Assessment of Selected Physicochemical Parameters of Selected Rivers around Umudim Nnewi, Anambra State Nigeria and its Environs in 2024

Obasi K. Ojo[1]*; Nwazunku A. Austine[1]; Chukwu Catherine I.[1]; Ede Alison O.[1]; Okereke Eric. E.[1]; Eze Peter M.[1]; Anunonwu C. C. Okereke[2]; Iwuoha Greg[2]; Okonji N. L.[1]; Eze E. Goodness[1]; Okonkwo Celestine I.[1]

[1]Department of Environmental Health Science, College of Health Sciences and Technology, Nnewi Campus, Nnamadi Azikiwe University, Awka, Nigeria.

[2]Department of Public Health, Federal University of Technology, Owerri, Nigeria.

***Corresponding Author**

DOI: https://dx.doi.org/10.47772/IJRISS.2024.8080322

Received: 14 August 2024; Accepted: 29 August 2024; Published: 23 September 2024

ABSTRACT

Background: Water pollution poses a significant threat to public health globally, with negligent disposal of industrial effluents and waste contributing to water quality degradation, particularly in metropolitan regions like Umudim Nnewi, Nigeria. Aim: To evaluate the physicochemical parameters (Total Dissolved Solids, pH, Temperature, and Electrical Conductivity) of rivers surrounding the industrial estate in Umudim Nnewi. **Materials and Methods:** This cross-sectional quantitative study employed convenience sampling, collecting water samples from five rivers. Measurements were taken using a Four Parameter water quality analyzer to determine Total Dissolved Solids, pH, Temperature, and Electrical Conductivity. Descriptive statistics summarized the data, and paired sample t-tests analyzed the results (μ = 0.05). **Results:** Total Dissolved Solids ranged from 9.50-59.50 mg/L, pH from 4.10-5.65, Temperature from 27.45°C-28.70°C, and Electrical Conductivity from 51.67 μS/cm. Physicochemical parameters significantly deviated from World Health Organization standards ($p < 0.05$), with pH showing the most significant variation. **Conclusion:** This study highlights the significant variation in physicochemical parameters, emphasizing the need for effective wastewater management and pollution control measures to protect public health and the environment.

Keywords: Water pollution, WHO, Total Dissolved Solids, pH, Temperature, Electrical Conductivity.

INTRODUCTION

Water, covering 71% of the Earth's surface, is a vital component of the environment and essential for life. Its unique properties make it an excellent solvent, crucial for human health, industrial processes, cooking, and the global economy (Bhat, 2014). Surface water, comprising 71% of the Earth's surface, plays a vital role in the hydrologic cycle, replenished by precipitation and evaporating into the atmosphere. However, rapid industrialization and urbanization have severely degraded water quality, posing a significant environmental and health risk worldwide (WHO, 2019; Lenart-Boroń et al., 2016). The degradation of surface water quality due to industrial effluents has severe consequences, including threats to human health through waterborne diseases, environmental damage to aquatic ecosystems, economic impacts on industries and communities, and limitations on water resources for future generations. This study's findings will contribute to informing policy decisions on wastewater management and pollution control, developing strategies for sustainable industrial practices, and raising awareness among industries, policymakers, and the public about the importance of protecting water resources. The main culprits behind surface water pollution are effluents from industrial and municipal sewage treatment plants (Nnane et al., 2011; Lenart-Boroń et al., 2016), discharge of industrial waste into water bodies, lack of proper waste disposal facilities in industries (World Health Organization, 2017) and uncontrolled waste disposal, particularly in developing countries like Nigeria. In developing countries like Nigeria and Nnewi as an industrial hub, industries may release untreated wastewater into water bodies, threatening the safety of surface and groundwater for human consumption. This highlights the urgent need for effective wastewater treatment and management, strict regulations and enforcement, and sustainable practices to protect water resources and public health. The discharge of untreated industrial effluents into water bodies poses a significant threat to human health, as these effluents contain hazardous and toxic substances (Rajaram & Ashutosh, 2008; Ukah et al., 2018). Industrial effluents have been found to exceed normal levels in various parameters, including temperature, pH, total dissolved solids (TDS), electrical conductivity (EC), and heavy metal contents such as Chromium, Iron, Manganese, Lead, Nickel, and Zinc (Singh, 2014). Globally, approximately 80% of wastewater is released into the environment without adequate treatment (United Nations, 2017), affecting at least 2 billion people who use contaminated water (World Health Organization, 2019). Water-related diseases are estimated to cause between 1.6 and 12 million deaths annually (Gleick, 2002; Troeger et al., 2018; Xagoraraki & O'Brien, 2020). This study aims to assess the physicochemical parameters (TDS, pH, EC, and temperature) of surface water around the industrial estate in Umudim Nnewi and its surrounding areas.

