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Assessment of the Impact of Anthropogenic Activities on Quality of Aba River, Abia State, Nigeria

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Abstract- The Aba River in Abia State Nigeria was investigated to determine the impact of anthropogenic activities. Water samples from the river were collected from seven sampling locations (A, B, C, D, E, F and G) for a period of three months during the rainy season between May and July, 2018. Sampling location A was the upstream and served as the control while sampling location G was the downstream. Water samples were collected from 4-6cm below the water surface by grab sampling method using sterile disposable hand gloves. Sterile Durham bottles were used for storage of samples used for bacteriological analysis. *In Situ* measurements were carried out on temperature, pH, electrical conductivity, dissolve oxygen (DO) and total dissolve solids. Descriptive analysis, Variation plots and principal component analysis (PCA) were used to analyze data. Results obtained show that some parameters such as temperature (25.83), pH (5.76), turbidity (31.97NTU), colour (43.80PCU), oil and grease (0.05mg/l), nitrate (50.37mg/l), magnesium (3.96mg/l), phosphates (8.08mg/l), faecal coliform ($4.3x10^2$cfu/ml), total heterotrophic bacteria count ($3.2x10^4$cfu/ml), and total coliform count ($1.8x10^4$cfu/ml), exceeded the maximum permissible limits of both NESREA (2011) and WHO (2010) limits for water quality. There were significant spatial differences in levels of total suspended solids (TSS), total solids (TS), electrical conductivity (EC), and total heterotrophic bacteria count between the control and other locations at $p<0.05$. Parameters that contributed most to variability in water quality include pH, temperature, total solids, electrical conductivity, and colour. Proper treatment of industrial and domestic effluents before discharge into the river should be carried out, coupled with regular monitoring to prevent excessive building of pollutants in the water body.

Keywords- *Aba, River, Water Quality, Upstream, Downstream, Parameters*

I. INTRODUCTION

Water is vital to the existence of all living organisms, but this valued resource is increasingly being threatened as human populations grow and demand more water of high quality for domestic purposes and economic activities. The quality of any body of surface or ground water is a function of either or both natural influences and human activities. However, increasing human population, industrialization and intensive agricultural practice, and discharge of waste water into rivers and other surface water bodies have resulted in deterioration of water quality (Balogun, Sojobi and Galkaye, 2017).

Rivers are the most important freshwater resource for man. Unfortunately, river waters are being polluted by indiscriminate disposal of sewage, industrial waste and plethora of human activities, which affects their physio-chemical characteristics and microbiological quality. Pollution of the aquatic environment is a serious and growing problem. Increasing numbers and amounts of industrial, agricultural and commercial chemicals discharged into the aquatic environment have led to various deleterious effects on aquatic organisms. Aquatic organisms, including fish, accumulate pollutants directly from contaminated water and indirectly via the food chain. The consumption of water from these rivers has led to high prevalence of water borne diseases such as cholera, diarrhea, hepatitis, dysentery, etc. among Nigerians (Oguntoke *et al.*, 2009; Raji and Ibrahim, 2011). The extent of discharge of domestic and industrial effluents is such that rivers receiving untreated effluent cannot provide the dilution necessary for their survival as good quality water sources. The transfer of unfavorable releases from industries is detrimental to human and animal health and safety. Disposal of sewage wastes into a large volume of water could increase the biological oxygen demands to such a high level that all the available oxygen may be removed, consequently causing the death of all aerobic species, e.g., fish.

Contamination of surface waters represents a growing environmental health challenge in several regions around the globe (Debela and Muhye, 2017). Uting *et al* (2007) noted that surface water pollution is a major environmental problem in many developing countries and that it is mainly due to human activities resulting from rapid population growth and increased productive activities. One of such human activities that currently threaten the quality of stream waters is the age-old practice of dumping wastes into or along stream channels.

Water quality is of influential and significant importance because of its role to human health, aquatic life, ecological integrity and sustainable economic growth (Vishnupriya *et al.*, 2015).

Rivers play major roles to the community especially in the fishing industry and a source of water supply for people residing within the vicinity of the area. River contamination either directly or indirectly will affect humans as a final consumer. Although some of heavy metals are required as micronutrients, it can be toxic when present higher than the minimum requirements (Ahmad *et al*., 2009).

