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Physicochemical Quality Assessment of River Orashi in Eastern Niger Delta of Nigeria

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Abstract

River Orashi is one of the major river in the Niger Delta, being a sister tributary that formed the triangular Delta with Rivers Nun and Focardos. The bioavalabiliy and water quality of any river is reflection some vital water quality parameters. In this study, river water samples were randomly collected from several stations of the river in both dry and wet seasons, and analyzed for physicochemical and other elemental parameters. Result were reported as; temperature (26.37 - 26.77 °C), pH (6.52 - 7.06), turbidity (22.17 - 31.23 NTU), conductivity (25.07 – 82.33 µS/cm), dissolved oxygen (5.80 - 15.73 mg/l), Biological oxygen demand (4.00 – 6.97 mg/l), total dissolved solid (6.77 - 12.58 mg/l), total alkalinity (1.53 – 2.20 mg/l), hardness (1.70 – 4.17 mg/l), nitrite (0.01 - 0.45 mg/l), nitrate (0.03 - 0.38 mg/l), sulphate (2.10 – 4.53 mg/l), chloride (0.03 - 0.38 mg/l), sodium(1.55 – 3.27 mg/l), potassium (1.08 – 8.35 mg/l), calcium (1.32 -14.54mg/l), Magnesium (0.38 - 8.41mg/l), manganese (0.003 – 0.01 mg/l), and total iron ranged from 0.01mg/g to 0.20 mg/l. Our findings indicate mild anthropogenic activities around the Orashi river. We therefore urge government and community leaders to intervene and educate inhabitants around the river on the danger posed by anthropogenic activities.

Keywords: Orashi River, Anthropogenic activity, Physicochemical parameters, Niger Delta

1 Introduction

Most river quality parameters play vital roles in the bioavailability and productivity of aquatic organisms. The variation of water quality undoubtedly linked to pollutants, and may affects the physical and chemical composition of the ecosystem [1]. Availability of potable water is a global challenge. Statistic in literature shows that over 40% of global populace lack access to potable water due to several reasons, which could be political, economic and climatic reasons [1, 3]. Another report indicated that over 25 % of the world's population still suffer from water-related health problems with [3]; out of which 16% are of the Sub-Saharan Africans [2, 3]. It is estimated globally that 2.6 billion persons lack access to improved sanitation facilities with attendant adverse effects on the quality of water bodies, especially river [2].

A Delta is that part of a country's flood plain through which its rivers systems are discharged to the Atlantic Ocean. The Niger Delta in Nigeria is a wetland, with a population estimate of 20 million people belonging to more than 40 different ethnic groups, whose floodplain is about 7.5% of Nigeria's total land mass [4]. The Niger Delta is a triangular delta linked to three basic tributaries namely: River-Forcados to the west, River-Nun central, and River-Orashi which is eastward. In the Niger Delta, the relative health and biodiversity of some communities aligning coastal settlement has become a source of concern due to their precarious dumping activities around the river [5]. For instance, in some riverine communities their rivers act as a waste dump sites [6]. The wastes streams discharged into the water bodies may include organic and inorganic waste such as; heavy metals, elemental ions, oil and grease and other wastes of organic origin [6, 7].

Water quality refers to the chemical, physical, biological and radiological characteristics of water [8]. It is a measure of the condition of water relative to the requirement of one or more biotic species and or to any human need or purpose. River quality is usually affected by anthropogenic agents originating from runoffs. The toxicity or adverse effects of these agents is largely dependent on their physico-chemical properties, leachability and source [7]. For instance, some of these agents may remain dissolved in the water phase, whilst others bind onto particles, sink to the ground as sediment. The river water also contains some dissolved substances and nutrients like; as oxygen, nitrogen, magnesium, sulphur, potassium, calcium and heavy metals these substances are either resourceful or harmful depending on their concentrations. Other factors that affects river quality and biodiversity may include; temperature, depth, turbidity pH, conductivity [6].

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Furthermore, waste originating from point and non-point sources as leachates swept by runoffs to contaminate most river. Several studies documented in literature revealed that most sources of water pollution in Nigeria originate from non-point sources [9 - 13]. Although the contamination of a river may be determined by its flow intensity and dilution capacity [6], however the persistent anthropogenic activities over a period of time may influence the contamination rate. River Orashi remains a vital tributary of the Niger Delta, notwithstanding, certain anthropogenic activities have become a threat to its biodiversity and public health, as such the river quality assessment of Orashi river is worthy of note.

