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Research Article

ASSESSMENT OF WATER QUALITY USING WATER QUALITY INDEX IN COASTAL WATER BODIES OF PORT HARCOURT

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Abstract

This study aimed to assess the water quality of selected bodies in Port Harcourt—Elechi Creek, Tourist Beach, and Marine Base—by calculating their Water Quality Index (WQI). Water samples were collected monthly from February to July 2019, and the physicochemical parameters were analyzed following the standard methods of the American Public Health Association (APHA). Nine parameters, including pH, turbidity, total suspended solids (TSS), chemical oxygen demand (COD), and sulfate (SO4), were used to compute the WQI. The data were subjected to analysis of variance (ANOVA) and Duncan's Multiple Range Test (DMRT) to determine any significant differences across the sampling stations. The findings revealed significant variations in most physicochemical parameters, with only temperature showing no significant difference ($p<0.05$). Seasonal variations were observed in pH, turbidity, TSS, COD, and SO4. The WQI values ranged from 211.776 at Tourist Beach to 303.644 at Marine Base, with an overall average of 258.262. The dry season had a lower mean WQI value (230.350) compared to the wet season (257.074). According to the quality grading, all water bodies fell into Class D and E, indicating poor to unsuitable water quality for domestic use and human consumption. The study emphasizes the need for remediation efforts and public awareness campaigns to mitigate anthropogenic activities, such as pollution and improper waste disposal, which contribute to water quality deterioration in these areas..

Keywords: Water Quality Index (WQI), Physicochemical Parameters, Anthropogenic Activities, Seasonal Variations, Water Pollution

Introduction

Aquatic systems, including rivers, lakes, estuaries, and coastal ecosystems, are essential to the functioning of both natural and human systems. They provide an array of critical services, including freshwater for drinking, irrigation, industrial use, and recreation. These systems support vibrant aquatic life, serve as critical habitats for a variety of species, and sustain livelihoods, particularly in regions where aquaculture, fishing, and agriculture are important economic activities. In the context of the ever-growing human population and urban expansion, these water resources face unprecedented challenges. Anthropogenic activities, particularly industrialization,

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urbanization, and agricultural practices, have significantly degraded the quality of these water bodies, which directly impacts their ability to support diverse ecological and economic functions.

The increasing importance of protecting and rehabilitating aquatic systems has become a global priority. Over the past few decades, the degradation of water quality due to both anthropogenic influences and natural processes has severely compromised the capacity of water bodies to fulfill these essential roles. Pollution, habitat destruction, overfishing, and nutrient overloads from agricultural runoff and industrial discharges are among the many anthropogenic factors that have led to the deterioration of water quality. Such degradation has far-reaching implications for public health, biodiversity, and the economy. The rapid decline in water quality in some areas has reached a point where recovery is becoming increasingly unlikely without significant intervention and remediation efforts.

Fishes, which form a critical part of aquatic ecosystems, rely on water for a variety of physiological functions, including respiration, excretion, feeding, reproduction, and maintaining salt balance. When water quality deteriorates, it directly affects fish populations and the broader aquatic ecosystem, ultimately impacting industries reliant on these ecosystems, such as fishing and aquaculture. These challenges are especially pronounced in coastal and estuarine systems, where human activities such as industrial waste disposal, sewage effluent, and land-based pollution contribute heavily to water contamination.

Water quality issues in both inland and coastal ecosystems are diverse, ranging from changes in physical characteristics such as temperature and turbidity to chemical contaminants like heavy metals, pesticides, and nutrients such as nitrogen and phosphorus. These contaminants can degrade water quality to the point where it is no longer suitable for human consumption, agricultural irrigation, industrial uses, or recreational activities. In addition, pollutants in the water can have harmful effects on aquatic life, leading to the loss of biodiversity, the proliferation of harmful algal blooms, and the disruption of food chains.

