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INVESTIGATION OF WATER QUALITY OF TWO RIVERS IN AGBEDE – WETLANDS IN SOUTHERN NIGERIA

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ABSTRACT

Water quality of Edion and Omodo Rivers were assessed chemically from March to October, 2010. The abstracted water samples were also subjected to bacteriological examination. The Rivers were each sampled at upstream and downstream locations. Twenty (20) physico-chemical characteristics which included heavy metals were determined in the laboratory. Air temperature ranged from the mean 30.69 to 31.38 °C, water temperature 26.50 to 27.00 °C, pH 7.05 to 7.15, electrical conductivity 7.99 to 25.55μScm^{-1}, turbidity 24.11 to 54.65FTU, total dissolved solids 6.14 to 7.78mgl^{-1}, total hardness 25.10 to 30.38mgl^{-1}, chlorine 22.06 to 25.02mgl^{-1}, BOD_5 0.88 to 2.42mgl^{-1}, DO 3.81 to 6.50mgl^{-1} and the nutrient elements such as sulphate, phosphate and Nitrate ranged between 0.03 and 3.81mgl^{-1}, sodium 1.87 to 3.81mgl^{-1} and potassium 1.08 to 1.27mgl^{-1}. Heavy metals levels were low, ranging from 0.0025 to 5.6650mgl^{-1} (Copper 0.0350 to 0.0910mgl^{-1}, Iron 0.2825 to 0.5112mgl^{-1}, cadmium 0.0015 to 0.0104mgl^{-1}, lead 0.0025 to 0.0230mgl^{-1}, zinc 2.7013 to 5.6650mgl^{-1} and chromium 0.0025 to 0.0263mgl^{-1}). Conductivity, sulphate, zinc and fecal coliform count showed significant difference ($P<0.05$) with low values indicating good water quality. Water Quality Index (WQI) revealed that Stations 2 and 4 respectively had good water quality. All the characteristics had their values within FEPA Limit except for Zn (> 3.0mgl^{-1}).

Keywords: Faecal Coliform, Correlation, Edo – North, Quality, Cattle Herds.

1. Introduction

Nowadays, the search for quality and safe water has increased substantially unlike in the past two decades. Urban residences have quite a number of options to the quality of water which they utilize for drinking and general domestic purposes. Their sources for such options include; borehole water, potable water supply, and processed bottled and sachet waters, which varies from district to district in typical Nigerian Cities.

In Nigeria over 76% rural communities rely on surface water bodies like Streams, Rivers, wells and even Ponds for their water sources. The experience of Agbede town and her neighbouring communities is typical but, human impact of these water bodies are majorly through Agricultural practices, rice and cassava mills, use of pesticides to harvest Fishes, bathing, washing of various forms and open Nomadic life style (Olomukoro and Dirisu, 2014).

The unsanitary condition of humans sharing the same waters with cattle herds which defecate in same, coupled with surface run – off and most importantly the effect of inundation in the peak months of annual raining season is a worrisome situation. The by-product of agricultural activities, urbanization and industrialization result in the pollution and degradation of the available water resources (Waziri *et al.,* 2009; Waziri and Ogugbuaja, 2010).

Fagbote *et al*. (2014) reported that the usual way to organize a wide set of data is to apply indexes and indicators as a tool which summarizes many parameters. The authors also demonstrated the use of water quality index as a reliable means of determining the quality of ground water impacted by bitumen deposit around farm settlement in Ondo State, Nigeria.

Studies on water quality in some Nigerian inland waters have been reviewed by several workers (Olayemi, 1994; Ogbogu and Hassan, 1996; Olomukoro and Egborge, 2004; Emere and Nasiru, 2009; Essien-Ibok *et al.,* 2010; and Waziri and Ogugbuaja, 2010). There is no documented study regarding chemical hydrology or water quality on water bodies in Agbede Wetlands in the past except the work of Olomukoro and Dirisu, (2012) on the benthic fauna of Edion River.

Edion and Omodo Rivers are quite significant in this study because, they are the major water supply sources to the communities and the cattle herds within. The study was aimed at examining the water quality status by measuring the seasonal and spatial variation in the physicochemical characteristics and faecal coliform analysis in the Rivers, and to establish a baseline archive for further studies.

