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ASSESSING SOME PHYSICAL AND CHEMICAL CHARACTERISTICS OF LUUBARA CREEK IN NIGER DELTA, NIGERIA

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ABSTRACT: *Water quality and biodiversity impacts are influenced by the physical and chemical properties of water. An annual study was carried out in Luubara Creek, located in the Khana Local Government Area of Rivers State, Nigeria, spanning from April 2022 to March 2023. Throughout the study period, the water temperature in Luubara Creek fluctuated between 24.50 and 30.20 ºC, with an average of 27.17±1.39 ºC. Noteworthy variations were observed among stations 1, 2, 3, and 4. Over the course of the investigation year, the pH levels in Luubara Creek ranged from 6.16 to 0.55, indicating a tendency towards neutrality or acidity. The PH levels at the four stations (Wiiyaakara, Luubara, Duboro, and Bane) gradually transitioned from acidic to neutral, except for Station 4 (Bane). The average dissolved oxygen content was 4.68±1.56 throughout the study, with a statistically significant difference observed at Station 4 (p<0.05). The mean conductivity of the creek during the study was 27.69 s/cm. The total alkalinity of the creek ranged from 5.23 to 84.74, with a mean value of 11.60±1.01. Station 1 exhibited a total alkalinity mean of 14.13± 3.54, while stations two, three, and four showed values of 8.03±1.61, 7.52±1.81, and 17.21±7.39, respectively. Phosphate levels at Station 1 ranged from 0.05–0.25, whereas at Stations 2, 3, and 4, they varied from 0.01–0.24, 0.05–0.15, and 0.07–0.25. The nitrate concentration during the study period was 0.54±0.46, with Station 1 recording a mean of 0.62±0.10, and Stations 2, 3, and 4 showing values of 0.48±0.30, 0.51±0.48, and 0.55±0.38, respectively. Both phosphate and nitrate levels fell within the recommended range set by SON.*

KEYWORDS: Niger Delta Creek, Water Quality, Biodiversity, Physicochemical Characteristics.

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INTRODUCTION

The physical and chemical characteristics of water reflect the condition, productivity, and sustainability of the water body (Akintola et al., 2011). Mustapha (2008) suggested that changes in these characteristics provide valuable information about water quality and its impact on the functionality and biodiversity of an aquatic ecosystem. Ewuzie et al. (2021) emphasized that the primary sources of water in the South-South region of Nigeria are boreholes, shallow wells, creeks, and rivers, and studies have been conducted on their water qualities (Owoyemi et al., 2019; Ihunwo et al., 2020; Ocheli et al., 2020; Owamah, 2020). Research in the South-West focused on rivers, lagoons, ground waters, lakes, and streams (Odukoya et al., 2017; Ezemonye et al., 2019; Ebele et al., 2020; Gbadebo, 2020; Ogunbanwo et al., 2020), while studies in the South-East region evaluated the physicochemical factors of ground waters such as dug-wells, boreholes, springs, streams, and lakes, with few studies on rivers (Chukwuka et al., 2019; Egbueri et al., 2019; Alum & Okoye, 2020; Ewuzie et al., 2020; Naganje et al., 2020). In Nigeria, there has been a keen interest in assessing and monitoring water quality, particularly in the areas of physico-chemical characteristics, bacteriological factors, and more (Beshiru et al., 2018; Afonne et al., 2020; Alum & Okoye, 2020; Bello et al., 2020; Egbueri, 2020; Ewuzie et al., 2020; Adesakin et al., 2020; Bamigboye et al., 2020). However, this study will not examine bacteriology.

Local researchers in the Niger Delta and Nigeria at large have assessed the status of surface waters using physico-chemical characteristics and have indicated that their qualities are compromised (Jonah et al., 2020; Jonah et al., 2023b). They have highlighted that the values exceed WHO recommendations and are inherently harmful to aquatic organisms. These environmental and fisheries experts have deliberated in their reports and proposed solutions to address the aquatic challenges. Therefore, this study aims to evaluate specific physical and chemical characteristics to contribute to the existing data on these factors.

MATERIALS AND METHODS

The Study Area

The research was conducted in Luubara creek in Khana Local Government Area of Rivers State, Nigeria, from April 2022 to March 2023 (Figure 1). The creek is located between longitudes 7015//E–7032//E and latitudes 4°321–4°37//N in the eastern part of the Niger Delta (Gbarakoro et al., 2014). Luubara creek experiences a climatic cycle of wet and dry seasons. The wet season sees an annual rainfall ranging from 160 mm to 300 mm (Ibim & Owhonda, 2017), while the dry season occasionally receives precipitation every month of the year (Gbarakoro et al., 2014; Ibim & Owhonda, 2017), indicating that the area is within the humid tropical zone (Gbarakoro et al., 2014). The creek consists of brackish water and freshwater areas. The brackish water section features typical mangrove vegetation, including *Rhizophora racemosa*, *Avicennia germinans*, and *Leguncularia racemosa* (Deekae, 2009; Zabbey & Malaquias, 2013; Zabbey & Tanee, 2016), which are characteristic of West African macrophytes (Okyere, 2015; Okyere et al., 2018, 2020). The vegetation in Luubara creek represents the prototype of the Niger Delta vegetation, as stated by Ibim and Owhonda (2017). Examples of macrophytes in the freshwater area include Cocos species, *Elaeis guineensis*,

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Nymphae lotus, *Lemna spp*, and *Raffia spp*. These fundamental characteristics of the creek make fishing one of the primary activities in the major settlements.