As water is one of the most important compounds of the ecosystem, but due to increased human population, industrialization, use of fertilizers in the agriculture and man-made activity. The natural aquatic resources are causing heavy and varied pollution in aquatic environment leading to pollute water quality and depletion of aquatic biota (Basavaraja *et al*., 2011). In Nigeria, contamination of surface water sources is a major environmental issue that attracts a lot of interest because of the importance of water quality on human health and on environmental quality (Obeta and Ajaero, 2010). Pollution of surface water sources occur in both urban and rural areas (Ikem, *et al* , 2000). Leachate and other pollutants from waste dumps migrate into surface waters and pollute them. In the rural areas, water scarcity and poor quality of drinking water from natural sources such as rivers and streams are major challenges facing the inhabitants of most communities (Bichi, 2000).The problem is even more acute in communities that lack access to piped water supplies and so must depend on wells and steam water. The health of the people depends largely on the quality of the water they drink and so water contamination is a serious concern to water authorities because of the health implications (Egbinola, 2017).

Historically, Aba River takes its source from Okpu-Umuobu town, few kilometers away from Aba town. It is used for domestic, agricultural and industrial purposes. Due to the poor sanitation habit of the populace and non-enforcement of sanitation laws by government on offenders, the banks of the river are used for various human activities which may affect the quality of the river. Industries and laundry services located downstream near the river channel discharged their untreated effluent into the river without any apology and these unhealthy practices have the tendency of deteriorating the quality of the river, hence the need for an water quality assessment of Aba River since it receive wastes on a daily bases due to urbanization and industrialization.

II. MATERIALS AND METHOD

Aba River is a tributary of Imo River and is the only river that passes through Aba town. It is situated between Latitudes $5^0 7^1$N and Longitudes $7^0 22^1$E (Njoku *et al.,* 2013) and is characterized by relatively low elevation and near flat topography which enhances its runoff. The river originates from the northern Ngwa hinterland of Aba and stretches down to Cross River State where it empties into the Atlantic Ocean (Ezereonye and Ubalua, 2005). The river is recharged by natural precipitation and groundwater**.**

The study area falls within the humid tropical rainforest region. The rainfall regime is bimodal and peaks between July and September with a little break known as August Break in between. The annual mean rainfall of Abia State is between 2550mm and 2990mm. According to Ijeoma and Chika (2014), Aba has an estimated population of 750,972 (NPC, 2006) with an area of about 6,320km^2.

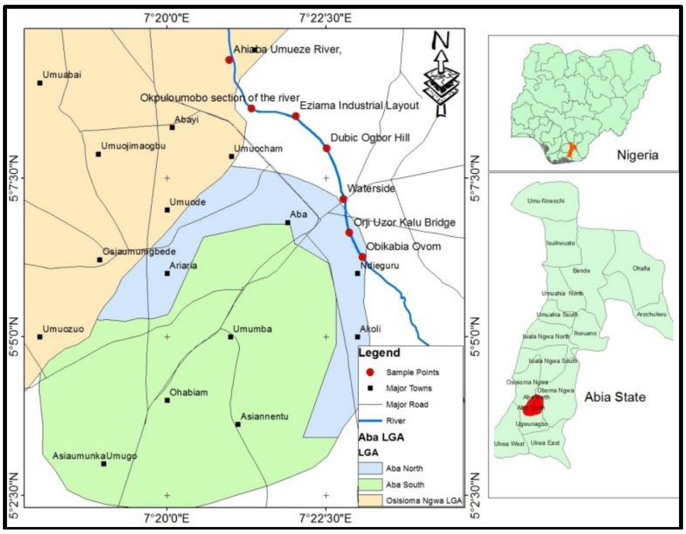

Figure 1. Map of the study area showing sampling locations along Aba River

A. *Sample collections*

This study is an experimental research design. The research was conducted in two phases: field sampling and laboratory analysis. Samples of the river were systematically collected for a period of three months May to July 2018, at seven sampling locations. One sample was collected at a time from each of the seven sampling locations. One of the locations was the upstream of the river which served as the control point while five locations had various activities taking place within its course and the last served as the downstream of the river. Water samples were collected from the seven sampling locations. Samples of Biological Oxygen Demand (BOD) were collected in 250mls bottle. Water samples for trace metals concentration were collected in 250mls plastic bottle and fixed with conc. HNO_3 while those for Oil and Grease O&G were fixed with conc. H_2SO_4. Water samples for other parameters were collected in 500mls sterile plastic containers. The bottles containing the samples were secured and labeled, stating source, date and time of collection. A GPS was used to take the coordinates of the various sampling points and snap shots of photographs were also taken in the field. Water samples were taken to the laboratory as soon as possible to maintain their integrity.

