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Quality Assessment of Ethiope River Course from Obiaruku, Delta State, Using Physicochemical Parameters as Indicators

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ABSTRACT

Ethiope River courses at Okuzu and Obiaruku quarters; in Obiaruku town, Delta State, was examined to ascertain their suitability for domestic consumption. Composite samples [Eight (8) samples in all] were collected in the months of December, 2012 and March, 2013 as well as in the months of July, 2012 and September, 2012 and in-situ parameters recorded before further laboratory analyses were performed on the samples. Results revealed seasonal variation in the pattern of contamination. Parameters such as temperature, electrical conductivity E.C.; Nitrate, NO_3^-; Sulphate, SO_4^{2-} as well as most of the heavy metals examined were found to have higher concentrations during the dry season periods. The concentrations of most of the parameters examined were above the WHO standards for drinking water. The metallic contaminants are in the range of Iron, Fe (0.582±0.002-0.910±0.003mg/l); Manganese, Mn (0.022±0.002-0.045±0.001mg/l); Lead, Pb (0.005±0.001-0.020±0.001mg/l); Cadmium, Cd (0.003±0.001-0.011±0.001mg/l) and Zinc, Zn (0.050±0.002-0.106±0.001mg/l) for both wet and dry seasons. BOD values varied from 2.69±0.04mg/l to 4.18±0.01mg/l while turbidity ranged from 3.2±0.6 NTU to 4.8±1.2 NTU for both wet and dry seasons. Parameters such as electrical conductivity, E.C., Hardness, Alkalinity, Nitrate, NO_3^-; Sulphate, SO_4^{2-} Dissolved Oxygen, DO; Chemical Oxygen Demand, COD; and P^H detected were below the WHO desirable limits for drinking water. In all, the two water bodies examined were found to be contaminated with high amounts of heavy metals, BOD as well as turbidity thus, not suitable for use without appropriate treatment. It is therefore recommended that these water sources be protected from direct exposure to storm water run-offs.

INTRODUCTION

Environmental contamination and pollution are becoming a common occurrence in parts of the developing world (Okuo et al, 2007 and Ogboi, 2005). Water pollution is the direct or indirect introduction, as a result of human activities, of substances such as pesticides, plastics, detergents, heavy metals, salt and among others, into water which may alter its characteristics and may become harmful to human health or the quality of the aquatic environment or impair or interfere with amenities and other legitimate uses of water (Amitaye, 2011). However, the point of use of water is paramount in defining the quality of water. According to Ademoroti (1996), Narayana (2009) and Manahan (2006), water is generally used for domestic, industrial and agricultural purposes. In line with Ogunnawo as cited by Egboh and Emeshili (2009), water is domestically used for drinking, cooking, bathing, washing and maintaining good hygienic condition.

Generally, Water which is a useful chemical element, exist as surface (river) water as well as groundwater resources. According to Rim-Kukeh (2009), river results when precipitation that does not evaporate or infiltrate into the ground, runs off over the surface drawn by the force of gravity back toward the sea. In the token, some research findings have shown that river water bodies are exposed to several degrees of contamination which may result from discharge of organic and inorganic wastes via storm water run offs as well as atmospheric fallouts resulting from precipitations (Okuo et al, 2007; Aiyesanmi et al, 2004; Rim-Kukeh et al, 2006 and Amitaye, 2011).

River Ethiope which has its root source from Umuaja community in Ukwuani Local Government Area of Delta State is one the fastest flowing surface water bodies with many tributaries spread across the state. The river flows from Umuaja (the base source) through Obiaruku town down to the Sapele axis before it empties into the Atlantic Ocean. The river is the only available surface water source in Obiaruku town with several economic and social benefits. It cut across the three major quarters in the town: Obiaruku, Okuzu and Umu-sume quarters. Beside the wide spread of boreholes in Obiaruku town, some people still rely on river Ethiope as a water source for domestic, industrial and agricultural activities because of its clarity and high flow rate (3.5cm/s). Although, little or no effort have been made by the people or even the government to protect this water source from possible contamination from storm water run-offs and other polluting agents hence, this study. This study was designed to asses some water quality parameters of Ethiope River course in Obiaruku, particularly the heavy metals, in order to determine its desirability and suitability for both domestic and industrial applications.