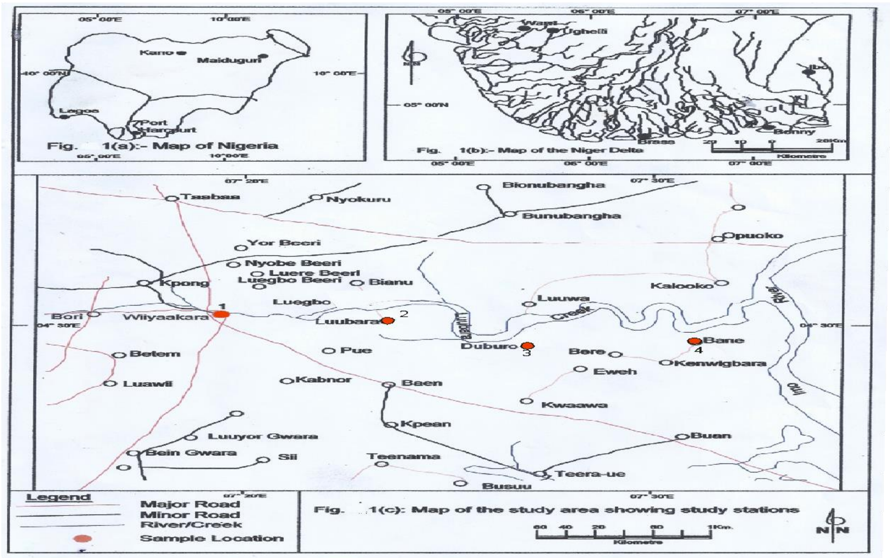

Figure 1: Map of Luubara creek showing study stations.

Physicochemical Parameter of the Water

Water quality was monitored for Temperature (°C), pH, Dissolved oxygen (mg/l), Salinity (‰) and Electrical conductivity (µS/cm) using a Hanna multimeter in-situ. Water samples were collected and taken to the Department of Fisheries and Aquatic Environment Laboratory for alkalinity (mg/l), Phosphate (mg/l), and nitrate (mg/l) analysis, employing APHA (2013) standards.

STATISTICAL ANALYSIS

Physicochemical data were presented as mean ± STD for n=2 and analyzed using one-way ANOVA. T-test was used to compare seasonal variation between the dry and wet seasons of the creek's physicochemical parameters.

RESULTS AND DISCUSSION

The water temperature at Luubara Creek during the study ranged from 24.50–30.20°C with a mean value of 27.17±1.39 (Table 1). The highest temperature occurred in January 2023 and the lowest in September 2022. Significant differences at $p<0.05$ were observed between Stations 1 and 3, and 4 and 3 (Table 1).

The pH of Luubara creek during the study ranged between 6.16 ± 0.55, indicating a shift from acidic to neutral. The four stations: Wiiyaakara, Luubara, Duboro, and Bane, represented as Stations 1, 2, 3, and 4, showed a gradual change from acidic to neutral in pH, except for Station

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4 (Bane). Table 2 illustrates the seasonal mean variation of the creek's pH and significant differences at $p<0.05$.

The overall dissolved oxygen means of 4.68±1.56 (Table 4.9) was recorded during the study, with station means in Table 1. The analysis shows a significant difference at $p<0.05$ in Station 4. The lowest dissolved oxygen value was recorded in August and October 2022, while the highest was recorded in December of the same year.

Stations 1, 2, and 3 in the study area showed an annual zero salinity content, indicating that the creek is freshwater. However, Station 4 showed variability in salinity content, with the highest value of 7.10 ‰ in January 2023 and the lowest of 2.4 ‰ in May 2022.

The creek's conductivity ranged between 10.00 and 759.35 µs/cm, with a mean of 27±19.69 µs/cm during the study (Table 4.9 and Appendix 8). Station 1 had 18.75±11.16 µs/cm, while Stations 2, 3, and 4 recorded 19.24±9.81, 28.19±19.58, and 45.36±23.15 µs/cm, respectively. Station 4 significantly differed from Stations 1, 2, and 3 (Table 1). The lowest conductivity of 10.00 µs/cm was recorded in January 2023, depicting the dry season, while the highest conductivity of 79.35 µs/cm was recorded in September, also during the dry season.

The total alkalinity of the creek fell within the range of 5.23–84.74, with a mean value of 11.60±1.01 (Table 1). Station 1 had a total alkalinity mean of 14.13±3.54, while Stations 2, 3, and 4 had means of 8.03±1.61, 7.52±1.81, and 17.21±7.39, respectively (Table 1). Stations 1 and 3 showed high alkalinity ranges, with Station 1 reaching 84.74 in March 2023, while Station 3 had the lowest at 5.00 in April.

