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Physicochemical Assessment of Surface Water Quality around the Sagbama Creek Water Body, Bayelsa State, Nigeria

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I. INTRODUCTION

Water is a veritable tool of natural origin which serves for useful purposes to man. The earth's surface is made up of 70% water, which include rivers, lakes, streams, seas, oceans and ground water. All these forms are very important in life cycle (Arimieari, *et al.*, 2014).

The Pollutionor adulteration of superficial waters can also be connected with the nature of water in neighbouring water bodies. The evaluation of water quality is not meant for fitness only inhumanintake or drinking, but also for other important anthropogenic activities and recreation (Arimieari *et al.*, 2014). The need to monitor the quality of water quality becomes very necessary, both as a check on its present state and also as an instrument for management and policy implementation. Total or complete evaluation or investigation of water quality involves examination of all the components of water analysis, such as; physical, chemical and biological properties of water in comparison to set standards, which may be natural or human for proposed purpose (UNESCO/WHO/UNEP, 1996).

Despite the fact that water contamination or pollution is a universal problem, yet the nature of contamination of pollution differs, depending on the developmental stage of the area under investigation. Areas or countries with a fast growing population which do not have proper waste managerial practice or system are more likely to produce wastes which constitute pollution to the environment than those countries with slower population growth rate, that also practice proper waste management control (WHO, 2003).

The characteristic changes that is associated with the river system in the Niger Delta region of Nigeria, presently is worrisome. These changes is associated with different forms of pollution or contamination of the surface water, which serves for drinking and other purposes for the people. The discovery of oil in the region has led to increased population and pollution of the area as a result of both legal and illegal industrial activities (Adesuyi *et al.*, 2015).Therefore, this study was undertaken to investigate the physicochemical properties of surface water around the Sagbama Creek.

II. MATERIALS AND METHODS

Water samples were collected from the sides of the stretch covering Bolou-rua to the Ebeni/Amasoma Bridge in Sagbama Local Government Area of Bayelsa State. Based on the topography and uniformity in the landscape, five sampling stations were made based on the traversed communities through which the road network passes. This could also mean some anthropogenic inputs from inhabitants may affect some of the water quality parameters. The simple random sampling technique was applied to create the sampling points and control. The Bolou-rua and Toru-orua samples were controlled using ground water samples whereas the Kalabiama, Amatolu, and Ebeni were controlled by the use of the adjoining river known as Sagbama Creek. Samples of water were collected from

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each station (five stations) excluding the control hence three from each and labeled accordingly.

The following parameters were measured *in situ* using the Hanna H19828 multi-parameter water quality checker: Temperature, Turbidity, Dissolved Oxygen, Total dissolved solids, conductivity, salinity, and pH were determined. All samples collected were kept in the ice chest as earlier stated to maintain them at a temperature below 4°C during transfer from the field to the laboratory within 24 hours. Similarly, in the laboratory, the samples were kept in the refrigerator under laboratory conditions until analysis was completed on them. The time between sampling and analysis of samples was kept short and between recommended times by the standard methods. To avoid contamination, the HNO_3 acid used in preservation was ultra-pure grade (J.T. Baker, Altrex).

III. RESULTS AND DISCUSSIONS

The result obtained from this study is presented in Tables 3-5 under the following headings; Physical Parameters such as Temperature, Total Dissolved Solids, Turbidity and Colour, Odour, Conductivity and Chemical and Gross Organic Pollutants; DO, COD, BOD, pH, Salinity, Alkalinity, Hardness; Nutrient parameters, Sulphate, Nitrate, Phosphate, Ammonium. The levels of these parameters are measures of water quality assessment and classification which were compared with known standards to ascertain the water quality status. The geographical locations and analytical techniques/ methods are shown in Tables 1 and 2 respectively.

Table 1: Sampling Stations and Descriptions

Station	Description	Location
A_B	Bolou-rua Station	N05°05'49.5''
B_C	Bolou-rua Control	E 006° 06' 57.2''
A_T	Toru-Orua Station	N05°05'49.4''
T_C	Toru-Orua Control	E 006° 06' 57.2''
A_K	Kalabiama Station	N05°02'40.1''
K_C	Kalabiama Control	E 006° 05' 08.8''
A_A	Amatolu Station	N006°03'50.1''
A_C	Amatolu Control	E 05° 01' 43.8''
A_E	Ebeni Station	N04°59'34.6''
E_C	Ebeni Control	E 006° 04' 28.6''

Table 2: Methods and Techniques of Analysis

Parameter	Techniques
Ammonium NH_4^+	Titrimetric (APHA 4500,1995)
Alkalinity	Titrimetric (APHA 2320 B;1995)
COD	Open reflux (APHA 5220 B;1995)
Hardness	EDTA Titrimetric method (APHA 2340 C;1995)
Phosphate (PO_4^{3-})	Colorimetric, Ascorbic acid method (APHA 4500-PE)
THC	APHA 507
BOD	

Table 3: Physical Parameters for the Sampling Station

Parameter	Experimental Stations						Control Stations					
	A_B	A_T	A_K	A_A	A_E	Mean	B_C	T_C	K_C	A_C	E_C	Mean
Temperature(°C)	25.71	27.30	29.83	30.45	29.50	28.56±1.99	27.77	26.29	28.82	27.12	27.60	27.52±0.93
Turbidity (NTU)	92.90	670	310	25.80	28	225±274	29.60	0.20	543	558	665	359±318
TDS (ppm)	33	10	89	36	28	39±29.60	40	0.00	28	16	20	20.80±14.81
Conductivity (μS/cm	66	75	178	73	77	94±47	79	1	56	32	36	40.80±29