B. *Determination of water quality parameters*

Surface water temperature, conductivity, pH, dissolved oxygen (DO), and Total Dissolved Solids (TDS) were determined electrometrically. Other parameters were analyzed according to standard procedures specified by American Public Health Association (APHA 1995).

III. STATISTICAL ANALYSIS

Both bivariate and multivariate analyses as provided by the SPSS v.22.0 and MS Excel Version 2010 were utilized in the analyses of data. Descriptive statistics were used to explore minimum and maximum values as well as ranges, means and

Standard Errors of the data set. Variation plots were used to represent mean values of the physical, chemical and biological attributes of the river.

IV. RESULTS AND DISCUSSION

The results of the quality parameters of the Aba River obtained during the sampling period are presented in Table 1. Temperature, pH and colour varied from 25.0 to 26.40 (25.83±0.09)^{0}C, 5.24 – 6.11 (5.76±0.06) and 10 -90 (43.80±5.94) PCU respectively. Total solids varied between 43.00 and 755.50 (324.54±61.04)mg/l, Electrical conductivity varied between 10.0 and 350.0(131.43±25.25) µS/cm, Total Hardness varied between 13.20 and 58.54(32.62±2.90) mg/l, while Total Dissolved Solids varied between 6.50 and 227.50 (85.44±16.41)mg/l.

The minimum and maximum values of TSS, O&G and Dissolved Oxygen (DO) as presented in Table 1 were 13.50 and 547.50 (227.14± 42.56)mg/l,0.00 and 0.10(0.01± 0.01)mg/l and 2.00 and 5.62 (4.14± 0.22)mg/l respectively. Biological Oxygen Demand (BOD) ranged from 0.80 to 3.29 (2.30±0.16)mg/l, Chemical Oxygen Demand (COD) ranged from 1.28 to 5.26(3.68±0.26)mg/l, while Turbidity ranged from 7.48 to 70.50(31.97±4.39) NTU.

Chloride (Cl$^-$), Nitrate ions (NO$^-_3$) and Ammonia (NH$_3$) varied between 15.40 and 233.93(108.79±12.53)mg/l,15.90 and 108.60(50.37±5.47)mg/l, 0.02 and 0.33(0.20±0.5) mg/l respectively while PO$^{4-}_3$ varied between 4.00 and 11.60(8.08±0.59) mg/l.

For the heavy metals, Iron, Magnesium and Zinc ranged from 0.03 and 0.23(0.13±0.01)mg/l, 0.20 and 11.27(3.96±0.60) mg/l, 0.00 and 0.29(0.08±0.02) mg/l respectively, while Copper, Manganese and Calcium varied between 0.00 and 0.32 (0.15±0.02)mg/l, 0.00 and 0.30 (0.03±0.02)mg/l,2.00 and 6.04 (4.16±0.23)mg/l. Faecal Coliforms Count varied between 230.0 and 820.0 (425.29±33.58)

TABLE I. DESCRIPTIVE STATISTICS OF THE QUALITY PARAMETERS OF ABA RIVER

Parameters	Minimum	Maximum	Range	Mean	SE	NESREA (2011)	WHO (2010)
pH	5.24	6.11	.87	5.76 *	.06	6.5-8.5	6.5-8.5
Temp(^{o}C)	25.00	26.40	1.40	25.83*	.09	-	10-15
TDS(mg/l)	6.50	227.50	221.00	85.44	16.41	500	<1000
EC(µS/cm)	10.00	350.00	340.00	131.43	25.25	-	300
TS(mg/l)	43.00	755.50	712.50	324.54	61.04	-	500
TSS(mg/l)	13.50	547.50	534.00	227.14	42.56	-	500
Turbidity(NTU)	7.48	70.50	63.02	31.97*	4.39	10	
Colour(PCU)	10.00	90.00	80.00	43.80*	5.94	10	-
O&G(mg/l)	.00	.10	.10	0.05*	.01	0.01	-
DO(mg/l)	2.00	5.62	3.62	4.14	.22	≥6	6
BOD5(mg/l)	.80	3.29	2.49	2.30	.16	≤3.00	
COD(mg/l)	1.28	5.26	3.98	3.68	.26	30.0	-
Cl(mg/l)	15.40	233.93	218.53	108.79	12.53	300.0	
TH(mg/l)	13.20	58.54	45.34	32.62	2.90	-	300
NO$_3$(mg/l)	15.90	108.60	92.70	50.37*	5.47	50.0	45.0
PO$^3_4$(mg/l)	4.00	11.60	7.60	8.08*	.59	3.5	-
NH$_3$(mg/l)	.02	.33	.31	0.20	.02	0.5	<1.50
Ca(mg/l)	2.00	6.04	4.04	4.16	.23		75.00
Mg(mg/l)	.20	11.27	11.07	3.96*	.60	0.2	0.2
Cu(mg/l)	0.00	.32	.32	0.15	.02	1.00	1.00
Mn (mg/l)	0.00	.30	.30	0.03	.02	-	0.05
Fe(mg/l)	.03	.23	.20	0.13	.01	0.30	0.30
Zn(mg/l)	0.00	.29	.29	0.08	.02	-	5.0
Faecal Coliform_(cfu/ml)	2.3x10^2	8.2x10^2	5.9x10^2	4.3x10$^{2\,*}$	3.4x10	0	0
THC_(cfu/ml)	0.9x10^4	5.1x10^4	4.2x10^4	3.2x10$^{4\,*}$	2.7x10^3	N/A	10
Total Coliform Count_(cfu/ml)	0.5x10^4	2.8x10^4	2.3x10^4	1.8x10$^{4\,*}$	1.7x10^3	N/A	10