The quality of water in a given location determines its suitability for various uses, whether for drinking, agricultural irrigation, industrial applications, or recreational activities. It also influences the health and survival of aquatic species. When water is contaminated with pollutants such as heavy metals, organic chemicals, or pathogens, it can pose significant risks to human health. For instance, the consumption of contaminated water can lead to a range of diseases, including gastrointestinal illnesses, neurological disorders, and even cancer. Moreover, water contaminated with heavy metals like mercury or lead can accumulate in the food chain, posing long-term risks to both aquatic life and humans.

Water quality monitoring plays a crucial role in addressing these issues. Regular monitoring provides essential data on the status of water bodies, tracks changes in water quality over time, and helps identify sources of contamination. This data is crucial for developing effective management strategies, remediation programs, and policy interventions aimed at protecting and restoring water resources. Additionally, water quality monitoring allows for the development of indices such as the Water Quality Index (WQI), which simplifies complex water quality data into a single, easily interpretable value that reflects the overall health of the water body.

The WQI is particularly valuable for assessing the health of aquatic systems in real time, providing a tool for evaluating the impact of human activities on water quality. It is derived from various physical, chemical, and biological parameters, including dissolved oxygen levels, pH, temperature, turbidity, and concentrations of key pollutants such as nitrates, phosphates, and heavy metals. By assigning numerical values to these parameters, the WQI offers a composite measure of water quality that can be used to assess whether water bodies are safe for their intended uses. A high WQI indicates good water quality, while a low WQI reflects poor water quality, signaling potential risks to human health, aquatic ecosystems, and associated industries.

The need for water quality monitoring is particularly pressing in regions where water bodies serve as vital sources of livelihood, such as in Port Harcourt, Nigeria. The water bodies in this area, including Elechi Creek, Tourist Beach, and Marine Base, provide essential resources for the local population, who rely on them for fishing, bathing, and agricultural activities. However, the increasing presence of anthropogenic activities—such as refuse disposal, industrial waste discharge, and overfishing—has led to significant water quality degradation. The local communities in Port Harcourt face the challenge of managing and maintaining these vital water resources amidst these growing pressures.

The degradation of water quality in these water bodies has direct consequences for the health and livelihoods of the local population. Industrial and domestic waste discharges are major contributors to water contamination, which adversely affects both the aquatic life and the local communities that depend on these water resources. The release of untreated sewage and industrial effluents into these water bodies poses serious health risks to the residents, who often rely on the water for daily activities such as drinking, cooking, and bathing. Moreover, the overexploitation of fish stocks and the destruction of aquatic habitats further compound the problem, leading to reduced fish yields and the loss of biodiversity.

The status of water bodies in Port Harcourt has drawn attention to the need for comprehensive water quality management strategies. This research aims to assess the water quality in these critical water bodies by applying the WQI index, evaluating the level of contamination, and identifying the sources of pollution. By understanding the specific water quality challenges faced by these water bodies, the research will provide valuable insights into the current state of the aquatic ecosystems and contribute to the development of effective management practices to mitigate pollution and improve water quality. The findings of this study will also provide a basis for developing public awareness campaigns to educate local communities about the importance of water conservation, pollution prevention, and the sustainable use of aquatic resources.

Water quality remains a critical factor in ensuring the success and sustainability of aquaculture and other water-dependent industries. As such, this study seeks to provide a comprehensive assessment of the water quality in

Port Harcourt's coastal and freshwater ecosystems, contributing to the ongoing efforts to protect and rehabilitate these vital resources. Ultimately, the research aims to contribute to the broader understanding of water quality issues in developing regions and offer practical recommendations for improving water management practices to ensure that these resources continue to support both ecological health and human well-being.

Materials and Methods

Study Area

The climate of the study areas is sub-tropical and characterized by high atmospheric temperature of 27.5^{0}C and relative humidity fluctuating between 70-90% (Gobo,1988). The annual rainfall of the Niger Delta is between 2000-3000mm per year. Dry season lasts for about six (6) months between November-April with occasional rainfall.