MATERIALS AND METHOD

The Study Area

'Obiaruku' is a fast developing town and also, the head quarters of Ukwuani Local Government Area of

Delta State. The town is geographically located between latitudes $5^{o}29^{1}$N and $5^{o}35^{1}$N and longitudes $5^{o}46^{1}$E and $5^{o}49^{1}$E and it is bordered to the North with the Benin division **(the Idus**), on the south by the **Akashiade** clan, on the west by **Abraka (Ethiope East Local Government Area)** and the South-East by **Umukwata.** The town is a focal point of trade between her boundary counterparters and has a fast growing population of over 85,000 people. Most of the people are crop farmers and traders with many civil servants and some fishermen. The town is geologically characterized by sedimentary deposits which usually occur in loose form hence, porous (Egboh & Emeshili, 2007 and Amitaye, 2011). The Ethiope River flows across major quarters in northern axis of the town. The climate is humid subequatorial. It rains all through the year but there are generally four months of dry season from December to March and eight months of rainy season from April to November.

Sample Collection and Preservation

River Ethiope tributaries at Okuzu and Obiaruku quarters, in Obiaruku town, were selected for this study based on their proximity to market place and the volume of economic activities in these quarters as well. The rivers were sampled both downstream and upstream twice in a month, over three sampling sessions: morning, afternoon and evening sessions in order obtain composite samples and the mean values of their analyses were reported. The samples were however, collected in the months of December, 2012 and March, 2013 as well as in the months of July, 2012 and September, 2012. At each sampling sites, the water samples were collected from the subsurface layer (at about 30cm) of the rivers using polythene plastic containers of 2-liters and 1-liter capacities respectively. The containers were first washed with detergent, rinsed with water and then with 5% Nitric acid and finally with distilled water. At each sampling point, the plastic containers were rinsed twice with water to be collected. Little amount of the sampled water was placed in plastic beaker and the in-situ parameters: temperature, P^{H}, Dissolved Oxygen (DO), and the Electrical Conductivity (E.C.) were determined using a multi-meter. The samples for heavy metal analysis were collected in plastic containers (1-liter capacity) and preserved with 5ml concentrated Nitric acid. The water samples, after collections were placed in an ice-parked cooler to maintain a temperature below 4^{0}C for further laboratory analysis of samples. (See figure 1 for the map of Obiaruku showing sample sites)

Geographical Location/ Reference of Sample Sites

	Site name	Site code	GPS coordinates
i.	Ethiope River at Obiaruku Quarters	RW_1	$N05^{0}51^{1}12.0^{11}$ $E006^{0}08^{1}42.3^{11}$
ii.	Ethiope River at Okuzu Quarters	RW_2	$N05^{0}51^{1}50.9^{11}$ $E006^{0}09^{1}10^{11}$

Laboratory Analysis

The **American Public Health Association's (APHA) methods** for drinking and wastes water analysis were used for this study. The temperature, Electrical Conductivity (E.C.), Dissolved Oxygen (DO) and P^{H} were determined using a **Multi-meter** and elemental analyses were done using Perkin Elmer **Atomic Absorption Spectrophotometer** (Buck Scientific Model 200A/210) with double beam and background corrector, Acetylene flame (Perkin Elmer: HGA 500) and hollow cathode lamp. All reagents used were of analar grade.

RESULTS AND DISCUSSION

Water as a universal solvent is not impurity-free. For water to be suitable and potable for drinking as well as useful for other domestic activities, the desirable concentrations of the impurities must not be exceeded (WHO, 2006). The results of the physicochemical studies of the river water samples collected are presented in tables: 1-3. Most of the parameters examined were found to vary seasonally in their concentrations. Parameters such as temperature, electrical conductivity E.C.; Nitrate, NO_3^-; Sulphate, SO_4^{2-} as well as most of the heavy metals examined were found to have higher concentrations during the dry season periods. However, the temperature values were in direct consonance with the ambient temperature variations in both wet and dry seasons. Similar observations have been made by Egboh and Emeshili (2009) and Ukuo et al (2009).

For heavy metals, the observed higher concentrations in dry season may be due to lowered dilution resulting from no or low precipitation. The concentrations of Iron, Fe (0.582±0.002-0.910±0.003mg/l); Manganese, Mn (0.022±0.002-0.045±0.001mg/l); Lead, Pb (0.005±0.001-0.020±0.001mg/l); Cadmium, Cd (0.003±0.001-0.011±0.001mg/l) and Zinc, Zn (0.050±0.002-0.106±0.001mg/l), detected in the river water samples, were above the desirable limits for drinking water for both wet and dry seasons (see table 3). Lead and Cadmium concentrations in the water samples from RW_2 were found to be higher than that obtain in water sample from RW_1. The reason for the above observations may be due to higher volume economic

activities as well as the closer location of the river to the main market in Okuzu quarters. No chromium was detected in water sample from RW_1 though, the concentration obtained in water samples from RW_2 [wet season (0.010±0.001mg/l) and dry season (0.015±0.001mg/l)] were a bit above the desirable limits for drinking water. This must have been eroded from the nearby farms and discharged into the river by storm water run-offs, since most of the farmers in the area make use of fertilizers as soil conditioner.