SE = Standard Error, TH= Total Hardness, EC=Electrical Conductivity, TS= Total Solids, TDS= Total Dissolved Solids, TSS= Total Suspended Solids, O&G=Oil and Grease, DO= Dissolved Oxygen, BOD= Biological Oxygen Demand, COD=Chemical Oxygen Demand, THC=Total Heterotrophic Count

A. *Spatial Variation*

There were spatial variations in the levels of the water quality parameters measured during the sampling period. Mean values of temperature (25.30^0C), color (16.67PCU), TH (15.06mg/l), NO_3 (20.50mg/l) were recorded in Sampling Location (SLA) and lowest across the sampling locations. Sampling location (SLD) recorded highest mean value of NO_3 (91.3mg/l), turbidity (55.81NTU) and colour (670PCU) Fig 2.

Fig. 3 shows mean values of TS (543.3mg/l), TSS (387.3mg/l), TDS (156.06mg/l) and EC (240.00(μS/cm) were highest at sample location (SLE). SLC recorded highest mean value of chloride (219.81mg/l). EC (31.67(μS/cm), TS (61.77mg/l), TSS (41.67mg/l), TDS (20.6mg/l) and Chloride (66.99mg/l) recorded mean lowest values at sampling location (SLA).

Fig 4 shows that at sampling location (SLA) maximum values of pH (6.06) and minimum values of Mg (1.71mg/l), BOD (1.33mg/l) and COD (2.13mg/l) were recorded. Highest mean values of Mg (7.15mg/l) were recorded at sampling location (SLE).

Mean values of NH_3 were recorded in SLA (0.1533mg/l), SLB (0.1867mg/l),SLC (0.2267mg/l), SLD (0.2233mg/l), SLE (0.2767mg/l), SLF (0.2367mg/l) and SLG (0.0933mg/l). Highest value of O&G (0.0800mg/l) was recorded in SLD while its lowest value was in SLE (0.0207mg/l). Cu (0.2167mg/l), Fe (0.1833mg/l) and Mn (0.1967mg/l) had highest values in SLs D, F and G respectively (Fig. 5).

Fig. 6 had mean values of TCC ($2×10^4$cfu/ml) and ($4.6×10^4$cfu/ml) recorded highest in SLC. Faecal Coliform recorded maximum value in SLE ($6.4×10^2$cfu/ml) and minimum value in SLA ($3.0×10^2$cfu/ml).

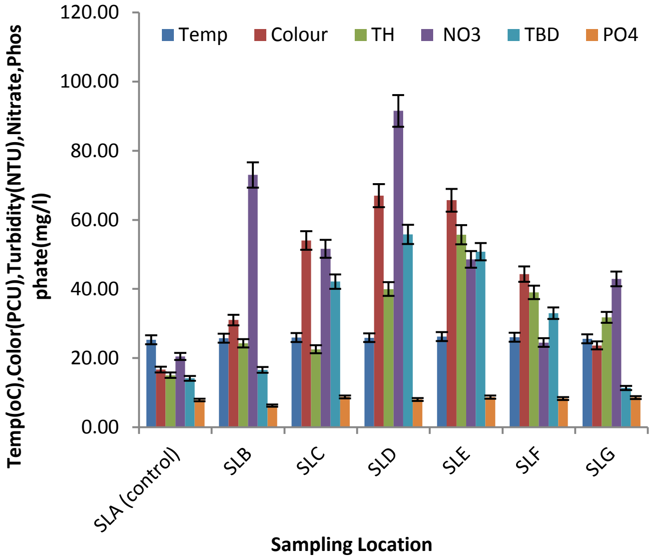

Figure 2. Spatial Variation in mean of Temperature, Color,Total Hardness,Nitrate,Turbidity and Phosphate ions concentration in Aba River of Abia state