2 Materials and Methods

2.1 Study area

River Orashi is located in in the Ahoda West Local Government Area of Rivers State of the Niger Delta in Nigeria. The Niger Delta is located within Latitudes 50º 45″ and 60º 35″, and longitudes 40º 50″and 50º 15″, in the central part of Southern Nigeria. It has a land mass covering about 70,000 square kilometers which accounts for about 7.5 % of Nigeria's land mass. The geology of the area is characterized by a vast flood plain built up by accumulation of sedimentary deposits washed down into the Niger and Benue Rivers. The Niger Delta has a tropical humid hot climate with two prevailing seasons, it is relatively cool in the rainy season which lasts between March and October and the dry season is between November and March [14]. The Niger Delta has precipitation level of over 2000mm per annum, and it is 45m above mean sea level.

2.2 Sampling

A total of five samples were collected in triplicates from five stations (Mbiama, Agbo, Akiogbologbo, Okaki and Okparaki), of River Orashi in both dry and wet season. The samples were collected as subsurface water samples at a depth of about 15 - 20cm below surface. The water samples were collected using Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) bottles and 1 litre plastic container for the measurement of other water quality parameters respectively. The sampling bottles/containers were rinsed three times with the water at the specific sampling spots before the collection of samples. Thereafter, the samples were subsequently taken to the laboratory, Department of Biological Sciences, Niger Delta University for analysis.

2.3 Analysis of Samples

All sample analysis was carried out following standard protocol [15]. The pH, temperature, dissolved oxygen and conductivity were measured using EXTECH Multi- probe meter (DO700). Salinity, total dissolved solid was measured using TDS multi-probe meter. Nitrate was analysed using Colorimetric method. Winkler's method was used for BOD_5, analysis. Hach's turbidimeter model 2100P was used for the measurement of turbidity. The heavy metals were analysed using Perkin Elmer 5100 PC AA Spectrometer Atomic Absorption Spectrophotometer (AAS).

2.4 Statistical Analysis

All statistical analysis for the purpose of this research were carried out using version 16 of SPSS software (SPSS Inc, Chicago). A one-way analysis of variance was carried out at P = 0.05.

3 Results and Discussions

Table 1 presents results of the seasonal variation of Orashi river. Results of sampling points showed that temperature of the river ranged from 26.77 - 28.07 and 26.37 - 27.13ºC in dry and wet seasons respectively. Although there is no regulatory limit for temperature; however, standard temperature that sustain life should be ambient; temperature variability might encourage the invasion of alien species, or adverse effect to biodiversity [5]. The pH of the sampling stations in this study, was lower in dry season (6.21 - 6.52) and higher in wet season (6.98 - 7.03). Several studies on pH of river water in the Niger Delta were reported as; 7.4 - 7.57 in dry season and 6.9 – 7.33 in wet season for Epie creek [15], 6.95 – 7.50 for lower Kolo creek [17], upper river Nun (7.17) [18], Nkoro River 6.8 – 8.5 [19] and 6.5-7.11 and 6.5-6.73 for Rivers Igbedi and Nun respectively [6].

The turbidity of the water sample in the study area indicated slight disparities in dry (24.03 - 26.60 NTU) and dry (22.17 - 31.23NTU) seasons. This study is comparable other studies in the Niger Delta, with values of 103.752±2.062 NTU upstream Agudama-Ekpetima axis of river Nun, and downstream 117.002±2.160 NTU [6]. Similarly, other study reported turbidity values of 62.54 NTU in Igbedi creek [20], 5 - 64 NTU around Tombia-Agudama bridge [21], values of 11.67 - 19.67 (dry season) and 16.67 – 28.00 NTU (wet seasons), were also reported along the Epie creek [16]. Kolo creek had values of 35.0 – 40.5 NTU in [17]. While Efi lake was of 7.87-17.29NTU [5]. Although the turbidity values of Orashi river exceed WHO permissible limit for potable water (5NTU). Notwithstanding, this may be consequent upon surface runoff and other anthropogenic activities of the inhabitants aligning the river or abrasion effect [5, 6].

