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Seasonal and Spatial Variations in Physico-Chemical Water Quality of Osun River, Southwest Nigeria at some of its Natural Points

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Abstract- This study was carried out at six selected sampling stations over the three reaches of Osun River along its main axis to determine seasonal and spatial variations in the general physico-chemical water quality parameters of the river water. From each sampling station, surface water samples were collected bi-monthly for an annual cycle, the samples were treated and analyzed for physico-chemical water quality parameters using applicable standard procedures. The river showed an increasing clarity from its headwaters to the lower reach with regard to mean transparency, turbidity and colour and was also clearer in the dry season than in the rainy season. The water was generally moderately alkaline (pH: 7.41±0.11 - 7.61±0.16) but significantly (P≤0.05) more alkaline in the dry season than in the rainy season. It can be classified as a dilute salt bicarbonate freshwater with mean conductivity at the three reaches ranging from 128.92±1016µS/cm to 141.79±27.29µS/cm. Ca^{2+} and HCO_3^- were the dominant cation and anion respectively in all stations investigated and in both seasons. The mean values of most parameters determined were within permissible limits making the river water suitable for most probable domestic and industrial uses and livestock support.

Keywords: anion, cation, Osun, physico-chemical, seasonal, spatial

1.0 Introduction

Osun River is a major component of the drainage networks of southwestern Nigeria and one of the two river networks in the region, the Ogun-Osun River Basin. Its headwaters and those of its major tributaries rise from the central highlands of the region and drain most of the composite states (Oyo, Osun, Ekiti and Ogun States) before emptying into Lekki Lagoon close to Epe in Lagos State. The river drainage network covers a total area of about 9,000 square kilometers and through a distance of about 270Km along its main course. Some basic geo-climatic information on the major towns within the drainage basin of the river is presented in Table 1. It is expected that the socio-economic activities of the river's riparian dwellers and its water quality status are intricately linked.

The many impoundments constructed along the main course of the river provide municipal potable water supply to the people of the region and also serve a secondary purpose of fish farming (Ayodele and Adeniyi, 2006). The quality and the quantity of the river water may determine how well it is able to sustain its application for these services as well as the diversity and richness of its freshwater biota. This study was carried out to determine the general status of the physical and chemical water quality parameters of the river from its headwaters to the lower reach before discharge into the sea.

Biological processes and a number of anthropogenic activities influence river water both in quantity and quality with parameters of physical and chemical qualities being mostly impacted by human activities. The physical and chemical characteristics of water bodies affect the species composition, abundance, productivity and physiological condition of aquatic organisms (Bagenal, 1978). Therefore, the determination of physical and chemical characteristics of water in an aquatic ecosystem is an important tool not only in the characterization of the system but also in assessing the recharge capacity and sustainable use of its living resources (Carvalho *et.al.* 2010). A number of earlier studies on Osun River have shown that this may be applicable to the river especially with regard to the many artificial impoundments scattered along the river course. Olajire and Imeokparia (2001) in a study of the river water at locations within Osogbo metropolis (the capital of Osun State of Nigeria) observed that the sources of pollution to the water are mainly from agricultural land use, anthropogenic activities and industrialization. Ogunfowokan *et.al.* (2011) in a study on three artificial lakes within the Osun River basin reported that values of temperature, electrical conductivity and Biological Oxygen Demand were within safe limits for drinking and aquatic life survival while concentrations of nutrient parameters showed incipient signs of eutrophication. Similarly, Ayodele and Adeniyi (2006) observed that some six major impoundments on the river showed high degree of similarity both in zooplankton fauna composition and in water quality. It is therefore considered worthwhile to know the physico-chemical status of the river along its main axis from the source to its mouth over the two seasons of the year.

2.0 Materials and Methods

Seven locations along the main axis of Osun River were established as sampling stations in this study. These stations were selected to represent climatic sub zonation of the river basin and the different reaches of the river (upper, middle and lower reaches) as it flows from its source to near discharge into the lagoon. Rivers Oba in Ogbomosho and Otin in Ikirun represent the upper reach of the river while Rivers Oba in Iwo, Erinle in Ede and Osun in Asejire represent the middle reach and Rivers Osun in Ijebu Igbo and Ijebu Ode represent the lower reach. Table 1 presents a brief description of the climatic seasons of some major towns within the catchment basin of River Osun. The grid co-ordinates of the seven sampling stations obtained using a Global Positioning System (GPS) handset is presented in Table 2. Fig. 1 shows the selected sampling stations as well as the major towns within the river basin.