Sampling Stations

The three sampling locations chosen were above 500m apart along the main stream course which include the following (fig 1)

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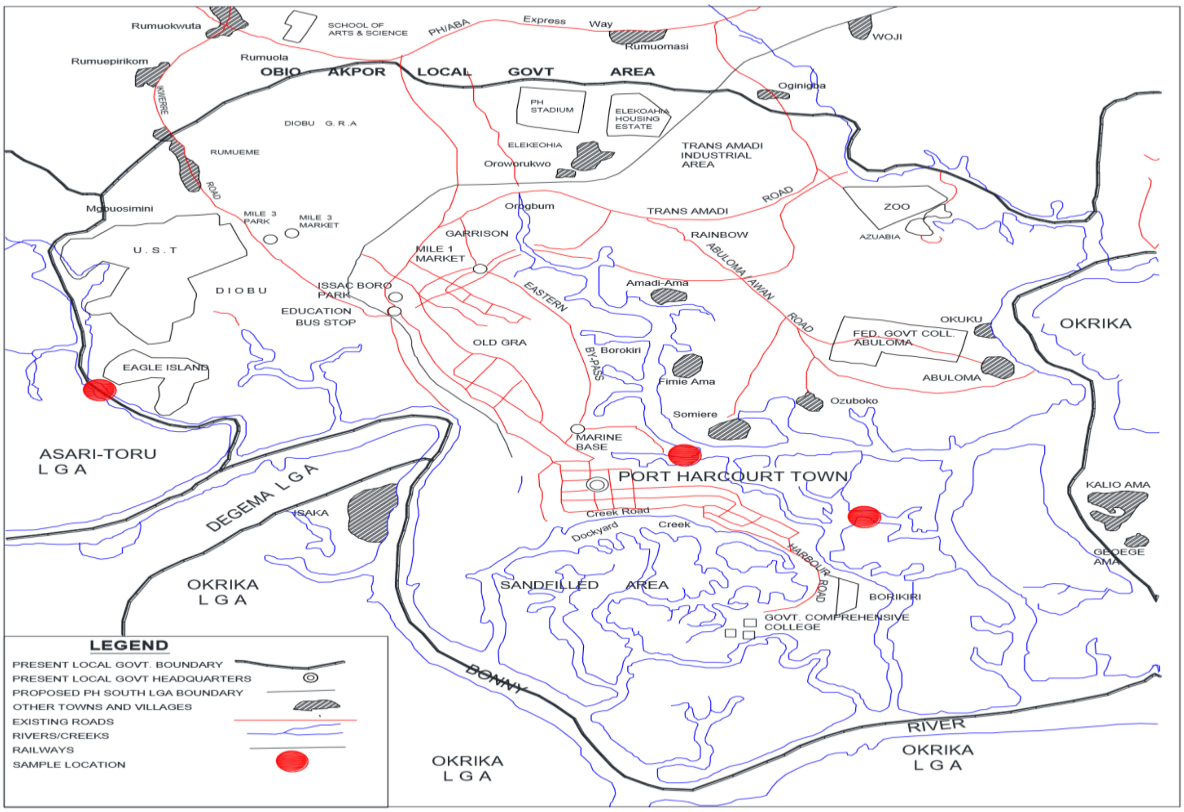

0Km. 2Km. SCALE:- 1:60,000

MAP OF THE STUDY AREA SHOWING SAMPLE LOCATION

Station 1: Elechi Creek (The base of the oil company, Agip which is known to discharge several quantum of wastes)

Station 2: Tourist beach (Point source of industrial & domestic disc charges)

Station 3: Marine base (Anthropogenic activities such as car washing, bathing, greasing etc take place here)

Samples collection and analysis

Water samples were collected for a total duration of six (6) months between February and July 2019 and analysed following standard method (APHA, 2002) for the physicochemical parameters, pH, conductivity, alkalinity, chloride, dissolved oxygen, biochemical oxygen demand, phosphate, nitrate and sulphate. Chemical Oxygen Demand was estimated by Open Reflux method while Biological Oxygen Demand was fixed in the field using Winkler method. Nitrates was estimated by Cadmium reduction method. Total phosphate is estimated by Ascorbic acid method. Silicate was estimated by Colorimetric method. Turbid metric method was used for the estimation of Sulphates.