Phosphate concentration in the creek over the year ranged between 0.05 and 0.25, with Station 1 showing a range of 0.05–0.25, and Stations 2, 3, and 4 showing 0.01–0.24, 0.05–0.15, and 0.07–0.25, respectively. Station 2 recorded the lowest phosphate value of 0.01, while Stations 1, 3, and 4 recorded higher values. Table 2 shows the seasonal variation of phosphate in the creek and significant differences at $p<0.05$.

The nitrate concentration in the creek during the study had an overall mean range of 0.54±0.46. Station 1 had a nitrate mean of 0.62±0.10, while Stations 2, 3, and 4 ranged between 0.48±0.30, 0.51±0.48, and 0.55±0.38, respectively. Station 4 had the highest nitrate value in October 2022, followed by Station 2 with 0.90 in September 2022, while Station 3 had the lowest at 0.04 in December 2022 and January 2023.

Table 1: Spatial Variations of the Physicochemical Characteristics of Luubara Creek

Parameters	**Stations**				**Overall**
	1	**2**	**3**	**4**	
Water Temp (°C)	27.16±1.30^{a}	26.95±1.31^{a}	27.00±1.53^{a}	27.61±1.37^{a}	27.17±1.39
pH	6.10±0.60^{b}	6.16±0.50^{ab}	6.43±0.57^{a}	5.95±0.39^{b}	6.16±0.55
Alkalinity (mg/L)	14.13±3.54^{ab}	8.03±1.61^{b}	7.52±1.81^{b}	17.21±7.39^{a}	11.60±1.01
Conduc. (µs/cm)	18.75±11.16^{b}	19.24±9.87^{b}	28.19±19.58^{b}	45.36±23.15^{a}	27.58±19.69
DO (mg/l)	5.03±0.78^{a}	5.11±0.80^{a}	4.98±2.29^{a}	3.50±1.28^{b}	4.68±1.56

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Salinity (‰)	0.06±0.01^{b}	0.063±0.10^{b}	0.024±0.03^{b}	4.75±1.91^{a}	1.15±0.18
Phos. (mg/L)	0.17±0.02^{a}	0.11±0.08^{ab}	0.067±0.031^{b}	0.15±0.07^{a}	0.12±0.00
Nitrate (mg/L)	0.62±0.10^{a}	0.48±0.30^{a}	0.51±0.48^{a}	0.55±0.38^{a}	0.54±0.46

Means with different superscripts in the same rows are significantly different at $p<0.05$

Table 2: Seasonal Variations of Physicochemical Parameters in Luubara Creek

Parameters	**Seasons**	
	Dry Season Mean ±SD	**Wet Season Mean ±SD**
Water Temperature (° C)	28.05±0.92^{a}	26.33±1.24^{b}
pH	6.09±0.54^{a}	6.23±0.56^{a}
Alkalinity (mg/L)	14.06±1.91^{a}	9.25±5.56^{b}
Conductivity (μs/cm)	22.59±15.71^{b}	32.43±21.93^{a}
DO (mg/L)	5.05±1.64^{a}	4.33±1.40^{b}
Salinity (‰)	1.17±0.27^{a}	1.12±0.25^{a}
Phosphate (mg/L)	0.11±0.007^{a}	0.13±0.12^{a}
Nitrate (mg/L)	0.53±0.49^{a}	0.55±0.44^{a}

Means in the same rows with different superscripts are significantly different at $p<0.05$

Figures 2 to 9 shows the temporal variation of the physicochemical parameters in Luubara Creek.