2. Materials and Methods

2.1 Study Stations

Agbede wetlands are a floodplain in the northern part of Edo State (Fig. 1). It is situated within a rainforest ecosystem which is fast becoming a derived savannah; it lies within longitude (06^{o}16.3E, 06^{o} 18.7E) and Latitude (06^{0}52.2N, 06^{0}55.4N). The wetlands are mostly fed by surface run-off from neighbouring communities of Auchi, Warake, Ewu, Ewora, Jagbe and Idoa respectively through streams and rivers. One of the selected rivers Edion took its source from somewhere in Ighieve in Owan East local Government Area, while River Omodo's source, is located at Jagbe community directly sharing border with Agbede town in the south-east direction. The area is underlain by the shale of the Imo formation. The shale is predominantly fine textured, dark grey and sometimes bluish – grey with occasional admixture of clay iron stone and thin sandstone bands. The overlying loose brownish sandy soil is not a competent rock material as shown by the several bad sports encountered on the roads in the area. The shale is intercalated with mudstone in some parts and thus, exposed sections revealed weathering to a dull mottled colour.

The climate of Agbede and its environs is not stable. It is comparatively like that of the Benin City as a rhythm of rainfall occurs in conjunction with the movement of the Southern-West monsoon wind across the Atlantic Ocean and the timing of this movement vary from year to year. There are two distinct annual seasons associated with this region: the rainy season which begins in April and terminates in October, and the dry season which starts from November and terminates in March. Rainfall for 2010, ranged from 158.4 – 608.7mm with the lowest recorded in the month of May (158.4mm) and the peak recorded in the month of September (608.7mm). The mean rainfall value was (356.76mm).

