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Evaluation of Pollution Status of Okamini Stream, Port Harcourt Using Palmer Algal Pollution Index and Water Variables

Anyiamuka, O.K. 1, Otene, B.B.2, Dube, R.L.3

[1]Department of Applied and Environmental Biology, Ignatus Ajuru University, Rumuolumeni, Port Harcourt, Nigeria
[2]Department of Fisheries and Aquatic Environment, Rivers State University,
Port Harcourt, Nigeria
[2]Department of Fisheries and Aquatic Environment, Rivers State University,
Port Harcourt, Nigeria

Corresponding Author: benjaminotene56@yahoo.com, benjamine.otene@ust.edu.ng

ABSTRACT: *Pollution status of Okamini Stream, Port Harcourt using Palmer algal pollution index and water variables was studied between July and September, 2025. Surface water and plankton samples were collected monthly and analyzed with SPSS 26.0 and PAST 4.0. A total of 34 species and 1,081 individuals were recorded across five taxonomic groups, dominated by Bacillariophyceae (51.06%), followed by Chlorophyceae (25.44%), Cyanophyceae (10.45%), Euglenophyceae (9.16%), and Chrysophyceae (3.88%). Spatially, phytoplankton abundance peaked at Station 2 (523 individuals). Diversity indices showed moderate variation: Shannon-Wiener (2.837–3.396), Evenness (0.656–0.904), Menhinick (1.443–2.394), and Margalef (4.989–6.099). Palmer Pollution Index (PPI > 20) confirmed high organic pollution. Water variables ranged as follows: temperature, 27.8–30.5^{0}C with the mean 28.11^{0}C, pH,5.00–6.55(5.93), Dissolved Oxygen, 4.50–6.30 mg/L(5.40 mg/L). Nutrient concentrations ranged from 0.40–0.71 mg/L (PO_4), 1.25–3.50 mg/L (SO_4), and 3.20–5.80 mg/L (NO_3). Phosphate exceeded the NESREA permissible limit (0.10 mg/L), while sulphate significantly varied spatially. The presence of Cyclotella species, Melosira monoliformis and Navicula distans and higher phosphate values are clear indications that pollution is eminent in the area. Generally, Okamini Stream exhibited organic enrichment linked to anthropogenic activities. Regulatory measures are urgently needed to mitigate pollution and protect aquatic biodiversity.*

Keyword: Evaluation, micro-algae, pollution status, Okamini stream, water quality, Palmer algal pollution index,

INTRODUCTION

Water is often described as the elixir of life, a giver and creator of existence, a priceless gift of nature to humanity and all living species. It forms the very foundation of the planet's intricate web of life (1). Human survival and progress depend heavily on water resources, which sustain agriculture, enable transportation, support recreation, and serve countless domestic purposes such as cooking, cleaning, laundry, and bathing. Yet, instead of treating water with reverence, humans exploit it relentlessly to satisfy their greed. This unchecked overuse has led to the degradation of water bodies, turning this vital resource into a rapidly diminishing commodity across many regions of the world (2).

Globally, algal communities are used to study aquatic pollution, and its use can be correlated with water pollution studies as opined by (3 ,4) and 5). Obviously, the most essential effect of organic pollution in an aquatic ecosystem is ascribed to enrichment of nutrients and total number of algal species (6). Plankton has been investigated and reported by several researchers to be a reflection of the hydro-environmental condition per time and therefore as bio-diagnostic components that points to the health of the aquatic ecosystem (7). Obviously, there are relationships between water environmental/ abiotic factors and changes in phytoplankton communities. There are so many established facts that phytoplankton serves as bio-indicator to monitor the water chemistry of a water body (8,9,10). The ecological roles of phytoplankton in the coastal aquatic ecosystem cannot be overemphasized. Phytoplankton, a microbial component responds rapidly to perturbations and are therefore considered as bioindicators of water condition which are beyond the tolerance of many other biota used for monitoring aquatic ecosystem (11).

It is evidently clear that due to increased anthropogenic activities ranging from urbanization and industrialization, majority of the freshwater resources are currently under serious threat (12, 13). According to (14), increasing water and sediment pollution does not only cause water quality deterioration but also threaten human health and the balance of aquatic ecosystem, economic development and social prosperity. Stresses caused by wastes introduced into the aquatic environment have a variety of effects on faunal and floral communities living therein which may result in either declining their number severely or eliminating them outrightly (15).

The physicochemical characteristic of water plays an important role in algal biodiversity and it determines the algal bloom of any specific species. Phytoplankton communities respond quickly to anthropogenic inputs of nutrients and toxic substances making them good indicators of changes in environmental water quality. Stresses caused by these wastes, have a variety of effects on faunal and floral communities living therein which may result in either declining their number severely or eliminating them altogether. There exists a correlation between the intensity of pollution and organisms living therein. Palmer (16) made the first attempt to identify and prepare a list of genera tolerant to organic pollution.

Biological monitoring using algae has become a reliable tool for assessing aquatic pollution. Algae respond quickly to changes in nutrient levels, organic matter, and toxic substances, making them effective bioindicators. The Palmer Algal Pollution Index (PAPI), developed by (17), is widely used to evaluate organic pollution by assigning tolerance scores to algal genera. A cumulative score ≥ 20 indicates high organic pollution, while scores < 10 suggest low pollution (18).

Okamini stream play so many vital roles in the lives of the inhabitants since it creates ready incentives for capture fisheries, transportation of fuel, wood production, domestic waste disposal and small-scale aquaculture). These environmental services are being seen by environmentalist as source of threat (19, 20).The ecology of aquatic environments has been widely studied in several water bodies in Niger Delta but very few limnological studies have been made on the freshwater ecosystem of Okamini (21).