Field surveys were conducted bi-monthly for a period of one annual cycle from November 2010 to November 2011, covering both dry and rainy seasons. Dry season sampling was conducted four times: November 2010 (early dry season), January2011 (mid dry season), March 2011 (late dry season) and November 2011 (early dry season). Rainy season sampling was conducted three times viz: May 2011 (early rainy season),

Table 1: Location description and climate of some major towns within River Osun catchment Basin

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Town	State	Co-ordinate*		Altitude amsl (m)	Climate pattern	
		Latitude (N)	Longitude (E)		Rainy Season	Dry Season
Ogbomosho	Oyo	08^{o}07'	004^{o} 15'	351	May-Oct	Dec-March
Osogbo	Osun	07^{o} 47	004^{o} 29'	274	May-Oct	Dec-March
Iwo	Osun	07^{o} 38	004^{o} 12'	244	May-Oct	Dec-Feb
Ibadan	Oyo	07^{o} 26	003^{o} 54'	227	April-Oct	Dec-Feb
Ijebu-Ode	Ogun	06^{o} 49	003^{o} 56'	61	April-Oct	Jan-Feb
Epe	Lagos	06^{o} 35	003^{o} 59'	6	March-Oct	Jan-Feb

Source: Papadakis, 1965 * = based on meteorological station location amsl = above mean sea level

July 2011 (mid rainy season) and September 2011 (late rainy season). At each of the sampling stations, water samples were collected from just below the river surface using clean, properly rinsed 5-liter capacity plastic bottle containers. The storage and treatment of samples were done according to Ademoroti (1996) and APHA (1995).

Hand held portable meters were used to measure water pH and electrical conductivity (Jenway 4071 conductivity meter) at sampling stations while water transparency was measured using a secchi disc. Samples were analyzed for colour, turbidity, sulphate and nitrate using applicable standard colorimeter methods (APHA 1995, Golterman *et al.*, 1978) while the concentrations of chloride ion, organic matter, alkalinity, acidity, calcium ion

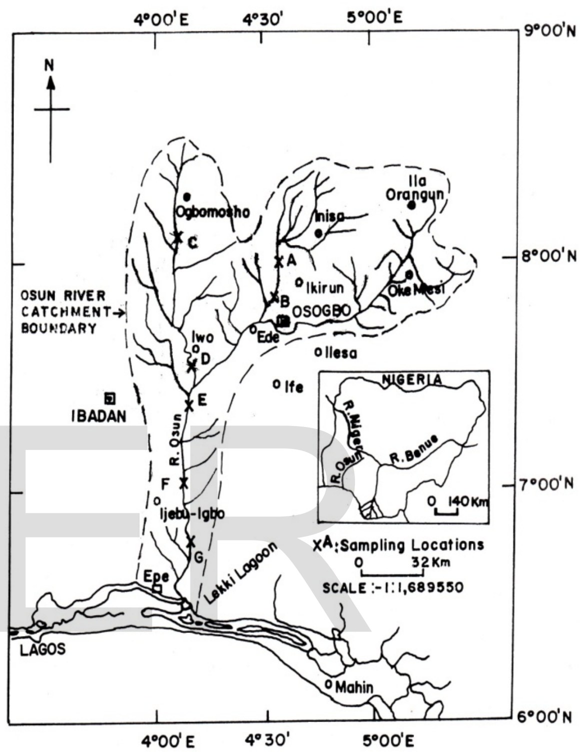

Figure 1: Map of Osun River Basin showing the sampling locations along the axis of the river

Table 2: Location grid co-ordinates and description of selected sampling stations