Statistical/Data Analysis

Statistical analysis carried out using the Statistical package for Social Sciences (SPSS 20).The data obtained were subjected to analysis of variance (ANOVA) and Duncan Multiple Range Test (DMRT) using SPSS (2003) and Microsoft excel (2003) packages.

The calculation of water quality index (WQI) made use of the nine (9) parameters chosen. The standards recommended by the World Health Organization (WHO), Bureau of Indian Standards (BIU) and Indian Council for Medical Research (ICMR) were followed in the calculation of water quality index. The weighted arithmetic index method (Brown *et al*., 1970) was used for the calculation of WQI of the water body while quality rating or sub index (qn) was calculated from the expression:

$qn = 100 \left[(Vn - Vio) / (Sn - Vio) \right]$ (Brown, et al.,1970)

Where

qn = Quality rating for the nth water quality parameters

Vn = Estimated value of the nth water quality parameters of collected sample,

Sn = Standard permissible value of the nth water quality parameters

Vio = Ideal value of the nth water quality parameter in pure water (i.e O for all other parameters except the parameters pH and Dissolved Oxygen (7.0 and 14.6mg/1 respectively).

Unit weight (Wu) was calculated by a value inversely proportional to the recommended standard value Sn of the corresponding parameter.

Therefore:

Wn = K/Sn

Were

Wn = Unit weight for the nth parameters

Sn = Standard value for nth parameters

K = Constant for proportionality

The overall WQI was therefore calculated by aggregating the quality rating with the unit weight linearly as follows:

$$WQI = \sum qnWn \Big/ \sum Wn$$

Where qn = Quality rating for nth water quality parameter wn =
Unit weight for nth water quality parameter
The water quality index (WQI) scale consists of five grades (1-5) ranging from excellent to unsuitable (Table 1).

Table 1: Water Quality Classification Based on WQI Value

WQI	Rating of water Quality	Grading
<50	Excellent water quality	A
50-100	Good water quality	B
100-200	Poor water quality	C
200-300	Very poor water quality	D
> 300	Unsuitable for drinking purpose but suitable for mariculture and irrigation of some crops	E

Source: NSDWQ in Amadi *et al* (2010) Ama *et al*.**, (2018)**

Results

The results of the physicochemical variables studied are as presented in table 2-6 below. Table 2 showed the level of significant difference among the physicochemical parameters across the various stations with only temperature not significantly different at $p<0.05$. The pH varied between acidic to neutral range (5.50-7.70) while water temperature ranged from 28.0 to 30.5^{0}c (Table 3). Turbidity value ranged between 30.0 and 42.70 NTU with the mean value of 35.24 ± 3.96 NTU) , TSS value ranged between 62.0 and 87.63mg/l while EC value ranged from 10101.0 µs/cm to 13869.0 µs/cm. Only pH, turbidity, TSS, COD and SO4 exhibited seasonality (Table 4). The obtained WQI in this study was lowest in Tourist beach(211.776) but highest (303.644) in Marine base with the overall mean value of 258.262(Table 5-8). WQI was lowest(230.350 in dry season but highest (257.074) in wet season (Table 9-10)

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Table 2: Spatial Mean Values of Physicochemical Parameters in the Study Area

