Comparism of Water Quality Indices of the Upper Segments of Bonny River Estuary, Port Harcourt, Nigeria

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Abstract

Water samples were collected for six (6) months between February and July 2019 and analysed following standard method of APHA, for the physicochemical parameters. The data obtained were subjected to analysis of variance (ANOVA) and Duncan Multiple Range Test (DMRT) using SPSS and Microsoft excel packages. The calculation of water quality index (WQI) made use of the nine (9) parameters chosen following the standards recommended by the World Health Organization (WHO), Bureau of Indian Standards (BIU) and Indian Council for Medical Research (ICMR). The results showed high level of significant difference among the physicochemical parameters across the stations with only temperature not significantly different at p<0.05 while only pH, turbidity, TSS, COD and SO4 exhibited seasonality. The obtained WQI was lowest in Tourist beach (211.776) but highest (303.644) in Marine base with the overall mean value of 258.262 with the dry season value (230.350) lower than the wet season value (257.074). By quality grading, the entire water was rated between class D and E (between poor to unsuitable for domestic use or human consumption). It was recommended that adequate measure should be taken towards remediation of the water while awareness campaign is necessary in reducing indiscriminate anthropogenic activities in the area.

Key words: *Comparism, Water Quality Indices, Upper Segments, Bonny River, Port Harcourt*

Introduction

As a result of increased awareness of the value of aquatic systems, the protection, maintenance and rehabilitation of these important resources has become a priority. Aquatic systems are important economic, ecological and recreational resources which provide drinking water, support industrial and agricultural water usage, and sustain commercial and recreational fisheries, including rapidly expanding aquaculture ventures.

Anthropogenic influences as well as natural processes degrade surface waters and impair their use for drinking, industrial, agricultural, recreation or other purposes (Carpenter *et al.*, 1998 and Jervie *et al.*, 1998). Fishes perform all their physiological activities such as breathing, excretion of waste, feeding, maintaining salt balance and reproduction in the water. Consequently, the resources in the coastal ecosystem have become progressively depleted, in some places, to a point of no recovery. Therefore, gradual deterioration of the coast across the globe and the failure to restore the marine ecosystem, even after the cessation of human interference have demanded comprehensive and comprehensible ecological assessment from societal, economic and political heads. Thus, water quality is the determining factor on the success or failure of an aquaculture including mariculture operations. The continued degradation of water resources due to anthropogenic sources necessitates a guideline in selecting sites for aquaculture including irrigation using water quality index as a basis. The coastal belt of some countries for example Bangladish is facing enormous challenges in meeting freshwater demand due to limited water supply from the groundwater and surface water sources as they are affected by the various degrees of salinity and other water quality problems (Chowdhury *et al.*2014, 2013).

Monitoring water quality provides the necessary information needed to address issues concerning characterization of water quality trends, specific problems of water quality, development of aquatic ecosystem, remediation programs and assessment of ecosystem management activities. Increasingly, natural aquatic ecosystems are influenced by anthropogenic activities causing both intentional and unintentional hydrologic alterations, sedimentation, toxic contamination and nutrient enrichment. Consequently, the deterioration of water quality has become a serious public health and environmental problem thereby becoming a threat to man. Safety of drinking water is of global concern in the face of population increases and degradation of natural waterways. Lakes and reservoirs are predisposed to poor water quality because unlike rivers, streams and estuaries which are not regularly flushed. As a result, nutrients or pollution entering the system will typically remain there for a prolonged period. Monitoring of water resources is a priority to reduce the risk of adverse human health effects from water contaminated by heavy metals, chemicals and pathogenic microbes (Sarkar *et al.*, 2006). The suitability of a given water source for an intended use depends on the magnitude of these quality variables. The quality of water may be good enough for drinking but not suitable for use as a coolant in an industry. It may be good for irrigating some crops but not suitable for irrigating some other crops (Narayanan *et al*, 2015**)**. It may be suitable for livestock but not for fish culture. The quality is a function of anything and everything the water might have picked up during its journey from the clouds to the earth to the water body: in dissolved, colloidal, or suspended form.

The alteration of ecosystem structure and function as a consequence of excessive nutrient loading has been widely reported in freshwater, estuarine and coastal systems. Decreasing species diversity and the advent of nuisance algal blooms are signs of ecosystem degradation.

Within the growing aquaculture industry, it is accepted that good water quality is needed for maintaining viable aquaculture production even in mariculture system (FAO,2006). Poor water quality can result in low profit, low product quality and potential human health risks. Production is reduced when the water contain contaminants that can impair development, growth, reproduction, or even cause mortality to the cultured species. Some contaminants can accumulate to the point where it threatens human health even in low quantities and cause no obvious adverse effects.

Water quality index provides a single number that expresses overall water quality at a certain location and time based on several water quality parameters. Basically, a water quality index attempts to provide a mechanism for representing a cumulatively derived, numerical expression defining a certain level of water quality (Miller *et al*., 1986).The present paper uses the WQI index to express the quality of water and is the major indices used to assess the pollution and one of the effective ways to create awareness among the public. Quality of water is defined in terms of its physical, chemical, and biological parameters (Almeida, 2007). Water quality index allows for a general analysis of water quality on many levels that affect a both coastal areas and stream's ability to host life and whether the overall quality of water bodies poses a potential threat to various uses of water (Akkaraboyina and Raju,2012). Several number of countries have begun the processes of developing composite indices of water quality to describe the state of their domestic waters, including the United States of America (Cude, 2001), Taiwan (Liou *et al*., 2004), Argentina (Pesce and Wunderlin, 2000), Australia (ICS, 2005), Canada (Khan, *et al*., 2003, Lumb *et al*., 2006.

