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Effects of Eutrophication on Ogbuamuma River in Emeabiam Community, Owerri West Local Government Area

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Abstract
The current study aims to assess factors contributing to eutrophication in the Ogbuamuma River in the Emeabiam community in Owerri West local government area of Imo state which is not exempt from the pervasive issue of eutrophication, a process exacerbated by anthropogenic activities such as urbanization, agricultural runoff, and industrial discharges. The surface water samples were collected from three sample points in the upstream to the downstream direction and screened for selected parameters such as temperature, colour, pH, turbidity, dissolved oxygen, total dissolved solids, biological oxygen demand, total suspended solids, and nitrates using standard methods. The colour and turbidity were reported to be muddy, and the pH of the studied surface water was acidic with mean values of 5.30 to 5.78. Total dissolved solids were all below the acceptable limit of 500 mg/l, but total suspended solids were all over the permissible limit of 10 mg/l with the highest value of 40.50 mg/l. Additionally, there was a surge of nitrate levels from 21.60 mg/l – 40.20 mg/l and low values of dissolved oxygen from 4.30 mg/l – 6.75 mg/l across the sample points. The river bank is surrounded by densely populated human settlements and agricultural fields. Sewage from the households and the runoff brings down fertilizers and other chemicals from household and agricultural fields into the river water. To optimize nutrient concentration reductions, particularly during the year's rainy season, it is crucial to address point sources in their entirety where they can be used by rooted plants and benthic algae.

Keywords: Anthropogenic, Run-Off, Fertilizers, Sewage, Eutrophication.

Introduction

Aquatic ecosystems are vital in supporting biodiversity, providing ecosystem services, and sustaining human livelihoods (Sucharit et al., 2016). However, the phenomenon of eutrophication poses a significant threat to the health and functioning of these systems. Eutrophication occurs when excessive nutrients, primarily nitrogen and phosphorus, enter aquatic environments, leading to accelerated growth of algae and aquatic plants. There has been a notable surge in eutrophication instances in water bodies, primarily due to the escalating discharge of domestic and industrial effluents into surface waters, which can differ in composition and pollution levels, thereby intensifying the chemical, biological, and physical pollution of these water bodies (Callaway et al., 1984). Under these circumstances, eutrophication might ensue if substantial amounts of nutrients, mainly through waste, are continually introduced into surface waters over an extended time frame (Graham, 2015).

The Ogbuamuma River, located in South-Eastern Nigeria, traverses through Imo State, serving as a significant water resource for communities in its vicinity. Eke (2023) has shed light on the effects of eutrophication in the Ogbuamuma River, revealing alarming trends such as reduced water quality, diminished biodiversity, and disruptions to aquatic habitats. For instance, Obi and SEgbuikwem (2023) assessed nutrient levels and water quality in the Otamiri River Basin, highlighting the deteriorating conditions caused by eutrophication. Furthermore, Nwankwo et al. (2024)

explored the dynamics of harmful algal blooms in the Ogbuamuma River, underscoring the implications for water quality and human health.

Materials and Methods

Sample Collection

Samples of surface water were taken in triplicates from densely populated areas along the Ogbuamuma River in July at the peak of the rainy season. The samples were collected in sterilized plastic bottles with a capacity of 1000ml for physiochemical examination. The samples were promptly corked under water to prevent oxidation of the components, correctly labelled, and kept in a cooler equipped with an icebox to maintain a constant temperature of 40°C subsequently transferred for further examination in the laboratory. Conventional testing methods were utilized to examine the properties of water samples, maintaining stringent quality control protocols.

Determination of BOD and pH

Standard techniques were used to determine physiochemical characteristics (water temperature, pH, and electrical conductivity) in the field (APHA, 2001). The samples for determining the (biochemical oxygen demand) BOD were collected in glass reagent bottles and the water samples were stored in a dark closet at room temperature (25 °C) for five days before their oxygen content was measured through incubation and the electromebrane technique (Jouanneau, 2013).

Appearance/colour by organoleptic analysis

Organoleptic parameters were appreciated by the senses of sight for the appearance, (Behailu, 2017).

Determination of DO.

Dissolved oxygen diffuses into an electrochemical DO sensor from the sample via an oxygen-permeable membrane. After entering the sensor, the oxygen goes through a chemical reduction process that results in the production of an electrical signal which can be read by an electromembrane that measures dissolved oxygen (Aniyikaiye, 2019).

Turbidity by Turbidimetric Method

The basis of the turbidimetric analysis is the measurement of transmitted light intensity in relation to dispersed phase concentration. A portion of the energy of the falling radiation is transmitted through absorption and reflection when light travels through the suspension, with the remaining energy being transmitted. The amount of turbidity is then determined by measuring the amount of light that is partially absorbed and partially passed through the water sample (Mohd, 2015).

Total dissolved solids and Total suspended solids

The gravimetric method was used to quantify TDS in the wastewater sample. After being heated to 100 ^{o}C in an oven, a desiccator was used to cool the Petri dish, and it was weighed to ensure it remained at the same weight. A pre-weighed filter paper was used to filter the obtained river water sample into a sanitized conical flask. After pouring a known volume of the filtrate into the petri dish and heating it to 180 ^{o}C in the oven, the resultant residue was cooled in a desiccator and weighed to a consistent amount. The following formula was used to calculate the TDS:

$$\text{Total Dissolved solids (mg/l)} = \frac{(A-B)\times 1000}{\text{Volume of Sample (ml)}}$$

where A = weight of dried residue + weight of evaporating dish (mg)
B = weight of evaporating dish (mg).