The significance of turbidity in water analysis is of both biological and aesthetic relevance as it may hinder disinfection by shielding microbes which may be pathogenic (Ademoroti, 1996; WHO, 2004). All the water samples examined were found to be highly turbid in the wet season with the highest value (4.8±1.2 NTU) recorded for Okuzu River (RW_2). This can be attributed to the exposure of these river bodies to organic and inorganic particulate matter and pollutants such as plant matters, paper and sewage to mention but a few. This also explains the high BOD values obtained from both water bodies. The BOD values for water sample from RW_2 varies from 3.16±0.11mg/l to 4.18±0.01mg/l in dry and wet seasons respectively while samples from RW_1 varied from 2.69±0.04mg/l to 3.82±0.02mg/l in dry and wet seasons respectively. The highest BOD value was obtained in sample from RW_2 in the wet season. However the BOD value (2.69±0.04mg/l) of the sample from RW_1, in the dry season, was below the desirable limit for drinking water (WHO, 2006).

Conclusion and Recommendations

Based on the above results, it can be concluded that Ethiope River courses at Okuzu and Obiaruku quarters in Obiaruku town are highly contaminated with heavy metals and turbid as well hence, unsuitable for use domestically, especially for drinking, without appropriate treatment. It is therefore recommended that

i. The water from these sources be subjected to appropriate treatment scheme before use
ii. Urgent measures be taken to prevent or minimize direct discharge of organic wastes into these water bodies
iii. These water bodies be protected from direct exposure to storm water run-offs
iv. Further investigations be carried out on theses water sources with special regard to microbiological indicators.

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TABLES:

Table 1: Physicochemical Water Quality Parameters of River Ethiope course at "OBIARUKU quarters" with WHO standards for drinking water

Parameters	Units	Wet Season Mean±S	Dry Season Mean±S	**WHO standards** Desirable level	Max. allowed level
Temperature	^{o}C	25.2±0.1	26.9± 0.1		
E.C.	μScm^{-1}	36.2 ±0.6	37.1±0.6	900	1200
Hardness as	mg/l $CaCO_3$	2.96±0.06	2.96±0.04	100.00	500.00
NO_3^-	mg/l	0.15±0.01	0.18±0.01	10.00	50.00
SO_4^{2-}	mg/l	0.64±0.01	0.66±0.01	200.00	400
DO	mg/l	7.20±0.07	6.88±0.10	3.0 -8.0	4.0 -8.0
BOD	mg/l	3.82±0.02	2.69±0.01	<3.00	<3.00
COD	mg/l	5.80±0.09	4.46±0.04	10.00	10.00
Ca	mg/l as $CaCO_3$	1.71±0.06	1.71±0.04	75.00	200.00
Mg	mg/l as $CaCO_3$	0.98±0.03	0.98±0.02	30.00	150.00
P^H	-	6.80±0.05	5.60±0.05	6.0-8.5	6.5-8.5
Turbidity	NTU	4.50±1.2	3.70±1.0	0.00	5.00
Alkalinity	mg/l as CaCO3	55.82±0.3	52.20±0.3	100.0	100.0

E.C. = Electrical Conductivity, DO = Dissolved Oxygen, COD = Chemical Oxygen Demand, BOD = Biological Oxygen Demand, S=Standard deviation

Table 2: Physicochemical Water Quality Parameters of River Ethiope course at "OKUZU quarters" with WHO standards for drinking water

Parameters	Units	Wet Season Mean±S	Dry Season Mean±S	WHO standards	
				Desirable level	Max. allowed level
Temperature	^{o}C	24.8±0.1	26.7±0.1		
E.C.	μScm^{-1}	33.6±0.5	34.3±0.5	900	1200
Hardness as	mg/l $CaCO_3$	3.45±0.11	3.44±0.11	100.00	500.00
NO_3^-	mg/l	0.17±0.01	0.20±0.01	10.00	50.00
SO_4^{2-}	mg/l	0.64±0.03	0.76±0.05	200.00	400
DO	mg/l	7.80±0.13	6.10±0.10	3.0 -8.0	4.0 -8.0
BOD	mg/l	4.18±0.01	3.16±0.01	<3.00	<3.00
COD	mg/l	6.05±0.03	4.86±0.02	10.00	10.00
Ca	mg/l as $CaCO_3$	2.46±0.11	2.46±0.11	75.00	200.00
Mg	mg/l as $CaCO_3$	0.09±0.03	0.98±0.03	30.00	150.00
P^H	-	7.20±0.06	6.45±0.05	6.0-8.5	6.5-8.5
Turbidity	NTU	4.8±1.2	3.2±0.6	0.00	5.00
Alkalinity	mg/l as CaCO3	28.10±0.20	24.60±0.20	100.0	100.0