MATERIALS AND METHODS

Study Area

Okamini stream is a tributory of New Calabar River which lies between longitude 006° 53' 53.086"E and latitude 04° 53' 19.020"N in Choba, Rivers State, Nigeria (Figure 3.1). However, the entire river course is situated between longitude 7° 60'E and latitude 5° 45'N in the coastal area of the Niger Delta and empties into the Atlantic Ocean. There are industries, dredging sites; weekly market and fishing activities going on alongside numerous other human activities. The New Calabar River region has an annual rainfall between 2000 -3000 mm (22) and is a rare tidal freshwater body. The highest tidal registration New Calaber river was 2.62m while the lowest was 0.31m51 with the mean tidal level of 1.52m and mean velocity in a vertical at the reference cross-section on a52 spring tide of 0.34m/s (23).

Sampling Stations

The four sampling stations were chosen almost 500m apart along the main stream course (Fig.1). Sampling for this study were carried out using four fixed sampling points along the Okamini Stream between Egbelu, Elioparianwo and Ogbogoro communities. These include one point each at the upstream, midstream, downstream, and the mouth of the stream. This fixed-point sampling method were allow for consistent and simple comparison of water quality across different zones of the stream.

They were:
Station 1: Upstream.
Station 2: Midstream.
Station 3: Downstream
Station 4: Mouth of the stream

Collection and Analysis of Algal and Water Samples

Surface water and plankton samples were collected from the four stations between Okamini Stream between Egbelu, Elioparianwo and Ogbogoro communities on monthly basis between July – September 2025 using wide mouth plastic bottles (sterilized) for both samples following standard method (24). (17) proposed a pollution index based on algal genus and species used in the rating water sample for high or low organic pollution. The pollution tolerant genera and species of algae were recorded from selected sampling stations. A list of most pollution tolerant genera and species according to Palmers index were calculated for all sampling stations. A pollution index factor was assigned to each genus and species by determining the relative number of total points scored by each alga. The pollution status of sampling stations of the river was determined based on their index and classified as in Table 1. The algal taxa were identified with the help of relevant monographs & standards literatures (25). All identified taxa recorded were arranged taxonomically in table 1.

Table 1: Classification of Palmer Pollution Index (PPI)

Pollution Index	Status of pollution
0-10	Lack of organic pollution
0-15	Moderate pollution
15-20	Probable high organic pollution
>20	Confirms high organic pollution

Source : (17)

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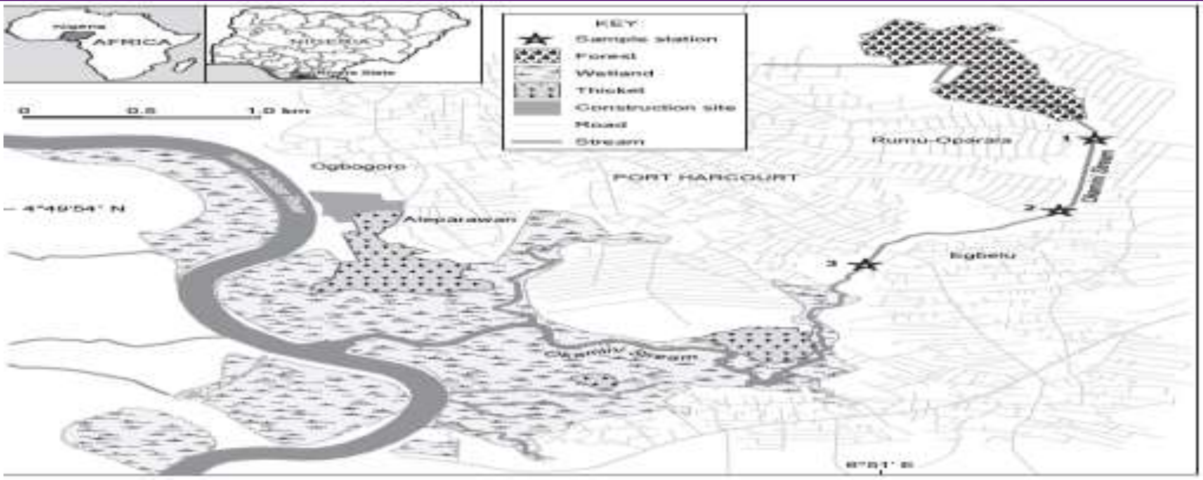

Figure 1: Map of the study Area with the Sampling Stations

Results

A total of 34 species and 1081 individual were encountered from the five (5) taxonomic groups Bacillariophyceae (14), Chlorophyceae (9), Cyanophyceae (5), Euglenophyceae (4) and Chysophyceae (2)(Table2). The percentage composition of the taxonomic groups was Bacillariophyceae (552) 51.064%, followed by Chlorophyceae (275) 25.439%, Cyanophycaea (113) 10.453% ,Euglenophyceae (99) 9.158 while the least was Chysophyceae (42) 3.885 (Table 2 and 3). The order of occurrence therefore is Bacillariophyceae > Chlorophyceae > Eugunophycaea >Chysophycaea (Table). Spatially the highest number of Phytoplankton (523) was encountered in State 2 followed by 3 while the least was stating 4 (150) (Table 3). The highest phytoplankton abundance was observed in the Month of August (728) while the least was encountered in June (687). The most dominant species in this study were *Cyclotella operculate* (112) followed by *Cyclotella combia*(67) all in Bacilliaiophyceae (Table3).