Ref Code	River	Sampling station	Longitude(E)	Latitude(N)	Elevation amsl (m)	River Order	*Depth (m)	Reach
A	R. Otin	Ikirun, Osun State	004^{0}32'08.6"	07^{0}59'58.9"	331±14	3	0.47	Upper
B	R. Erinle	Ede, Osun State	004^{0}27'15.8"	07^{0}45'24.8"	282±5	3	0.6	Middle
C	R. Oba	Ogbomosho, Oyo State	004^{0}08'35.4"	08^{0}02'50.5"	302±12	2	0.85	Upper
D	R. Oba	Iwo, Osun State	004^{0}07'42.6"	07^{0}39'41.8"	218±11	3	1.17	Middle
E	R. Osun	Asejire, Osun/Oyo State	004^{0}07'55.3"	07^{0}21'27.1"	154±14	4	0.43	Middle
F	R. Osun	Ijebu-Igbo, Ogun State	004^{0}04'38.3"	07^{0}02'31.3"	78±9	4	0.54	Lower
G	R.	Ijebu-Ode,	004^{0}07'25.2"	06^{0}45'37.7"	22±13	4	1.03	Lower

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Osun	Ogun State

*measurements taken at sampling points

and magnesium ion were determined using applicable standard volumetric analysis (Golterman *et al.*, 1978). Samples for Dissolved Oxygen (DO) and five-day Biochemical Oxygen Demand (BOD_5) were collected in oxygen bottles (250ml reagent bottles). Dissolved Oxygen samples were fixed on the field immediately on collection with Winkler's reagents comprising manganous sulphate (solution A) and alkaline iodide (solution B). BOD_5 samples were collected in black reagent bottles and kept in dark cupboard at room temperature (28 ± 3^0C) for 5days after which they were treated for dissolved oxygen determinations. The values of DO and BOD (after five days of incubation in the dark) were determined in the laboratory using the standard method described by Golterman *et al.* (1978). Sodium and potassium ions were determined using flame emission spectrophotometer (Flame Analyzer). The error of ionic balance in analysis of the major ions was estimated based on the agreement between the sum of major anions (HCO_3^-, SO_4^{2-} and Cl_-) and the sum of the major cations (Ca^{2+}, Mg^{2+}, Na^+ and K^+), expressed in % milliequivalent per litre. The data obtained were subjected to descriptive statistics, ANOVA and cluster analysis, as applicable.

3.0 Results and discussion

The data obtained on the investigated physico-chemical water quality parameters of Osun River are given in Tables 3, 4 and 5. Transparency, turbidity and colour are parameters of under-water light conditions which can serve as indicators of pollution resulting from some dissolved materials and suspended particles in the water column. These parameters also determine the extent of light penetration and affect the vision and visibility of aquatic organisms. The mean values of most of these parameters showed significant spatial variation characterized by decreasing turbidity and colour hue down the water course as shown in Table 3. While turbidity decreased significantly ($P\leq0.001$) down the course of the river, the mean values of apparent colour ($P\leq0.01$) and true colour ($P\leq0.05$) significantly decreased from the upper reach to the lower reach of the river. Though not statistically significant ($P>0.05$), the mean value of transparency increased down the course of the river. These variations indicate increased water clarity down the course of the river probably due to sedimentation of both organic and inorganic materials as the water travels along its course from the erosion zone in the upper reach to the deposition zone in the lower reach. There is no statistical significance in the seasonal variation (Table 4) of these physical parameters; however, the mean values of transparency in the three reaches of the river were higher in dry season than in rainy season. On the other hand, the mean values of turbidity, apparent colour and true colour were higher in the rainy season than in the dry season of the study period. These variations are indicative of clearer water in the dry season than in the rainy season. The influx of inorganic and dead organic materials from over land run-off might have been responsible for decreased water clarity observed in the rainy season

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Table 3: Spatial variation in investigated physico-chemical water quality parameters of Osun River