Table 4: Chemical parameters for sampling stations

Parameter	Experimental Stations						Control Stations					
	A_B	A_T	A_K	A_A	A_E	Mean	B_C	T_C	K_C	A_C	E_C	Mean
pH (units)	5.46	5.02	6.59	5.29	5.4	5.55±0.6	5.68	5.19	5.71	5.77	5.70	5.61±0.24
Salinity (PSU)	0.03	0.03	0.08	0.03	0.04	0.04±0.02	0.04	0.00	0.02	0.01	0.01	0.016±0.015
Alkalinity (mg/l)	5	62	60	4	4	27±31	5	4	31	2	2	8.80±12.5
Hardness (mg/l)	6.1	40	50	4.6	3.4	20.82±22	4.6	2.8	20	2.1	3.8	6.66±7.52
THC (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table 5: Gross Organic Pollutants for Sampling Stations

Parameter	Experimental Stations						Control Stations				
	A_B	A_T	A_K	A_A	A_E	Mean	B_C T_C	K_C	A_C	E_C	Mean
DO (mg/l)	2.28	2.22	2.16	2.16	2.30	2.22±0.065	2.212.23	2.21	2.27	2.50	2.26±0.15
COD (mg/l)	0.612	1.925	1.810	0.518	0.498	1.07±0.41	0.4940.318	1.318	0.410	0.387	0.58±0.41
BOD (mg/l)	0.408	1.283	1.207	0.345	0.332	0.72±0.49	0.3290.212	0.873	0.273	0.258	0.39±0.27

BOD_5/COD= 0.67 in all the stations

The variations of measured physical parameters relative to the control stations are shown in Figures 1 and 2. The results in Figure 1 indicated that turbidity recorded the most significant variation followed by conductivity from the control which is also analogously replicated in Figure 2. The least changes were recorded for temperature and TDS. The parameters were measured in the scales shown in Table 3 correspondingly. Similarly, Figure 3 and 4 indicated that Alkalinity and Hardness observed the highest variations from the control where salinity and THC were almost negligible, but pH was the least. In a similar fashion but gross organic pollutants, DO was high but low comparative variation, COD and BOD had the highest from the control station values.