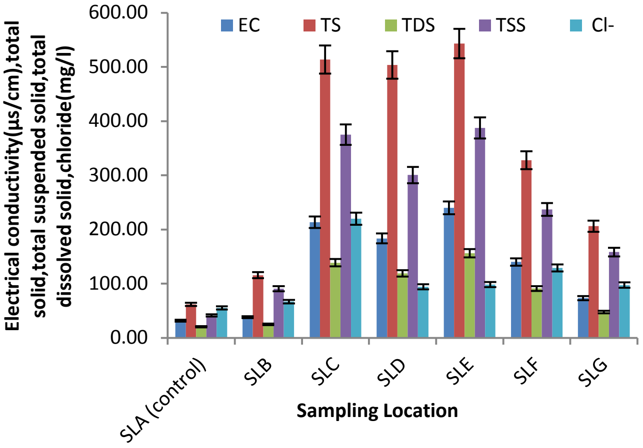

Figure 3. Spatial variation in mean of Electrical conductivity,Total solid,total suspended solid,total dissolved solid and chloride ion concentrations of Aba River in Abia state

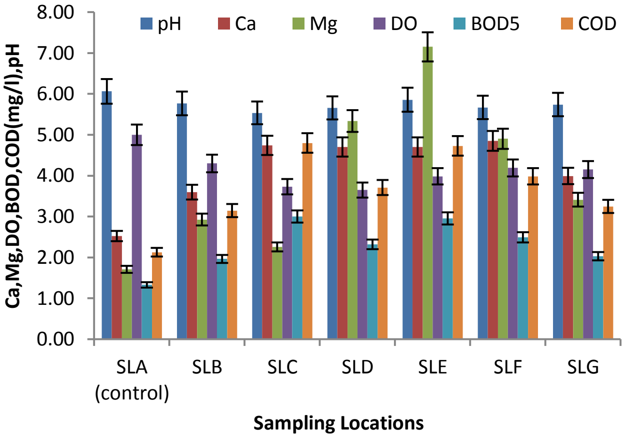

Figure 4. Spatial variations in mean pH,Calcuim,Magnesium,Dissolved Oxygen,Biological Oxygen Demand,Chemical Oxygen Demand ion concentrations of Aba River in Abia State.

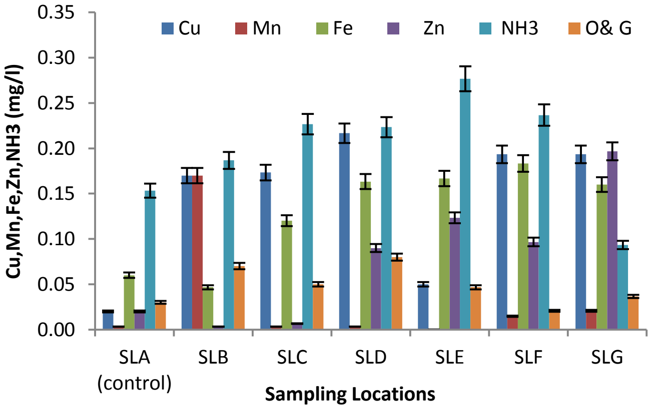

Figure 5. Spatial variations in mean Copper, Manganese, Fe, Zn,Ammonia and Oil and grease ion concentrations of the Aba River in Abia state

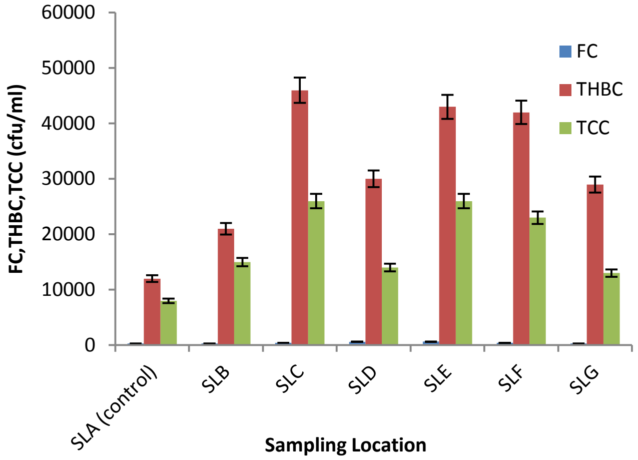

Figure 6. Spatial variation in mean of Faecal coliform, Total heterotrophic bacteria count and Total coliform count concentrations of Aba River in Abia state