Parameter	Upper Reach (n=14)			Middle Reach (n=20)			Lower Reach (n=12)			ANOVA	
	Min	Max	Mean±S.E	Min	Max	Mean±S.E	Min	Max	Mean±S.E	F	P
Transparency (m)	0.12	0.85	0.42±0.05	0.18	0.77	0.46±0.03	0.3	0.78	0.52±0.04	1.382	0.262
Turbidity (NTU)	7.02	86.66	48.88±6.93	0.38	80.03	22.61±4.93	0.38	46.84	16.14±4.27	8.779	6.35E-4
Apparent Colour (Pt-Co)	142.19	1062.18	658.51±84.82	43.61	1029.32	337.69±61.12	76.47	733.61	290.04±59.23	7.639	1.45E-3
True Colour (Pt-Co)	0	667.9	291.62±59.72	10.76	667.9	145.47±35.11	10.76	306.47	109.33±28.02	4.547	0.016
pH	6.85	8.1	7.41±0.11	6.85	8.1	7.51±0.08	6.7	8.4	7.61±0.16	0.716	0.495
Conductivity (µS/cm)	51	357	141.79±27.29	63	384	139.85±17.55	73	197	128.92±10.16	0.101	0.904
Acidity (mgCaCO$_3$/L)	10	52	21.57±3.17	8	86	18.90±3.78	10	26	15.08±1.35	0.785	0.463
Alkalinity(mgCaCO$_3$/L)	12.6	99.4	38.85±7.82	14	106.4	33.08±4.46	23.1	43.4	31.5±1.91	0.463	0.633
Total Hardness (mgCaCO$_3$/L)	16.1	117.67	43.35±8.34	23.23	112.23	39.08±4.71	30.3	50.01	37.80±1.78	0.232	0.794
DO (mg/L)	0.8	8	5.13±0.67	3	13.6	7.76±0.58	1.2	10	6.93±0.80	4.201	0.022
BOD$_5$ (mg/L)	0.4	12	3.91±0.86	0.2	14.4	3.13±0.69	0.2	5.2	3.22±0.43	0.349	0.707
Ca^{2+} (mg/L)	4.44	35.72	12.67±2.62	6.57	34.29	11.37±1.44	7.29	12.97	10.72±0.49	0.273	0.763
Mg^{2+}(mg/L)	0.34	6.92	2.85±0.65	0.34	6.49	2.60±0.34	0.78	4.29	2.68±0.32	0.082	0.921
Na^{+}(mg/L)	0.4	9.8	1.55±0.65	0.4	1.95	0.94±0.11	0.6	1.5	0.91±0.07	0.989	0.380
K^{+}(mg/L)	1.75	15.25	5.82±1.35	1.25	13.75	3.95±0.67	2.75	6.25	3.92±0.43	1.413	0.255
Cl^{-}(mg/L)	2.64	16.04	5.56±1.16	2.88	15.08	6.48±0.90	3.12	7.9	5.30±0.46	0.476	0.625
SO_4^{2-}(mg/L)	0	9.17	3.92±0.80	0	9.4	4.81±0.81	0	7.76	4.60±0.93	0.641	0.532
HCO_3^{-}(mg/L)	15.12	119.28	46.62±9.39	16.8	127.68	39.69±5.35	27.72	52.08	37.8±2.29	0.463	0.633
NO_3^{-} (mgL^{-1})	0	1.42	0.60±0.14	0	1.99	0.58±0.15	0	1.99	0.53±0.18	0.039	0.962

Table 4: Seasonal variation in investigated physico-chemical water quality parameters of Osun River