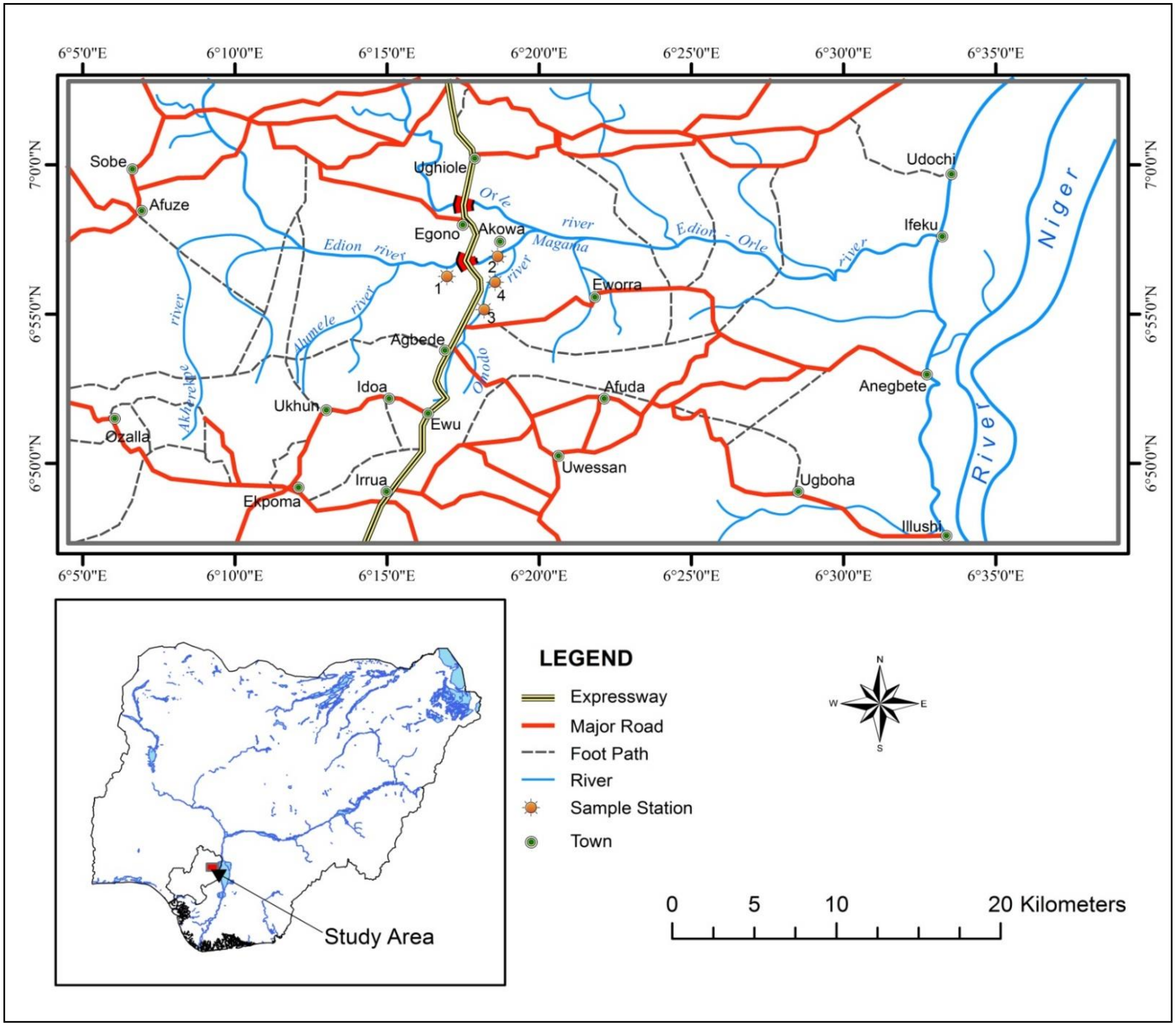

Figure 1. Map of the Study Area

Station 1: This station is located (06^{o}55.4N and 06^{o}16.4E) on the Benin and Auchi/Abuja high way. There was an occasional inundation of the surrounding banks in the months of July, August, and September. The station is surrounded by a number of ponds on its banks as well as settlements. It is subjected to all forms of human activities. The mean velocity of flow was determined to be 0.372m/s and the depth 76cm. *Lemna pausicostata* where found floating here.

Stations 2: Station 2 (06^{o}55.4N and 06^{o}16.4E) is located about 1,050m downstream of the same Edion River. There are lots of aquatic macrophytes (*Lemna pausicostata*) and algae (*Chlorophyta sp)* here. There is vegetation of shrubs and trees on the banks. Cattle dung is commonly associated with this station. The mean velocity of flow was 0.24m/s and the depth was 82cm.

Station 3**:** This is the upstream of river Omodo at Odighie community (06^{o}52.2N and 06^{o}16.8E), by Ewora-Idegun road. It is surrounded by *Bambusa bambusa* tickets. Macrophytes are rare here. Mean velocity of flow was 0.27m/s and the depth was less than 35cm, in dry season; it flows in South – North direction. Human activities in this station include washing, bathing, fishing and fermentation of starch (cassava). It is the only source of domestic water to the immediate communities.

Station 4: It is located about 840m downstream of stations 3 (06^{o}52.2N and 06^{o}18.7E), features and Human activities here are similar to those in station 3 except the fermentation of starch activities. Mean current velocity was equally high here (0.29m/s) and the water depth did not exceeded 35cm.

2.2. Physico-chemical Characteristics analysis

Water samples from the four stations were collected monthly between 9:00am and 1:30pm local time (Nigeria time) throughout the period of study (March to October, 2010); to analyse for physiochemical characteristics and faecal coliform bacteria. The samples were strictly collected by adhering to the quality control and quality assurance method of APHA, (1998). Air and water temperatures were measured in-situ using mercury-in-glass thermometer, while other physical and chemical parameters such as pH, conductivity, total dissolved solids, turbidity, alkalinity, dissolved oxygen (DO), biochemical oxygen demand (BOD_5), Phosphate, sulphur and nitrogen were determined using the methods of APHA, (1998). Chlorine determination was by the argentometric method Olomukoro, (1996). Sodium and potassium cations were determined using a Conning flame photometer IV and Lithium being the references filter.

Heavy metals were analysed with the aid of Atomic Absorption spectrophotometer (AAS) SOLAAR 969AA Unicam Series. Faecal coliform count was analyzed using the multiple tube procedure as described by APHA (1998). **Statistical Analyses of Results**

The Results of the physico-chemical characteristics and coliform count were analyzed statistically using the computer software SPSS 16.0 and by performing analysis of variance (one-way ANOVA), testing the level of significance using Duncan. Correlation coefficient between the fecal Coliform count, and the physico-chemical characteristics were equally performed using the SPSS.

2.3. Water Quality Index

In this study water quality index (WQI) was calculated by using the Weighted Arithmetic Index method which has been described (Cude, 2001). The model utilised different water quality components which were multiplied by a weighting factor and were then aggregated using simple arithmetic mean.