B. *Principal Component Analysis (PCA)*

The water Quality parameters measured during the study period was subjected to the PCA analysis to investigate the parameters that contributed the highest variability in the water quality. The results put together communalities that were all high in the initial and extracted columns. This indicates that the extracted components represented the variables well. The first five principal components (PCs) formed the extraction solution with a cumulative percentage variability of about 98.238% in the original variables. This reduces the complexity of the data set by using these components, with only about 1.762% loss of information.

The rotation maintained the cumulative percentage of variation explained by the extracted components; with the values more evenly spread (Table 2). The first component gave almost 45.680% to the total variability in this rotation, the second, third, fourth, and fifth components contributed 13.985%, 13.106%, 12.967%, and 12.500% respectively to the total variability

TABLE II. ROTATION SUMS OF SQUARED LOADINGS OF THE WATER QUALITY PARAMETERS

Components	Total	% of Variance	Cumulative %
1	11.877	45.680	45.680
2	3.636	13.985	59.665
3	3.408	13.106	72.771
4	3.371	12.967	85.738
5	3.250	12.500	98.238

The Screen plot represents the Eigen values of each of the components in the initial solution. The extracted components are on the steep slope, while the components on the shallow slope contributed little (1.762%) to the solution. The last big drop occurred between the 4th and 5th components (Fig 7).

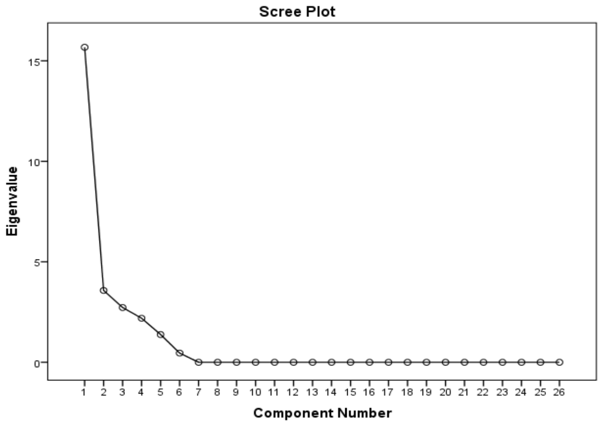

Figure 7. Scree Plot of Eigen values by component numbers of water quality parameters.

The first PC was most highly correlated with TSS concentration (0.979) and also had high positive loadings for EC (0.969), TDS (0.969), TS (0.974), COD (0.945) & BOD_5 (0.946), Ca^{2+} (0.942). PC 2 was most highly correlated positively with Oil and Grease (0.878) and also had high positive loading for Nitrate (0.872), Mn (0.705) and had negative loadings for phosphate (-0.720).

However, PC 3 was most highly correlated positively with pH (0.627), also had high positive loadings for Mg^{2+} (0.605), TH (0.526), Faecal Coliform (0.515) and correlated negatively with Cl^-(-0.714). PC 4 was most highly correlated with Zinc (0.800), also had high loadings for Cu (0.628), Fe (0.511) and negatively with NH_3 (-0.514), Nonetheless, PC 5 was most highly correlated positively with Manganese (0.546).

The Rotated component matrix showed that the water quality parameters were not evenly distributed in space. Nitrate, Oil and Grease, and Coliform appeared to be more closely related than the other parameters. The Rotated component matrix showed that the water quality parameters were not evenly distributed in space. Nitrate, Oil and Grease, and Coliform appeared to be more closely related than the other parameters (Table 3).

C. *Discussions*

The variations in the physico-chemical and biological parameters of the Aba River showed that like most Nigerian inland waters, it is influenced by external factors as well as interactions between the various facet of its hydrology and biology. The variations in time and space as regards water temperature were primarily influenced by the climatic factors and human activities. The water temperature trend showed that the values were generally higher in SL E as against the control SL A and could be attributed to the effluents of high temperature discharged from the abattoir. Related studies recorded water temperatures close to this range or slightly higher. Eni *et al.* (2014) recorded water temperature values of 25.4 to 27.2°C in Obot-Okoho Stream, Nassarawa village, Calabar, Nigeria.