Parameter	Upper Reach		Middle Reach		Lower Reach		ANOVA	
	DS (n=8)	RS (n=6)	DS (n=12)	RS (n=8)	DS (n=8)	RS (n=4)		
	Mean±S.E	Mean±S.E	Mean±S.E	Mean±S.E	Mean±S.E	Mean±S.E	F	P
Transparency (m)	0.46±0.06	0.45±0.08	0.47±0.04	0.39±0.05	0.56±0.04	0.44±0.07	3.615	0.130
Turbidity (NTU)	35.06±9.24	57.35±10.01	16.14±4.21	39.79±10.52	10.75±2.38	26.93±10.75	3.247	0.146
Apparent Colour (Pt-Co)	491.29±114.15	744.56±112.44	262.66±54.61	552.90±136.75	199.69±28.28	470.76±136.14	5.11	0.087
True Colour (Pt-Co)	181.91±69.84	377.66±91.54	106.59±25.08	248.97±81.38	80.58±20.06	166.83±71.45	4.269	0.108
pH	7.26±0.17	7.73±0.10	7.33±0.10	7.68±0.07	7.31±0.14	8.21±0.07	11.34	0.028
Conductivity (µS/cm)	154.50±34.03	154.00±50.03	152.58±25.37	98.88±12.94	137.25±10.69	112.25±21.52	0.12	0.888
Acidity (mgCaCO$_3$/L)	27.00±4.60	15.67±2.60	21.33±6.19	14.25±1.03	16.63±1.68	12.00±1.41	0.843	0.442
Alkalinity(mgCaCO$_3$/L)	47.78±8.74	42.93±12.23	33.31±7.07	20.74±2.22	33.43±2.49	27.65±1.93	0.905	0.395
Total Hardness (mgCaCO$_3$/L)	49.78±10.74	42.51±13.17	43.28±7.22	26.99±2.70	39.54±2.23	34.33±2.34	0.396	0.677
DO (mg/L)	5.15±0.85	6.03±0.83	7.73±0.88	7.10±1.11	6.23±1.12	8.35±0.35	0.619	0.476
BOD$_5$ (mg/L)	5.10±1.33	2.77±0.71	3.07±1.10	2.90±0.62	2.58±0.43	4.50±0.57	0.041	0.849
Ca^{2+} (mg/L)	13.51±3.65	13.69±3.86	12.02±2.29	8.80±0.94	10.66±0.67	10.84±0.77	0.338	0.592
Mg^{2+}(mg/L)	3.91±0.78	2.02±0.90	3.23±0.43	1.22±0.22	3.14±0.34	1.77±0.37	26.85	6.6E-3
Na^{+}(mg/L)	0.91±0.14	2.41±1.51	1.02±0.15	0.81±0.17	0.94±0.09	0.85±0.13	0.574	0.491
K^{+}(mg/L)	5.16±1.67	4.54±1.66	4.63±1.08	4.56±1.55	3.63±0.46	4.50±0.94	0.018	0.900
Cl^{-}(mg/L)	5.46±1.40	5.69±2.11	6.64±1.24	6.24±1.34	5.31±0.53	5.28±0.99	0.018	0.901
SO_4^{2-}(mg/L)	5.08±0.54	2.35±1.58	6.25±0.64	3.11±1.53	5.14±1.00	2.53±2.04	23.55	8.32E-3
HCO_3^{-} (mg/L)	57.33±10.49	51.52±14.68	39.97±8.48	24.89±2.67	40.11±2.99	33.18±2.31	0.904	0.396
NO_3^{-} (mgL^{-1})	0.24±0.13	1.02±0.18	0.36±0.15	0.95±0.25	0.38±0.17	0.83±0.44	73.77	1.01E-3

Table 5: Concentrations (meq/L) and the Ionic Error of Balance (%) of major Cations and Anions determined

Location	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	NO_3^{-}	SO_4^{2-}	ΣC	ΣA	|ΣC - ΣA|	ΣC + ΣA	Ionic error of balance (%)

Ogbomosho	0.8753	0.2757	0.0509	0.1564	1.0509	0.2118	0.0082	0.0664	1.3583	1.3373	0.021	2.6956	0.8
Ikirun	0.3887	0.1934	0.084	0.1418	0.4782	0.1012	0.0111	0.0963	0.8079	0.6868	0.1211	1.4947	8.1
Iwo	0.5968	0.2395	0.0278	0.0942	0.7478	0.2366	0.0121	0.0971	0.9583	1.0936	0.1353	2.0466	6.6
Ede	0.3738	0.1778	0.0505	0.0732	0.4271	0.1218	0.0105	0.0992	0.6753	0.6586	0.0167	1.3339	1.3
Asejire	0.7595	0.2272	0.0448	0.1418	0.799	0.1906	0.0047	0.1044	1.1733	1.0987	0.0746	2.272	3.3
Ijebu-Igbo	0.5409	0.2206	0.0409	0.1034	0.6406	0.1523	0.009	0.0905	0.9058	0.8924	0.0134	1.7982	0.8
Ijebu-Ode	0.5289	0.2206	0.0378	0.097	0.5993	0.1464	0.0082	0.1011	0.8843	0.855	0.0293	1.7393	1.7

ΣC = sum of cations, ΣA = sum of anions

compared to the dry season. Similar observations on variations in water clarity of some other tropical water bodies were made by Adebisi (1981) in upper Ogun River, Ikom *et.al*. (2003) in River Adofi and Idowu *et.al*. (2013) in a reservoir conducted on Ireje River.