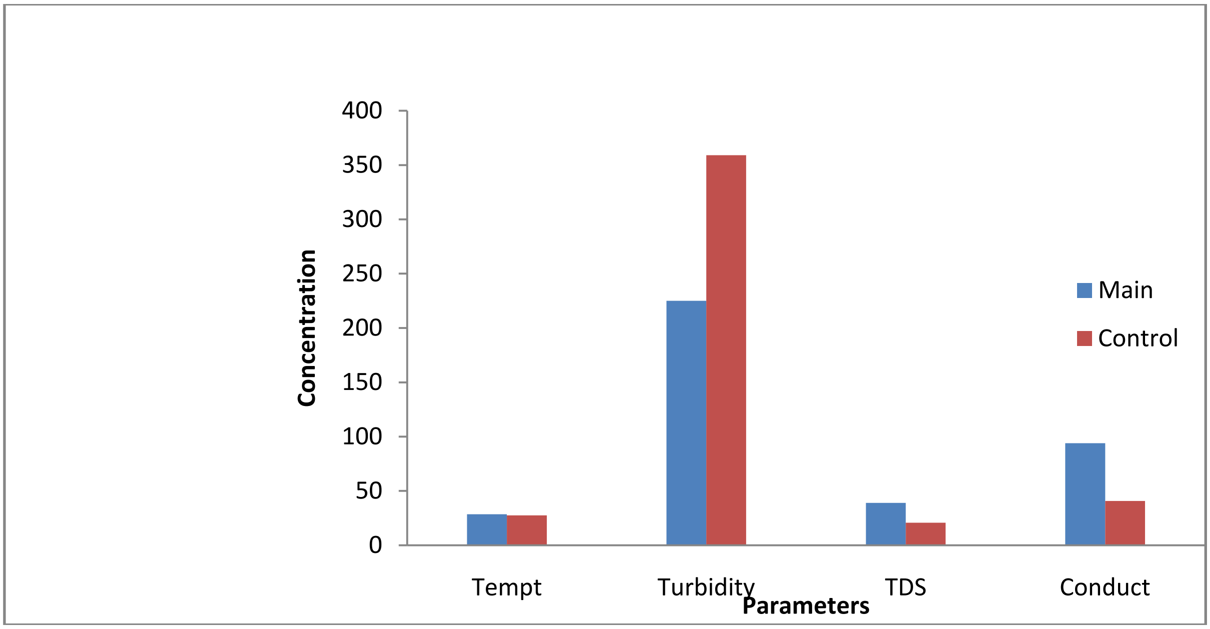

Figure 1: Variation of Physical parameters relative to the Control

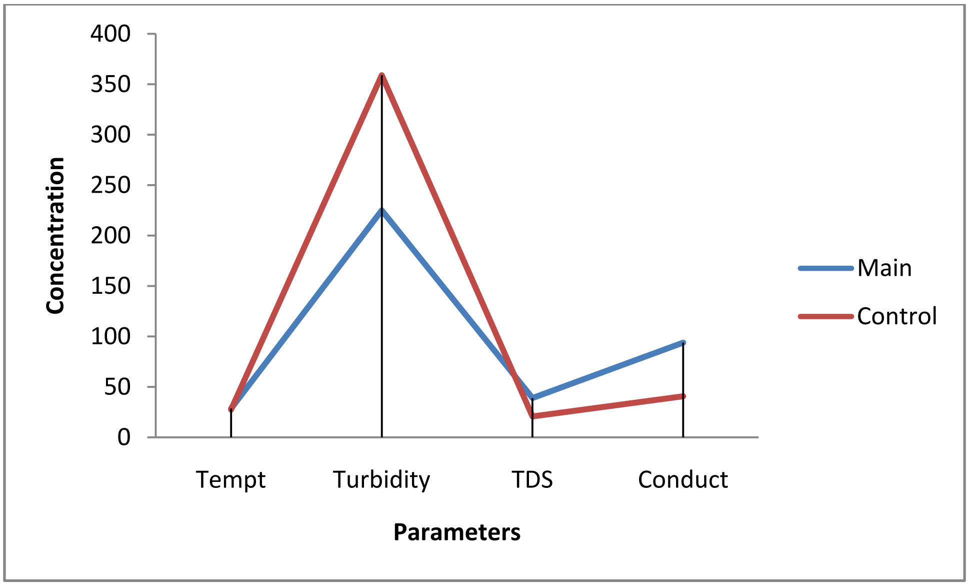

Figure 2: Line Plot of Physical Parameters against Control Values

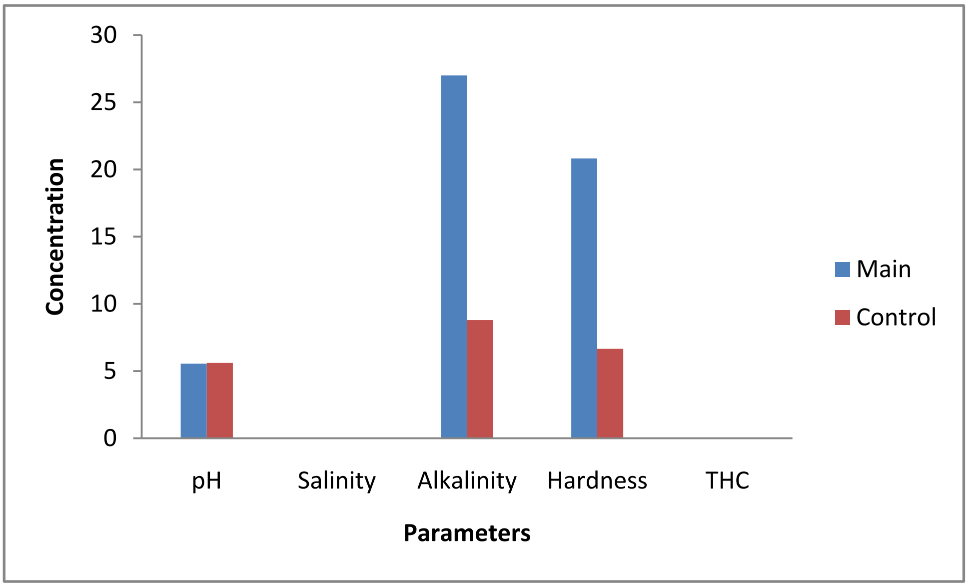

Figure 3: Chemical Parameters compared to the Control

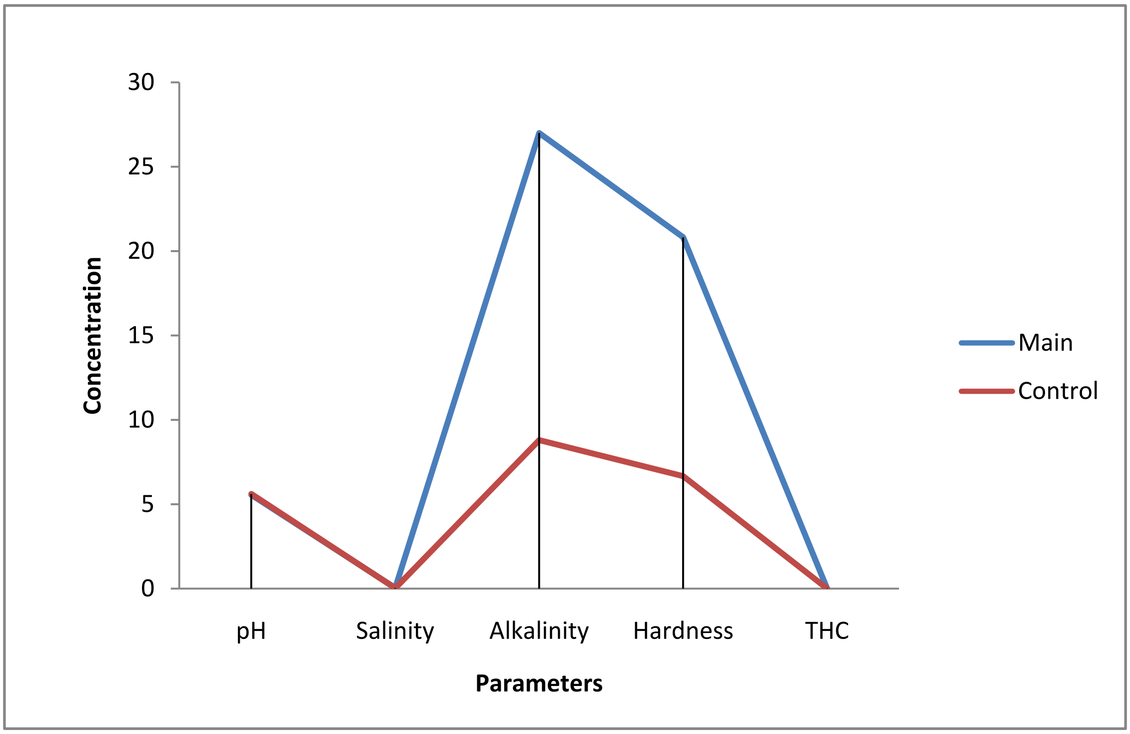

Figure 4: Line Plot of Chemical Parameters versus the Control

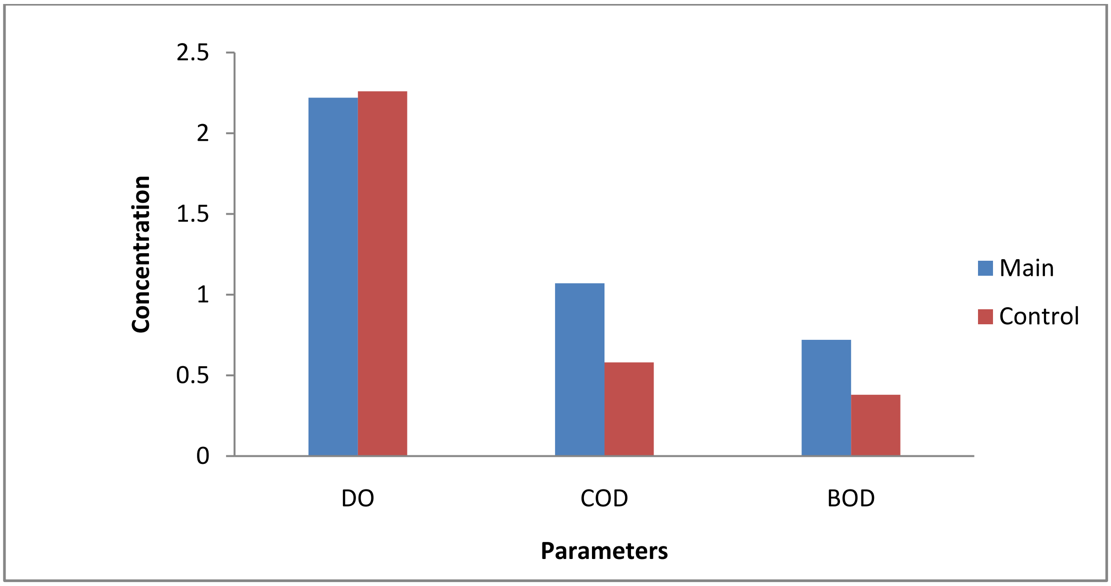

Figure 5: Variation of Gross Organic Pollutants from the Control

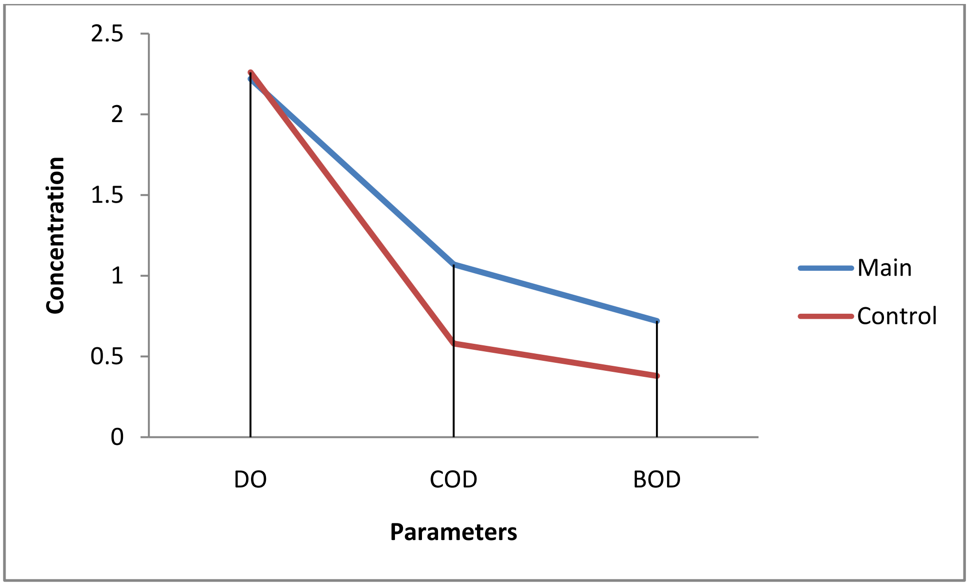

Figure 6: Variation Pattern of Gross Organic Pollutants and the Control Value

Table 8: Environmental Standards for Surface Water Quality

S/N	Parameter	Surface water standards (Drinking water)	Limit for discharge into surface water	WHO	DPR/FMENV
1	Temperature (°C)	-	<40	-	35
2	Alkalinity(mg/l)	-	200	200	200
3	Turbidity (NTU)	-	-	5	40
4	Conductivity(µ s/cm)	-	-	-	10,000
5	TSS(mg/l)	-	300	-	-
6	TDS(mg/l)	250-500	-	100	500
7	pH(units)	5-9	6-9	6.5-8.5	7.0-8.5
8	Salinity(PSU)	100-300/350	-	-	-
9	Hardness(mg/l)	-	-	500-1000	100
10	DO(mg/l)	6	-	7.5-10	10
11	COD(mg/l)	5	-	500	40
12	BOD(mg/l)	1.5	50	-	10

IV. DISCUSSION

The result shows the following parameter classified as physical, chemical and gross organic pollutants. The results are shown accordingly in Tables 3 to 5 whereas Tables 1 and 2 are descriptions of the study stations and analytical techniques and methods adopted respectively.