For assessing the quality of water in this study, firstly, the quality rating scale (Qi) for each parameter was calculated by using the following equation;

- Qi = {[(V actual – V ideal) / (V standard – V ideal)] * 100}
- Qi = Quality rating of ith parameter for a total of n water quality parameters
- V actual = Actual value of the water quality parameter obtained from laboratory analysis

- V ideal = Ideal value of that water quality parameter can be obtained from the standard Tables. V ideal for pH = 7 and for other parameters it is equalling to zero, but for DO V ideal = 14.6 mg/L
- V standard = WHO Standard for drinking water

Then, after calculating the quality rating scale (Qi), the Relative (unit) weight (Wi) was calculated by a value inversely proportional to the recommended standard (Si) for the corresponding parameter using the following expression;

- Wi = 1/ Si

Where,

- Wi = Relative (unit) weight for nth parameter
- Si= Standard permissible value for nth parameter
- 1= Proportionality constant.

Finally, the overall WQI was calculated by aggregating the quality rating with the unit weight linearly by using the following equation:

- WQI = Σ WiQi/ Σ Wi

Where,

- Qi = Quality rating
- Wi = Relative weight

Table 1. Water Quality Index (WQI) and Status of Water Quality

WQI Levels	Description
< 50	Excellent
50 – 100	Good
100 – 200	Poor
200 – 300	Very poor (bad) water
> 300	Unsuitable (unfit)for drinking

Source: (Ramakrishniah *et al.*, 2009)

3. Results

3.1. Physico-chemical Characteristics

The physicochemical characteristics of the mean, minimum and maximum values are shown in Table 2

3.2. Air and water Temperatures

The air temperature was lowest in station 3 with a mean of 30.69 °C and highest in stations 1 and 2 with the means of 31.38 °C respectively. The minimum and maximum air temperatures during the study period were, 29.00 °C (Station 1) and 34.00 °C (Station 2) respectively. The mean water temperature was lowest (26.50 °C) in station 1 and highest (27.00 °C) in station 4. However, there was statistically no significant difference *($P>0.05$)* in the mean air and water temperatures in the four stations.

Table 2: Summary of the Mean Physico-chemical Characteristics and Microbiology of Edion and Omodo Rivers in Agbede Wetlands (March – October 2010).

