WET AND DRY SEASON WATER QUALITY PARAMETERS OF THE MIDDLE REACHES OF ORASHI RIVER, NIGER DELTA

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ABSTRACT
Every living creature needs water to survive. The quality of water is important as it plays a vital role in the distribution and abundance of organisms. The present study was conducted to assess the water quality of Orashi River in both dry and wet seasons between October 2017-September 2019. Water samples collected from five stations were taken to the laboratory and analysed for BOD, Total Hardness, Sulphate, Nitrate, Chloride, Total Alkalinity, Phosphate and trace metals. Other parameters such as Temperature, pH, Salinity, DO, EC, TDS and Turbidity were measured in-situ in the field using Extech water checker. Temperature, Salinity, Conductivity, TDS, DO, CL,NO_3, Zn and Fe were high during the dry season. Results when compared with National Environmental Standards and Regulations Enforcement Agency (NESREA) standard showed that there was minimal influence from anthropogenic activities. Overall water Quality for dry season was 178.66, while that of wet season was 162.57. The WQI for dry and wet seasons indicate that the surface water of Orashi River at these stations is not fit for consumption. Strong positive correlations were between pH and TDS, pH and Phosphate, TDS with BOD, Phosphate with TDS, Phosphate with BOD, Phosphate with Temperature and Nitrate with THC. Significant but negative correlations were Temperature with Salinity, TDS with Salinity, Temperature with Turbidity, Phosphate with Salinity and Sulphate with Turbidity.

Key words: anthropogenic,dry,sample,water,wet

INTRODUCTION
Water is essential in the survival of any living organism. It forms the basic constituent of plants and animals communities in all ecosystems. Its supply is continuous as 97% of the total volume of water is in the ocean, 2% is stored in the form of ice-sheels and less than 1% fresh water. The quantity of water in rivers, lake, swamps constitute only about 0.36% of the world fresh water that is easily accessible to man and available to use (Ayoade & Oyebande 1983).
Issue of water globally is affected by the quantity, quality, financing and reliability. The quality of water is determined by the biological, chemical, physical and radiological parameters (Diersing, 2009). It measures the state of the water when compared to the needs of man or other organisms for a specific requirement or reason. River water quality is usually affected by anthropogenic activities that originate from runoffs. The effects of pollutants released as a result of human involvement in stressing the aquatic ecosystem depends greatly on their physico-chemical properties, leachability and source (Angaye et al; 2015). Some of these pollutants may dissolve in the water and some binds to particles and objects in the water while others sink or get attach to sediments that eventually affects aquatic organism. Some other factors that could equally affect the quality of water in the river and species diversity might include; temperature, depth, turbidity pH, conductivity (Agedah et al 2015).

An increase in population leads to increase demand for fresh water for domestic and industrial uses and in turn affect the availability and quality of water resource in a given area. The problem therefore is not with the global amount of water but its distribution, availability and quality. Though human activities contribute greatly to the causes of water quality degradation, natural factors should not be overlooked as natural water is never pure chemically. Precipitation and surface run off, minerals, gases, particulate matter collected in the water bodies contaminate the water. Other natural causes as torrential rainfall and hurricanes can also lead to excessive erosion and landslides, which leads to increases in the content of suspended materials river affected. The river water also contains some dissolved substances and nutrients as oxygen, nitrogen, magnesium, sulphur, potassium, calcium and heavy metals these substances are either resourceful or harmful depending on their concentrations. Hence, this study is to determine the variation in water quality parameters in wet and dry seasons.

MATERIALS AND METHODS

The study area

Study was conducted along the middle reaches of the Orashi River, at the eastern section of the lower Niger Delta between October 2017 and September 2019. The study area lies between longitude 060 26' 32.5" to 060 30' 05.0" E and latitude 050 26'32.5" to 050 08' 24.6" N (figure 1). Orashi River originates after Oguta Lake, and flows south where it joins the Oguta Lake water system. The water from Oguta Lake discharges into Orashi River both in the dry and wet seasons, which serves as the second main source of the Orashi. Orashi River drains in one directional flow into the sea through the Sombreiro, St Bartholomew and St Barbara rivers into the Atlantic Ocean.