The Hydrogen ion potential (pH) values at the stations showed that the river was generally slightly alkaline with mean pH values in the three reaches ranging from 7.4 to 7.6 over the annual cycle. It increased (i.e. more alkaline) from near source to the mouth of the river (Table 3). The overall range (6.85 – 8.4) falls within the WHO permissible limits of 6.5 to 8.5 (WHO, 1984) for drinking water and also within the pH range required by most finfish and shellfish (6.5 to 8.5 [USEPA, 1994]). However, acidification of water by increased metabolism, elevated microbial degradation of organic debris and concentrated dissolved solids in warmer water might have been responsible for the river water being significantly ($P \leq 0.05$) less alkaline in the dry season than in the rainy season (Rajasegar, 2003, Tukura *et.al*., 2012) but nonetheless still within the stated limits (Table 4).

There was some sort of near spatial uniformity in the mean concentrations of chemical parameters evaluated as there was no statistical significant difference in the mean values of each of these parameters spatially. However, some patterns of variation worthy of note can be observed in the mean concentrations of these parameters as the river water flows from the upper reach to the lower reach of the basin. Conductivity is a measure of the ability of water to conduct electric current and it is sensitive to variations in the concentration of dissolved solids, mostly mineral salts. The degree of dissociation of these solids into ions, the valency of each ion, ion mobility and water temperature all have influence on conductivity. Run-off from agricultural land is suspected to be chief contribution to solids and dissolved ions in this river. However, it was observed that the upper reach and the middle reach of the river have more riparian and commercial/industrial presence in comparison to the lower portion of the basin. Contributions from domestic waste and industrial discharge in addition to input from agricultural run-off may have been responsible for higher conductivity values at the upper and the middle reach than at the lower reach (Table 3). The dry season values of conductivity were however observed to be higher than rainy season values in the stations investigated. Increased fetch and solar radiation both combine to increase the rate/amount of evapo-transpiration during dry season resulting into increased concentration of dissolved ions in water, higher water temperature in the dry season would also raise dissociation of solids and as well enhance ion mobility in water. All these combine to make conductivity values in dry season higher than in wet season. Though there is no specific set standard conductivity values for most water uses, overall, the range of conductivity values observed (51µS/cm to 384µS/cm) in this study is within the limit expected (20µS/cm to 2000µS/cm [USEPA, 1994]) of a freshwater.

The range of the mean values of total hardness (37.80±1.78mg$CaCO_3$/L to 43.35±8.34mg$CaCO_3$/L) in the three reaches of the river showed that the water is generally soft and its hardness decreased down the course of the river as shown in Table 3. The dry season values were also higher than the rainy season values. Both seasonal and spatial variations in the values of other salinity parameters (acidity, alkalinity) followed the same trend shown in conductivity and total hardness. However, the range of the mean value of alkalinity in the three reaches of River Osun as observed during this study was 31.5±1.91mg/L to 38.85±7.82mg/L which is within the desirable limit.

Dissolved Oxygen (DO) concentration along Osun River showed highly significant ($P \leq 0.01$) increase from the upper reach to the lower reach although the middle reach of the river recorded the highest mean value of oxygen concentration. This is probably due to the fact that two (Asejire and Ede) out of the three stations in the middle reach lack wood cover while the third station (Iwo) was only thinly/sparsely covered. The available fetch would increase wind action for mixing and thereby increases the concentration of dissolved oxygen in the water. Rainy season mean value of DO was higher than dry season mean value; reduced temperature in the rainy season resulting in increased solubility as well as increase in aeration due to rainfall and runoff could have been responsible. Similar observations were made by Ayodele & Adeniyi (2006) on the six impoundments on River Oshun. It is however different from the observations of Tukura *et.al*. (2012) in Mada River located in a semi-arid region of Nigeria where deoxygenation rate due to biological decomposition is expectedly higher than oxygenation from atmosphere. The range of DO observed in the three reaches of the river (≈5.0 to ≈8.0 mg/L) would however be good for the production and survival of a large spectrum of aquatic biota (Stickney, 2000). The mean value of BOD_5 decreased from upper reach to lower reach. The flow rate of a river increases along its course towards its discharge; fewer organisms are adapted to high current thereby reducing the biological oxygen demand from the upper reach to the lower reach. Dry season mean values of BOD_5 were higher than rainy season mean values in two (upper and middle) out of the three reaches of the river. This is probably due to the fact that increased water temperature in the dry season would increase biological activities such as decomposition and respiration.