S/N	Parameters	Elechi Creek (S1)	Marine Base (S2)	Tourist Beach(S3)
1	pH	6.53±0.74^{a}	6.37±0.79^{a}	6.75±0.64^{a}
2	Turbidity (NTU)	35.30±2.71^{b}	39.28±2.25^{a}	31.15±1.14^{c}
3	Total Suspended Solid (TSS) (mg/l)	66.89±2.94^{c}	78.26±7.12^{a}	70.01±1.54^{b}
4	Electrical Conductivity (EC)(μs/cm)	11050±773.89^{b}	12537.60±805.35^{a}	12093. ±86.96^{a}
5	Total Dissolved Solids (TDS)(mg/l)	5560.50±163.93^{C}	6267.67±53.40^{a}	6120.33±47.60^{b}
6	Chloride (Cl)(mg/l)	3302.50±88.99^{b}	4319.67±329.1^{a}	3590.83±49.68^{C}
8	Biological Oxygen Demand (BOD)(mg/l)	26.66±1.37^{b}	29.99±1.89^{a}	24.24±1.04^{b}
9	Dissolved Oxygen (DO)(mg/l)	5.36±0.32^{a}	4.79±0.52^{b}	5.63±0.37^{a}
10	Nitrate ($N0_3$) (mg/l)	0.63±0.11^{b}	0.81±0.05^{a}	0.57±0.10^{b}
11	Phosphate ($P0_4$) (mg/l)	0.69±0.05^{b}	0.82±0.05^{a}	0.53±0.10^{b}
12	Sulphate ($S0_4$) (mg/l)	170.88±33.34^{b}	193.88±5.70^{a}	176.57±19.0^{b}

Table 3: Overall Mean values, SD, Miximum and Maximum Values of Water Parameters in the Area

S/N	Parameters	Mean±SD	Mini-Maxi
1	pH	6.55±0.70	5.5 -7.7
1	Temperature (0C)	29.97±0.83	28 -30.5
2	Turbidity (NTU)	35.24±3.96	30 -42.70
3	Total Suspended Solid(TSS)(mg/l)	71.72±6.52	62 -87.63
4	ElectricalConductivity(EC) (µs/cm)	1189.3±883.38	10101-13369
5	Total Dissolved Solids (TDS)(mg/l)	5982.83±328.23	5471 -6299
6	Chloride (Cl)(mg/l)	3737.67±478.44	3232 -4922
7	Salinity (%0)	6.63±0.14	5.50 -7.88
8	Biological Oxygen Demand (BOD)(mg/l)	26.96±2.79	22.55-2.60
9	Dissolved Oxygen (DO)(mg/l)	5.24±0.52	4.19 -5.99
10	Chemical Oxygen Demand(COD)(mg/l)	40.99±3.90	36.33-9.67
11	Nitrate ($N0_3$)(mg/l)	0.67±0.14	0.45-.90
12	Phosphate ($P0_4$) (mg/l)	0.68±0.13	0.47 -0.89
13	Sulphate ($S0_4$) (mg/l)	180.44±23.35	105.3-00.5

Table 4: Seasonal Mean Values of Physicochemical Parameters in the Study Area

S/N	Parameters	Dry Season	Wet Season
1	pH	7.08±0.40[a]	6.02±0.52[b]
1	Temperature (0C)	29.28±0.91[a]	28.67±0.66[a]
2	Turbidity (NTU)	34.33±2.71[b]	36.16±4.15[a]
3	Total Suspended Solid(TSS)(mg/l)	68.78±4.38[b]	74.66±7.19[a]
4	Electrical Conductivity(EC)(μs/cm)	11484.22±844.96[a]	12303.56±752.78[a]
5	Total Dissolved Solids (TDS)(mg/l)	5980.33±363.31[a]	5985.33±311.33[a]
6	Chloride(Cl)(mg/l)	3302.50±88.99a	4319.67±329.1[a]
7	Salinity (%0)	6.95±0.54[a]	6.31±0.55[a]
8	Biological Oxygen Demand(BOD)	26.06±2.65[a]	27.87±2.77[a]
9	Dissolved Oxygen (DO)(mg/l)	5.36±0.54[a]	5.12±0.51[a]
10	Chemical Oxygen Demand (COD)	39.86±3.13[b]	42.14±4.43[a]
11	Nitrate ($N0_3$)(mg/l)	0.73±0.10[a]	0.61±0.15[a]
12	Phosphate ($P0_4$) (mg/l)	0.69±0.12[a]	0.66±0.15[a]
13	Sulphate ($S0_4$) (mg/l)	184.17±15.81[b]	176.72±29.62[a]