Table 4 showed the diversity indices of microalgae in the area. Shannon Wienner index ranged between 2.837 (Station 4) and 3.396 (Station 2), Evenness index, from 0.6562(Station 4) - 0.9045(station2), Menhinick index, 1.443(station 2)-2.394(station 1) while Margalef ranged between 4.989 (Station 4) and 6.099 (Station 1).

Table 6 and figure 2 showed the **Palmer's pollution index of Okamini Stream**. Temporally, out of the 20 genera used for Palmer pollution index, 10 genera were observed between June to August scoring 27. Spatially, stations 1-3 had equal number of genera (10) scoring 27 while station 4 recorded 8 genera scoring 25. Okamini therefore temporally and spatially experienced high organic pollution (PPI>20).

Table 2: Percentage Composition of Phytoplankton per Taxa

S/N	Taxa	No of Species	Total Individual	Percentage
1	Bacillariophyceae	14	552	**51.064**
2	Chlorophyceae	9	275	**25.439**
3	Cyanophyceae	5	113	**10.453**
4	Euglenophyceae	4	99	**9.158**
5	Chrysophyceae	2	42	**3.885**
Total		34	1081	**100.00**

Table 3: Spatial and temporal distribution of Microalgae in Okamini Stream

Family/Taxa	June	July	August	TT	ST 1	ST 2	ST 3	ST 4	TT
Bacillariophyceae									
Amphora ovalis	13	14	20	47	5	17	9	16	47
Asterionella formosa	5	4	6	15	2	10	2	1	15
Bacillaria paradoxa	5	10	6	21	1	11	5	4	21
cyclotella opericulata	41	31	40	112	21	45	23	23	112
cyclotella combia	20	20	27	67	15	25	12	15	67
Diatonia acus	3	6	7	16	3	12	1	0	16
Eunotia linearis	1	3	0	4	1	2	0	1	4

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Flagilaria intermedia	8	7	17	32	3	9	15	5	32
Melosira varians	13	13	14	40	9	23	8	0	40
Navicula plicata	12	10	7	29	5	19	3	2	29
N. restellata	18	10	10	38	2	23	3	10	38
Nitzchia gracilis	18	18	28	64	15	23	12	14	64
Syndra nana	12	12	7	31	6	17	8	0	31
Tabellaria fenestrate	14	13	9	36	5	20	9	2	36
	183	**171**	**198**	**552**	**93**	**256**	**110**	**93**	**522**
Chlorophyceae									
Astidesmius hookerii	6	7	12	25	7	16	2	0	25
Akinstrodesmus falcutus	9	17	12	38	6	18	2	12	38
Clostridium dianae	9	11	16	36	4	19	7	6	36
Desmodium optogonium	10	16	17	43	3	24	15	1	43
Chlamydomona satactogam	5	11	6	22	3	12	6	1	22
Tetrahedron gracilli	10	17	12	39	8	21	9	1	39
Volcox aurus	14	8	9	31	3	14	11	3	31
Strauarstrum gracilis	8	16	17	41	6	16	12	7	41
	71	**103**	**101**	**275**	**40**	**140**	**64**	**31**	**275**
Cyanophyceae									
Anabaena flos-aquae	5	10	6	21	5	13	3	0	21
Dactylococcopsis rhapoides	13	8	0	21	3	12	1	5	21
Microcystis actuginesa	11	2	8	21	4	13	2	2	21
Oscillatoria limosa	5	10	8	23	5	10	4	4	23
Spirulina substilissima	12	6	9	27	7	14	6	0	27
	46	**36**	**31**	**113**	**24**	**62**	**16**	**11**	**113**
Euglenophyceae									
Euglena tripteris	7	9	8	24	6	12	5	1	24
Trachelomonas hispida	11	8	6	25	8	14	3	0	25
Euglena sangulena	9	10	2	21	5	6	5	5	21
Eugena viridis	8	10	11	29	5	11	7	6	29
	35	**37**	**27**	**99**	**24**	**43**	**20**	**12**	**99**
Chrysophyceae									
Dinobryno cylindrium	9	6	5	20	5	12	1	2	20
Uroglenopsis botrys	8	5	9	22	4	10	7	1	22
Total	**17**	**11**	**14**	**42**	**9**	**22**	**8**	**3**	**42**
Grand Total	**687**	**705**	**728**	**1081**	**190**	**523**	**218**	**150**	**1081**

Table 4: **Diversity Indices Of Algae In Okamini Stream**

	ST 1	ST 2	ST 3	ST4
Taxa_S	33	33	32	26
Individuals	190	523	218	150
Dominance_D	0.04582	0.03692	0.04772	0.076
Simpson_1-D	0.9542	0.9631	0.9523	0.924
Shannon_H	3.289	3.396	3.217	2.837

Evenness_e^H/S	0.8126	0.9045	0.7796	0.6562
Brillouin	3.01	3.262	2.976	2.584
Menhinick	2.394	1.443	2.167	2.123
Margalef	6.099	5.112	5.757	4.989
Equitability_J	0.9406	0.9713	0.9282	0.8707
Fisher_alpha	11.54	7.825	10.34	9.08
Berger-Parker	0.1105	0.08604	0.1055	0.1533
Chao-1	33.33	33	32.6	30.2

