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Temperature, Salinity, Electrical Conductivity, Dissolved Oxygen, Total Suspended Solids and pH Conditions in Okerenkoko Estuarine, Delta State, Nigeria

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Temperature, Salinity, **Electrical Conductivity,** Dissolved Oxygen, Total Suspended Solids and pH Conditions in Okerenkoko Estuarine, Delta State, Nigeria

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ABSTRACT

The conservation of aquatic flora and fauna and the protection of the aquatic biota in recent times has become a great challenge to fish biologists and limnologists. The location of most estuaries in connection with their linkages with freshwater and the marine environment make them to be heavily impacted with anthropogenic activities. However, information on the present state of physico – chemical parameters of Okerenkoko Estuarine are scarce. Therefore, the dynamics of physico – chemical parameters of Okerenkoko Estuarine, Delta State, Nigeria were studied. Okerenkoko Estuarine (62.79 Km) was spatially stratified into five stations (Z1, Z2, Z3, Z4 and Z5) based on closeness to major anthropogenic activities. Three sampling points were randomly selected from each station. Temporal stratification covered June to December. Water samples were collected from each station monthly for 7 months following standard methods. Water samples were analysed for Temperature (^oC), Dissolved Oxygen (DO, $mg.L^{-1}$) and Total Suspended Solids (TSS, $mg.L^{-1}$) by using standard procedures. Data were analysed by using descriptive statistics and ANOVA at $\alpha_{0.05.}$ Spatially, the highest (31.86±2.12) ^oC and least (24.45±1.67) ^oC Temperature were obtained in Z5 and Z1; DO (6.45±0.26, 3.97±0.24) $mg.L^{-1}$ occurred in Z2 and Z3; TSS (70.17±3.90, 41.54±1.70) $mg.L^{-1}$ were recorded in Z4 and Z2, respectively. Temporally, Temperature ranged from 24.70±5.13 ^oC in July to 31.50±4.87 ^oC in December; DO (3.85±0.43, 5.70±0.45) $mg.L^{-1}$ in September and June; TSS (25.32±0.90, 75.05±0.64) $mg.L^{-1}$ in December and September, respectively. The patterns of physico – chemical parameters of Okerenkoko Estuarine are highly unstable with TSS. Thus, its rich fauna biodiversity could be threatened.

Keywords: Okerenkoko Estuarine, Inland water, Anthropogenic activities.

1. INTRODUCTION

The conservation of aquatic flora and fauna abundance and the protection of the aquatic biota in recent times has become a great lacuna (Ewutanure and Olaifa, 2021). The formation and location of most estuaries, their connections with freshwater and the marine environment make them highly impacted with anthropogenic activities (Effiong and Akpan, 2015). High rate of effluent entrant into estuary ecosystems could threatened their conservation potentials and the abundance of their fauna species (Abowei, 2010). According to Ewutanure and Olaifa, (2018a), human activities such as dredging and pilling of rivers and their banks could result in high level of siltation, total suspended solids, temperature, biological oxygen demand and decreased dissolved oxygen. Since man depends to a large extent on the harvesting of most aquatic fauna and flora for food and aesthetics values, their conservation and judicious exploitation is of utmost importance (Ewutanure and Olaifa, 2018b).

The awareness of the response of estuarine organisms to the dynamics of the environmental factors will enhance the knowledge base of estuarine flora and fauna, also establish the impacts of human activities on the abundance of the estuarine fish species compositions. According to Abowei, (2010) temperature is a major abiotic factor regulating the physiological processes and influencing the survival and abundance of aquatic flora and fauna. It has been observed that, fish exhibits thermal preference behaviour that adequately supports their physiological systems (Baran and Guerin, 2012; Braide et al. 2004). Wide variation in surface water temperature could be associated with effects of tidal fluctuation (Salman et al. 2011). Tidal action is a common phenomenon in Okerenkoko Estuarine. It has been reported by Ewutanure and Olaifa, (2018b) that lower temperature than expected could lead to low metabolic and growth rates.