y index for Elech **(S1)**

S/N	Parameters	Observed Value	Sn	Wn	qn	Wnqn
1	pH	6.55	6.5-8.5	0.0278	30	0.834
2	EC	11050	300	0.000707	3683.33	2.604
3	Turbidity	35.30	5	0.04713	706	33.274
4	Chloride	3302.50	250	0.000943	1,321	1.246
5	N03	0.63	45	0.00471	1.44	0.000678
6	P04	0.69	0.30	0.7846	230	194.58
7	S04	170.88	150	0.0158	113.92	1.800
8	COD	40.57	10	0.0236	405.70	9.575
9	BOD	26.66	5	0.04713	533.20	**25.13**

10	DO	5.30	5	**0.04713**	**96.875**	**4.566**
11	TDS	5560.50	500	**0.000471**	**1112.10**	**0.5238**
	Summation (Ɛ)			**1.000**		**274.132**

Water Quality Index (WQI) = $\sum q_nW_n / \sum W_n$ **= 274.132**

Table 6: Water Quality index for Marine Base (S2)

S/N	**Parameters**	**Observed Value**	**Sn**	**Wn**	**qn**	**Wnqn**
1	pH	6.37	6.5-8.5	0.0278	42.00	1.172
2	EC	12537.60	300	0.000707	4174.20	2.951
3	Turbidity	39.28	5	0.04713	785.60	37.025
4	Chloride	4319.67	250	0.000943	1727.868	1.629
5	N03	0.81	45	0.00471	1.80	0.00848
6	P04	0.82	0.30	0.7846	273.33	214.455
7	S04	193.88	150	0.0158	129.25	2.042
8	COD	45.28	10	0.0236	452.80	10.686
9	BOD	29.99	5	0.04713	599.80	**28.269**
10	DO	4.79	5	**0.04713**	**102.188**	**4.816**
11	TDS	6267.67	500	**0.000471**	**1253.534**	**0.5238**
	Summation (Ɛ)			**1.000**		**303.644**

Water Quality Index (WQI) = $\sum q_nW_n / \sum W_n$ **= 303.644**

Table 7: **Water Quality index for Tourist Beach**

S/N	**Parameters**	**Observed Value**	**Sn**	**Wn**	**qn**	**Wnqn**
1	pH	6.37	6.5-8.5	0.0278	42.00	1.1676
2	EC	12093.30	300	0.000707	4031.10	2.850
3	Turbidity	31.15	5	0.04713	623	29.362
4	Chloride	13590.83	250	0.000943	1436.33	1.355
5	N03	0.51	45	0.00471	1.133	0.00533

6	P04	0.53	0.30	0.7846	176.667	138.613
7	S04	176.57	150	0.0158	117.713	1.8599
8	COD	37.15	10	0.0236	371.50	8.7674
9	BOD	24.24	5	0.04713	484.80	22.849
10	DO	5.63	5	0.04713	92.708	4.3693
11	TDS	6120.33	500	0.000471	1224.066	0.577
	Summation (Ʃ)			**1.000**		**211.776**