Key: ST1-4= Study stations 1-4

Table 5 : Palmer's Algal Pollution Index Values in the Study Area

S/N	Algal Genera	Pollution Index	June	July	August	ST1	ST2	ST3	ST4
1	*Anacystis*	1	-	-	-	-	-	-	-
2	*Ankistrodesmus*	2	2	2	2	2	2	2	2
3	*Chlamydomonas*	4	4	4	4	4	4	4	4
4	*Chlorella*	-	-	-	-	-	-	-	-
5	*Closterium*	1	1	1	1	1	1	1	1
6	*Cyclotella*	1	1	1	1	1	1	1	1
7	*Euglena*	5	5	5	5	5	5	5	5
8	*Gomphonema*	1	-	-	-	-	-	-	-
9	*Lepocinclis*	1	-	-	-	-	-	-	-
10	*Melosira*	1	1	1	1	1	1	1	-
11	*Micractinium*	1	-	-	-	-	-	-	-
12	*Navicula*	3	3	3	3	3	3	3	3
13	*Nitzschia*	3	3	3	3	3	3	3	3
14	*Oscillatoria*	5	5	5	5	5	5	5	5
15	*Pandorina*	1	-	-	-	-	-	-	-
16	*Phacus*	2	-	-	-	-	-	-	-
17	*Phormidium*	1	-	-	-	-	-	-	-
18	*Scenedesmus*	4	-	-	-	-	-	-	-
19	*Stigeoclonium*	2	-	-	-	-	-	-	-
20	*Synedra*	2	2	2	2	2	2	2	-
Total		**44**	**27**	**27**	**27**	**27**	**27**	**27**	**25**

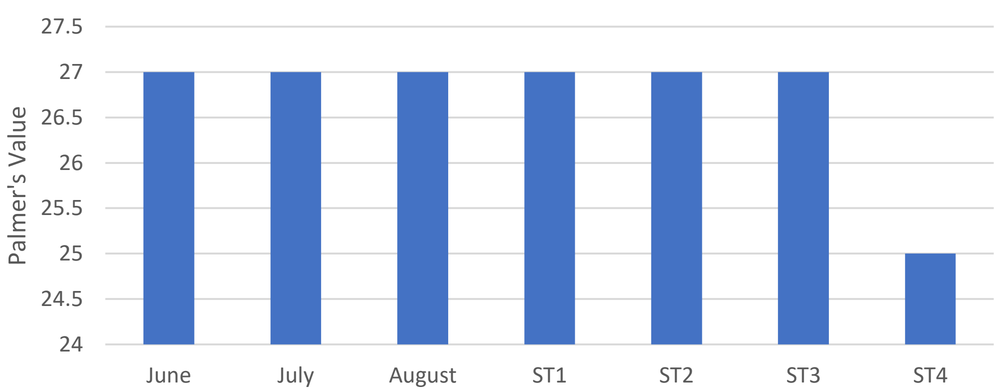

Figure 2: Spatio-Temporal Values of Palmer's Algal Pollution Index in Okamini Stream

Temperature values ranged between 27.80 and 30.50 ºC with the overall mean value of 28.114ºC (Table 4.6). Temperature values was highest in station 1 (31.433 ± 6.438ºC) but lowest in Station 4 (28.600 ± 0.86) without significant difference (Table 6 and 7). pH values ranged between 5.00 and 6.55 ºC with the overall mean value of 5.929±0.483(Table 6). pH value was highest in Station 2 (6.200± 0.346 but lowest in Station 3(5.433±0.404 without significant difference (Table 6 and 7). Dissolved oxygen values ranged between 4.500 and 6.300 mg/l with the overall mean value of 5.404±0.563mg/l (Table 6). Dissolved oxygen was highest in Station

4 (5.767±0.681mg/l) but lowest in Station 3 (4.700±0.200mg/l) with Stations 1,2 and 4 significantly different from Station 3 (Table 7).

BOD values ranged between 2.300 and 5.400 mg/l with the overall mean value of 3.088 mg/l (Table 6 and 7). BOD value was highest in station 3(5.000± 0.450mg/l but lowest in station 4(2.400±0.173) with station 3 significantly different from other stations (Table 6 and 7). Electrical conductivity ranged from 28.20-40.30µs/cm with the mean value of 33.088±4.313µs/cm with spatial significant difference while TDS ranged from 14.20-19.50mg/l with the mean value of 16.200±1.563mg/l) with spatial significant difference at P<0.05(Table 6 and 7).

Among the three nutrients, the values ranged from 0.40-0.71mg/l, 1.25-3.50mg/l and 3.20-5.80mg/l for $P0_4$, $S0_4$ and $N0_3$ respectively with only sulphate exhibiting significant difference spatially and only $P0_4$ exceeding the standard permissible limit (0.10mg/l) of NESREA. The value of all the nutrients were higher in station 3 than all other stations (1,2 and 4).

Table 6: Overall Mean Values of Water Variables in the Study Area

Parameters	Mean	SD	Minimum	Maximum	Permissible (**26**)
Temperature(0C)	28.114	8.719	27.8	30.50	$30^{o}C$
pH	5.9292	0.48263	5.00	6.55	6.5-8.5
Dissolved Oxygen(mg/l)	5.4042	0.56345	4.50	6.30	5.00mg/l
Biological Oxygen Demand(mg/l)	3.0875	1.17398	2.30	5.40	0-6.00mg/l
Conductivity(µs/cm)	33.375	4.3134	28.2	40.3	1000µs/cm
Total Dissolved Solids(mg/l)	16.200	1.5638	14.2	19.5	1000mg/l
Phosphate (PO_4)	0.5092	0.10238	0.40	0.71	0.10mg/l
Sulphate (SO_4)	2.2458	0.66826	1.25	3.50	10.0mg/l
Nitrate (NO_3)	4.5017	0.86887	3.20	5.80	100mg/l