MATERIALS AND METHOD

This study utilized a cross-sectional quantitative design to investigate surface water quality in Umudim and Okofia, Nnewi-North Local Government Area, Anambra State. Purposive sampling was employed to collect water samples from five rivers: Ele, Ukwaka, Ubu, Fada, and Olugbu, situated near industrial estates in Umudim and Okofia. Samples were collected using 1.5-liter glass beakers at two points: Point A (effluent entry point) and Point B (50 meters downstream). This yielded a total of 20 samples from the five rivers.

Physicochemical parameters (total dissolved solids, pH, temperature, and electrical conductivity) were measured in situ using a multi-parameter instrument. Three readings were taken, and the mean value recorded. Sample t-tests analyzed significant differences between the measured parameters and World Health Organization standards, with a significance level set at $\alpha = 0.05$. Results were presented in tables.

RESULTS

Table 1 presents the mean values of physicochemical properties of water samples collected from five rivers (Ele, Fada, Olugbu, Ubu, and Ukwaka) at two points: Upper Point and Lower Point. The mean Total Dissolved Solids (TDS) values ranged from 36.00 mg/L (Ele River, Upper Point) to 59.50 mg/L (Ukwaka River, Lower Point). The Ukwaka River had the highest mean TDS values at both points, while the Ubu River had the lowest values. The mean pH values ranged from 4.10 (Ubu River, Lower Point) to 5.65 (Ele River, Lower Point), indicating acidic conditions in all rivers. The Ubu River had the lowest mean pH values at both points. The mean Electrical Conductivity (EC) values ranged from 0.00 µS/cm (Ubu River, both points) to 0.07 µS/cm (Fada and Ukwaka Rivers, both points). The Fada and Ukwaka Rivers had the highest mean EC values at both points. The mean Temperature values ranged from 27.45°C (Ele River, Lower Point) to 28.70°C (Ukwaka River, Upper Point), with minimal variations across rivers and points. These mean values indicate significant variations in physicochemical properties across the five rivers, with some parameters exceeding recommended standards. The Ubu River showed the most concerning values, with high acidity and low TDS and EC values, while the Ukwaka River had high TDS and EC values, indicating potential water pollution.

Table 2 compares the mean values of these parameters with World Health Organization (WHO) standards. One-sample t-tests revealed significant differences between the river water parameters and WHO standards: Table 2 presents the comparison of mean physicochemical parameter values with World Health Organization (WHO) standards. The parameters include Total Dissolved Solids (TDS), pH, Temperature (TEMP), and Electrical Conductivity (EC). The mean TDS values at both Upper (44.80 ± 16.15 mg/L) and Lower (42.40 ± 20.50 mg/L) points exceeded the WHO standard of 500 mg/L, indicating significant deviations ($p < 0.001$). The mean pH values at both Upper (5.06 ± 0.48) and Lower (5.06 ± 0.58) points fell below the WHO standard range of 6.5-8.5, indicating acidic conditions ($p = 0.003$ and $p = 0.005$, respectively). The mean Temperature values at both Upper (28.14 ± 0.41°C) and Lower (27.96 ± 0.46°C) points differed significantly from the ambient temperature ($p < 0.001$). The mean EC values at both Upper (0.042 ± 0.030 µS/cm) and Lower (0.038 ± 0.028 µS/cm) points exceeded the WHO standard of 1000 µS/cm, indicating significant deviations ($p < 0.001$). These results indicate that the physicochemical parameters of the river water samples deviate significantly from WHO standards, highlighting potential water quality issues and health risks.

Table I Parameter Readings of physicochemical Properties from Four Parameter Instrument.

Physicochemical Properties	**Rivers / points**	**Ele River**	**Fada River**	**Olugbu River**	**Ubu River**	**Ukwaka River**
Total Disolved solid **TDS (mg/L)**	Upper Point	36.00	54.50	54.50	20.50	58.50
	Lower Point	35.50	53.50	54.00	9.50	59.50
pH **(acidic-alkaline) 0-14**	Upper Point	5.50	5.05	5.25	4.25	5.25
	Lower Point	5.65	5.10	5.20	4.10	5.25
Electrical Conductivity (**EC**) **(µS/cm)**	Upper Point	0.03	0.07	0.04	0.00	0.07
	Lower Point	0.03	0.07	0.03	0.00	0.07
Temperature(**TEMP**) **°C (Celsius) / °F (Fahrenheit)**	Upper Point	28.20	28.20	27.55	28.05	28.70
	Lower Point	27.45	28.65	27.85	27.70	28.15