Water Quality Index (WQI) = $\sum qnWn / \sum Wn$ **= 211.776**

Table 8: Overall Mean Water Quality Index in the Study Area

S/N	Parameters	Observed Value	Sn	Wn	qn	Wnqn
1	pH	6.55	6.5-8.5	0.0278	90	0.834
2	EC	5982.83	300	0.000707	3964.63	2.803
3	Turbidity	35.24	5	0.04713	1704.80	33.217
4	Chloride	3737.67	250	0.000943	1495.068	1.410
5	N03	0.67	45	0.00471	1.422	0.0067
6	P04	0.68	0.30	0.7846	226.67	177.845
7	S04	180.44	150	0.0158	120.29	1.901
8	COD	40.99	10	0.0236	409.90	9.674
9	BOD	26.96	5	0.04713	5307.20	**25.412**
10	DO	5.24	5	**0.04713**	**97.50**	**4.590**
11	TDS	5982.83	500	**0.000471**	**11967.57**	**0.564**
	Summation (Ʃ)			**1.000**		**258.262**

Water Quality Index (WQI) = $\sum qnWn / \sum Wn$ **= 258.262**

Table 9: Water Quality index for Dry Season in the Area

S/N	Parameters	Observed Value	Sn	Wn	qn	Wnqn
1	pH	7.08	6.5-8.5	0.0278	53.33	1.482
2	EC	11484.22	300	0.000707	3828.07	2.706
3	Turbidity	34.33	5	0.04713	686.60	3.236
4	Chloride	3840.33	250	0.000943	1536.132	1.449
5	N03	0.73	45	0.00471	1.622	0.00764
6	P04	0.69	0.30	0.7846	230	180.458
7	S04	184.17	150	0.0158	122.78	1.9399
8	COD	39.86	10	0.0236	398.60	9.467
9	BOD	26.06	5	0.04713	521.20	24.564
10	DO	5.36	5	0.04713	96.250	4.536
11	TDS	5980.33	500	0.000471	1196.066	0.5637
	Summation (Ƹ)			**1.000**		**230.350**

Water Quality Index (WQI) = $\sum qnWn / \sum Wn$ **= 230.350**

Table 10: Water Quality index for the Wet Season in the Area

S/N	Parameters	Observed Value	Sn	Wn	qn	Wnqn
1	pH	6.02	6.5-8.5	0.0278	65	1.807
2	EC	12303.56	300	0.000707	4101.187	2.8995
3	Turbidity	36.16	5	0.04713	723.20	34.084
4	Chloride	3635.00	250	0.000943	1454	1.371
5	N03	0.61	45	0.00471	1.444	0.00681
6	P04	0.66	0.30	0.7846	220	172.612
7	S04	176.72	150	0.0158	117.813	1.861
8	COD	42.14	10	0.0236	421.40	9.945
9	BOD	27.87	5	0.04713	557.40	26.270
10	DO	5.12	5	0.04713	98.75	4.654
11	TDS	5985.33	500	0.000471	1197.066	0.5638
	Summation (Ƹ)			**1.000**		**257.074**

Water Quality Index (WQI) $= \sum q_nW_n \big/ \sum W_n$ **= 257.074**

Discussion

The observed values of most of the physicochemical parameters were outside the recommended guidelines by the various agencies such as WHO, SON, FEPA and among others which symbolize stress. The water is therefore unsuitable for domestic use such as drinking but could be suitable for some activities irrigation and aquacultural practices especially in mariculture. The low level of dissolved oxygen especially in station 2 and the consistently higher level of biological oxygen demand and phosphate in this study indicate that the water status is purely eutrophic as opined by Otene and Alfred-Ockiya (2019). Additional increased concentration of chlorides and sulphate in the various stations in this study indicate the usability of water for domestic use which is, in line with the finding of Yogendra and Puttalah (2008). The physicochemical status of an aquatic system determines the quality of the water in the area and season.