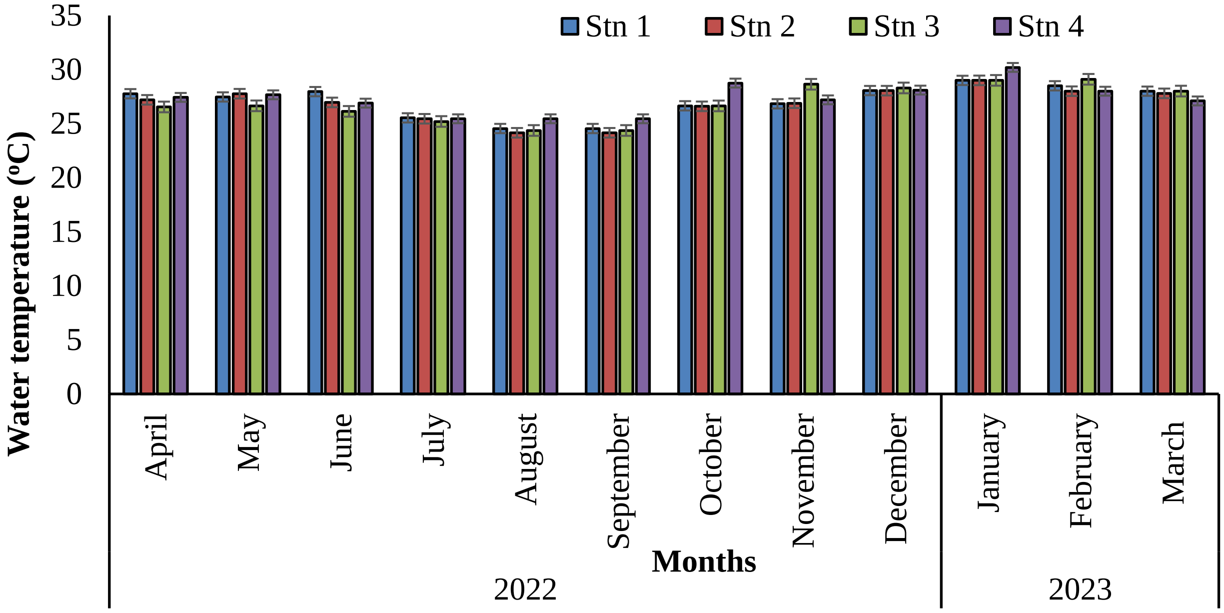

Figure 2: Temporal variation of water temperature in Luubara Creek

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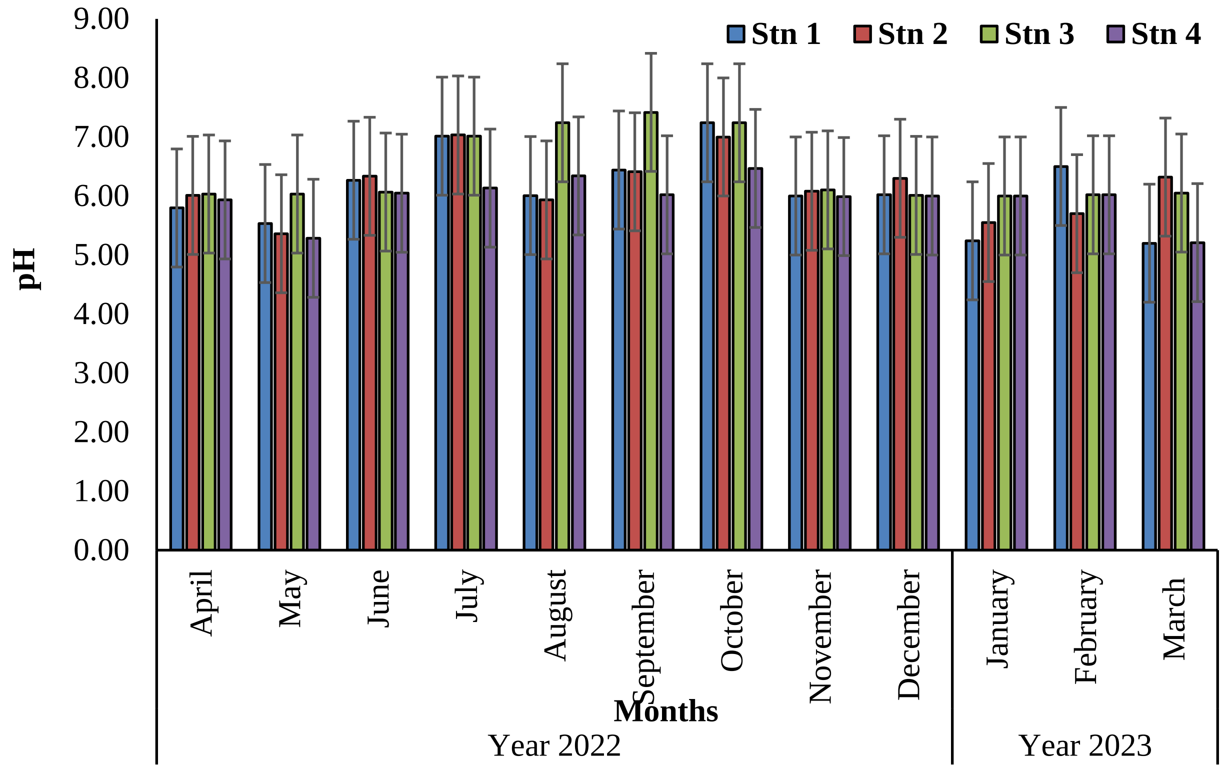