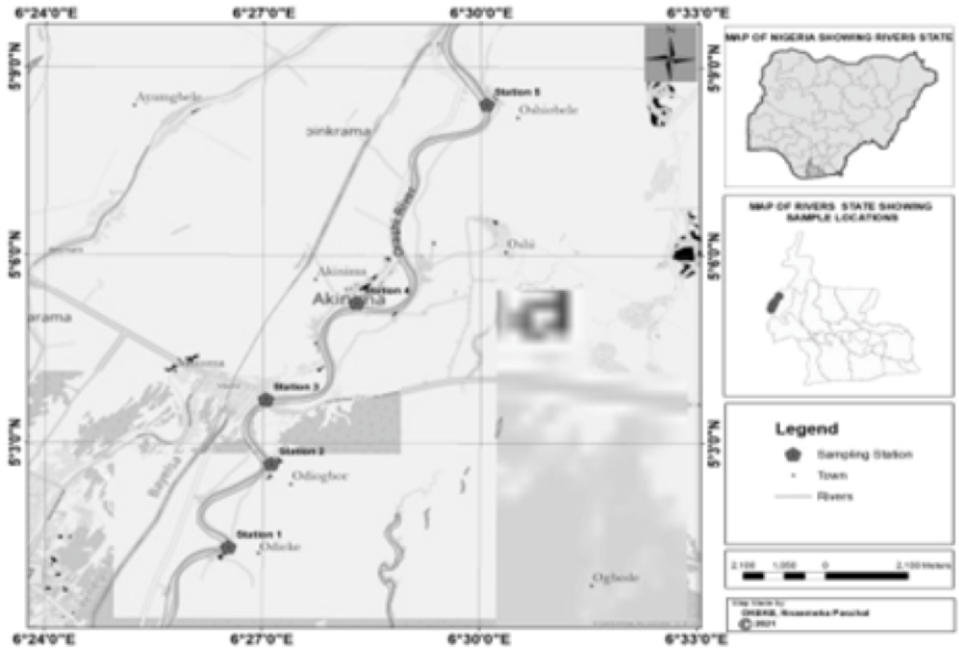

Fig. 1: Map of study area.

Measurement of Water Parameters

The sampling stations were OdiekeUgbobi (station1),Odiobor (station 2), Mbiama (station 3), Akinima (Station 4) and Oshiobele (station 5).

Temperature, Hydrogen ions, Salinity, Dissolved oxygen, Electrical conductivity, Total Dissolved Solids and Turbidity, were measures in-situ in the field using Extech water checker (Model DO: 700 and Model Turb: 400) after calibrating the instrument with the standard Extech

solutions and rinsed with distilled water. The instrument probe was dipped directly into the water, allowed to acclimatize for few minutes before the power switch was put on and allowed to stabilize. At the stability of instrument, the parameters Temperature, pH, Salinity, DO, EC, TDS, and Turbidity were read accordingly.

Biochemical Oxygen Demand (BOD): Biochemical oxygen demand (BOD) was analyzed using the five – days BOD test adapted from APHA (1998).

Total Hardness: Total hardness was determined by EDTA titrimetric method of (APHA, 1998).
Chloride: Chloride was determined by the Argentometric titration method (APHA-AWWA-WEF, 1998).

Nitrate: Nitrate measurement was by Brucine Method (APHA, 1998)

Phosphate: Phosphate determination was by the stannous chloride method (APHA-WEF, 1998).

Sulphate: Sulphate determination was by the turbidimetric method (APHA-AWWA-WEF, 1998).

Total Alkalinity: The ions such as bicarbonate (HCO3), carbonate (CO32-), and hydroxide (OH-) assumed to be present in water was analysed through hydrolysis of solutes.

Total Hydrocarbon Content (THC): Was determined with standardized spectrophotometer. THC concentration was calculated with reference to the standard curve and multiplication by the appropriate dilution factor. The detection limit was 0.01 mg/l.

Trace Metals (Cadinium, Chromium, Lead, Iron, Zinc) Determination in Water
Trace metals in water samples were determined using an Atomic Absorption Spectrophotometer (AAS) as described in APHA, 1998.3111B and ASTM D3651.

Analysis of Environmental Parameters Results
All data collected for the environmental parameters were subjected to statistical analysis using Analysis of variance (ANOVA) to determine their variations at stations and seasons.