a) Physical Parameters

The water has an objectionable taste in all the study stations and peculiar brownish colour for the control stations of the Sagbama Creek. Temperature of the water samples has a mean of 28.56°C whereas the control stations have a mean of 27.52°C. The highest temperature of 30.45°C was recorded at Amatolu(A_A) sampling station whereas the least was at Bolou-rua station (25.71°C). This gave a range of 25.71-30.45°C. The temperature of surface water is needed to support dissolved oxygen, conductivity, pH, rate and equilibrium of chemical reactions, biological activity, fluid properties and can be used to even classify streams either as cold-water or warm-water (Natural Biological Assessment and Criteria Workshop, NBACW, 2003). The Temperature (°C) for the study stations were within the DPR/FMENV set limits of 35°C (or < 40°C) and discharged in the surface water. This agrees favourably with that recorded for the Woji Creek and Okrika Rivers (Okoye & Chukwuneke, 2008; Iyama & Edori, 2013). The range 25.71–30.45^{o}C fell within the temperature of 20-35^{o}C which is most suitable for plant growth, but above 30^{o}C may lead to regression in growth and plant decomposition (Kara*et al.,* 2004). The result also agrees with those of other researchers (Iyama & Edori, 2013; Iyama*et al.*, 2014).

Turbidity being the composition of clay, silt, finely divided organic and inorganic matter, soluble,coloured organic compounds, plankton, and microscopic organisms gives an indication of the condition and productivity of a water system (NBACW, 2003). The result gave a range of 25.80-670 NTU and a mean value of 225 NTU. This is at variance with those of the control stations 0.20–665 NTU. The minimum turbidity value (25.80) was recorded at the Amatolu sampling point whereas its maximum was at Toru-Orua and the maximum of 665 NTU was at Amatolu control river station (Table 3). These values are above the WHO and DPR/FMENV permissible limits except those at Amatolu, Ebeni (sample points) and Bolou-orua/Toru-Orua control stations. This agrees with the works of different researches who also observed that turbidity is temporary and also increases near areas of turbulence (Iyama & Edori, 2014a, Iyama & Edori, 2014b). This high presence of colloidal solids gives the water the cloudy and aesthetically unattractive and the muddy nature of the area. According to Boyd (1999), the relatively high turbidity may be due to tidal flows, storm, receipt of sediments and particulates from upland (lotic river).

Total dissolved solids (TDS) were ranged between 10 and 89ppm which were recorded at Toru-orua and Kalabiama study stations. The mean TDS value was 39 which is less than the limit for discharge into surface water bodies. The range of 0.00-40 was observed by the control station at Bolou-rua and Toru-Orua control stations but of mean value 20.80mg/l. When TDS levels exceed 1000 mg/l, it is considered unfit for drinking. High TDS values indicated hard water and the presence of toxic minerals which emanated from some dissolved solids of organic origin (Iyama & Edori, 2016). The values for TDS in the study were all below the limits recommended by both DPR and FMENV. Sampling stations recorded the following as well as their corresponding controls; A_B (33:40), A_T (10:0.00), A_K (89:28), A_A (36:16), and A_E (28:20). This showed that organic solids in water were negligible compared to the standard limits.

Electrical conductivity (µS/cm) being the specific conductance is a measure of the potential a body of water has to conduct an electric current. It is a function of the types of and amount of dissolved substances dissolved in the water (NBACW, 2003). It is very important because it gives approximate measure of the groundwater intrusion, correlates with nutrients and can be an indicator of mine or waste water. The highest value of conductivity was recorded at the Kalabiama study station (A_K) as 178 while the least was at Bolou-rua (A_B) as 66. Other stations recorded A_T (75), AA (73) and A_E (77). The mean conductance was 94. In a similar fashion, but in a reverse order, Bolou-rua control station had the highest conductance of 79 (borehole) followed by Kalabiama Kc (56) whereas the least was Toru-orua (1µS/cm) which was also from a tap water. This sharp contrast in conductivity of both tap water sources showed that there were some unique features for further studies. The other control stations recorded the following concentrations of A_C (32) and E_c (36) with mean concentration of 40.80. These concentrations are well below the set limits of DPR/FMENV (Table 8). These values are lower than those recorded for Bassan Rivers, Bayelsa State (Iyama & Edori, 2016). According to Victor and AL-Mahrouqi (1996) decomposition and mineralization of allochthonous organic matter can increase the concentration of conductivity.

b) Chemical and Gross Organic Pollutant Parameters

These include pH, salinity, and alkalinity, Hardness, DO, COD, BOD and THC. The pH which is a measure of the hydrogen-ion activity of water recorded a range of 5.02-6.59. The least pH of 5.02 was recorded at Toru-Orua (A_T) whereas the highest was 6.59 at Kalabiama station. The other stations were A_B (5.46), A_A (5.29) and A_E (5.40). These values showed acidic water, but the control stations also had the following B_c (5.68), T_E (5.19), K_c (5.71), A_C (5.77) and E_C (5.70). The mean pH value for the sampling stations was 5.55 whereas that for the control was 5.50. The pH of a water body can be used for stream classification purposes (either as black water or as white water). This decrease or acidic water can be caused by several factors, including; agricultural activities and acid rain. Though the pH range fell within that recommended values for surface water standards, it is below the lower limits permissible by WHO and DPR/FMENV as shown in Table 8. This is at variance with those reported by several other researchers (Iyama & Edori, 2016; Uwadiae et al., 2009).