Parameters	* Unit of Measurement	Stations 1			Stations 2			Stations 3			Stations 4			FEPA Limit	WHO Limit	P – value
		$\overline{\chi}$ + S. E	MIN	MAX	$\overline{\chi}$ + S. E	MIN	MAX	$\overline{\chi}$ + S. E	MIN	MAX	$\overline{\chi}$ + S. E	MIN	MAX			
Air Temperature	^0C	31.38 ± 0.57	29.00	33.50	31.38 ± 0.57	30.00	34.00	30.69 ± 0.35	29.00	32.00	31.31 ± 0.33	30.00	33.00	NS	25	P > 0.05
Water temp	^0C	26.50 ± 0.21	25.50	27.00	26.61 ± 0.25	26.00	23.00	26.87 ± 0.21	26.00	28.00	27.00 ± 0.19	26.00	28.00	<40	NS	P > 0.05
pH		7.99 ± 0.36	6.30	8.20	7.10 ± 0.17	6.20	7.80	7.05 ± 0.21	5.90	7.90	7.15 ± 0.15	6.80	7.90	6-9	6 – 8	P > 0.05
Conductivity	µS/cm	7.11 ± 0.21	6.78	9.47	23.86 ± 3.19	11.34	36.00	22.53 ± 2.66	9.48	32.10	25.55 ± 2.75	10.46	38.72	NS	NS	P < 0.001
Turbidity	ftu	24.11 ± 7.16	5.00	61.00	24.55 ± 6.48	3.00	62.00	53.26 ± 31.83	3.70	265.00	54.65 ± 16.42	3.70	152.00	NS	5	P > 0.05
TDS	mg l^{-1}	7.78 ± 1.59	4.70	18.50	7.55 ± 0.29	6.35	8.60	6.14 ± 0.61	4.40	9.80	6.43 ± 0.79	4.50	11.40	2000	1000	P > 0.05
Hardness	mg l^{-1}	28.22 ± 21.77	20.09	40.90	30.38 ± 1.74	20.33	36.10	25.93 ± 1.33	20.98	32.11	25.10 ± 2.33	17.00	36.10	NS	NS	P > 0.05
Chlorine	mg l^{-1}	22.06 ± 2.54	10.22	30.23	23.39 ± 2.65	11.15	30.62	24.55 ± 2.07	14.61	30.10	25.02 ± 1.57	18.32	30.20	600	500	P > 0.05
Sulphate	mg l^{-1}	1.19 ± 0.29	0.00	2.20	0.07 ± 0.26	0.00	0.20	0.06 ± 0.26	0.00	0.20	0.06 ± 0.02	0.00	0.20	500	500	P < 0.001
Phosphate	mg l^{-1}	0.20 ± 0.09	0.00	0.80	0.12 ± 0.07	0.00	0.50	0.25 ± 0.15	0.00	1.20	0.03 ± 0.15	0.00	0.10	5	NS	P > 0.05
Nitrate	mg l^{-1}	0.14 ± 0.06	0.00	0.40	0.19 ± 0.06	0.00	0.50	0.11 ± 0.08	0.00	0.68	0.03 ± 0.02	0.00	0.10	20	50	P > 0.05
BOD_5	mg l^{-1}	0.14 ± 0.17	0.10	1.60	1.83 ± 0.49	0.10	4.80	2.42 ± 1.01	0.20	9.80	0.88 ± 0.19	0.00	1.60	30	NS	P > 0.05
DO	mg l^{-1}	3.81 ± 0.47	2.10	6.20	4.62 ± 0.83	1.20	7.40	6.50 ± 2.66	1.50	23.90	4.88 ± 1.19	2.00	9.50	NS	NS	P > 0.05
Sodium	mg l^{-1}	1.10 ± 0.03	1.40	5.11	1.87 ± 0.29	0.89	3.21	1.87 ± 0.13	1.08	2.30	2.12 ± 0.29	0.82	2.93	5	NS	P > 0.05
Potassium	mg l^{-1}	0.0350 ± 0.01	0.98	1.22	1.27 ± 0.10	0.89	1.70	1.08 ± 0.13	0.46	1.70	1.26 ± 0.15	0.72	1.96	75 - 200	NS	P > 0.05
Copper	mg l^{-1}	0.4612 ± 0.69	0.00	0.10	0.0575 ± 0.02	0.00	0.10	0.0910 ± 0.02	0.00	0.20	0.0551 ± 0.03	0.00	0.20	< 1	0.05	P > 0.05
Iron	mg l^{-1}	0.0075 ± 0.01	0.17	0.63	0.5112 ± 0.06	0.16	0.72	0.2825 ± 0.12	0.00	1.00	0.2929 ± 0.12	0.00	0.82	20	0.4	P > 0.05
Cadmium	mg l^{-1}	0.0025 ± 0.00	0.00	0.05	0.0025 ± 0.00	0.00	0.01	0.0104 ± 0.01	0.00	0.08	0.0015 ± 0.00	0.00	0.01	< 1	0.01	P > 0.05
Lead	mg l^{-1}	2.7013 ± 0.52	0.00	0.01	0.0100 ± 0.01	0.00	0.05	0.0230 ± 0.01	0.00	0.10	0.0155 ± 0.12	0.00	0.10	< 1	0.01	P > 0.05
Zinc	mg l^{-1}	0.002 ± 0.00	0.62	4.89	5.3200 ± 0.61	2.98	7.40	5.5888 ± 0.64	3.72	8.92	5.6650 ± 0.51	3.80	8.30	< 1	3.0	P < 0.01
Chromium	mg l^{-1}	5.75 ± 3.12	0.00	0.01	0.0263 ± 0.01	0.00	0.10	0.0122 ± 0.01	0.00	0.09	0.0105 ± 0.01	0.00	0.06	< 1	0.03	P > 0.05
Faecal Coli Count	MPN 100^{-1}		0.00	20.00	33.75 ± 7.20	0.00	60.00	31.31 ± 7.69	0.00	60.50	20.00 ± 9.82	0.00	80.00	400MPN 100^{-1}	NS	P < 0.05

Note that:

P < 0.05 - shows a significance difference, P > 0.05 - Means there was a significant difference; P < 0.01 and P<0.001 show a highly significant difference; ***** Unit - Unit of Measurement, NS: Indicates not specified

Hydrogen Ion Concentration (pH)

The pH ranged from acidity to slightly alkaline in the four stations. It ranged between 5.90 and 8.20 in the wet season, and between 6.80 and 7.90 in the dry season respectively in the study stations. There was no significant difference in the stations 1 to 4, (*P>0.05*). Duncan multiple range tests revealed that stations 1, 2, 3 and 4 were significantly the same (slightly alkaline).