RESULTS AND DISCUSSION

The results of the wet and dry season variations of the water quality parameters of middle reaches of Orashi River from Table 1 indicate that there were seasonal variations between dry and wet seasons. Temperature was significantly higher during dry than in wet. The variation in water temperature sometimes depends on atmospheric condition of a particular place, but this is mostly subjected to variety of several environmental factors such as latitude, land elevation, period of day, wind, wave action, water current, water depth, cloud cover or vegetative cover, climate and season among others (Ogbeibu & Victor, 1995). Study according to Seiyaboh et al., (2016) conducted downstream of the middle reaches of Orashi river reported surface water temperature range of 26.77 to 28.07 0C in dry season and 26.37 to 27.130C in wet season.

Table 1: Seasonal Variations of the Water Quality Parameters of Middle Reaches of Orashi River

Parameters	Dry Season	Wet Season	P Values	NESREA standard
Temp (^{O}C)	28.12 ± 0.64	27.58 ± 0.43	< 0.0001	
pH	7.06 ± 0.59	7.26 ± 0.38	0.0120	8.5
Sal (psu)	0.012 ± 0.004	0.010 ± 0.002	0.0043	-
Cond. (us/cm)	31.76 ± 3.03	24.65 ± 7.15	< 0.0001	-
TDS (mg/l)	15.94 ± 1.98	13.13 ± 3.31	<0.0001	2000
Turb (Ntu)	25.61 ± 5.89	35.63 ±19.42	0.0006	-
DO (mg/l)	7.06 ± 0.60	6.81 0.49	0.0147	4
BOD (mg/l)	2.88 ± 2.73	2.91 ± 0.66	0.9108	6
THC (mg/l)	0.35 ± 0.90	0.71 ± 1.22	0.0751	-
T.alk (mg/l)	4.20 ± 1.85	4.40 ± 1.82	0.5570	-
Cl (mg/l)	3.24 ± 0.90	1.72 ± 0.46	< 0.0001	-
NO_3 (mg/l)	0.50 ± 0.22	0.33 ± 0.12	< 0.0001	9.10
SO_4 (mg/l)	4.22 ± 1.45	4.93 ± 1.85	0.0251	100
Fe (mg/l)	3.45 ± 0.52	3.39 ± 0.40	0.5159	0.5
Zn (mg/l)	0.11 ± 0.09	0.05 ± 0.04	< 0.0001	0.2

$P < 0.05$ is significant

The variation observed in pH may be attributed to anthropogenic activities in the area accompanied by seasonal dilution effects from rainfalls. This is in agreement with Ben–Eledo et al., (2017). The variation in salinity could be due to dilution in wet season and that may be the reason for low value while in dry season the high value may be due to reduction in water volume and concentration of salt. Salinity is an important determinant factor for aquatic life. Any slight change of salt content of the water system renders the resident organisms to serious stress, because the internal fluids of the organism become disorganized and is not balanced with the external salinity of the organism's environment (UNESCO/WHO/UNDP, 1992).

There was significant variation in total dissolved solids as higher value was recorded in dry (15.94 ± 1.98mg/l) than in wet season (13.13 ± 3.31mg/l). Variations of total dissolved solids were observed in Warri river system (Egborge, 1994). According to the study, higher values of TDS were obtained in the dry season (November - April), than the wet season months (May to October). Electrical conductivity was significantly higher in dry (31.76 ± 3.03 µS/cm) than in wet (24.65 ± 7.15 µS/cm) season. The variation between the seasons could be attributed to sea influence on surface water and dilution from rainfall (Chindah et al., 2005).

The turbidity level was significantly lower in dry season (25.61 ± 5.89Ntu) than in wet season (35.63 ± 19.42Ntu). The high level in wet season may be attributed to turbulence experienced by rainfall causing flooding of the stations and other factors like erosion resulting from precipitation, wind action, surface water run-offs, algal bloom, human activities. The study of Egborge, (1994) in Niger Delta reported that turbidity was high in almost all the points of sample collection in wet season (6 to 1,500 Ntu) than the dry season (31 to 46 Ntu) months.