The conductivity of Orashi river indicated significant differences, in both dry (25.07 – 82.33 μS/cm) and dry seasons (26.00 – 28.83 μS/cm). The of this study, complied with WHO regulatory limits of 1000 μS/cm. This value agrees with the range of values reported in other Niger Delta river water quality studies; which are (56.075±0.591) downstream and upstream river Nun with 64.950±0.681μS/cm [6]. Kolo creek with 82.30 – 102.0 μS/cm [17], Igbedi creek 76.23 umhos/cm [19], and 87 – 95 umhos/cm during the construction of Tombia bridge [21], and 48.13 - 68.93 μS/cm for Efi lake [5].

In this study, dissolved oxygen (DO) ranged from 5.80 – 7.60 mg/l in dry season and 11.10 – 15.73 mg/l in wet season. Although there is no regulatory DO limit by WHO, however extreme (very low) DO might be antagonistic to aquatic biota [22], especially in cases lower than 2.0mg/l [23, 24]. Some rivers in the Niger Delta had DO in the ranges of 4.8mg/l – 7.2mg/l [21], 9.07-19.52mg/l for Efi Lake [5], 5.0 – 7.92 mg/l for Kolo creek [17], 1.38 – 9.06 and 1.76 – 5.68 mg/l for dry and wet seasons of Epie creek respectively [16].

Table 1: Seasonal and station mean physic-chemical parameters of water samples in Orashi River

Parameters	**Agbo**		**Akiogbologbo**		**Mbiama**		**Okarki**		**Okparaki**		**Range**	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Temp. (ºC)	27.73±1.09	26.37±1.07	27.80±1.05	26.67±1.03	27.53±1.09	26.70±1.03	26.77±1.01	27.13±1.03	28.07±1.03	26.75±1.03	26.77 - 28.07	26.37 - 27.13
pH	6.56±1.04	7.06±1.03	6.60±1.08	7.02±1.13	6.52±1.03	6.98±1.07	6.61±1.08	7.03±1.08	6.67±1.03	7.03±1.03	6.52 - 6.67	6.98 - 7.06
Turbidity (NTU)	26.60±1.01	24.57±1.07	24.03±1.07	22.17±1.21	25.77±1.01	26.40±1.09	24.77±1.03	28.43±1.02	26.13±1.03	31.23±1.03	24.03 - 26.60	22.17 - 31.23
Conductivity (µS/cm)	25.87±1.03	28.80±1.03	82.33±1.05	26.00±1.06	33.97±1.09	28.83±1.03	25.07±1.03	27.73±1.08	67.37±1.03	27.73±1.03	25.07 - 82.33	26.00 - 28.83
DO (mg/l)	6.93±1.05	12.30±1.08	7.60±1.11	11.10±1.13	5.80±1.01	13.23±1.06	6.83±1.11	14.22±1.03	6.77±1.03	15.73±1.01	5.80 - 7.60	11.10 - 15.73
BOD (mg/l)	5.50±1.20	7.67±1.01	6.05±1.00	6.45±1.06	4.00±1.01	6.97±1.09	5.49±1.23	6.39±1.03	5.36±1.03	6.64±1.08	4.00 - 6.05	6.45 - 6.97
TDS (mg/l)	13.10±1.13	7.40±1.01	41.17±1.08	8.10±1.03	16.88±1.01	6.77±1.08	12.58±1.03	7.57±1.03	34.08±1.04	7.60±1.07	12.58 - 41.17	6.77 - 8.10
Alkalinity (mg/l)	3.63±1.07	1.53±1.11	6.33±1.08	2.03±1.13	2.60±1.01	1.90±1.07	2.53±1.03	2.20±1.07	3.73±1.04	1.90±1.03	2.53 - 6.33	1.53 - 2.20
Hardness (mg/l)	4.87±1.11	1.70±1.08	35.27±1.03	2.11±1.23	4.40±1.03	1.80±1.09	4.17±1.03	1.90±1.11	34.53±1.03	2.17±1.03	4.17 - 34.53	1.70 - 2.17
Nitrite (mg/l)	0.01±1.13	0.02±1.04	0.24±1.11	0.05±1.01	0.08±1.00	0.07±1.03	0.09±1.03	0.07±1.01	0.05±1.07	0.45±1.04	0.01 - 0.24	0.02 - 0.45
Nitrate (mg/l)	0.19±1.05	0.18±1.03	0.04±1.20	0.03±1.03	0.13±1.00	0.12±1.17	0.11±1.07	0.12±1.03	0.38±1.03	0.30±1.01	0.04 - 0.38	0.03 - 0.30
Sulphate (mg/l)	3.53±1.08	2.46±1.01	2.46±1.23	2.10±1.13	4.47±1.11	2.58±1.17	4.53±1.03	3.57±1.01	3.10±1.03	2.53±1.03	2.46 - 4.53	2.10 - 3.57
Chloride (mg/l)	34.90±1.03	1.83±1.04	13.17±1.80	1.77±1.03	46.93±1.03	3.47±1.21	23.17±1.03	2.40±1.01	36.77±1.03	1.80±1.07	0.04 - 0.38	0.03 - 0.30
Sodium (mg/l)	1.95±1.09	1.55±1.03	3.27±1.00	1.71±1.40	2.11±1.22	1.77±1.11	2.47±1.06	1.92±1.03	1.92±1.07	1.78±1.05	1.92 - 3.27	1.55 - 1.92
Potassium (mg/l)	8.35±1.07	0.92±1.09	3.43±1.06	0.88±1.05	7.04±1.13	1.08±1.02	4.65±1.03	0.88±1.07	6.74±1.03	0.79±1.03	3.43 - 8.35	1.08 - 0.79
Calcium (mg/l)	9.70±1.08	1.72±1.00	7.25±1.05	1.32±1.09	14.54±1.01	2.25±1.03	7.63±1.02	2.40±1.01	14.30±1.11	1.40±1.05	7.25 - 14.54	1.32 - 2.40
Magnesium (mg/l)	8.41±1.00	0.61±1.07	3.67±1.03	0.78±1.01	8.03±1.04	0.98±1.11	4.47±1.01	0.92±1.03	5.26±1.04	0.38±1.03	3.67 - 8.41	0.38 - 0.98
Iron (mg/l)	0.01±1.09	0.01±1.09	0.07±1.03	0.05±1.13	0.02±1.01	0.01±1.01	0.02±1.02	0.02±1.01	0.20±1.08	0.16±1.05	0.01 - 0.20	0.01 - 0.16
Manganese	0.01±1.02	0.003	0.02±1.01	0.01±1.05	0.01±1.01	0.01±1.01	0.02±1.01	0.003±1.03	0.02±1.35	0.01±1.07	0.01 - 0.02	0.003 - 0.01

