 ± 0.00	0.3
23	Lead (mg/L)	0.0 ± 0.00	0.0 ± 0.00	0.0 ± 0.00	0.05
24	Aluminium (mg/L)	0.231 ± 0.00	0.252 ± 0.00	0.364 ± 0.00	0.2
25	Chromium (mg/L)	0.210 ± 0.00	0.019 ± 0.00	0.0 ± 0.00	0.05
26	Copper (mg/L)	0.99 ± 0.00	0.76±0.00	0.23±0.00	1.5
27	Arsenic (mg/L)	ND	ND	ND	0.05
28	Cobalt (mg/L)	ND	ND	ND	0.1
29	Nickel (mg/L)	0.06 ± 0.00	0.01 ± 0.00	0.03 ± 0.00	0.1
30	Selenium (mg/L)	ND	ND	ND	0.01

*K: river Karofi, N: river Nukkai, D: river Donga, DO: Dissolved oxygen, TSS: Total suspended solids; BOD: Biochemical oxygen demand, COD: Chemical oxygen demand; TOC; Total organic carbon; DOC: Dissolved organic carbon. *ND: Not Detected

3.2 Bacteriological Properties of Water Samples from the three Rivers used in the Study

The result of the analysis of the bacteriological parameters of the water samples used in the study is presented in Table 2. The result showed that coliform ranges from (cfu/100 mL) to 105 cfu/100 mL for river Karofi while those of rivers Nukkai and Donga were too numerous to be counted (TNTC). Escherichia coli counts obtained were 30, 41 and 34 cfu/100 mL for rivers Karofi, Nukkai and Donga in that order.

Table 2. Results of Bacteriological Analysis of Water Samples used in the Study

Parameter	K	N	D	WHO (2014), NSDWQ (2007)
Coliform (cfu/100mL)	105±5.08	TNTC	TNTC	10
<i>E. coli</i> (cfu/100mL)	30±3.31	41±6.53	34±4.46	0

Table 3. Results of Canadian Council of Ministers of the Environment Water Quality Index (CCME WQI) Statistical Analysis of Physicochemical Properties of Water samples from the three rivers

S/N	River	CCME WQI (%)	Ranking	CCME, 2001
1	K	28.25		Poor water quality is almost always threatened or impaired, a departure from natural or desirable level.
2	D	31.10		Poor water quality is almost always threatened or impaired, a departure from natural or desirable level.
3	N	19.77		Poor water quality is almost always threatened or impaired, a departure from natural or desirable level.

The analysis of water samples from Karofi, Nukkai, and Donga rivers showed that pH value is in the range of 7.20 to 7.98 and within the permissible limit of 6.5 - 8.5 specified by NSDWQ, (2007). Similar pH range has been reported by Edimeh *et al.* (2011). Dissolved oxygen (DO) values were similarly within acceptable limits, ranging from 7.38 to 8.72 mg/L. Water temperature across the sites varied slightly (24.5 - 25.3 °C), which is typical for tropical surface waters. Dissolved oxygen (DO) and temperature were also within acceptable limits, ensuring suitable conditions for aquatic life. However, turbidity levels of Karofi, Nukkai and Donga were found to be 49.60, 77.60 and 46.0 NTU in that order and exceeded the threshold of 5 NTU set by NSDWQ (2007) and WHO (2014). This indicates the presence of significant suspended particulate matter likely from runoff and erosion. This finding agrees with that of Awogbemi *et al.* (2025) who reported elevated turbidity in the Shetiko River in Abuja due to human activity and rainfall-induced sedimentation. Electrical conductivity (EC) values varied significantly among the rivers: 271 μ S/cm (Karofi), 390 μ S/cm (Nukkai) and 102.4 μ S/cm (Donga) indicating different levels of dissolved ions and anthropogenic influence and is consistent with the trends observed by Ande *et al.* (2023) who worked on water samples from Pil-Gani River in Plateau State. Total suspended solids (TSS) for the three rivers had a range of 25 - 45 mg/L and within the safe limit of 50 mg/L set by NSDWQ (2007) and WHO (2014).