E.C. = Electrical Conductivity, DO = Dissolved Oxygen, COD = Chemical Oxygen Demand, BOD = Biological Oxygen Demand, S=Standard deviation

Table 3: Levels of Heavy Metals in the Water Samples from Ethiope River Course at OBIARUKU quarters (RW_1) and OKUZU quarters (RW_2)

Analytes (mg/l)	← RW_1 →		← RW_2 →		WHO standards	
	Wet season	Dry season	Wet season	Dry season	Desirable level	Maximum allowed level
Fe	0.880±0.002	0.910±0.003	0.582±0.002	0.650±0.002	0.010	0.300
Mn	0.043±0.001	0.045±0.001	0.022±0.002	0.030±0.001	0.010	0.400
Zn	0.050±0.002	0.052±0.002	0.105±0.001	0.106±0.001	0.010	3.000
Cu	0.003±0.001	0.005±0.001	NDL	NDL	0.500	2.000
Pb	0.010±0.001	0.005±0.001	0.016±0.001	0.020±0.001	0.01	0.01
Cd	0.003±0.001	0.007±0.001	0.005±0.001	0.011±0.001	0.003	0.003
Cr	NDL	NDL	0.010±0.001	0.015±0.001	0.05	0.05

NDL = Not within Detection Limit

FIGURE

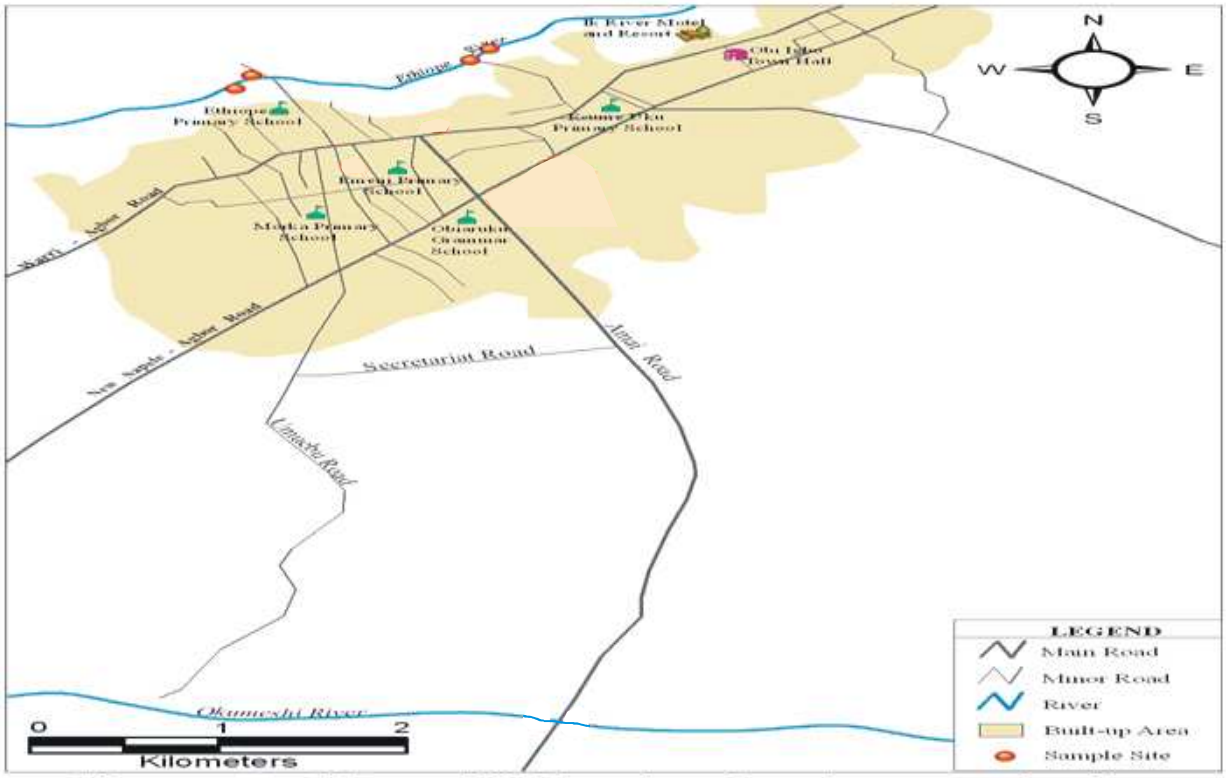

Figure 1 : Map of Obiaruku showing sample sites