Figure 3: Temporal variation of pH in Luubara Creek

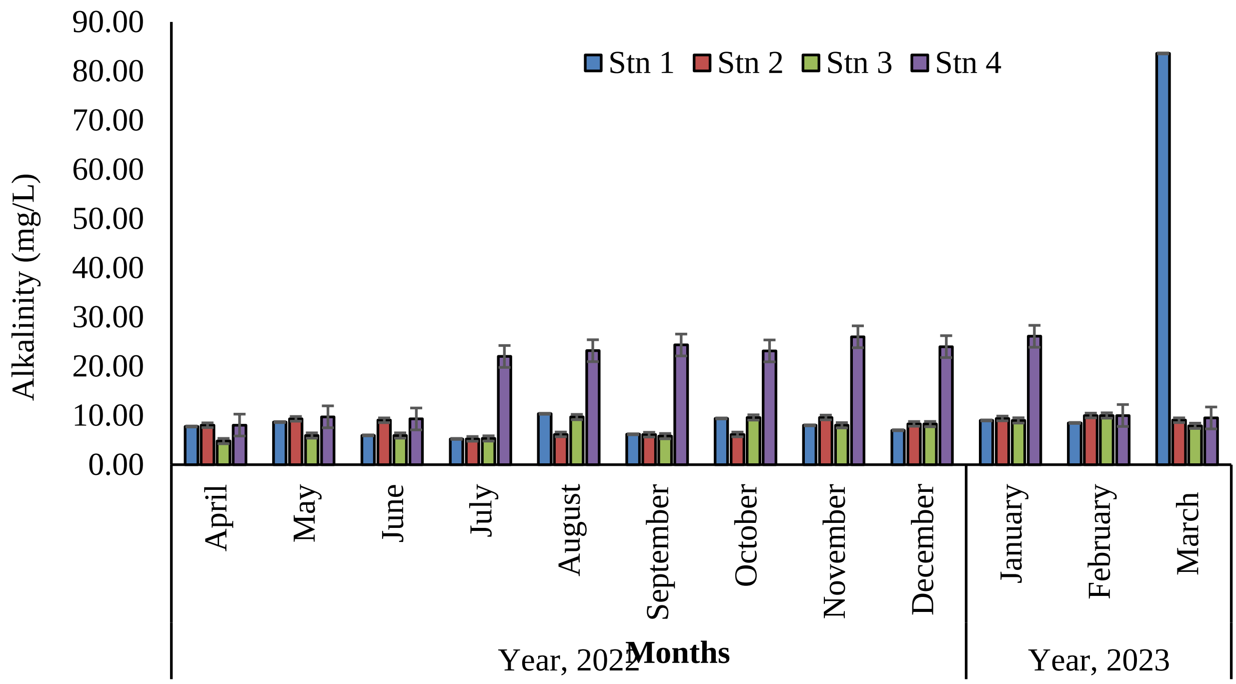

Figure 4: Temporal variation of alkalinity of Luubara Creek

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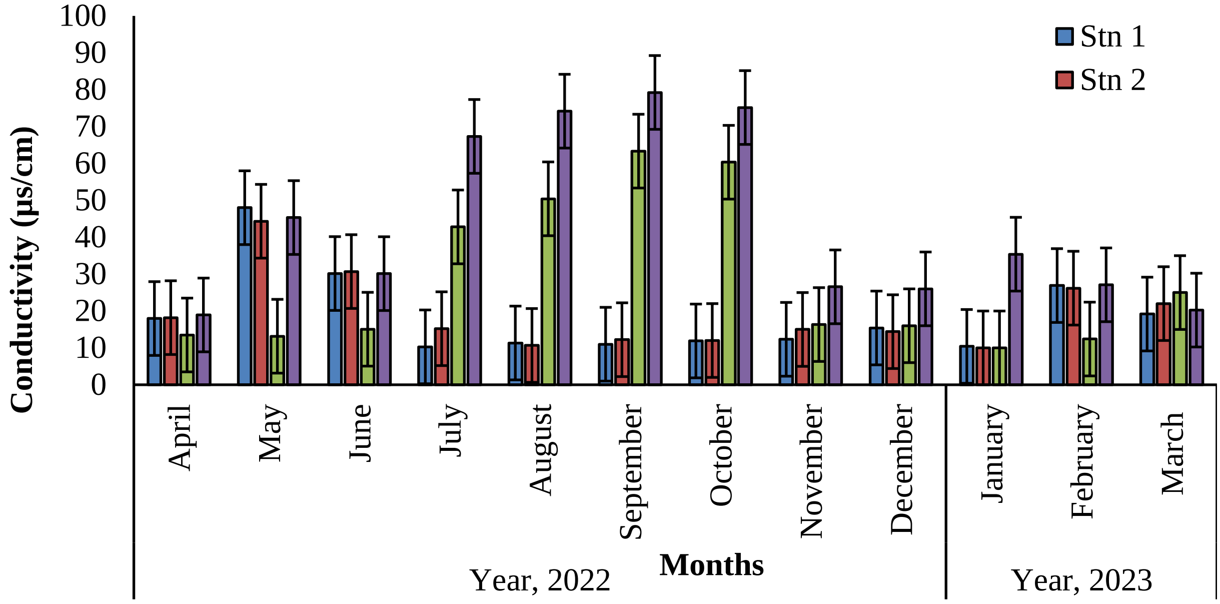