DO levels of 10.200±0.283 and 14.225±0.263mg/l were reported in Igbedi and Ogobiri which are along the river Nun axis [6].

Biological oxygen demand (BOD) was higher during the dry season (12.58 - 41.17 mg/l), than during the dry season (6.77 – 8.10 mg/l). The higher BOD load recorded could be attributed to increased degradable organic waste load as noted [3]. The water quality of the creek can also be classified using BOD-NO_3^- ratios, which is useful in determining the portability of water from the creek.

This is because creek stretches that are potable have ratios less than 4 whereas creek stretches with ratios greater than 4 are not portable. Generally, in most river systems, variations in precipitation between seasons affects the physical and chemical characteristics of water bodies in Nigeria [1, 25, 26], with gross pollution indicators such as BOD and COD [3]. The presence of such pathogenic microbes in the water sample indicates the proliferation of waterborne diseases such as cholera, typhoid, and dysentery etc.

While total dissolved solid (TDS) ranged from 6.77 - 12.80 mg/l in Orashi river, the TDS was higher in dry season (12.58 - 41.17), compared to wet season (6.77 - 8.10 mg/l). Values of this study is comparable to other studies. The TDS value for Kolo creek ranged from 41.5 – 51.0 mg/l [17], Amassoma and Igbedi axis of river Nun were 28.180±0.048 and 32.550±0.666mg/l respectively [6]. Also Epie creek TDS had values of 55 - 62 and 33 – 37.33 mg/l in dry and wet seasons respectively [16], while Tombia axis of the river Nun was 62.1 – 67.9 mg/l for [21].

The total alkalinity of Orashi river ranged from 1.53 - 2.20 mg/l with significant difference, but was higher in dry season (2.53 – 6.33 mg/l), compared to wet season (1.53 – 2.20 mg/l). The concentration of dissolved anions (HCO_3^- and CO_3^-) largely determine the alkalinity and reflects the pH. These ions could originate from anthropogenic, natural (i.e dissolved rocks, salt, soils) or industrial sources [6, 26]. Extreme alkalinity could grossly affect the biodiversity of water bodies. For instance, water bodies whose total alkalinity range exceeds 20 - 50mg/l affects the bioavalability of planktons. Alkalinity in surfaces waters rarely exceeds 500mgs/L and it is desirable that there should be no sudden variation in the alkalinity of water so that productivity is not affected [1, 6]. Also the total hardness value ranged from 1.70 – 4.17 mg/l, whereas it was higher in dry season (4.17 – 34.53 mg/l), compared to wet season (1.70 - 2.17 mg/l).