Electrical Conductivity and Turbidity

Conductivity values ranged from 7.97 to 22.55μScm^{-1} in all the stations. There was a significance difference (*P<0.001*) in the mean conductivity values across the four stations. *A posterior* Duncan multiple range tests revealed that stations 2, 3 and 4; were significantly higher than station 1.

The Turbidity mean value was lowest (24.11FTU) in station 1 and highest (54.65FTU) station 4. There was no significant difference (*P>0.05*) in the means of the study stations.

Total Dissolved Solid

Total Dissolved Solid (TDS) varied from stations 1 to 4, with the highest mean value (7.79mgl^{-1}) in station 1 and lowest (6.14 mgl^{-1}) in station 3. A gradual decrease in the mean values from station 1 to 3 was noticed except, in station 4 (6. 43 mgl^{-1}). There was no significance difference (*P>0.05*) in the stations.

Hardness

Hardness mean values ranged from 28.21 mgl^{-1} in station 1, 30.38 mgl^{-1} in station 2, and 25.93 mgl^{-1} and 25.10 mgl^{-1} in station 3 and 4 respectively. There was no significance difference among the stations (*P>0.05*). *A posterior* Duncan multiple range test revealed that station 1 and 2, were slightly higher than stations 3 and 4.

Biological Oxygen Demand (BOD) and Dissolved Oxygen (DO)

The means of these two parameters revealed a close relationship; as the DO was increasing, so the BOD was increasing except in station 4, were it was the contrary. BOD mean ranged between 2.43mgl^{-1} and 0.86mgl^{-1}. The minimum and maximum values throughout the study were 0.00mgl^{-1} and 9.80mgl^{-1}.

Mean concentration value of DO varied from 3.81mgl^{-1} (lowest in station 1) to 6.50mgl^{-1} (highest in station3). The minimum value of 1.20mgl^{-1} was recorded in station 2 and maximum of 23.90mgl^{-1} was recorded in station 3. There was no significant difference (*P>0.05*) among the two parameters of the stations compared.

Sodium (Na) and Chloride (Cl)

Among the alkaline metals tested in this study, sodium recorded higher mean values which ranged from 3.03 mgl^{-1} (station 1) to 1.87 mgl^{-1} (Stations 2 and 3 respectively). Chlorine mean concentration was from 10.22 to 25.02 mgl^{-1}. There was no significant difference (*P>0.05*) with the two parameters in the stations.

Potassium (K)

Potassium mean value varied from 1.27 mgl^{-1} to 1.09 mgl^{-1} and there was no significant difference (*P>0.05*) in the stations.

Sulphate (SO_4)

Mean value of sulphate was between 0.06 mgl^{-1} and 1.19 mgl^{-1}. These means differed significantly (*P<0.001*). *A posterior* Duncan multiple ranged tests revealed that station 1 was much higher than stations 2, 3 and 4 respectively.

Phosphate (PO_4) and Nitrate (NO_3)

The phosphate mean concentration was lowest (0.03 mgl^{-1}) in station 4 and highest (0.25 mgl^{-1}) in station 3. Mean while there was no significant difference (*P>0.05*) among the stations.

Nitrate means was lowest (0.03 mgl^{-1}) in station 4 and was highest (0.19 mgl^{-1}) in station 2. There was also no significant difference (*P>0.05*) among the studied stations.

Phosphate and Nitrate had almost the same mean value (0.03 mgl^{-1}) in station 4.

Heavy metals

The mean concentration of Copper ranged from 0.0350 in station 1 to 0.0910 mgl^{-1} in station 3.

Iron (0.283 to 0.511mgl^{-1}), Cadmium means concentration ranged from 0.0075 to 0.0104 mgl^{-1}.

Lead from 0.0025 to 0.0230 mgl^{-1}. Zinc was from 2.7013 to 5.6650 mgl^{-1}. Chromium ranged between 0.0025 and 0.0263 mgl^{-1}. All the metals showed no significant difference ($P>0.05$) except for Zinc which showed a highly significant difference ($P<0.01$) between the stations.

Water Quality Index

Table 3. Summary of Water Quality Index (WQI) for the individual stations

	Station 1	**Station 2**	**Station 3**	**Station 4**
WQI	10612.020	70.942	151.431	81.218

In relation to the physicochemical parameters used in this assessment and time of water samples collection, water from stations 2 and 4 were good for domestic purposes. Waters from station 3 (Table 3) were poor for the same purpose while that of station 1 were unsuitable.