Salinity is one of the water quality parameters affecting the survival of aquatic fauna (Boyd and Craig, 1992). Sphyraena are euryhaline species found to tolerate salinity range of 0 to 35‰. In the study area, Sphyraena were harvested in salinities range of 5 to 22.5 ‰. Electrical conductivity in water is the ability of water to allow electrical current (Boyd, 1979). This is directly in association with the concentration of ions in the water formed from the dissolution of salts and inorganic materials (Majolagbe et al. 2011). The electrical conductivity of water gives an assessment of the total dissolved ions in water (Sarkula et al. 2010) and serves as an important water chemistry often recognised as an indicator of the extent of mineralisation of water (Arimoro, 2008). Boyd, (1979) reported 50 – 500 μScm^{-1} as the ideal range for fish survival and growth. Values outside this range could be detrimental to certain species of fish, while higher values (1000 to 10,000 μScm^{-1}) indicate saline conditions (UNESCO/WHO, 1978).

The availability of Dissolved Oxygen (DO) at the right concentration is essential to the survival of aquatic animals. Abowei, (2010) reported that UNESCO/WHO, (1978) stated that the required DO concentration needed for the maximum carrying capacity of typical coastal waters ranged from 4.0 – 5.0 $mg.L^{-1}$. The major sources of DO in the aquatic environment are atmospheric re – aeration and aquatic plants (Ewutanure and Olaifa, 2021). Aquatic plants release oxygen as a bye – product into water during photosynthesis (Arimoro and Ikomi, 2008). The level of DO may fall below established concentration due to pollution (Ewutanure and Olaifa, 2018a). Increased Pollution could lead to high rate of Biological Oxygen Demand which could result in a decline in DO level (Ewutanure and Olaifa, 2018b). Water pollution could cause a decline in primary production and thus reduction in fish stock in such an area where it occurred (Arimoro, 2008). Polluted water has negative effects on the quality of fish that get to the consumers as well as high cost of water treatment (Abowei, 2010). Decline in the concentration of DO could lead to reduction in respiration, fish mortality, repress feeding behaviour and inability of fish eggs to hatch (Ewutanure and Olaifa, 2018a). This could impede reproduction, decline in the diversity of the aquatic fauna abundance, unstable fish stock recruitment rate (Ogaga et al. 2015).

Ewutanure and Olaifa, (2018b) reported that, reduced level of DO in a river could be due to increased levels of total suspended solids, turbidity, excessive precipitation and increased effluents volume. Similar low level of DO has been recorded for coastal water of Warri River (Ogaga et al. 2015). Increased anaerobic decomposition of organic matter in water could cause a decrease in the concentration of DO in river. Total Suspended Solids (TSS) are fine particulate matters that are in suspension in water. Polluted water contains large volume of suspended organic and inorganic materials that are harmful to fish survival. Boyd, (1979) put the acceptable level of TSS for fish survival at < 10 $mg.L^{-1}$.

Ewutanure and Olaifa, (2021) reported that, higher concentration of TSS beyond the established limit could cause reduced light penetration through the water column, mortality of eggs and larvae of benthic invertebrates, decline in primary productivity and fish abundance. According to Boyd, (1979), pH range of 6.8 – 8.9 is the most ideal for fish survival, reproduction and growth in any aquatic environment. Abowei, (2010) reported that, in fish production, low pH could be detrimental to fish health and that, values less than 6 has negative effects on oogenesis, egg fertility, hatchability and fry growth. According to Mathew, (1998) as reported in Abowei, (2010) observed that most fish species live in water of pH range of 5.5 – 10. The Okerenkoko Estuarine is one of the most economically viable to the Nigeria economy and very rich in biodiversity in the Niger Delta Region of Nigeria serving as breeding ground for numerous fish species. Oil exploration, sand mining and agricultural practices are common anthropogenic activities found within the region. This study was carried out to assess some key physical and chemical parameters for the effective management Okerenkoko Estuarine fishery resources.

2. MATERIALS AND METHODS

The study area is an integral part of the Eschravos River located in Delta State, Niger Delta Region of Nigeria. Okerenkoko Estuarine with an average depth of 35 m traverses up to 62.79 Km and it is situated on latitudes 5°30′0″N and 5°50′0″N of the Equator and Longitudes 5°10′0″ E and 5°40′0″ E of the Greenwich meridian (Figure 1). The Niger Delta is one of the ten most important wetland and marine ecosystems in the world (Anifowose, 2008). It is one of the five most severely petroleum destroyed ecosystems in the world and has an area of 20,000sq/km (Ewutanure and Olaifa, 2018a).