Key: SD=Standard Deviation

Table 7: Spatial Mean Values of Water Variables in the Study Area

ST	Mean/Std Dev	Tem	pH	DO	BOD	Cond	TDS	PO_4	SO_4	NO_3
1	Mean	36.433	5.9333	5.4833	2.4667	29.900	15.633	.4533	2.2833	4.1067
	Std. Dev	17.438^a	0.45092^a	0.41932^b	0.05774^b	1.4933^b	0.7767^b	0.04509^a	0.17559^a	0.50013^a
2	Mean	29.133	6.2000	5.6667	2.4833	30.333	15.933	.4167	1.7500	4.3667
	Std. Dev	0.7767b	0.34641^a	0.11547^b	0.12583^b	1.8930^b	.5508^b	.02887^a	.43301^b	1.10604^a
3	Mean	30.400	5.4333	4.7000	5.0000	39.433	18.433^a	0.6533	3.0833	5.3667
	Std. Dev	0.1732^b	0.40415^a	0.20000^a	0.45826^a	0.9018^a	1.0066	0.05508^a	0.48563^a	0.75056^a
4	Mean	28.600	6.1500	5.7667	2.4000	33.833	14.800^b	.5133	1.8667	4.1667
	Std. Dev	0.8544^b	0.49244^a	0.68069^b	0.17321^b	2.8885^b	0.7211	0.05508^a	0.60277^b	0.75056^a

Key: Means with similar superscript along the same column are not significantly different at P<0.05

DISCUSSION

The evaluation of the pollution status of Okamini Stream, Port Harcourt, using the Palmer Algal Pollution Index and selected water quality variables is essential for understanding the ecological health of this freshwater system (27,28). Algal communities are widely recognized as sensitive bioindicators of organic pollution, with the Palmer Index providing a standardized approach to assess the presence of tolerant algal genera in relation to nutrient enrichment and organic contamination (29). Phytoplankton productivity and composition are influenced by the spatial and temporal dynamics of environmental factors. The relationship between the physico-chemical characteristics and plankton production of water bodies are of great importance in management strategies of aquatic ecosystems. The quality of water may be described according to their physico-chemical and plankton characteristics.

The total number of species of phytoplankton observed in this study is contrary to the finding of (30) in Sombriero river who reported a total of 38 species with 2,888 individuals' phytoplankton from the families, Bacillariophyceae, Chlorophyceae, Cyanophyceae, Chrysophyceae and Euglenophyceae recorded during the study period but comparable to the 91 species observed/reported by (31) in Ntanwogba stream,Rivers state, (32), 92 species in a swamp forest stream, Niger Delta, (33) ,89 species in Bonny estuary, (34),

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89 species in New Calabar River, (32) 126 species in Bonny river and (35), 84 species in Minichinda stream. The difference in number of species could be attributed to difference in the environment studied and other ecological factors.

Spatially and temporarily, certain plankton genera such as *Ankistrodesmus, Chlamydomonas, Closterium, Closterium, Cyclotella, Euglena, Melisora, Navicula,, Nitzschia, Oscillatoria and Synedra are* present in common which include which is in line with the finding of Prashant (2017) from Chulband River, Gondia District. (MS), India. This confirmed the assertion by Warren (1971) in (36) that continued persistence of a species or genera at a particular location is sure evidence that conditions in that environment are favorable for its existence, but its absence does not mean that the unfavorable conditions prevail.

According to (37), the dominance of Bacillariophyceae is a common phenomenon and feature of the open eutrophic water systems. The predominant abundance of *Bacillariophyceae* in Niger Delta waters observed was not only in phytoplankton communities but also in periphyton communities (38,39). In open eutrophic water, individuals of the genus, *Melosira* are commonly known to dominate (40). In this study, it was observed that the most dominant is from the genus, *Cyclotella* with the species *Cyclotella operculata*, *Cyclotella combia* and *Cyclotealla bedanica*. Other genus and species are *Flagilaria consbums*, *Diatoma species, Chaetoceus gracilis and Melosira monilifornis.*

The dominance of the phytoplankton taxa in terms of species and abundance in the order, Bacillariophyceae> Cyanophyceae> Chlorophyceae is an indication of pollution in the area which is in line with the finding of (41) in Orashi river, Port Harcourt, (42). The presence of *Cyclotella species, Melosira monoliformis and Navicula distans* is also a clear indication that pollution is eminent in the area. This is in line with the assertion that phytoplankton species have been used as indicators of organic pollution (43, 44) and that taxas like *Euglena, Ceratium, Peridinium, Anabaena, Closterium, Scenedesmus and Pediastrum* are indicative of eutrophic condition (45).

According to the classification of the Shannon Wiener index, if the diversity index is lower than 1, then biota communities would be regarded as unstable, whereas a diversity index of 1-3 would be considered moderately stable, and a value higher than three would signify a stable or prime condition (46). Shannon-Wiener indices between two to three (2-3) and above recorded in most of sampled stations confirmed that these stations were moderately stable and not under pollution stress, suggesting that Okamini Stream is relatively vulnerable to environmental changes which is in line with the finding of (47) from Bonny estuary. (48) reported low Margalelf's diversity values from 2.871 to 3.513 in the Qua Iboe estuary. This was similar to 2.93 reported by (49), which is in disagreement with the findings of this study. The high diversity of values, especially Margalef inex in this study across the stations could be attributed to the influence of bunkering activities and other anthropogenic activities which are highly likely in the area as also reported by **(**50, 27,28).