TABLE III. ROTATED COMPONENT MATRIX OF THE WATER QUALITY PARAMETERS

Component Matrix^a					
	Component				
	1	2	3	4	5
Temp^{0c}	0.911				0.377
pH	-0.635	-0.342	0.627		
Colour PCU	0.933				
EC _µScm	0.969				
TS mg/l	0.974				
TDS mg/l	0.969				
TSS mg/l	0.979				
Turbidity NTU	0.889				
DO mg/l	-0.862	-0.360			
BOD_5 mg/l	0.946				
COD mg/l	0.945				
TH mg/l	0.743		0.526		0.303
OG mg/l		0.878			
Cl^- mg/l	0.618		-0.741		
Ammonia mg/l	0.757			-0.514	
Nitrate mg/l	0.312	0.872			
Mg mg/l	0.711		0.605		
Zn mg/l		-0.454		0.800	
Ca mg/l	0.942				
Cu mg/l		0.475	-0.477	0.628	
Mn mg/l	-0.413	0.705			0.546
Fe mg/l	0.751	-0.380		0.511	
Phosphate mg/l	0.568	-0.720			-0.332
FC cfu/ml	0.827		0.515		
THBC cfu/ml	0.914				
TCC cfu/ml	0.839				0.349

Extremes of pH value recorded in SL C could be attributed to a discharge of industrial effluent and combined impact of dredging activity carried out within that section of the river during the period and cumulative impact. Ohimain *et al.* (2008) and Seiyaboh *et al.* (2013) reported that dredging lowers the pH of water bodies.

The wide variations of turbidity were recorded in SL C, D, E & F as against the control and the standard of NESREA and WHO. The turbidity value recorded in these sampling Locations could be attributed to washing of cars, and rug carpets. Aikins and Boakye (2015) observed the carwash wastewater contribute to high turbidity in the receiving water body. Total solid is the sum of total suspended solids and total dissolve solids. SL E had the highest mean value and the lowest were recorded at SL A. This shows that there is minimum activity at SL A. The mean values of SL C, D and E are higher than the permissible limit of both WHO and NESREA.

The relatively higher electrical conductivity values were recorded in SL C, D E and F but highest in SL E and could be attributed to the impact of the dredging carried out in that section of the river during that period (Seiyaboh *et al.*, 2013; Rehman *et al.*, 2016); lower values were recorded in the study at SL A, B, and G. Abattoir effluent also impact on the electrical conductivity of a receiving water body (Eni *et al.*, 2014). However, the range observed in all the locations was lower as recommended by the WHO. This low levels of EC at the SL A, B and G can be attributed to the low levels of total dissolved solid (TDS) in the locations and the reverse is the case for the SL C, D, E, and F locations. This holds true as reported by (Mekonnen, Brook and Kannan, 2016) who recorded high level of EC corresponding to TDS in Omoku Creek. High concentration of conductivity and salinity in water has been reported to cause danger to both aquatic and human lives (Verla *et al.*, 2015).

TDS in the study was observed to correspond to EC. However, there was no significant difference between SL C, D, E, and F. The highest total Dissolved solids (TDS) values were recorded in SL C, D, E, F. The values of TDS followed almost the same trend in all the Sampling Locations, except SL A (control). The observed range though falls below the WHO and NESREA recommended level for TDS. This could be attributed to a cumulative impact (Obibesan and Ozabor, 2016).

The mean Total Hardness in the present study showed similar trend with EC as SLE recorded highest values. However, there was significant difference in the level of total hardness in different locations with highest values observed in the SL E as compared to other locations. The observed high levels of total hardness could be attributed to high quantity of calcium and magnesium in the water body than common salt. The observed values for the sample points were lower than WHO Standard. (Umunnakwe *et al.*, 2013) deposited that water bodies that receive discharge from homes and industries have higher values of total hardness.

Dissolved Oxygen (DO) is the amount of oxygen, dissolved in the water (Effendi *et al.*, 2015). Low Dissolved Oxygen (DO) values were recorded in all the sampling locations

Respectively and fall outside the permissible limit of both WHO and NESREA. PC 2 was most highly correlated with DO. The low DO values (<5mg/l) recorded in the locations could be attributed to cumulative impact because DO values in this study showed the same trend in all the locations. The low mean value recorded in the sampling Locations, could be attributed to abattoir effluent, industrial effluent, run off from agriculture, washing and was in line with related studies (Eni *et al.*, 2014).