A higher significant level of dissolved oxygen was recorded in dry (7.06 ± 0.60mg/l) than in wet (6.81 ± 0.49mg/l) season. This may be due to high photosynthetic activities by the autotrophs releasing more oxygen that dissolved at high temperatures into the water bodies. Bio-depletion and re-aeration of bye products in the water also controls the dissolved oxygen concentration in surface water bodies. For this reason, reduction in dissolved oxygen of water is faster where organic wastes materials and oxidation of organic products are discharged into an aquatic ecosystem to the extent that oxygen depletion can reduce to zero level. Fish and other aquatic faunas may not grow normally at low dissolved oxygen conditions below 4 mg/l. The result obtained in this study agrees with the work of Ajao and Fagade (2002) which recorded a higher value of oxygen concentration in dry season than in wet season in Bonny river. A higher significant level ($p < 0.0001$) of chloride was recorded during the dry season (3.24 ± 0.90mg/l) than the wet period (1.72 ± 0.46mg/l).
Previous study according to Seiyaboh et al., (2016) reported low values of chloride ion in Orashi River during the wet season (2.10 to 3.57mg/l) and a higher value (2.46 to 4.53mg/l) in dry period. The variations observed especially in wet season could be attributed to dilution of salt from rainfall.

Similar significant levels of variations at $p < 0.0001$ were observed for Nitrate and Zinc, while for Sulphate, $p = 0.0251$. A higher value of Nitrate was recorded in dry season (0.50 ± 0.22mg/l) than in wet season (0.33 ± 0.12mg/l). Also, Zinc level was higher in dry season (0.11 ± 0.09mg/l) than in wet season (0.05 ± 0.04mg/l) period. Both values were below the NESREA standards of 9.10mg/l and 0.20m/l respectively.
The study of Orashi River by Seiyaboh et al., (2016), reported high values of sulphate in dry season, which ranged from 2.46 to 4.53 mg/l and low values of 2.10 mg/l and 3.57 mg/l in wet season. The value differs from the findings of this study where, the value for wet season was 4.93mg/land and that of dry season was 4.22mg/land. Sulphate is an essential nutrient required for plants growth.

The results of the overall water quality index (WQI) of dry and wet seasons from Tables 2 and 3 are 178.66 and 162.57 respectively. The water quality indices for dry and wet seasons indicate that the surface water of Orashi River at these stations is not fit for consumption. Water quality index range and their status are 0 – 25 (excellent), 26 – 50 (good), 51 – 75 (poor), 76 – 100 (very poor) and > 100 (unfit for consumption).

Table 2: Water Quality Index (WQI) of Surface Water of the Middle Reaches of Orashi River for Dry Season

		WQI	DRY							
	NESREA Standards(Sn)	1/Sn	∑ 1/Sn	K=1/ (∑1/Sn)	Wi = K/Sn	Ideal value (Vo)	Mean Conc. Value (Vn)	Vn/Sn	Vn/Sn * 100 =Qn	WnQn
pH	8.50	0.12	9.66	0.10	0.01	7.00	7.04	0.83	82.82	1.01
TDS	2000.00	0.00	9.66	0.10	0.00	0.00	15.94	0.01	0.80	0.00
DO	4.00	0.25	9.66	0.10	0.03	0.00	7.06	1.77	176.50	4.57
BOD	6.00	0.17	9.66	0.10	0.02	0.00	2.87	0.48	47.83	0.83
Cl	300.00	0.00	9.66	0.10	0.00	0.00	3.24	0.01	1.08	0.00
SO4	100.00	0.01	9.66	0.10	0.00	0.00	4.21	0.04	4.21	0.00
NO3	9.10	0.11	9.66	0.10	0.01	0.00	0.50	0.05	5.49	0.06
Fe	0.50	2.00	9.66	0.10	0.21	0.00	3.45	6.90	690.00	142.89
Zn	0.20	5.00	9.66	0.10	0.52	0.00	0.11	0.55	55.00	28.47
Cr	0.50	2.00	9.66	0.10	0.21	0.00	0.02	0.04	4.00	0.83
		9.66			1.00					178.66

Overall Water Quality = ? $\frac{\text{WnQn}}{\text{Wn}}$ = 178.66 / 1.00 = 178.66

Table 3: Water Quality Index (WQI) of Surface Water of the Middle Reaches of Orashi River for Wet Season