Alkalinity, ammonia, chloride, nitrate, nitrite, and sulphate levels were largely within NSDWQ, 2007 and WHO, 2014 safe limits. However, phosphate concentrations were significantly elevated, with values of 17.97 mg/L (Karofi), 40.80 mg/L (Nukkai), and 59.39 mg/L (Donga), far exceeding the 1.0 mg/L guideline set by WHO (2014). Elevated phosphate levels are strongly associated with nutrient loading from fertilizer runoff and domestic waste. A similar trend was reported by Onyiwalu *et al.* (2023) where high nutrient inputs led to eutrophication risks. Elevated phosphate and nitrate concentrations are known to trigger algal blooms, reduce dissolved oxygen and result in mass death of aquatic organisms (Moshoeshe and Obuseng, 2018; Agbazue *et al.*, 2015). However, Karofi river had a nitrate value of 52.1 mg/L which was slightly above the 50 mg/L safe limit set by NSDWQ (2007) and WHO (2014).

Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) were also found to be alarmingly high: BOD ranged from 50 - 82.7 mg/L and COD from 64 - 91 mg/L. These values are well above the threshold for clean water (< 6 mg/L for BOD), indicating severe organic pollution, likely from sewage or industrial discharges. The findings by Adewumi and Laniyan (2023) in mining-impacted water bodies in Northeastern Nigeria affirm our observations. Similarly, Chemical Oxygen Demand (COD) values were elevated: 64 mg/L (Karofi), 75 mg/L (Nukkai) and 91 mg/L (Donga), the high values may be as a result of intensive mining activities in Taraba State. These findings are consistent with the high organic load observed by Adewumi and Laniyan (2023) in mining-impacted waters. Total Organic Carbon (TOC) was found to be 3.92 mg/L (Karofi), 4.03 mg/L (Nukkai), and 3.78 mg/L (Donga), while Dissolved Organic Carbon (DOC) ranged from 8.9 - 10.1 mg/L. These values indicate moderate organic contamination. Oil and grease content was within acceptable limits (< 0.2 mg/L), recorded at

0.156 mg/L (Karofi), 0.2 mg/L (Nukkai), and 0.152 mg/L (Donga). Urea, often associated with agricultural runoff and sewage had values of: 0.16 mg/L (Karofi river), 0.21 mg/L (Nukkai river), and 0.19 mg/L (Donga river). These values are within safe limits but suggest potential anthropogenic input and agree with the findings reported by Soper *et al.* (2003) and Bakker (2006).

Iron concentrations were 0.97 mg/L (Karofi river), 0.82 mg/L (Nukkai river), and 0.49 mg/L (Donga river). Iron is an aesthetic contaminant and does not constitute a health hazard but has metallic taste and causes discolouration of teeth (IDPH, 2010). Zinc, lead and manganese concentrations for the rivers were within permissible levels allowed by NSDWQ (2007) and WHO (2014). However, manganese level in River Donga (2.1 mg/L) far exceeded the 0.05 mg/L limit, posing potential health risks. This agrees with the findings of Ibe and Nnorom (2023) who reported elevated manganese concentrations in urban river basins in South-Eastern Nigeria due to erosion and run off.

Aluminium levels in the three rivers (0.231- 0.364 mg/L) were above the 0.2 mg/L limit. The high concentration of aluminium in these rivers may also be due to anthropogenic activities such as incessant washing of cars or motorcycles whose body paints may likely be peeled off into the rivers, aluminium and manganese being important components of these paints. These findings are consistent with those reported by Ibe and Nnorom (2023) and Oniywalu *et al.* (2023), who reported elevated aluminium and manganese concentrations in river systems near urban and industrial centers. Aluminium in drinking water has long been associated with potential neurological risks, including a suspected link to Alzheimer's disease and dialysis-related complications. According to Jekel (1991), the presence of aluminium in water supplies has raised health concerns due to its possible role in the development of neurological disorders. Driscoll and Letterman (1988) observed that patients undergoing dialysis treatment are particularly vulnerable to aluminium toxicity, which may result in encephalopathy and bone mineralization disorders such as dialysis osteodystrophy. Supporting this, Martyn *et al.* (1989) conducted an epidemiological survey in England and Wales and reported that regions with mean aluminium concentrations exceeding 0.11 mg/L experienced Alzheimer's disease rates approximately 1.5 times higher than those in regions with concentrations below 0.01 mg/L.