Table II Difference between Total Dissolved Solids, pH Level, Electrical Conductivity and Temperature of the Water around the Industrial Estate and W.H.O Standard

Variables	**WHO Standard**	**Points**	**mean±SD**	**t**	**P**
TDS	500	Upper	44.80±16.15	-63.010	<0.001
		Lower	42.40±20.50	-49.925	<0.001
pH	6.5-8.5	Upper	5.06±0.48	-6.707	0.003
		Lower	5.06±0.58	-5.590	0.005

TEMP.	Ambient	Upper	28.14±0.41	17.067	<0.001
		Lower	27.96±0.46	14.341	<0.001
EC	1000	Upper	0.042±0.030	-75806.620	<0.001
		Lower	0.038±0.028	-80579.234	<0.001

DISCUSSION

Industrial effluents harm water quality and human health, causing river pollution, harming aquatic life, and contaminating plants (Ukah et al., 2018). The consequences are dire: harmful algal blooms, reduced oxygen levels, and increased risk of cancer and neurological damage. This study explores the devastating impact of industrial effluents on the environment and public health, highlighting the urgent need for effective wastewater treatment, regulation enforcement, and sustainable industrial practices. The high TDS values (>500 mg/L) suggest contamination from industrial or agricultural activities (Troeger et al., 2018). Acidic pH values (<6.5) may harm aquatic life and indicate organic pollution (Xagoraraki & O'Brien, 2020). Elevated EC values (>1000 μS/cm) indicate ionic contamination, potentially harmful to humans and aquatic life (Lenart-Boroń & Murgul, 2016). The results indicate significant deviations from WHO standards for physicochemical parameters in the surface water of five rivers around the industrial estate in Nnewi, Nigeria (WHO, 2017). High levels of TDS, acidity, EC, and thermal pollution have implications for human health and the environment (Gleick, 2019; Troeger et al., 2018). Exceedance of WHO standards for TDS and EC suggests harmful dissolved substances and ionic compounds, while acidity levels in Ubu River can harm aquatic organisms and human health (Xagoraraki & O'Brien, 2020). Thermal pollution in all five rivers can alter aquatic ecosystems, affecting species distribution and abundance (Gleick, 2019). The findings align with recent studies highlighting water quality issues in rivers due to industrial, agricultural, and domestic activities (Ukah et al., 2018; Singh et al., 2020).

The significant differences between river water parameters and WHO standards highlight the need for:

1. Improved wastewater treatment and management practices (Singh, 2019).
2. Enhanced regulatory enforcement (United Nations, 2017).
3. Public awareness and education (WHO, 2019).
4. Sustainable industrial practices (Xagoraraki & O'Brien, 2020).

The findings have implications for:

1. Human health: Exposure to contaminated water can lead to waterborne diseases (Troeger et al., 2018).
2. Aquatic ecosystems: Changes in water quality can impact biodiversity and ecosystem services (Gleick, 2019).
3. Economic development: Water pollution can affect industrial processes and agricultural productivity (United Nations, 2017).

Addressing these concerns requires collective efforts to mitigate the environmental and health impacts of industrial effluents and promote a cleaner and healthier environment.

CONCLUSION

The findings of this study indicate that the most striking significant value is the pH of the water samples from the five rivers, with upper point and lower point average values of 5.06, and standard deviations of 0.48 and 0.58, respectively. Moreover, significant differences were observed between the values of physicochemical parameters (total dissolved solids, pH, temperature, and electrical conductivity) of the current study and those recommended by the World Health Organization. These results suggest that the discharge of effluents from industries into the surrounding rivers is likely the primary cause of the deviations from WHO standards. The acidity levels observed in this study can harm aquatic organisms and affect human health. This study highlights the urgent need for corrective actions to address water pollution in the study area and other industrial areas. Improved wastewater management, regulatory enforcement, public awareness, and sustainable industrial practices are essential to protect water resources and ensure sustainable development. We recommend: 1) Implementing regular water quality monitoring programs, 2) Enforcing stricter regulations on industrial effluent discharge, and 3) Promoting sustainable industrial practices through incentives and education. These recommendations aim to mitigate the environmental and health impacts of industrial effluents and promote a cleaner and healthier environment. By addressing these concerns, we can ensure the protection of water resources, public health, and the environment, ultimately achieving sustainable development in the region.

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