		WQI	WET							
	NIS Standards(Sn)	1/Sn	∑ 1/Sn	K=1/ (∑1/Sn)	Wi = K/Sn	Ideal value (Vo)	Mean Conc. Value (Vn)	Vn/Sn	Vn/Sn * 100 =Qn	WnQn
pH	8.50	0.12	9.66	0.10	0.01	7.00	7.26	0.85	85.41	1.04
TDS	2000.00	0.00	9.66	0.10	0.00	0.00	13.13	0.01	0.66	0.00
DO	4.00	0.25	9.66	0.10	0.03	0.00	6.81	1.70	170.25	4.41
BOD	6.00	0.17	9.66	0.10	0.02	0.00	2.91	0.49	48.50	0.84
Cl	300.00	0.00	9.66	0.10	0.00	0.00	1.72	0.01	0.57	0.00
SO4	100.00	0.01	9.66	0.10	0.00	0.00	4.93	0.05	4.93	0.01
NO3	9.10	0.11	9.66	0.10	0.01	0.00	0.33	0.04	3.63	0.04
Fe	0.50	2.00	9.66	0.10	0.21	0.00	3.39	6.78	678.00	140.40
Zn	0.20	5.00	9.66	0.10	0.52	0.00	0.05	0.25	25.00	12.94
Cr	0.50	2.00	9.66	0.10	0.21	0.00	0.07	0.14	14.00	2.90
		9.66			1.00					162.57

Overall water Quality=∑WnQn/∑Wn=162.57/1=162.57

The Pearson correlation matrix between the physicochemical parameters of surface water of Orashi River is presented in Tables 4. The result showed a very strong positive significant relationship between pH with TDS ($p < 0.05$, $r = 0.912$), pH with PO_4^{3-} ($p < 0.05$, $r = 0.903$), TDS

with BOD ($p < 0.01$, $r = 0.966$), PO_4^{3-} with TDS ($p < 0.05$, $r = 0.949$), PO4 with BOD ($p < 0.05$, $r = 0.893$), PO_4^{3-} with Temp. ($p < 0.05$, $r = 0.900$) and NO_3^- with THC ($p < 0.01$, $r = 0.967$). This suggests that increase in one parameter has a corresponding increase in the other parameter and vice versa. Increase in pH (towards alkalinity) leads to increase in the levels of total dissolved solids and phosphate. Low level of total dissolved solids leads to low biochemical oxygen demand. Low phosphate leads to low biochemical oxygen demand, high temperature leads to high phosphate and high nitrate leads to high total hydrocarbons from the same source. Very strong significant but negative correlation is also noticed between Temperature and Salinity ($p < 0.05$, $r = -0.934$), TDS with Salinity ($p < 0.05$, $r = -0.922$), Temperature with Turbidity ($p < 0.01$, $r = -0.963$), PO_4^{3-} with Salinity ($p < 0.01$, $r = -0.994$) and SO_4^{2-} with Turbidity ($p < 0.05$, $r = -0.884$). This indicates that increase in one parameter leads to decrease in the other.

Table 4: Correlation analysis of surface water of middle Orashi River

	Temp	pH	Sal	Cond	TDS	Turb	DO	BOD	THC	Talk	Cl	T.Hard	NO3	PO4	SO4
Temp	1														
pH	.627	1													
Sal	**-.934***	-.857	1												
Cond	.646	-.135	-.346	1											
TDS	.783	**.912***	**-.922***	.049	1										
Turb	**-.963****	-.458	.847	-.692	-.690	1									
DO	.758	.138	-.580	.825	.251	-.819	1								
BOD	.717	.864	-.877	-.050	**.966****	-.673	.260	1							
THC	.625	.363	-.599	.183	.692	-.739	.328	.773	1						
Talk	.c	.c	.c	.c	.c	.c	.c	.c	.c	.c					
Cl	-.060	.177	-.091	-.187	-.092	.075	.303	.040	-.297	.c	1				
T.Hard	.c	.c	.c	.c	.c	.c	.c	.c	.c	.c	.c	.c			
NO3	.476	.200	-.419	.136	.568	-.607	.161	.636	**.967****	.c	-.492	.c	1		
PO4	**.900***	**.903***	**-.994****	.269	**.949***	-.793	.491	**.893***	.575	.c	.062	.c	.402	1	
SO4	.774	.345	-.708	.487	.546	**-.884***	.821	.650	.748	.c	.259	.c	.585	.635	1

a. Correlation is significant at the 0.05 level (2-tailed).
b. Correlation is significant at the 0.01 level (2-tailed).
c. Cannot be computed because at least one of the variables is constant.

AUTHOR' CONTRIBUTIONS

UH, data collection and analysis. SAN, writing, reviewing and editing. NSD, designed and supervised the research.

COMPETING INTEREST

No competing interest declared by authors. The study was conducted to determine wet and dry season water parameters and the water quality of the middle reaches of Orashi River without any financial support from individuals or organization.

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