Microbiology

Fecal Coliform Count (FCC)

The mean values of coliform count bacteria were highest (33.75 MPN $100ml^{-1}$) in station 2 and lowest (5.75 MPN $100ml^{-1}$) in station 1. Faecal coliform count values were minimal in the stations (0.00 MPN 100^{-1}) particularly in the month of May. There was a significant difference ($P<0.05$) between the stations.

4. Discussion

The physico-chemical and bacteriological characteristics of Edion and Omodo Rivers in Agbede wetlands revealed slightly negatively the nature of the human activities such as farming, fishing, washing of auto-mobiles, clothes and agricultural produce; among these activities also include; Nomadic agriculture and the milling industries.

Surface water temperature closely followed the ambient temperature in this study. Mean while temperatures were higher during the dry season months. These findings have been reported in previous studies elsewhere in Nigeria inland waters (Ogbeibu and Victor 1985; Akpan, 2000; and Olomukoro and Egborge, 2003).

The pH of a water body is regulated by the bicarbonates (HCO^-_3) and Carbonates (CO_2) present and also by photosynthetic activities in the aquatic environment. pH values across the stations showed slightly alkaline condition (slightly above 7.0). This is an indication that the rivers were well buffered. Animals like fishes and crustaceans are well favoured in this condition. pH was rarely positively correlated with some of the physico - chemical parameters, like; temperature, dissolved oxygen, biochemical oxygen demand, total solids, phosphate, conductivity, sodium and some heavy metals in the study stations.

Turbidity is the ability of water to recall light and it is caused by small particles present in water bodies. There was a gradual increase in the level of turbidity in stations 1 and 2 and far higher values in stations 3 and 4. This could be attributed to the advent of surface run-off caused by rain fall. However, the values were within FEPA and WHO limits.

The electrical conductivity is the ability of the water to conduct an electrical current. Conductivity measures the total ionic composition of water. Gradual increasing patterns in the values recorded were observed. There was a relative increase towards the peak of the rains. Lowest mean value (7.99μScm^{-1}) was recorded in station

1. These findings are contrary to Olomukoro and Egborge (2003). However, the values obtained in this study suggest complete freshwater, characterized by the very low conductivity levels.

Total Dissolved Solids ranged from 4.40 to 18.50mgl^{-1} across the stations. The pattern of values recorded was highly irregular. Alabaster and Lloyd (1980) reported that excessive concentration of total solids might be harmful to aquatic life. The values were extremely low when compared with FEPA limit of 2000mgl^{-1}.

Total hardness values showed a high irregular fluctuation in all the sampled stations. Hardness values ranged between 17.00 and 40.90mgl^{-1}, with station 1 recording the lowest mean value. This may be due to influx of weathered mineral salts and the use of soapy products for washing activities at station 1.

Nitrate and phosphate were analyzed to ascertain the nutrient load of the waters. Phosphate and nitrates have often been cited as the limiting nutrients in aquatic environments and have been widely adopted as indicators for eutrophication in Lakes, ponds, reservoirs and rivers (Thornton, 1986; and Ovie 1997). Nitrates and phosphates play vital role in flora metabolism of aquatic species, such as phytoplankton and macrophytes notably. They can be considered pollutants when present in higher concentration. Meanwhile, the concentrations were generally low in the sampled stations (values within FEPA and WHO Limits). Phosphate was mostly not detected during the dry season. A similar finding was reported by Kadiri (2000) for Ikpoba River, and Ehaise and Anyasi (2005) but, was contrasted with that of Olomukoro and Egborge (2003) for Warri River and Olomukoro and Igbinosun (2004) for Ikpoba River. Phosphate showed positive correlation with turbidity, conductivity and hardness

Sulphate is a major ion occurring in natural waters and waste water. Sulphate values were low across the stations except, with the relative high of 2.20mgl^{-1} in station 1 in the month of May. Highest mean value (1.19mgl^{-1}) was recorded in station 1. This conforms to the report of Ogbeibu and Edutie (2002). The main natural sources of sulphate in surface and ground water are the process of chemical weathering and dissolution of sulphur containing materials, predominantly gypsum. Other, natural sources are the oxidation of sulphides and elemental sulphate and decomposition of animals and plants residue (Mason, 1990). Direct anthropogenic sources of sulphate include; industrial and municipal waste, agricultural drainage and run – offs.