Figure 5: Temporal variation of conductivity in Luubara Creek

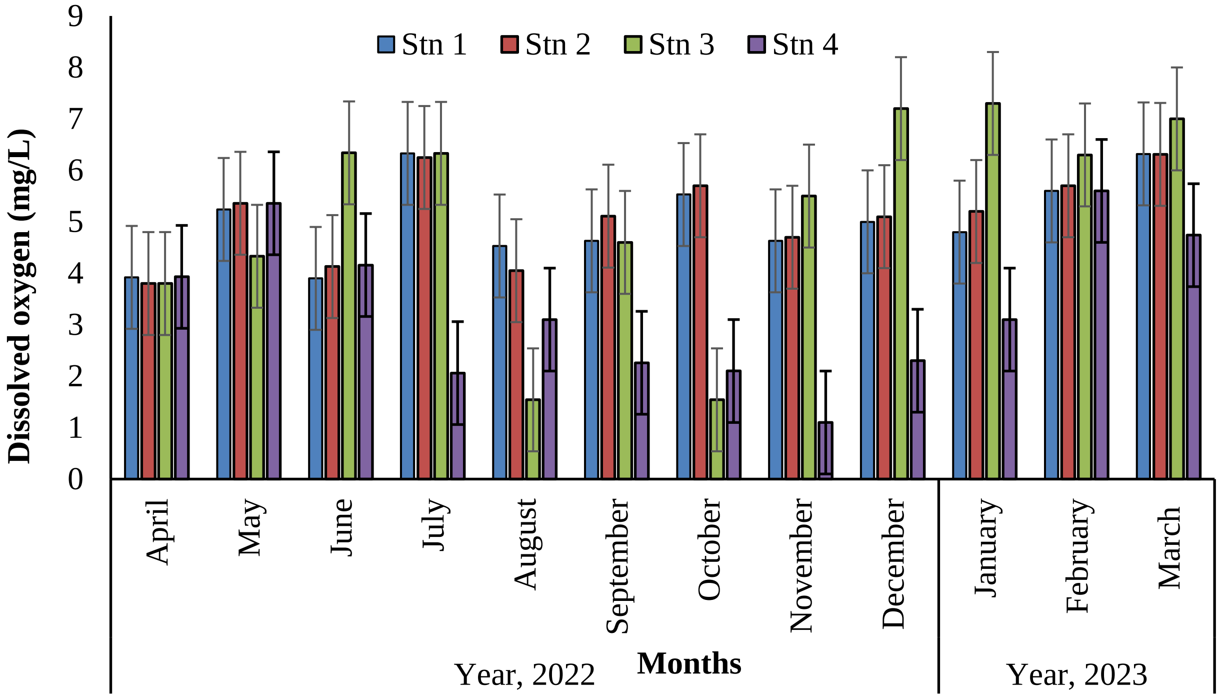

Figure 6: Temporal variation of dissolved oxygen of Luubara Creek

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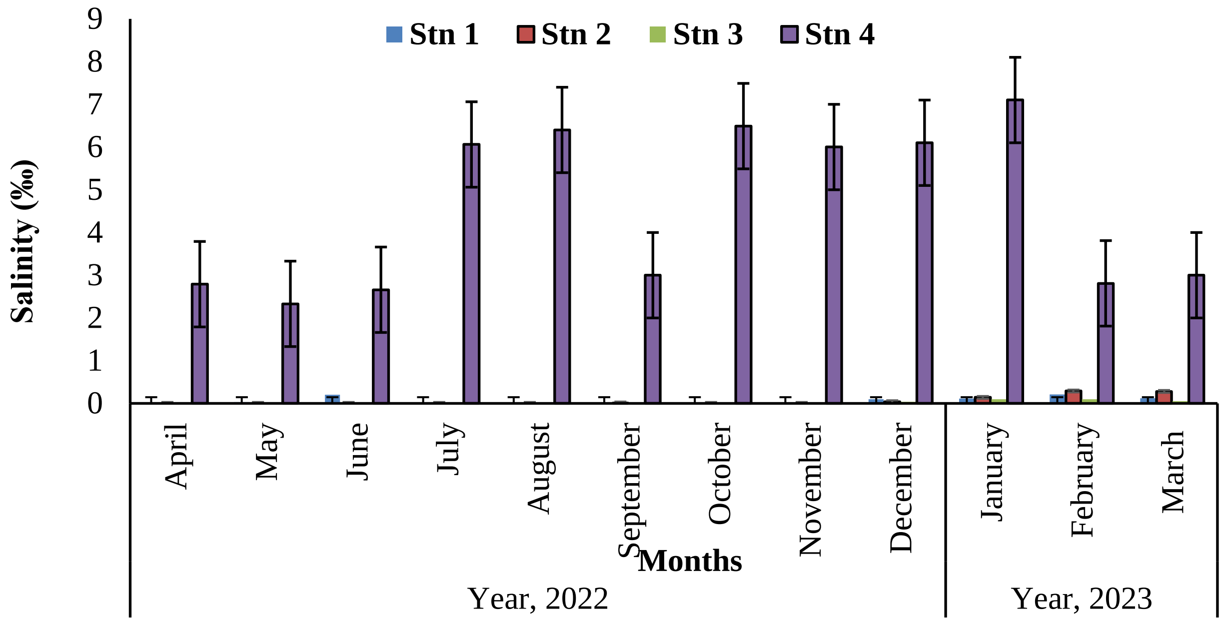