According to Palmer's Algal Pollution Index values between 0-10 indicate lack of organic pollution, 10-15 moderate pollution, 15-20 probable high organic pollution and 20 and above as confirmed high organic pollution (**51)**. The consistency in PPI values across the stations and Months in this study is contrary to the finding of (52) from six lotic water bodies in Delta state which was said to confirm the assertion by (53) that differences in PPI signal intensity and types of contaminants received spatially and temporally. The observed organic pollution status in this study showed free dumping of effluents into the stream because they are beehive of industries (53). Algal communities dominated by *Chrococcus, Microcystis, Ankistrodesmus, Dictyosphaerium, Pediastrum, Scenedesmus, Trachelomonas, Melosira* and *Nitzschia* were found in the Okamini stream and their presence is an indication of organic pollution of the water as established by (17). This study is contrary to the finding of (54) where euglenoids were the eminent and diverse algae in the floodplain both in number and composition. The eminence of this organically loving group of algae in this system elicits a stable organically contaminated water body). The organic load from the various anthropogenic activities in the study area such as agriculture, pond preparation and cattle pasture are culpable and which saliently contributed to the enormous fish production in the study area (Self-observation)

The temperature range at the different sampling stations falls within the 30^{O}C (55) acceptable limit. The slight variations in the sampling time at each station and the seasonal dynamics of the weather in the study area may be the cause of these recorded temperature variations. Temperature regulates the hydrochemistry of parameters such as DO, BOD5, solubility, pH, conductivity, etc. The observed low values of pH in this study could be the as a result of acidic runoffs and are suggestive of acidic conditions. All of the measured pH values fell outside of the advised range of 6.5 to 8.5 when compared to drinking water quality standards. The high acidity may have resulted from burning fossil fuels, precipitation, or petroleum spills. The acidic nature of the stream water may have resulted from the presence of higher concentrations of carbon dioxide, nitrogen oxides, sulfur oxides, and various other acidic compounds in the research area. The observed low dissolved oxygen (DO) and low pH in station 3 in the water body in this study could be attributed to organic pollution, algal blooms followed by decomposition, high temperatures, nutrient enrichment (eutrophication), and acidifying inputs such as industrial effluents or acid rain. These conditions stress aquatic life and often indicate poor water quality. These therefore suggest nutrient enrichment, organic loading, and reduced water quality because they are tolerant to polluted conditions and thrive in environments with high organic matter and low dissolved oxygen. The significant difference in conductivity between stations observed in this study may be attributed to differences in environmental factors owing to nutrient regenerating from bottom sediment, decomposition, heavy run-off and mineralization of microbes. This result also tallied with the mean value reported by (56) in Omoku creek. The observed high nutrients especially phosphate, above the permissible limit of

0.10mg/l recommended by (26) and (55) in this study is in agreement with the finding of (57) was attributed to surface water runoff and rainfall.

CONCLUSION AND RECOMMENDATION

The pollution status of Okamini Stream was studied using Palmer's algal index and water variables. The presence and dominance in water body by plankton genera such as *Ankistrodesmus, Chlamydomonas, Closterium, Closterium, Cyclotella, Euglena, Melisora, Navicula,, Nitzschia, Oscillatoria and Synedra as* widely recognized in Palmer's algal pollution index as indicators of organic pollution, the PPI value above twenty (>20) and the exceedance of some water variables such as pH and Phosphate outside the permissible limits of WHO and NESREA showed that the water is moderately to heavily polluted organically.
Adequate monitoring measures should be put in place to regulate the anthropogenic activities in the study area.

