Water Quality Indices of Underground Water in Bayelsa State: Physicochemical and Microbiological Assessment

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Abstract- This study assessed the physicochemical and microbiological parameters of underground water sources in Ibelebiri and Otuasega towns, Ogbia Local Government Area, Bayelsa State, Nigeria. Water samples were collected from boreholes and wells and analyzed using standard methods for pH, electrical conductivity (EC), total dissolved solids (TDS), chloride, nitrate, sulphate, carbonate, and microbial load. The Water Quality Index (WQI) was computed for both locations. Results showed that Ibelebiri had higher levels of EC (411.4 µS/cm), TDS (27.64 mg/L), chloride (67.84 mg/L), and carbonate (17.28 mg/L) compared to Otuasega (EC 186.96 µS/cm, TDS 123.18 mg/L, chloride 38.56 mg/L, carbonate 9.6 mg/L). WQI scores indicated poor water quality in Ibelebiri (40) and marginal quality in Otuasega (50). Microbiological analysis revealed elevated microbial load, suggesting contamination. The study concludes that underground water in these communities is unsuitable for direct human consumption without treatment and recommends community-based water safety interventions.

Index Terms- Water quality index, groundwater, borehole, well water, public health.

I. INTRODUCTION

Water is a critical natural resource that underpins human health, agricultural productivity, and industrial development. However, anthropogenic activities such as oil exploration, artisanal refining, and improper waste disposal threaten the quality of groundwater, particularly in resource-dependent regions like the Niger Delta (Akpofure, 2020). The United Nations estimates that nearly one billion people in developing countries lack access to safe drinking water, with groundwater serving as the main source in many rural communities (WHO, 2021).

The Water Quality Index (WQI) is widely recognized as a robust tool for simplifying complex datasets into a single, interpretable metric that reflects the overall quality of water (Tirkey et al., 2015). WQI has been applied in diverse settings to assess suitability of water for human consumption, agriculture, and industrial use (Bharti & Katyal, 2011). In Nigeria, studies highlight increasing groundwater contamination due to industrial effluents and oil-related activities (Ugwuadu et al., 2019).

This research focused on two rural communities, Ibelebiri and Otuasega, in Bayelsa State, aiming to: (i) analyze the physicochemical properties of borehole and well water, (ii) assess microbiological loads, and (iii) compute WQI scores to determine water suitability for consumption.

II. MATERIALS AND METHODS

Study Area

Ibelebiri and Otuasega are located in Ogbia LGA of Bayelsa State, a region characterized by low-lying terrain, high rainfall, and dependence on boreholes and wells for domestic water.

Sample Collection

Water samples were collected from five boreholes and five wells in each town. Sterile plastic containers were used for physicochemical parameters, while sterile glass bottles were used for microbiological analysis. Collection, preservation, and transport followed APHA (2017) guidelines.

Physicochemical Analysis

Parameters measured included pH, EC, TDS, chloride, sulphate, carbonate, nitrate, and DO. Standard methods such as titration and spectrophotometry were employed (APHA, 2017).

Microbiological Analysis

Total coliform and Escherichia coli counts were determined using the multiple tube fermentation technique and selective agar methods.

WQI Calculation

WQI was calculated using the weighted arithmetic index method (Breaban & Paiu, 2014). Parameters were assigned relative weights, sub-indices were computed, and aggregate scores were derived.

Data Analysis

Data were analyzed using SPSS 25.0. Descriptive statistics and independent sample t-tests were used to compare differences at $p<0.05$.

III. RESULTS

Physicochemical Properties

- Ibelebiri: pH 9.64, EC 411.4 µS/cm, TDS 27.64 mg/L, chloride 67.84 mg/L, carbonate 17.28 mg/L.
- Otuasega: pH 9.15, EC 186.96 µS/cm, TDS 123.18 mg/L, chloride 38.56 mg/L, carbonate 9.6 mg/L.

Elevated EC and chloride in Ibelebiri exceeded WHO (2021) limits.

Microbiological Load

Both locations showed total coliform presence. Ibelebiri had higher counts (>100 CFU/mL) compared to Otuasega (~50 CFU/mL).

Water Quality Index

- Ibelebiri: WQI = 40 (poor quality).
- Otuasega: WQI = 50 (marginal quality).

IV. DISCUSSION

Results indicate poor to marginal water quality in both towns. Elevated chloride and EC in Ibelebiri suggest hydrocarbon and salt infiltration from artisanal refining, consistent with findings by Ben-Eledo et al. (2017). Microbiological contamination confirms vulnerability to waste infiltration, corroborating Hunter et al. (2010), who linked diarrheal disease to unsafe water in developing nations.

The WQI categorization demonstrates that both communities' water is unsafe for direct consumption, necessitating treatment interventions. These findings align with similar studies in the Niger Delta, which highlight artisanal refining as a major contaminant source (Nwineewi et al., 2019).

CONCLUSION AND RECOMMENDATIONS

Groundwater in Ibelebiri and Otuasega is unsafe for drinking due to poor physicochemical balance and microbial contamination. Recommendations include:

1. Installation of community-based water treatment systems.
2. Enforcement of environmental regulations on artisanal refining.
3. Regular groundwater monitoring.
4. Health education on hygiene.

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