The highest Biochemical Oxygen Demand (BOD) value was recorded in Sampling Locations C&E respectively. The high BOD values could be attributed to the high organic contents of industrial and abattoir effluent released in the station. Studies have shown that abattoir and industrial effluents impact seriously on BOD values of the receiving water bodies (Ubwa *et al.*, 2013).

The highest Chemical Oxygen Demand (COD) value was recorded at sampling Locations C&E respectively. Though did not exceed the NESREA limit. The trend observed in the COD values is similar to that of BOD; SL C&E generally recorded higher values throughout the study, the values recorded in this study were quite low and similar to studies of (Amah *et al.*, 2017) on the same river. But Omole and longe (2008) recorded values of 425.0 – 1675 mg/l in Illo River, Ota and Ubwa *et al.* (2013) recorded values of 444.0 – 1508 mg/l in a stream in Gboko all in Nigeria.

The highest Phosphate value was recorded in sampling location SL E. PC 3 correlated highly with the Phosphate ions. Phosphate values followed the same trend in all the locations throughout the study and could be attributed to cumulative impact (Clarke, 1994). The phosphate levels observed in the study, may have entered the river from land surrounding the river, since their levels in water reflects the influence of human activities like farming, washing, bathing on lands surrounding the water body (APHA, 2005). The values recorded in the sample locations are higher than NESREA limit. The mean phosphate values recorded in this study were generally low compared to Osibanjo and Adie (2007) that recorded higher values of 142 - 180 mg/l in Oshunkaye stream in Ibadan City, Nigeria. Phosphate is rarely found in high concentrations in freshwaters as it is actively taken up by plants. As a result there can be considerable seasonal fluctuations in concentrations in surface waters. In most natural surface waters, phosphate ranges from 0.005 to 0.020 mg/l (Chapman, 1996).

The off mean specification nitrate value were recorded in SL B, C, D & E. PC 4 correlated most highly with Nitrate ions. These values were generally higher than the SL A (control), NESREA (2011) & WHO (2011), which could be attributed the effect of abattoir effluent, runoff from agricultural farm land, industrial waste water and waste dump. Ubwa *et al.* (2013) recorded values within the range (9.30 - 68.0 mg/l) in a stream in Gboko, Nigeria.

Chloride is a widely distributed element in all types of rocks in one form or the other and is an indication that the water is of a marine source (Amadi *et al.,* 2010). Its affinity towards sodium is high and hence its concentration is high in groundwater due to geothermal gradient. Soil porosity and permeability plays a key role in building up the chloride concentration. High concentration of chloride makes water unpalatable and unfit for drinking and livestock watering. The considerable amount of mean chloride ions in the Aba River is within the specifications of NESREA and WHO. High mean values of ammonia ions were recorded in all the sample locations except SL A and G. but SL E recorded the highest value and this higher value could be attributed to run off from abattoir, agriculture, sanitary landfills, industrial waste water and waste dump. PC 6 was most highly correlated with ammonia ions.

Manganese exceeded its limit set by WHO of 0.05 mg/l only at the sampling location B. The concentrations of Manganese are enhanced by industrial waste disposal, leaching of manganese from dry cell batteries at dump sites. Manganese is known to affect the taste of water (Duru *et al.,* 2012).

All other trace metals detected in Aba River were within NESREA and WHO specification, except Magnesium ions which are higher in all the sample location than the WHO and NESREA limit. The deviations in magnesium ions could be attributed to application of fertilizer from farmlands and nearby cattle slaughter area which may find their way into the river. The mean values of calcium in all sample locations are within the permissible limit of NESREA.

Faecal coliform gave a very high mean results of the seven sampling Locations compared to the specifications of NESREA and WHO. This is due to the poultry, piggery, fish farming activities seriously going on along the Aba River. Incessant dumping of animal waste and human waste along the Aba River tributaries could be the major factor in the high result of Coliform in the River. According to Akubugwo *et al.*, 2013, Coliform bacteria of which E. Coli is a member, indicated the presence of faeces in the river water. Total viable bacteria were also high in Njaba River. The presence of faecal coliform in the studied water samples further indicated faecal contamination of the river. Nevertheless, due to the suggestive effects of anthropogenic activities in the Aba River.

V. CONCLUSION

The study has tried to determine the effect of anthropogenic activities on the water quality parameters of Aba River. Results showed that the most probable sources of water pollution are the major human activities taking place along the river banks. The constant discharge of raw industrial effluents and run-offs from abattoirs, waste dumps, farmlands, poultry, dredging, washing of rugs, car and car maintenance activities constitute the major sources of pollution of the river. This action therefore makes the River unfit for human consumption.

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