The selected water bodies in Port Harcourt (Elechi Creek, Tourist beach and Marine base) play vital roles in the lives of the inhabitant since they served as their sources of livelihood which are fishing and crop farming. Fishing, bathing, car washing, refuse disposal, industrial wastes disposal and other anthropogenic activities too numerous to mention are constantly going on around and within the area (Davies, *et al*.,2006). It therefore became necessary to carry out this research to determine the water quality index and status of water bodies.

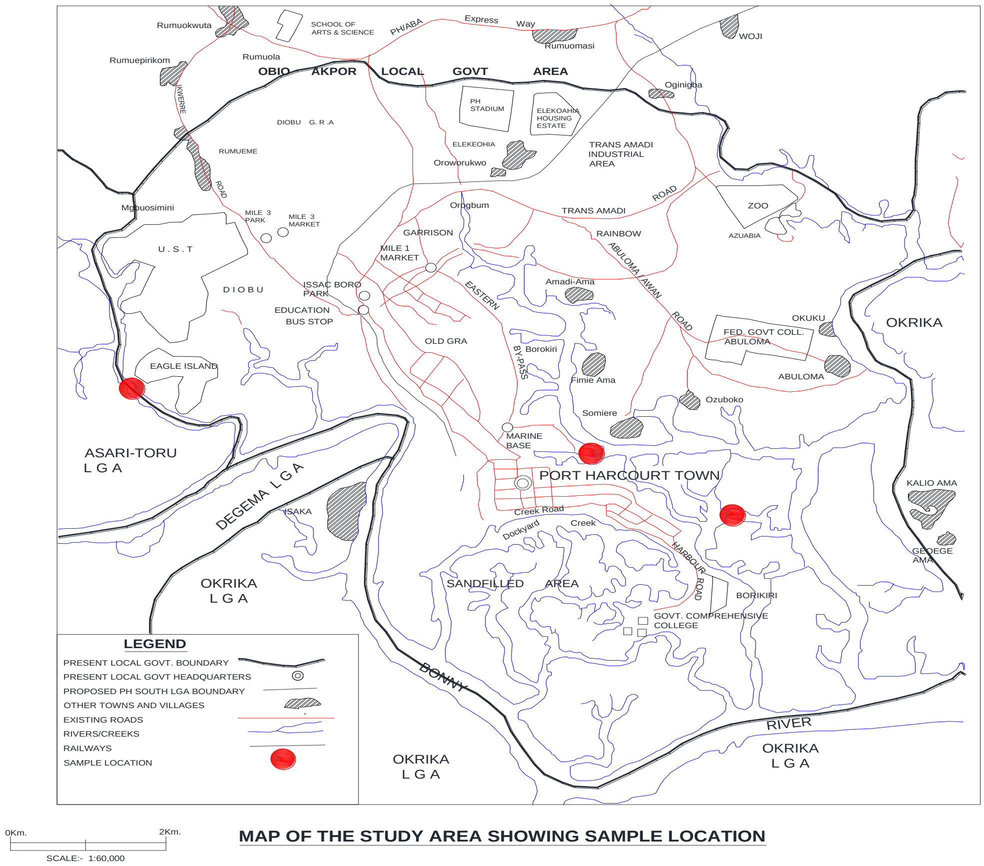
Materials and Methods

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)



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:

$$qn = 100 \, {(V_n - V_{io})}\big/{(S_n - V_{io})}$$ (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

Where

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:

$$\text{WQI} = {\sum qnWn}\big/{\sum Wn}$$

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)

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	$6.53{\pm}0.74^{a}$	$6.37{\pm}0.79^{a}$	$6.75{\pm}0.64^{a}$
2	Turbidity (NTU)	$35.30{\pm}2.71^{b}$	$39.28{\pm}2.25^{a}$	$31.15{\pm}1.14^{c}$
3	Total Suspended Solid (TSS) (mg/l)	$66.89{\pm}2.94^{c}$	$78.26{\pm}7.12^{a}$	$70.01{\pm}1.54^{b}$
4	Electrical Conductivity (EC)(µs/cm)	$11050{\pm}773.89^{b}$	$12537.60{\pm}805.35^{a}$	$12093.{\pm}86.96^{a}$
5	Total Dissolved Solids (TDS)(mg/l)	$5560.50{\pm}163.93^{C}$	$6267.67{\pm}53.40^{a}$	$6120.33{\pm}47.60^{b}$

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]

Table 5: Water Quality index for Elechi Creek (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 (Ʃ)			**1.000**		**274.132**

Water Quality Index (WQI) = $\sum qnWn / \sum Wn$ **= 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 (Ʃ)			**1.000**		**303.644**

Water Quality Index (WQI) = $\sum qnWn / \sum Wn$ **= 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 (Ƹ)			**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 (Ʃ)			**1.000**		**257.074**

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