REFERENCES

1. Murray KE, Thomas SM, Bodour AA(2010). Environmental pollution, 2010; 158(12):3462-3471.
2. Maheshwari, R., Singh, U., Singh, P., Singh, N., Lal Jat, B., & Rani, B. (2014). Assessment of water quality using physico-chemical parameters of River Yamuna at Agra, India. *Journal of Advanced Scientific Research*, *5*(2), 7–15.
3. Sonneman, J.A., C.J., P.F. Walsh Breen A.K. Sharpe(2001)."Effects of urbanization on streams of the Melbourne region, Victoria, Australia. II. Benthic diatom communities." *Freshwater Biology* 46(4), 553-565.
4. Walsh, C.J.(2000)."Urban impacts on the ecology of receiving waters: a framework for assessment, conservation and restoration."
5. Bate, G.C., J.B. Adams & J.S. Van Der Molen (2002)- Diatoms as Indicators of Tropical water reservoirs in Eastern India 15 Water Quality in South *African River Systems*. WRC Report No. 814/1/02. Water Research Commission. Pretoria. 164 pp.
6. Winter, J.G. & H.C. Duthie (2000)."Epilithic diatoms as indicators of stream total N and total P concentration." *Journal of the North American Benthological Society* 19(1), 32-49.
7. Emmanuel, B. E., & Onyema, I. C. (2007). The plankton and fishes of a tropical creek in South-Western Nigeria. *Turkish Journal of Fisheries and Aquatic Sciences*, *7*(2), 105–113.
8. Davies, O.A, Abowei, JFN & **Otene, B.B. (2009)**. Seasonal Abundance and Distribution of Plankton of Minichinda Stream, Niger Delta, Nigeria. *American Journal of Scientific Research*, 2: 20-30. http://www. eurojournals. com/ ajsr. htm.
9. Allison, M.E and **Otene, B.B (2012)**. Phytoplankton Assemblage and Physicochemical Parameters of Minichinda Stream, Port Harcourt, Rivers State, Nigeria. *International Journal of Applied Research and Technology*, 1(7)52-59
10. Davies, O.A., **Otene, B.B.** Amachree, D &Nwose, F.A **(2019)**. Phytoplankton Community of Upper Reaches of Orashi River, Rivers State, Nigeria. Science Arena Publications *Specialty Journal of Biological Sciences*, 5 (3): 1-12. ISSN: 2412-7396 Available online at www. sciarena.com,.
11. Nwankwo, D. I., & Akinsoji, A. (1992). The benthic algal community of a eutrophic lagoon: Lagos, Nigeria. *Archiv für Hydrobiologie*, *124*(4), 501–511.
12. **Otene, B.B &** J.F. Alfred-Ockiya (2019[a]**)**. Assessment of water Quality Index (WQI) and Suitability for Consumption of Elele-Alimini Stream, Port Harcourt. *Global Scientific Journal*, 7(2) 2320-9186.www.global scientific journal.com
13. **Otene, B.B** and Alfred-Ockiya, J.F (2020). Pollution Status of Sediment of Elele-Alimini Stream, Port Harcourt, Nigeria. *Global Scientific Journal* (GSJ): 8(4)2320-9186 www.globalscientificjournal.com
14. Milenkovic,N.M, Damjanovic, M and Ristic,M(2005). Study of heavy metal pollution in sediments from the iron Gate (Danube River), Serbia and Montenegro.. Polish Journal of Environmental Studies, 14(6),781-787
15. Shahare, P. (2017). Assessment of drinking water quality in selected locations in selected states of North Central Nigeria. *IOSR Journal of Environmental Science, Toxicology and Food Technology*, *13*(1), 12–21. https://doi.org/10.9790/5736-1301011221
16. Palmer, C. M. (1968). *A composite rating of algae tolerating organic pollution*. *Journal of Phycology*, *4*(1), 78–82.
17. Palmer, C. M. (1969). *A composite rating of algae tolerating organic pollution*. *Journal of Phycology*, *5*(1), 78–82.
18. Veenashree,I., Kumar, M., Nandini, N(2022). Algal Species Diversity And Palmer Pollution Index Of Puttenahalli Lake In Bengaluru, India. *Journal of Advanced Scientific Research*, 13 (10): *41-46*
19. **Otene,B.B and** Nnadi, P.C. (2019[b]). Water Quality Index and Status of Minichinda Stream, Port Harcourt,Nigeria. *IIARD International Journal of Geography and Environmental Management* ISSN2505-882,5(1).www. iiard pub. org.
20. **Otene,B.B and** J.F. Alfred-Ockiya (2019[C]**)**. Human and Ecological Risk Assessment of Heavy Metals in Water and Sediment of Elechi Creek, Port Harcourt, Nigeria. *IOSR Journal of Environmental Science, Toxicology, and Food Technology (IOSR-JESTFT), 13(3):, pp01-07.* www.iosrjournals.org
21. **Otene, B.B,** Alfred-Ockiya, J.F & Amadi, F **(2019).** Physicochemical Properties and Zooplankton Community Structure of Okamini Stream, Port Harcourt, Nigeria. *International Journal of Research and Innovation in Applied Science* (IJRIAS) | Volume IV, Issue X, 2454-6194.

22. Abowei, J. F. N. (2000). Aspects of fisheries of the Lower Nun River, Nigeria. *Ph.D. Thesis*, University of Port Harcourt, Nigeria.
23. Ekpete, O. A. (2012). Assessment of phenolic compounds in surface waters from New Calabar River, Niger Delta. *Journal of Applied Sciences and Environmental Management*, 16(2), 223–230.
24. American Public Health Association (APHA). (2012). *Standard methods for the examination of water and wastewater* (22nd ed.). Washington, DC: American Public Health Association, American Water Works Association, Water Environment Federation.
25. Coesel, P. F. M., & Meesters, K. J. (2007). *Desmids of the Lowlands: Mesotaeniaceae and Desmidiaceae of the European Lowlands*. Leiden: BRILL.
26. National Environmental Standards and Regulations Enforcement Agency (NESREA). (2011). *National environmental (sanitation and waste control) regulations, S.I. No. 28 of 2009*. Abuja: Federal Republic of Nigeria.
27. **Otene,B.B,** I Thornhill & J Amadi(2023[a]). A comparison of the water quality and plankton diversity of the Okamini Stream to the freshwater systems within the New Calabar River catchment, Port Harcourt, Nigeria. *African Journal of Aquatic Science.*
28. Otene, B.B, Simbi-Wellington W. S and Robinson, N (2023b). Limnological properties and phytoplankton as indicators of pollution, Choba Segment, New Calabar River Niger Delta, Nigeria. *World Journal of Advanced Research and Reviews*, 15(2), 123–135. PDF Source
29. Itekere, O., Okon, E. M., Folowosele, D. O., & Oluwafemi, P. T. (2024). Aquatic food resources in tropical Africa: A comprehensive analysis. *Frontiers in Sustainable Food Systems, 8,* Article 1252119. https://doi.org/10.3389/fsufs.2024.1252119
30. **Otene, B.B,** O.M.G, Abu and Asawo, M.C (2022). Evaluation of Heavy Metal Bioaccumulation by Phytoplankton and Water, Sombriero River, Port Harcourt. Research & Reviews: *Journal of Ecology* ISSN: 11(2). DOI: DOI (Journal):10.37591/RRJoE
31. Chindah, A.C.& Braide,S.A.(2004).The physico-chemical quality and phytoplankton community of tropical waters. A case of 4 biotopes in the lower Bonny River, River State, Niger Delta, Nigeria. *Caderuo depesquisa.Ser. Bio.Santa Crus de sul,* 16(2),7-37.
32. Chindah, A. C., & Braide, S. A. (2001). Meiofauna occurrence and distribution in different substrate types of Bonny brackish wetland of the Niger Delta. *Journal of Applied Sciences and Environmental Management, 5*(1), 33–41.
33. Chindah, A.C,Braide,S.A & Onwuteaka,J.N.(2005).Vertical distribution of periphyton on woody substrate in a Brackish wetland embayment of Bonny River, Niger Delta. *Delta Biologia*,5(1),97-108.
34. Chindah, A. C., & Keremah, R. I. (2001). Comparative study of different gill net mesh sizes in the exploitation of bonga fish (*Ethmalosa fimbriata*) and sardines (*Sardinella eba*) in Brass coastal waters, Bayelsa State, Nigeria. *Journal of Applied Sciences and Environmental Management, 5*(2), 123–130.
35. Davies, O.A & Otene, B.B (2009). Zooplankton Community of Minichinda Stream,Port Harcourt, Rivers State, *European Journal of Scientific Research,* 26(4),490 – 498.http: //www.eurojournals**.**
36. Prashant, S., Tyagi, S., Sharma, B., & Dobhal, R. (2017). Water quality assessment in terms of water quality index. *American Journal of Water Resources, 1*(3), 34–38. https://doi. Org /10. 12691 /ajwr-1-3-3
37. Townsend, M. C. (1991). *Essentials of psychiatric mental health nursing*. F.A. Davis Company.
38. Chindah, A.C.and Nduaguibe,B.(2008).Effects of Tankfarm wastewater on water Quality of a River in Niger Delta. *Journal of Nigerian Environmental Society*,2 (2),210-214.
39. Chindah, A.C.(2004). Response of Periphyton community to salinity gradient in Tropical estuary, Niger Delta, Nigeria. *Pollution Journal of Ecology*, 52 (1), 83-89
40. Erondu, E.S & Chindah, A.C.(1991). Physico-chemical and Plankton changes in a Tidal Freshwater Station of the New Calabar River, South-Eastern Nigeria. *Environment and Ecology*,9 (3), 561 – 570
41. Davies, O.A., Otene, B.B. Amachree, D and Nwose, F.A (2019). Phytoplankton Community of Upper Reaches of Orashi River, Rivers State, Nigeria. *Specialty Journal of Biological Sciences*, 5 (3): 1-12
42. Sorayya, M., Salleh, A., Milow, P., Baba, M. S., & Sharifah, S. A. (2011). Applying artificial neural network theory to exploring diatom abundance at tropical Putrajaya Lake, Malaysia. *Journal of Freshwater Ecology, 27*(2), 211–227. https://doi.org/10. 1080/0 2705060.2011.635883
43. Nwonumara, G. N. (2018). Water quality and phytoplankton as indicators of pollution in a tropical river. *Zoological Society of Nigeria Publications*, 25, 1–10.
44. Ugbeyide, J. A., & Ugwumba, O. A. (2021). Water quality and phytoplankton as indicators of pollution in Ibuya River, Nigeria. *British Journal of Environmental Sciences, 9*(1), 45–58
45. Idumah, O. K., Okogwu, O. I., & Nwonumara, G. N. (2013). Pollutant sources, entry routes, implications, and mitigation of water pollution in the Niger Delta aquatic ecosystem, Nigeria. *Journal of Applied Sciences and Environmental Management*, 17(4), 567–574.