Salinity is simply a measure of the salt content of a water body. The mean concentration of salinity was 0.04 PSU. The sampled stations showed that A_B, A_T, A_A had same salinity values of 0.03 but A_E was 0.04 and the highest was at the A_K station of 0.08. Similarly, the control station B_c, T_c, K_c, A_c, E_c recorded 0.04, 0.00, 0.02, 0.01 and 0.01 respectively (Table 4). This showed that the control stations had relatively lower salinity values than the actual samples from the study stations. Kalabiama study station had the highest salinity whereas the three study stations of Bolou-rua, Toru-Orua and Amatolu recorded the least. These values indicated that of a fresh water environment, which was at variance with those earlier reported by other notable researchers (Iyama & Edori, 2016; Edokpayi et al., 2010; Tait & Dipper, 1998). These values were far below those recommended for surface water standards and even for drinking water.

Alkalinity remains the potential of a water system to neutralize strong acid and very useful for stream classification and to determine susceptibility to acidic deposition (NBACW, 2003). The study stations recorded a range of alkalinity 4-62. The least value was in stations A_A (Amatolu) and A_E (Ebeni) whereas the highest was found in A_T (62) while A_K (60), A_B (5) and mean alkalinity was 27. The control stations of B_C, T_C, K_C, A_C, and E_C recorded 5, 4,31,2,2,12 respectively, whereas their mean concentration was 8.8. These values compared to the sampled stations indicated that there are some significant factors or conditions responsible for the high variation (see Table 4). Alkalinity is mostly produced by the action of ground water on limestone.

Hardness (total hardness) is a measure of the presence of certain insoluble and soluble salts in water, which may be products of calcium and magnesium salts. This may affect the use of soap. The study recorded hardness level in the sampling points for A_B, A_T, A_k, $A_{A,}$ A_E as 6.1, 40, 50, 4.6, 3.6, 3.4 respectively. The mean values of the samples and control stations were 20.82 and 6.66 respectively. The control stations recorded 4.6, 2.8, 20, 2.1, 3.8 for B_C, T_C, K_C, A_C, E_c respectively. These values were below the permissible limit for water by WHO (1993, 2003), but some stations A_T (40) and A_K (50) had higher total hardness values above the DPR (1991) and FMENV (2001) permissible limits (Table 8). Result of hardness is shown in Table 4. Hardness is generally caused by the presence of Ca^{2+}, Mg^{2+}, $Fe^{2+}$and Sr^{2+}ions in water as they are usually associated with HCO_3^-, SO_4^{2-}, Cl^-, $NO_3^-$and expressed in terms of $CaCO_3$.

Dissolved oxygen (DO) is the amount of oxygen in a body of water which is available for biochemical activities. Result in Table 4 showed that the study stations A_B, A_T, A_k, A_A, A_E, recorded 2.28, 2.22, 2.16, 2.16, 2.30 respectively. Similarly, the control stations B_c, T_C, K_C, A_C, E_C have 2.21, 2.23, 2.21, 2.27, 2.50 correspondingly. These values are practically below that recommended for surface water standards and potable water. This is also below WHO limit of 7.5mg/L (Table 8). The mean values for the sampling stations and the control are 2.22 and 2.28. Water saturated with oxygen is usually of a pleasant taste while the reverse have insipid taste. Clean surface waters are normally saturated with DO, but such DO is readily exhausted by the oxygen demand of organic wastes. These values were far below those of Mustapha *et al*.,, (2013) on similar environment. So many factors affect DO concentration such as temperature which has an inverse relationship.

Biological Oxygen Demand (BOD) refers to the amount of oxygen required for the biodegradation or decomposition of organic matter by micro-organisms. The results from the sampled stations are shown in Table 1 and the results in Table 4 indicated that A_B (0.408), A_T (1.283), A_K (1.207), A_A (0.345), A_E (0.332) and their control stations recorded 0.329, 0.212, 0.873, 0.73 and 0.258 respectively. The mean values for the sampled and control stations were 0.72 and 0.39 correspondingly. These values when compared to permissible standards for surface water (1.5), limit for discharge into surface water (50) and DPR/FMENV of 10mg/l, shows that they are lower, as shown in Table 8. These values are also below those reported by some other studies (Okoye & Chukwuneke, 2008; Iyama *et al*., 2017) but similar to those reported by Iyama and Edori, (2014a) on the water quality of the Imonite Creek, Rivers State.

Chemical Oxygen Demand (COD) which is another form of oxygen demand gives a measure of the oxygen required or demand for the chemical oxidation using $KCrO_4$ and concentrated H_2SO_4. From the sampling stations of $A_{B,}$ A_T, A_K, A_A, A_E, the COD concentration were respectively 0.612, 1.925, 1.810, 0.518, and 0.498 with their corresponding controls as 0.494, 0.318, 1.310, 0.410 and 0.387 (mg/L). This is shown in Table 4, with mean sampling control station values as 1.07 and 0.58mg/L. The COD values recorded during the study were all below the recommended limits both for discharge into surface water and surface water standards by WHO and DPR/FMENV (WHO, 2003) as shown in Table 8. These results are far lower than those reported by Okoye & Chukwuneke (2008), and Marila & Tamuno-Adoki (2007), on the Woji Creek and Okrika River. Total Hydrocarbon Content (THC) was all through the sampled stations and control less than 0.001mg/L. This showed the near absence of THC in the water bodies of the entire study area. These values are below those recorded for the Ekerikana River as posited by Iyama *et al*., (2017) on similar environment.

c) Nutrient Parameter (mg/L)