Most of the Nigeria's oil and gas companies in Nigeria which account for over 70 % of the federal government revenue are located within the Niger Delta Region (Ewutanure and Olaifa, 2018b). The area is located in a mangrove swamp forest. The major species of mangrove identified were the red and white. Rhizophora racemose (red), Avicennia africana (white) mangroves and flood plain border the estuarine and its surrounding creeks.

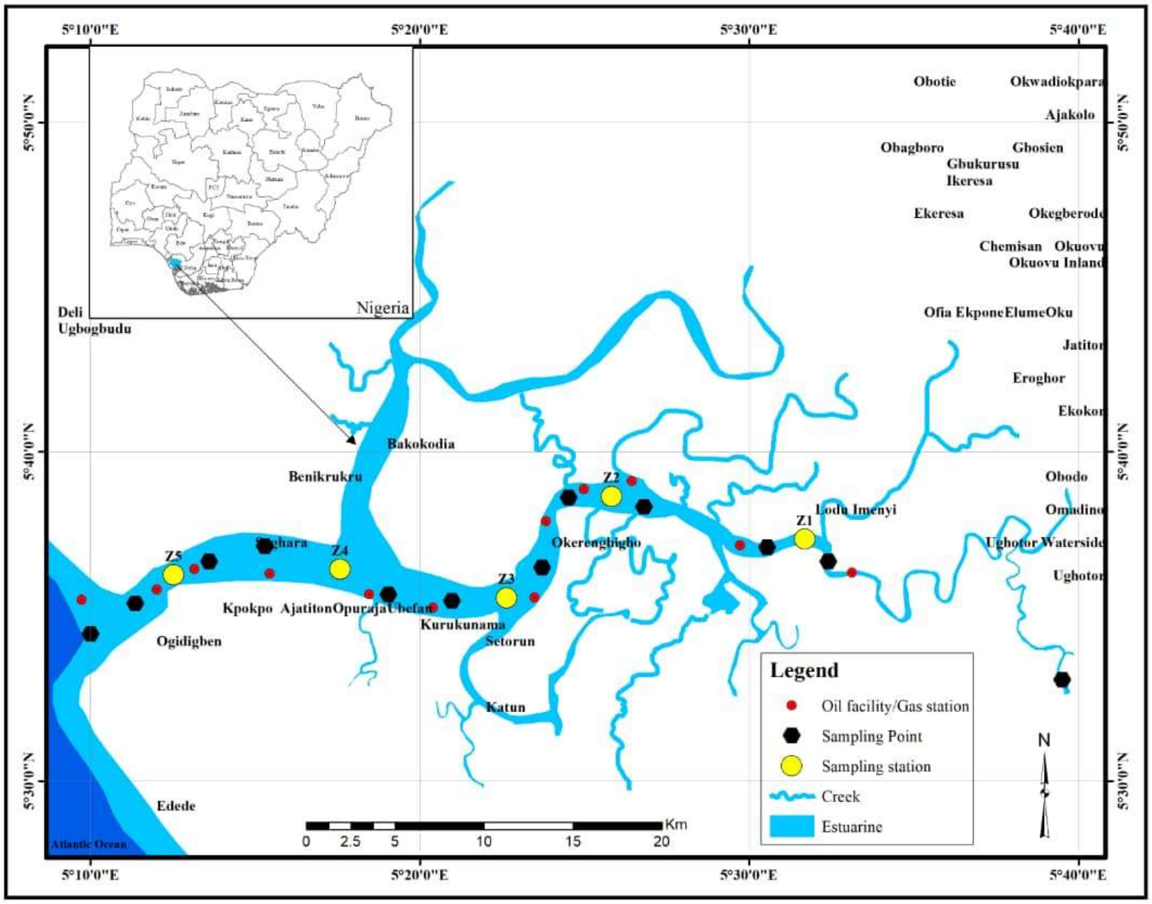

Figure 1. Map of Okerenkoko Estuarine
Source: Ewutanure, (2021)

The physical and chemical parameters measured were temperature, salinity, dissolved oxygen, total suspended solids and pH. Surface water temperature was measured by using mercury in glass thermometer (^{o}C) as described by Boyd (APHA, 1998), Salinity (‰) and electric conductivity (EC) was measured by a Salinometer (Thermo Electron Corporation, model: Orion 150A+, USA), Dissolved oxygen was determined ex – situ following Winkler's method as described by Gupta, (2001). The formula stated below was used to calculate DO.