Figure 7: Temporal variation of salinity in Luubara Creek

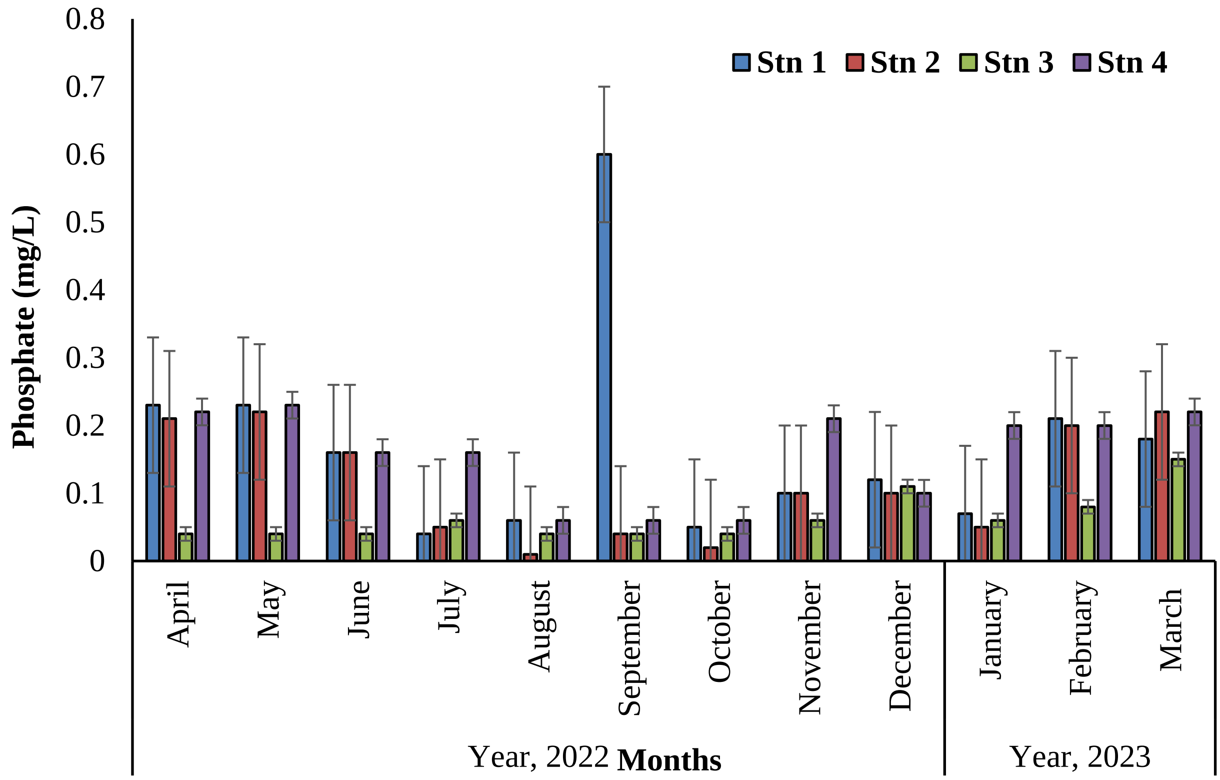

Figure 8: Temporal variation of phosphate in Luubara Creek

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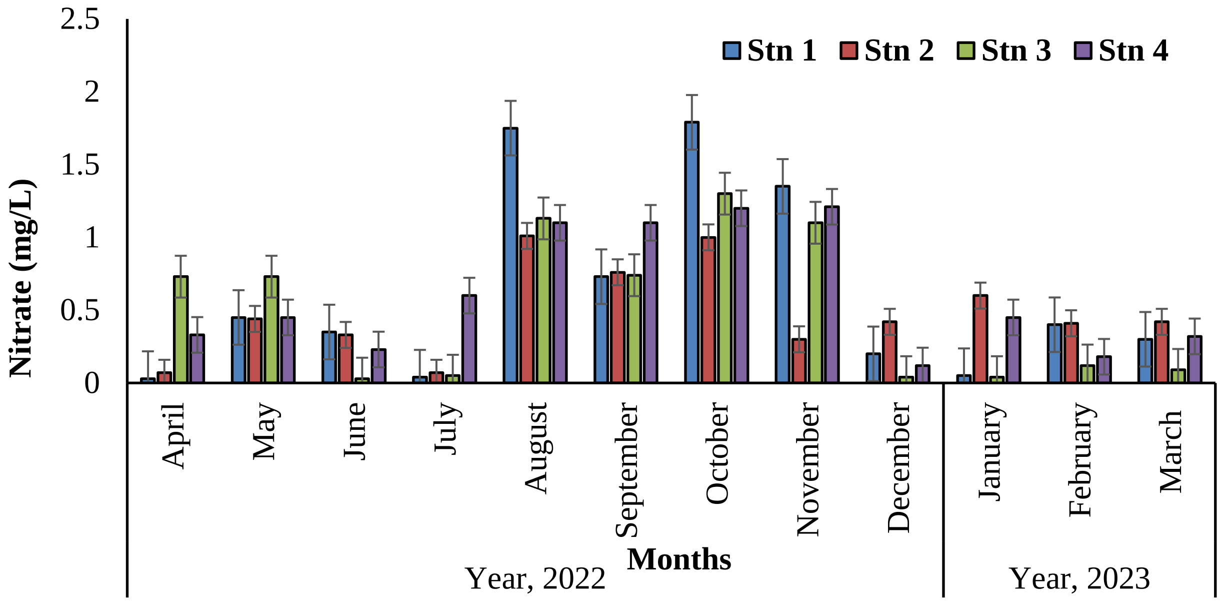