Cationic hierarchy (i.e. $Ca^{2+}>Mg^{2+}>K^{+}>Na^{+}$) expressed in milliequivalent per liter ($meqL^{-}$) (Table 5) is the same for all the stations investigated suggesting a similar/common geology and/or similar weathering influence within the river basin. Calcium and magnesium ions (in that order) are the dominant cations in the river water having higher concentrations than other cations. This is probably responsible for the alkaline nature of the water since calcium and magnesium combine with carbonate and bicarbonate ions in water to raise alkalinity. In the same vein, the uniform anionic hierarchy ($HCO_3^- > Cl^- > SO_4^{2-}$) shows that the water is of the bicarbonate type with the concentrations of bicarbonate ion being highest in all stations investigated.

Fig. 2 and Fig. 3 show the relationships among the investigated stations with respect to the determined parameters of water quality. The clustering of the stations particularly in the rainy season (Fig. 3) shows the flow pattern/direction as well as the regionalization of the river system. Because the mass of the river water at a station virtually flows into the next station in the same reach/region, there is a great deal of uniformity in the physico-chemical conditions of the stations concerned. For instance, the stations at Ijebu-Igbo and Ijebu-Ode, forming a cluster, are both in the lower reach of the river. Stations at Ede and Asejire, also forming a cluster, are both in the middle reach of the river. From the map of the river catchment basin in Fig. 1, it is evident that River Oba in Ogbomosho flows into the station at Iwo (also called R. Oba) before joining to the flow from the Ikirun axis of the river source.

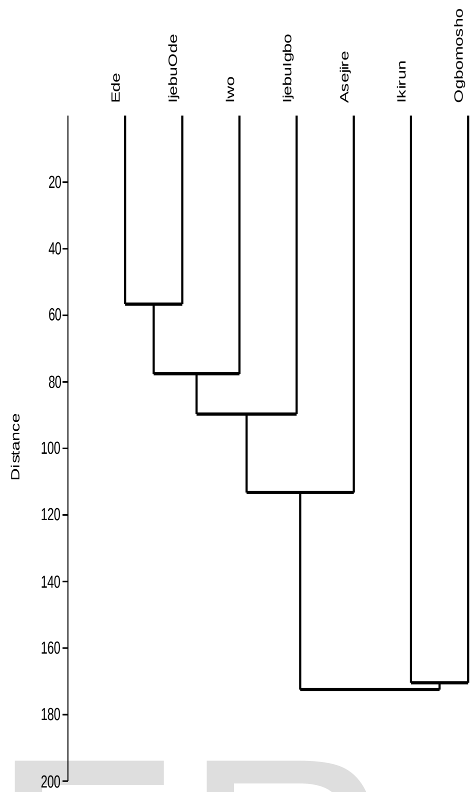

Figure 2: Relationship among sampling locations based on water quality parameters in dry season

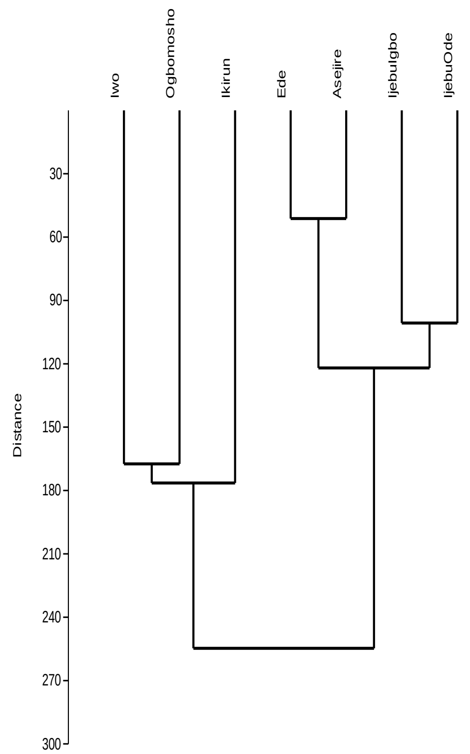

Figure 3: Relationship among sampling locations based on water quality parameters in wet season

4.0 Conclusion

This study has shown that River Osun is generally moderately alkaline, soft, fairly clean, dilute bicarbonate freshwater suitable for most probable domestic and industrial uses. The river water, if properly harnessed can serve a good proportion of the population of southwest Nigeria with municipal water supply and aquatic livestock. There is however, the need for continuous monitoring and assessment as the whole area of the river basin becomes progressively industrialized and populated.

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