$$\text{DO (mg/L)} = \frac{V1 \times N \times 8 \times 1000}{V2 - V3} \quad \text{(Gupta, 2001).}$$

Where:
V_1 = Volume of titrant (ml); N = Normality of titrant (0.025N)
V_2 = Volume of Sampling bottle after placing the stopper (ml)
V_3 = Volume of manganous sulphate + potassium iodide solutions added (ml)

The TSS level was determined as described by AOAC, (1990) and Gollenman et al. (1978) method

Calculation:

TSS (mg/L) $= \frac{A-B}{C}$ X 1000,000 (AOAC, 1990)

Where:

A = Dry weight of residue + filter paper

B = Dry weight of filter paper alone

C = Total ml of water filtered

pH was determined by using digital pH meter (Hanna model: HI – 98107, USA).

3. RESULTS

The means of monthly physico – chemical parameters of Okerenkoko estuarine presented in Table 1. Temperature values ranged from 24.70±5.13 °C in July to 31.50±4.87 °C in December. Highest (24.05±1.76) ‰ and least (14.81±3.98) ‰ Salinity occurred in August and September; EC ranged from 39.26±2.07 µScm^{-1} to 59.92±1.11 µScm^{-1} in September and August; DO (3.85±0.43, 6.60±0.78) mg.L^{-1} occurred in September and October, respectively. Highest (75.05±0.64) mg.L^{-1} and least (28.57±5.13) mg.L^{-1} TSS were recorded in September and August, while Ph ranged from 6.30±0.75 to 7.50±0.11 in August and June, respectively.

Table 1. Mean monthly physico – chemical parameters of Okerenkoko Estuarine

Months	Temp (°C)	Salinity (‰)	EC (µScm^{-1})	DO (mg.L^{-1})	TSS (mg.L^{-1})	pH
June	25.50±0.21	21.56±0.55	45.93±4.92	5.70±0.45	32.89±3.90	7.50±0.11
July	24.70±5.13	20.87±6.03	39.98±2.45	4.80±0.41	50.76±4.97	7.10±2.08
August	26.80±5.87	24.05±1.76	59.92±1.11	4.99±0.32	28.57±5.13	6.30±0.75
September	25.50±3.09	14.81±3.98	39.26±2.07	3.85±0.43	75.05±0.64	7.00±1.09
October	28.30±7.24	21.76±0.71	50.53±0.43	6.60±0.78	32.55±2.01	7.40±1.90
November	29.50±2.65	17.95±0.88	39.98±1.49	4.90±2.67	40.31±1.91	7.90±0.23
December	31.50±4.87	18.89±2.65	55.32±0.99	5.20±0.74	25.32±0.90	6.90±1.09
Boyd, (1979);Whitfield et al. (1981)	25 – 32	0 – 90	50 – 500	5 – 10	< 10	6.5 – 8.9

Mean physico – chemical parameters of Okerenkoko Estuarine among stations are shown in Table 2. Highest (31.86±2.12) °C and least (24.45±1.67) °C Temperature were recorded in Z5 and Z1; Salinity (21.37±1.13, 18.57±0.35) ‰ occurred in Z3 and Z2; EC (65.4±6.98, 46.67±3.55) µScm^{-1} were obtained in Z5 and Z4; DO (6.45±0.26, 3.97±0.24) mg.L^{-1} occurred in Z2 and Z3; TSS (70.17±3.9, 41.54±1.7) mg.L^{-1} occurred in Z4 and Z2, while the least (5.83±0.89) and highest (7.26±0.78) pH were recorded in Z4 and Z1, respectively.