46. Mokoginta, I. (2016). The use of water quality index method to determine the potability of surface water and groundwater in the vicinity of a municipal solid waste dumpsite in Nigeria. *American Journal of Engineering Research*, 5(10), 96–101.
47. Dienye 1,H.E, Francis D. S Ikoki, G Eoffrey N. W Oke and O.La.O Lopade(2022). Diversity of bloom forming harmful algal species in the central Bonny estuary, Niger delta, Nigeria. *Marine and Fishery Sciences* 35 (3): 387-402.
48. Ofonmbuk, L., & Lawrence, P. (2015). *Nigerian standard for drinking water quality (NIS 554:2015).* Standards Organization of Nigeria, Abuja.
49. Ogbuagu, D. H., & Ayoade, A. A. (2012). *Assessment of water quality and plankton taxa of Nworie River in Owerri, Southeastern Nigeria.* IOSR *Journal of Environmental Science, Toxicology and Food Technology*, 14(9), 43–51.
50. Otene, B.B & Iorchor, S.I (2013). Seasonal Variability in Some Parameters of Water of Amadi-Ama Creek, Upper Bonny Estuary, Niger Delta. *Scientific Journal of Zoology*, 2(1):1-5. www.Sjournals.com
51. Jose, L., & Kumar, C. (2011). Evaluation of pollution by Palmer's algal pollution index and physico-chemical analysis of water in four temple ponds of Mattancherry, Ernakulam, Kerala. *Nature Environment and Pollution Technology, 10*(3), 471–472.
52. Iloba, K. I. (2020). The pollution status of six lotic water bodies in Delta State using Palmer's pollution index. *Nigerian Journal of Science and Environment, 18*(1), 1–12.
53. Abdulmumini, A.,Gumel,S.M and Garba,J (2014). Industrial effluents as significant source of water pollution in Nigeria. An overview. *American Journal of Chemistry and application*, 1(5),45-50.
54. Bellinger EG, Signee DC(2015). Freshwater Algae: Identification, Enumeration and Use as Bioindicators. 2nd Edition. WILEY Blackwell. 2015, 114.
55. World Health Organization (WHO). (2017). *Guidelines for drinking-water quality* (4th ed.). Geneva: World Health Organization.
56. Ewa, I. O. B., Iwar, R. L., & Amah, E. A. (2011). Assessment of heavy metal concentrations in drinking water sources in Nigeria. *Journal of Applied Sciences and Environmental Management*, *15*(1), 147–150.
57. Chukwuma, A.,Ugbebor,J, Ugwoha,E(2024). Assessment Of The Physicochemical Characteristics And Water Quality Index Of Nkisa River In The Niger Delta, Nigeria**.** *International Journal of Novel Research in Engineering and Science***,**10(2), (95-105)