The Biochemical Oxygen Demand (BOD) values were very low and far below the value that defines pollution. The variation in the BOD values may be due to the differential anthropogenic activities influencing the various stations. The BOD has been widely used to determine the organic pollutional strength of wastewaters and as well as the quality of receiving surface water bodies. Any river can self purify itself if the BOD value is below 4mgl^{-1} but, not when it is greater than 4mgl^{-1}.

Dissolved oxygen showed irregular pattern of fluctuation, with the high recorded values during the wet season. Dissolved oxygen concentration is a function of environmental temperature (air and water temperature), pressure, salinity and mostly the biological activities in the water body. Tropical aquatic ecosystem should have oxygen concentration of at least 5mgl^{-1} in order to support biotic diversity (Radojevic and Bashkin, 1999).

Sodium (Na) and potassium (K) values were within the permissible limit stipulated by FEPA. Sodium recorded higher mean values in this study than potassium (i.e. Na > K) in the stations. This trend is in agreement with an earlier study by Ogbeibu and Anagboso (2004) for Utor River in Esan south - east, Edo State, Nigeria.

Heavy metals in surface water can be from natural or anthropogenic sources (Ajayi and Osibanjo, 1981). However, all the metals analyzed have their values within available standards except for Zinc. Copper ranged value from (0.0350mgl^{-1}) in station 1 to (0.0911mgl^{-1}) in station 3. Higher rate of fluctuation was noticed with copper, as there was no detection in some of the samples. Copper is a trace element generally not of major public health significance but at higher concentrations ;> 0.05mgl-^{1} the impacted water would have an unpleasant taste. Mason (1981) reported that the consumption of water containing Cu at values of > 0.05mgl^{-1} can lead to the development of a metabolic disorder; Wilson disease in susceptible individuals.

An irregular pattern of fluctuation was exhibited by Iron (Fe) from the study. Although values recorded in monthly and spatial variations were less than one (values < 1). Iron is the second most abundant element in the earth's crust. Its presence in natural water is small and may be present in the various ionic forms inorganic and mineral forms whose stability is related to a number of factors such as redox potentials and pH.

Chromium was extremely low in values as shown in the monthly and spatial variation. Cr was not detected in most of the samples. When detected, Cr values were lowest during the wet season. The low values of Cr recorded in this study may be due to absence of most of the industries afore mentioned. Olomukoro and Azubuike, (2009) have reported higher concentrations of heavy metals in Ekpan creek, Southern Nigeria.

Zinc recorded relatively high mean values across the studied stations. A high concentration of $8.92 mgl^{-1}$ was recorded in June for station 3. Murugan *et al*. (2008) reported that the accumulation of Zn in humans can lead to the development of condition such as Alzheimer's disease. However, Zinc is an essential element which acts as a structural component and exhibits specific properties indispensable for life (Murugan *et al*. 2008). Oguzie (2002) recorded high values of Zinc in the sediment of lower Ikpoba River at Temboga, Benin City, Edo State, Nigeria. Sources of zinc include animal dung, excreta, and wastes from slaughter and mineralization processes. Zinc was positively significantly correlated with Nitrate dissolved oxygen, air temperature and sulphate respectively across the stations.

Cadmium did not show regular pattern in the values recorded. There was a high irregular seasonal fluctuation. Cadmium was lowest in station 4 with a mean value of ($0.0015 mgl^{-1}$). Egborge (1994) in Warri River, Fufeyin, (1994) in Ikpoba River, Puyate *et al*. (2007) in Orogodo River and Olomukoro *et al*., (2009) in Ekpan creek, have reported the anthropogenic occurrence of Cd in rivers.

Microbiological Quality in Water

Fecal coliform count consist fairly high values between July and October 2010, in the stations. Highest value of 80 $MPN100ml^{-1}$ was recorded for the month of August (station 4). The monthly mean values were low when compared with Olayemi (1994) who recorded as high as 1000 MPN $100ml^{-1}$ in River Asa.. However, the source of fecal coliform in the Rivers investigated included: cattle dung, surface run-off from open toilet systems and the poor disposal of excrement in the adjoining settlements.

In conclusion, the water quality of the two rivers was rated to be good particularly at stations 2 and 4 respectively as revealed by Water Quality Index computation. All the chemical characteristics with the exception of Zinc and the bacteriological values obtained were within the stipulated limit by Federal Ministry of Environment Guide Line for surface water. This must be sustained and the human impact should be checked particularly nomadic farming, bathing and washing into the Rivers directly.

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