Sulphate (SO_4^{2-}), nitrate (NO_3^-), Phosphate (PO_4^{3-}) and Ammonium (NH_4^+) were sampled for and analyzed. The concentration of sulphate in the sampled area is shown in Table 5. The sampled stations and their concentrations are A_B (2.0), A_T (210), A_K (130), A_A (2), A_E (2) whereas their corresponding control stations are B_C (2), Tc(1), K_C(120), Ac(1), E_C(2). The mean concentrations for the sampled stations and controls are 69.2 and 5.04 respectively. The range of sulphate is 2-130mg/L. The high concentration recorded at A_T (Toru-Orua) and A_K (Kalabiama) shows some naturally occurring tendencies by the presence of coal seams or sulphur containing rocks or soils and from acid rains (NBACW, 2003). Sulphate concentration can affect taste and odour of water, changes in surface water, Chemistry and aquatic biota (NBACW, 2003). When compared to limit for discharge into surface water, WHO and DPR/FMNV; the sulphate concentration is relatively lower, but those of A_T and A_K need be checked to avoid nutrient enrichment (eutrophication) around the rivers and lake. These values were lower than the recommended standard limits and guidelines by WHO and DPR/FMENV. These values were lower than those reported earlier in researches (Ikem *et al.*, 2002; Orebiyi *et al.* 2010; Iyama *et al.*, 2016; Iyama and Edori, 2014a) on similar ecosystems. This was though higher than those reported by other researchers in similar environments (Lahlurja, 2005; Edet, 1993; Olabaniyi & Owoyemi, 2006).

Nitrate (NO^-_3) concentration (mg/L) recorded in the study is shown in Table 4 and are A_B (1.2), A_T (8.2), A_K (2.7), A_A (1.8) A_E (2.1) while the control readings were correspondingly B_C (1.8), Tc(1.7), K_C (5.3), A_C(2.0) and E_C (2.20). The mean for both the sampled stations and the controls are 3.2 and 2.6 mg/L respectively. The range of nitrate concentrations in the study area was 1.2-8.2.The least value of 1.2mg/l was recorded in the sample from Bolou-rua, whereas the maximum was from Toru-Orua. The increased variation may emanate from anthropogenic inputs from natives as nitrate concentration can be affected by combustion of fossil fuels and Agricultural activities. This sharp increase can affect trophic dynamics, increase higher turbidity, decrease DO concentration, increase algal and macrophyte production, as nitrogen-ammonia is also toxic to fish (NBACW, 2003). When compared to both WHO and DPR/FMENV standards, nitrates was found to be lower but close to less than 5mg/L for surface water standards. This result agrees with earlier ones recorded in similar ecosystems by different authorities and researchers (Mustapha *et al.,* 2013; Manila &Tamuno-Adoki, 2007; Emovin, Akporhonor, Akpoborie & Adaikpoh, 2006).

Phosphate (PO_4^{3-}) (mg/L) recorded spatial variations in the study stations as A_B(0.34), A_T (0.73), A_K (0.63), A_A(0.41), A_E(0.28), whereas the control stations have B_C(0.28), T_C (0.18), K_C(1.21), A_C(0.31), E_C(0.19). The mean concentration of phosphates for both sampling stations and control are 0.48 and 0.43 respectively. These phosphate concentrations are lower than those recommended as standard limits by both WHO and DPR/FMNV. These values are in consonance with those earlier reported by other authorities in similar environments (Mustapha *et al.*, 2013; Osibanjo & Majolagbe, 2012; Iyama *et al.*,, 2014).The values obtained showed that the water body meets the standards for salmonids (Mustapha *et al.,* 2013).These values were lower than those recorded by Okoye *et al.*,(2008) which were higher than the DPR/FMENV limit. These concentrations of phosphates are shown in Table 5.Similarly, Ammonium ion concentrations as shown in Table 5 are relatively higher compared to the DPR/FMENV limits for surface water which agreed favourably with earlier researches on similar terrains (Iyama, Eze & Ede, 2014). These concentrations are A_B (0.5), A_T (1.90), A_K (5.9), A_A (0.40), A_E (0.20) whereas their corresponding controls are B_C (0.30), T_C (0.20), K_C(1.20), A_C (0.30) E_C(0.30). The mean ammonium (NH_4^+) concentration for the sampling stations and controls are 1.78mg/L and 0.46mg/l respectively.

V. CONCLUSION

This study was to determine the surface water quality of a stretch of road from Toru-Orua community through Bolou-rua to Ebeni by the Amasoma Bridge in Bayelsa State. Surface water quality was collected from five sampling stations with corresponding control stations using boreholes and river water. From the results of physical, chemical and gross organic pollutants relevant concentrations levels of specific water quality were determined and compared to WHO, DPR and FMENV standards where applicable.

REFERENCES RÉFÉRENCES REFERENCIAS

1. Adesuyi, A. A., Njoku, K. L. and Akinola, M. O. (2015). Assessment of Heavy Metals Pollution in Soils and Vegetation around Selected Industries in Lagos State, Nigeria. Journal of Geoscience and Environment Protection, 3, 11-19.
2. Arimieari, L. W., Sangodoyin, A. Y. and Ereoforiokuma, N. S. (2014). Assessment of Surface Water Quality in Some Selected Locations in Port Harcourt, Nigeria. International Journal of Engineering Research and Technology, 3(7): 1146–1151.
3. Boyd, C. E. (1999). Water quality in warm water fish ponds. Alabama, USA, University press.
4. DPR (1991). Department of petroleum Resources. Guidelines and standards for petroleum industry in Nigeria. The Federal Ministry of Petroleum and Mineral resources.
5. Edet, A. E. (1993). Ground water quality assessment in parts of Eastern Niger Delta. *Environmental Geology,* 22: 41-46.
6. Emovin, O. O., Akporhonor, E. E., Akpoborie, I. A & Adaikpoh, E. O. (2006). Water quality assessment of River Ijana, Ekpan, Warri, Delta State, Nigeria. *Journal of chemical society of Nigeria*, 156-160.
7. FMENV (2001). Federal Ministry of Environment. National Guidelines and standards for Water Quality in Nigeria. *Federal Ministry of Environment Publications* (114).
8. Ikem, A., Osibanjo, O., Shridar, M. K. C. & Sobande A. (2002). Evaluation of ground water quality characteristics near two waste sites in Ibadan and Lagos, Nigeria. *Water, Air and Soil Pollution,* 140: 307- 333.
9. Iyama W. A. & Edori, O. S. (2016). Comparative Analysis of the Water Quality status of the Bassan Rivers in Bayelsa State, Nigeria. *International*

Journal of Chemistry and Chemical Engineering 6(1): 59-69.