The concentrations of heavy metals in the river water varied notably across the three sampling sites. Chromium concentrations in the water samples were 0.210 mg/L (Karofi River), 0.019 mg/L (Nukkai River) and undetectable (0 mg/L) for Donga River. The chromium level in water sample from Karofi River was slightly high and exceeded the NSDWQ (2007) and WHO (2014) permissible limit of 0.2 mg/L which may pose a potential health risk. In contrast, high concentrations of chromium were observed in the Pil-Gani River system in a study by Ande *et al.* (2023), who attributed the source to mining runoff and untreated wastewater. Elevated chromium levels have been linked to carcinogenic and mutagenic effects.

The levels of copper in water samples from the rivers were 0.99, 0.76 and 0.23 mg/L for Karofi, Nukkai and Donga respectively and below 1.5 mg/L permissible limit recommended by NSDWQ (2007) and WHO (2014). Arsenic, cobalt and selenium were found to be beyond detection level for all samples. Our findings agree with those reported by Oniywalu *et al.* (2023) for river Ahi. Nickel concentration for the three rivers had a range of 0.01 - 0.06 mg/L and are within the recommended safe limit of 0.1 mg/L set by NSDWQ (2007) and WHO (2014). The toxic effect of prolonged exposure to nickel causes cardiovascular diseases and renal failure which are well documented (de Souza & Silva, 2019).

The microbial analysis showed alarmingly high levels of total coliform and *Escherichia coli* (*E. coli*), rendering the water microbiologically unsafe for human consumption. Coliform bacteria, including *E. coli*, are widely recognized as indicators of fecal pollution and are commonly found in the intestines of warm-blooded animals. The abundance of these bacteria suggests significant contamination likely stemming from human activities such as open defecation and poor waste management practices, which are prevalent in the riverine areas of Jalingo metropolis. These findings are corroborated by those of Niyoyitungiye *et al.* (2020) who reported high microbial loads in surface waters exposed to anthropogenic waste.

Water quality assessment using the Canadian Council of Ministers of the Environment Water Quality Index (CCME WQI) strongly suggests that the rivers are significantly impaired (D = 31.10 % K= 28.25 %; and N= 19.77 %) and no longer meets safe standard for domestic use and human consumption.

4. Conclusion

The findings of this study underscore significant ecological and public health concerns associated with the Karofi, Nukkai, and Donga rivers in Jalingo Metropolis, Nigeria. Elevated concentrations of phosphate, biochemical oxygen demand (BOD), chemical oxygen demand (COD), and heavy metals particularly aluminium and chromium reflect increasing anthropogenic pressures on freshwater systems. These results are consistent with recent studies across Nigeria, highlighting a national trend of deteriorating surface water quality due to unregulated urbanization, agricultural runoff, and industrial effluent discharge. The presence of heavy metals at concentrations exceeding

regulatory limits poses ecotoxicological threats to aquatic organisms through bioaccumulation and potential biomagnification. These contaminants disrupt key ecosystem functions, including nutrient cycling and food web interactions, and may also drive the evolution of metal-resistant microbial communities. The high prevalence of *Escherichia coli* and total coliform in water samples signals substantial fecal contamination, likely linked to open defecation and poor sanitation infrastructure around riverine communities. This condition presents an immediate public health hazard, as it increases the risk of waterborne disease transmission. Although heavy metals are critical to various industrial and technological processes, their adverse health effects especially under chronic exposure necessitate stringent environmental monitoring and management. While clinical interventions for heavy metal toxicity exist, they are often reactive and costly. Therefore, preventive strategies, including robust regulatory enforcement, improved sanitation, and public awareness campaigns, are essential to mitigate further degradation of water resources and protect public health.

The statistical results of the Canadian Council of Ministers of the Environment Water Quality Index strongly suggest that the water from the three rivers is grossly impaired and therefore not suitable for drinking or domestic use. Mass sensitization efforts should be implemented to educate local populations on the dangers of open defecation, improper waste disposal, and unsafe water consumption. Government and civil society organizations should collaborate in launching behavioral change programmes. In addition, Taraba State Government should embark on continuous water quality monitoring programs in Jalingo and other urban centers. Policy makers should enforce standards on effluent discharge and introduce penalties for non-compliance to reduce industrial and domestic pollution of water resources.

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