The value of nitrite ranges from 0.01 - 0.45 and 0.02 - 0.07mg/l in dry and wet seasons respectively; while that of Nitrate values was between 0.04 - 0.38 mg/l in dry season and 0.03 -0.30 mg/l in wet season. Nitrites and nitrate (NO_2 and NO_3) levels were higher during the wet season than the dry season (Table 1). This result is in conformity with the findings of Aguigwo (1998), and Ezra & Nwankwo (2001), who further asserted that such nutrient levels leads to high nutrient productivity and favours high plankton growth. This increase was perhaps enhanced by runoffs from agricultural lands, livestock and human wastes. These nutrients result in increased amount of energy input (of allochthonous organic origin) into the water system. Nitrate salts enter natural water sources through domestic effluents, sewage sludge, industrial discharges, leachates from refuse dumps, runoff through fertilized farmlands, leguminous soil, decayed vegetables and animal matter. They could be either direct or indirect contamination and also by percolation over a period of time.

The value of chloride ranged from 0.03 mg/l to 0.38 mg/l. The dry season recorded the higher value of chloride in dry season (2.46 - 4.53 mg/l) compared to wet season (2.10 – 3.57 mg/l). Chlorides are widely distributed in nature as salts of sodium (Nacl), potassium (KCl), and calcium ($CaCl_2$). Chlorides are leached from various rocks into soil and water by weathering. The chloride ion is rapidly peripatetic and swept in runoffs to water bodies. Although low concentration of chloride during the wet season than the dry season may be due to dilution effects of precipitation and runoff containing road de-icing salts, and other organic agents. This finding is in tandem with Izonfuo and Bariweni [17] who reported low Cl^- during the dry season. The value of sodium ranged from 1.55 mg/l to 3.27 mg/l, but is higher in dry season (1.92 mg/l - 3.27 mg/l) than wet season (1.55 mg/g to 1.92 mg/l). Also manganese has a low significant value ranging from 0.01 - 0.02 mg/l in dry season and 0.003 - 0.01 mg/l in wet season.

The value of calcium which ranged from 1.32 -14.54 mg/l, was 7.25 -14.54 mg/l in dry season and 1.32 -2.40 mg/l in wet season. calcium is naturally present in water. It may dissolve from rocks such as limestone, marble, calcite, dolomite, gypsum, fluorite and apatite. Calcium is a determinant of water hardness. The calcium value was higher in the dry season than the wet season (Table 1). This can be due to rain water which contributes to dilution. Magnesium value ranged from 2.22 - 4.51mg/l significant figure. The value for magnesium recorded was higher in the wet season than the dry season (Table 1). This can be attributed to runoff that contains fertilizers during the flood season.

The value of Iron ranged from 0.01mg/g to 0.16mg/g. But is higher in wet season than dry season. Also manganese has a low significant value from 0.01mg/g-0.003mg/g. But dissolved Iron is higher in wet season (0.01 – 0.02mg/l) than dry season (0.01 – 0.16mg/l). Previous studies showed that was relatively high due to the geology of the Niger Delta. Values ranging from 0.393 - 0.740 upstream, 0.101 - 0.204mg/l midstream and 0.094 - 0.143mg/l downstream were recorded in Efi lake [5]. From the foregoing high level of iron has been detected in both surface and groundwater of Bayelsa state [26, 27]. Dissolved manganese is a little higher (0.01 – 0.02) in dry season than wet (0.003 – 0.01). These were as a result of runoff due to precipitation or flooding.

4 Conclusion

River quality assessment is essential to the sustenance of biodiversity, the environment and public health. Our results showed that the river quality assessment of Orashi river indicated mild anthropogenic activities in terms of parameters assessed. However, if mitigation measures are not put in place, anthropogenic effects could rise beyond tolerant or permissive limits, which could affect the biodiversity. As such we recommend further sensitization of people residing around the river and Government intervention aimed at cushioning anthropogenic activities around the river.

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