The high concentration of chemical oxygen demand in this study above the permissible limit in the surface water is an indication that the solid waste in the area is highly polluted with oxidizable organic and inorganic pollutants (Otukune and Biykwu, 2005). This is confirmed by high total dissolved solutes ranging between 5479 – 6299mg/l in this study which is above the maximum permissible limit of 500mg/l stipulated by WHO (2008, 2011,2018), NSDWQ (2007) and Chapman (1996) opined that high TDS in a surface water is an indication of high presence of anthropogenic activities along the river course and run-off containing suspended materials. The high value of WQ1 obtained in this study is comparable to the range of 34 – 513 with an average of 287 reported by Ahmed (2013) in Riyadh mainstream Saudi Arabia for a variety of uses. Therefore, the water from the various stations belong to categories D and E which by status are eutrophic and unsuitable for human use especially for drinking (Ravichandran (2003). This result is also comparable with the finding of Amadi *et al.*, (2010) who reported 174.49 which according to water categorization was considered eutrophic and poor. This poor water status as observed in this study could be ascribed to surface run-off or discharge of some contaminants from domestic or industrial source into the aquatic environment.

This observation is in disagreement with the various indices (31.269,29.050 and 26.429) reported by Otene and Alfred-Ockiya (2019) from Elele – Alimini stream, Port Harcourt and range of 84.13 to 86.36 reported by Leizon *et al* (2017) from Brass River, Bayelsa state. This variation could be ascribed to difference in climatic factors or difference in anthropogenic activities in the area. This is confirmed by the assertion that globally surface water characteristics are governed by the numerous anthropogenic man made and natural processes (Javie *et al.*, 1998) such as weathering, erosion hydrological features, climate change precipitation, industrial activities, agricultural land use sewage discharges as well as human exploitation of aquatic resources. These values are in agreement with the values (320.51, 543.18, 581.52 and 593.4) reported by Akshata *et al.*, (2017) from Vishuamitri River, Gularat, India. This observation is also contrary to the values (29.732, 37.9.44 and 28.127) reported by Otene and

Nnadi (2019) from Minichinda Stream, Port Harcourt. The water quality rating in this study showed that the water from the various stations are of bad quality (unsuitable for drinking) as confirmed by by Chatterji and Raziuddin (2002) since they are within the ranges of 200 – 300 and > 300. The order of quality of this water spatially is S3 > SI > S2 showing that station 3 is though poor while station 2 (Marine Base) is the poorest.

Seasonally, the lower value of the index in the dry season (230.350) than the wet season (257.074) could be attributed to difference in surface run off resulting from high level of precipitation/ rainfall in the wet season. By rating the water qualities were poor in both seasons but poorest in the wet season. This result is in line with the assertion by Eboh *et al* (2020) from Ajali River Enugu that water quality index gets higher and river water get deteriorated as rainy season approaches. This was said to reflect the discharge of pollutants to the surface water from domestic sewers, storm water discharge, industrial have significant effects of both short and line term duration on the quality of water.

Jindal and Sharma (2011) opined that water that is unsuitable for drinking could only be used for aquaculture, irrigation and industrial purposes. The concentration of water nutrients (PO_4, NO_3 and SO_4) in this study is higher than the concentration reported by Otene and Alfred-Ockiya (2019) in Elele-Alimini Stream, Port Harcourt, Otene and Nnadi (2019) in Minichinda stream etc. The high-water nutrients (PO_4, NO_3 and SO_4) in this study showed that the water body is eutrophic as confirmed by Harbel (2009). Flynn (2001) also confirmed that high nutrient is a reflection of direct discharge of pollutants into the river. The observed poor quality of water in the wet season than the dry season in this study is a confirmation of a finding by Padmaja *et al* (2016) in Osmansaga lake of legal regelation and dissolution of the high level of the nutrients, PO4, SO4 and NO3 present.

This result is also in tandem with the finding of Ibiam *et al.*, (2018) who reported that all the rivers studied showed poor to very unfit for human use and that the water quality index was poorer in the rainy/wet season than the dry season.

Conclusion

The Bonny River studied showed poor to very unfit water for human use. The WQ1 was higher in the wet season than the dry season. Adequate measure like awareness campaign and strict adherence to policies should be put in place to regulate the anthropogenic activities in the area.

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