Figure 9: Temporal variation of nitrate in Luubara Creek

The examination of the interplay between the physical and chemical traits of an aquatic environment is crucial, given its potential impact on the food web of aquatic ecosystems (Offem et al., 2011).

Temperature significantly influences the survival and various aspects of aquatic organisms such as metabolism, feeding, growth, reproduction, and fish migration, particularly for migratory species (Crillet & Quetin, 2006; Deekae, 2009; Lawson, 2011).

The water temperature range observed in this study aligns with previous reports from the region (Gbarakoro et al., 2014; Hart & Zabbey, 2005; Francis et al., 2007; Jamabo, 2008; Zabbey & Hart, 2014; Dieye & Woke, 2015; Ibim & Owhonda, 2017; Seiyaboh et al., 2016; Udosen et al., 2016; Akankali et al., 2017; Seiyaboh & Sikoki, 2018; Jonah & George, 2019; Obot et al., 2019; Kwen et al., 2019; Amadi et al., 2020) and can potentially sustain the survival of cichlids and other fishes (Deekae, 2009).

The hydrogen ion concentration range in this study is consistent with previous reports from the region (Gbarakoro et al., 2014; Okorafor et al., 2013; Zabbey & Hart, 2014; Dieye and Woke, 2015; Andem et al., 2015; Seiyaboh et al., 2017; Ebuete & Bariweni, 2019; Kwen & Binyotubo, 2019), indicating similar pH levels.

Adequate dissolved oxygen is pivotal for the growth, behavior, physiology, distribution, and survival of cichlids and other aquatic fauna (Deekae, 2009). The dissolved oxygen range and values observed in this study are comparable to previous findings from the region (Gbarakoro et al., 2014; Zabbey & Hart, 2014; Dieye & Woke, 2015; Ibim & Owhonda, 2017; Ogamba et al., 2015; Ben-Eledo et al., 2017; Seiyaboh & Sikoki, 2018; Kwen & Binyotubo, 2019; Akankali et al., 2017; Obot et al., 2019; Jonah & George, 2019), indicating consistency in the dissolved oxygen levels.

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The salinity values and ranges observed in this study align with previous reports, suggesting the influence of saltwater intrusion from river estuaries (Gbarakoro et al., 2014; Ansa, 2005; Jamabo, 2008).

The electrical conductivity values recorded in this study are similar to previous findings from the region (Gbarakoro et al., 2014; Ibim & Owhonda, 2017), indicating freshwater characteristics.

The alkalinity range observed in this study is consistent with previous reports from the region (Gbarakoro et al., 2014; Seiyabih et al., 2017; Ben-Eledo et al., 2017; Seiyaboh & Sikoki, 2018; Binaebi, 2022).

The phosphate range recorded in this study is in line with previous reports from the same creek, suggesting favorable conditions for aquatic productivity and finfish production (Gbarakoro et al., 2014).

The nitrate range observed in this study aligns with previous reports and falls within acceptable values recommended for drinking water (Gbarakoro et al., 2014; SON, 2015; Binaebi, 2022). However, it differs from other studies in the region (Amauche et al., 2017; Yusuf, 2020), possibly due to various environmental influences.

CONCLUSION

In conclusion, the study carried out on Luubara Creek in the Niger Delta, Nigeria, from April 2022 to March 2023, offers valuable insights into the environmental dynamics of the aquatic ecosystem. Seasonal variations in water temperature impacted the metabolic activities of aquatic organisms. pH levels showed a shift from acidic to neutral conditions, with noticeable differences among stations. Dissolved oxygen, essential for aquatic life, averaged 4.68±1.56, with significant variations at Station 4. Salinity differences were evident, indicating saltwater intrusion. Conductivity values and total alkalinity were within acceptable ranges, indicating Luubara Creek's freshwater nature. Phosphate and nitrate concentrations met recommended limits, suggesting a relatively healthy aquatic environment. Nitrate concentration showed seasonal changes, likely influenced by agricultural runoff and other human activities. The results highlight the importance of continuous monitoring to assess long-term trends and potential environmental shifts. This study offers crucial data for making informed decisions regarding the conservation and sustainable management of Luubara Creek, supporting the overall health and biodiversity of this vital aquatic ecosystem.

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