10. Iyama, W. A. & Edori, O.S. (2013). Water Quality index Estimate for Isiodu River Water during Dredging in Niger Delta, Nigeria. *Global Journal of Pure and Applied Science* 19, 163-167.
11. Iyama, W. A. & Edori, O. S. (2014a). Analysis of the Water Quality of Imonite Creek in Ndoni, Rivers State, Nigeria. *IOSR Journal of Applied Chemistry*, 7 (11): 06-09.
12. Iyama, W. A. & Edori, O.S. (2014b). Seasonal variations in Water Quality during Dredging of Typical Fresh water in the Niger Delta, Nigeria. *International Journal of Advanced Science and Engineering,* 4(2): 407- 417.
13. Iyama, W. A., Edori, O. S. & Ikpe, S. (2014). Study of Pollution Levels in Ahoada-Ihuaba Axis of Sombreiro River Ahoada, Rivers State, Nigeria. *International Research Journal of Pure and Applied Chemistry*, 4(4): 379-387.
14. Iyama, W. A., Eze, C. L. & Ede P.N. (2014). Seasonal water quality variations during dredging of a typical brackish water habitat in the Niger Delta, Nigeria. *Journal of Nigerian Environmental society* (JNES), 1(2): 63-78.
15. Iyama, W. A., Waribo, H. A. &Okpara, K. (2016). Assessment of nutrient and biological status of Bassan River water in Bayelsa State, Nigeria. *Advance in Agriculture and Biology*, 5(3): 76-81.
16. Iyama, W.A., Eugene-Nwala, O. & Igoni, I. K. (2017). Assessment of the variations in physico-chemical parameters and heavy metals pollution potentials of Ekerikana Water body, Rivers State, Nigeria. *International Journal of Chemistry, pharmacy and Technology*, 2(43):162-168.
17. Kara Y., Kara, I. & Basaran, D. (2004). Investigation of some physical and chemical parameters of water in the Lake Isykli in Denizli, Turkey. *International Journal of Agriculture and Biology*, 6(2): 275-277.
18. Lahlurja, S.M. (2005). Groundwater chemistry of shallow aquifer. *Applied Ecology and Environmental Research,* 3(1): 133-199.
19. Marila, P. N. & Tamuno-Adoki T. (2007). Physical and chemical Assessment of Okrika River. *Journal of Nigerian Environmental society*, 4(1) 88-94.
20. Mustapha, A., Driss, B. & Mohamed, B. (2013). Seasonal variations in physico-chemical parameters of Water Body, Amghass II Province Ifrane, Morocco. *Universal Journal of Environmental Research and Technology*, 3(6): 660-666.
21. NBACW (2003). National Biological Assessment and Criteria Workshop
22. Okoye, I. P. & Chukwuneke, F. N. (2008). Study of pollution levels in water of Woji Creek in Port Harcourt, Rivers States, Nigeria. *Journal of Nigerian Environmental Society* (JNES), 4 (3): 120-127.
23. Olabaniyi, S. O. B. & Owoyemi, F. B. (2006). Characterization by factor analysis of the chemical faces of ground water in the Deltaic plain sands Aquifer in Warri, western Niger Delta and Nigeria. *African Journal of science and Technology* (AJST), 7: 73-81.
24. Orebiyi, E. O., Awomeso, J. A., Idowu, O. A., Martins, O., Oguntoke, O. & Taiwo, A.m. (2010). Assessment of pollution Hazards of shallow well water in Abeokuta and Environs, Southwest, Nigeria. *American Journal of Environmental Sciences* 6(1): 50-56.
25. Tait, R. V. & Dipper F. A. (1998). *Elements of marine ecology,* 4th ed., London, Butterwirth-Heinemann.
26. United Nations Educational, Scientific and Cultural Organization, World Health Organization and United Nations Environment Programme. Water Quality Assessments-A Guide to Use of Biota, Sediments and Water in Environmental Monitoring- Second Edition, UNESCO/WHO/UNEP, 1996.
27. Uwadiae, R. E., Edokpayi, C. A., Adegbite, O. & Abimbola, O. (2009). Impact of sediment characteristics on the macro-benthic invertebrates community of a perturbed tropical lagoon. *Ecology and Environmental conservation,* 15(3): 441-448.
28. Victor, R. & Al-Mahrouqi, A. I. (1996). Physical, chemical and faunal characteristics of a perennial stream in Northern Oman. *Journal of Arid Environment*, 34: 465- 476.
29. WHO (1993). World Health Organization. Guidelines for Technologies for Water Supply systems in small communities, WHO, CEHA.
30. WHO (2003). The World Health Organization Report: Shaping the future, World Health Organization, 1211 Geneva 27, Switzerland.
31. World Health Organization (WHO), Environmental Health Criteria, 27, Guidelines on studies on Environmental Epidemiology. Joint Sponsorship UNEP/ILO/WHO. Geneva, 2003.