Table 2. Mean physico – chemical parameters of Okerenkoko Estuarine among stations

	Stations				
Parameters	Z1	Z2	Z3	Z4	Z5
Temp (°C)	24.45±1.67	30.5±3.98	29.5±2.91	27.34±1.98	31.86±2.12
Salinity (‰)	19.89±0.78	18.57±0.35	21.37±1.13	18.95±0.17	20.56±3.23
EC (µScm^{-1})	58.27±2.65	49.93±2.09	50.09±5.91	46.67±3.55	65.4±6.98
DO (mg.L^{-1})	5.15±0.09	6.45±0.26	3.97±0.24	4.34±0.98	6.12±7.12
TSS (mg.L^{-1})	45.87±6.98	41.54±1.7	60.86±1.33	70.17±3.9	59.89±3.23
pH	7.26±0.78	6.98±0.93	7.11±0.67	5.83±0.89	6.97±1.29

4. DISCUSSION

Surface water temperature recorded were within the acceptable limit (25 – 32 ^{o}C) for fish growth as established by Boyd, (1979) except in July and Z1. Lower value obtained in July and Z1 could be associated with higher level of rainfall and upwelling effect. Inland water temperature in the tropics ranges from 25 – 35 ^{o}C (Alabaster and Loyd, 1980). Higher value recorded in Z5 could be due to its proximity to gas flaring station that heats up the water temperature. Results from this study are in agreement with earlier reported findings in the Niger Delta by Ewutanure and Olaifa, (2021), Ewutanure and Olaifa, (2018a), Ewutanure and Olaifa, (2018b), Abowei, (2010), Sikoki and Zabbey, (2006). Temperature exhibits significant monthly variation.

The relative fluctuation in Salinity recorded during this study could be due to tidal effects, intense rainfall and high dilution rate emanating freshwater (Boyd and Craig, 1992). McLucky, (1989) reported that precipitation can cause dilution of river and estuarine thereby leading to a decrease in Salinity concentration. High temperature during dry season could increase evaporation, salt concentration and hence, increasing the salinity of the water (Ewutanure and Olaif, 2021). Higher salinity value recorded in August could be associated with a break in rainfall and relative rise temperature. Results from this study showed that the salinity of Okerenkoko Estuarine oscillates between mesohaline (5 – 18 ‰) and hypherhaline (18 – 50 ‰).

Means of EC recorded during the study period among the months and stations were less than the recommended levels of 50 - 500 µS/cm (Boyd, 1979) and 2000 µS/cm (ASTM, 2006). The lower values recorded due to high amount of rain fall and freshwater discharge from storm water (Ampon and Taeng-On 2014). The presence of EC in inland waters can also be influenced by dissolved salt content (Abowei, 2010). It has been reported that as salts content of inland water increases, its electrical conductivity rises, the surface water temperature increases (Arimoro et al. 2007). The mean dissolved oxygen were higher in October and in Z2. This result is in agreement with Boyd, (1979); Abowei, (2010); Ewutanure and Olaifa, (2018a). Lower value recorded in September could be associated with excessive rainfall. Low DO can be caused by excessive decomposition of organic matter in the water and high concentration of TSS due to inflow from surface run – off. Decline in DO concentration could inhibits fish eggs hatchability, fry survival and the abundance of fish stock in Okerenkoko Estuarine.

Generally, higher concentration of TSS than the recommended levels of 10 $mg.L^{-1}$ (Boyd, 1979) and 30mg/L (FEPA, 1991) were recorded across moths and stations. Ewutanure and Olaifa, (2021) noted that excessive TSS in inland water could interferes with its light penetration through the photic zone thereby causing a drastic reduction in primary productivity, DO level and reduction in fish population abundance. High TSS concentration could cover and prevent eggs from hatching, clog fish gills and eventual death of hatchlings and fry. This could cause an unstable fish abundance (Arimoro, 2008). Finding of this study were in agreement with Ewutanure and Olaifa, (2021) that observed a rise in TSS level compared with Boyd, (1979) in Gbalegbe River and concluded that it could reduce visibility, poor feeding and growth rates.

Ajuonu et al. (2011) reported that high TSS concentration settles on the river bed and cover benthic organisms and eggs. This coating prevents sufficient DO transfer and results in the death of suspended organisms. Many organic and inorganic pollutants sorb to solids thereby increasing the concentration of the pollutants on the solid. Sorb pollutants could be moved elsewhere in estuarine and river ecosystems. This could result in the exposure of fishes to pollutants away from the point source.

The monthly and spatial variations in the pH concentration recorded in Okerenkoko Estuarine fluctuates narrowly. This is a typical characteristic feature of a tidal brackish water ecosystem (Ajao and Fagade, 2002). Except in Z4, mean pH recorded were within the recorded level by Boyd, (1979). The relative lower level of pH recorded in Z4 during this study period may be due to the decay of anthropogenic wastes upstream thereby making the Z4 relatively acidic.

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