Determination of Nitrate

The determination of nitrite is based on the reactions involving sulfamic acid with methyl anthranilate as the coupling agents and the determination of nitrate is based on their reduction to nitrite in the presence of Zn/NaCl. The produced nitrite is subsequently diazotized with sulfamic acid and then coupled with methyl anthranilate to form an azo dye which is measured at 493 nm (Wang, 2021).

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Results

Table 1 Physicochemical parameters of Ogbuamuma River water

Parameter	Emeabiam (SWQ1) Mean ± Stdev	Eziobodo (SWQ2) Mean ± Stdev	Ihiagwa (SWQ3) Mean ± Stdev	Nigerian Industrial Standard, 2015
Temperature	28.50 ± 0.00	28.75 ± 0.65	27.90 ± 0.00	20.00-30.00
Colour, PCU	38.50 ± 0.50	70.50 ±1.50	54.00 ± 1.00	15.00
Ph	5.78 ± 0.18	5.60 ± 0.00	5.30 ±0.00	6.50-8.50
DO, mg/I O_2	6.75 ± 0.05	6.30 ±0.00	4.30 ± 0.00	>7.50
BOD, mg/I O_2	2.80 ± 0.10	4.40 ± 0.00	3.10 ± 0.10	NS
Turbidity, NTU	17.38 ± 0.015	19.96 ± 0.02	9.43 ± 0.06	10.00
TDS, mg/I	25.35 ± 0.00	23.40 ± 0.00	32.50 ± 0.00	500.00
TSS, mg/I	20.65 ±0.00	0.00 ±0.00	40.50 ±0.00	<10.00
Nitrate, mg/I NO^-_3	21.60 ± 0.00	40.24 ± 0.00	23.00 ± 0.00	50.00

***Key*: DO – dissolved Oxygen, TDS – Total dissolved solids, BOD – Biological Oxygen demand TSS – Total suspended solids.**

Discussion

Physical examination of the river sample revealed that the mean pH values of the surface water samples varied between 5.30 and 5.78 at the tested sites. Generally, these values are significantly lower than the stipulated acceptable limit of the 2015 Nigerian Industrial Standard (NIS) reference. Furthermore, the pH of the studied surface water was acidic (low). pH is commonly used to express a solution's acidity or alkalinity concentration. Studies conducted in some rivers in Nigeria have reported a similar pH value (Akubugwo, 2013 & Eke, 2023). The colour and odour of the water body were changed, falling short of the required level. The temperature also fluctuated from low to high, which may be ascribed to the river's path changing from regions of intensive human activity to large expanses of woodland and vegetative cover. This is consistent with the findings of (Fagorite et al., 2019). However, the temperature ranges adhere to Nigerian Industrial Standard (NIS) recommendations. Additionally, findings indicate that the turbidity of the water body varies. Certain places fell short of the maximum allowed threshold, while others significantly exceeded it. These fluctuations may be explained by industrial pollutants discharged into the Otamiri River by dredging firms. According to Okeke and Adinna (2013), runoff from urban activities can introduce soil particles and solid waste materials into rivers, increasing the river's turbidity. Turbidity may affect aquatic life by obstructing light penetration. *Analytical Chemistry*

Total dissolved solids were all below the acceptable limit of 500 mg/l, but total suspended solids were all over the permissible limit of 10 mg/l. The maximum concentration of 40.50 mg/l was detected in SQW1 water samples. The elevated TDS level is consistent with extensive human activity throughout the river's course and run-off including suspended debris (Eke, A, 1996). Additionally, nitrate levels were found to be much higher than requirements, whereas nitrite levels were found to be significantly lower. The amount of nitrate in water may be used as a productivity indicator, providing a genuine indication of aquatic life species abundance and activity. Nitrate and nitrite may be discharged into water bodies as a result of fertilizer leachates on farms and garbage disposal (World Health Organization, 1998). The BOD and COD varied significantly across sample sites, with regions of high and low values detected. The DO concentration, on the other hand, was somewhat lower than the norm. The current study's relatively low DO levels are consistent with Okechi and Chukwura's 2020 findings.

Conclusion

The purpose of this research was to assess the factors contributing to eutrophication in the Ogbuamuma River in the Emeabiam community in Owerri West local government area. The surface water sample was taken from two points (Ihiagwa and Eziobodo) which flow from upstream to downstream. Generally, it was ascertained that the values of certain selected physiochemical parameters such as high nitrate values indicated the presence of algae blooms on the surface water. A majority of the river bank is surrounded by densely populated human settlement areas and agricultural fields. Sewage from the households is regularly discharged into the river water. The runoff brings down fertilizers and other chemicals from agricultural fields. The nitrogen and phosphorus contained in these effluents are known to promote excessive growth of plants. Several environmental factors have also been found to add to the problem of eutrophication in addition to nutrients. The limiting factors - namely temperature, pH, turbidity, dissolved oxygen, and CO_2 level are known to affect eutrophic water bodies.

Recommendation

1. It is anticipated that the anthropogenic activities along the banks of the Ogbuamuma River in the Emeabiam community will continue to rise and will ultimately contribute largely to the various factors that serve as precursors of Eutrophication.
2. It is important to tackle point sources comprehensively so that reductions in nutrient concentrations are maximized especially during the rainy season of the year.
3. Diffuse sources, particularly from agriculture, are a major contributor to nutrient levels in riverine surface water and river sediments, where they can be utilized by benthic algae and rooted plants.

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