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The Impact of Concrete Structure on the Physical and Chemical Characteristics of Ogbei Stream in Southern Nigeria

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Abstract:-Following the concrete structure erected in Ogbei Stream, Nkpologwu Anambra State, Nigeria in 2005, changes in physical and chemical characteristics were monitored for twelve months (May 2008 – April 2009). Six sampling stations were selected for study. The water samples for physical and chemical characteristics of the stream was collected and analysed. Result of physical and chemical characteristics revealed that water temperature consistently followed the ambient temperature. The high mean water temperature in station 1 (29.07±0.11 °C) was significantly difference ($p<0.05$) from the values recorded for all other stations. The concrete structure erected in this station 1 was responsible for the high temperature observed in the station. The maximum mean water velocity and the lowest mean depth in station may be attributed to concrete structure erected in this station as well as evaporation caused by deforestation and logging. The highest mean nitrate-nitrogen (0.04±0.07 mg/l) in station 1 which was not significantly different ($p>0.05$) from the values of all other stations was due to fertilizer applied to farms along the stream bank in addition to increase in organic matter due to deforestation.

Keywords:-Impact, Concrete Structure, Physical and Chemical Characteristics, Ogbei Stream

I. INTRODUCTION

Ogbei Stream is a lotic freshwater rain forest stream with its source at Umuezeagwu highlands in Isioji village, Nkpologwu, Southern Nigeria. The concrete structure was sponsored by Nkpologwu community under the rulership of Igwe Nathaniel Ogbonnaya Obi, the Obi 1 of Nkologwu to provide drinking water for the Nkpologwu community and her environs. Pre-concrete structure study of physico-chemical parameters of the stream has been studied by Ibemenuga and Inyang (2007). The establishment of the concrete structureprovided an opportunity to conduct a post-concrete structure ecological study. The findings are presented in this paper with emphasis on changes on the physical and chemical characteristics of the stream.

II. MATERIALS AND METHODS

A. The Study Area

The stream location has been described by Ibemenuga and Inyang (2006). The concrete structure lies eastward at the source of Ogbei stream.

B. Station Selection and Description

Six sampling stations namely stations 1, 2, 3, 4, 5 and 6 which lies within the stretch of the stream were chosen for study (Fig. 1). The sampling stations selected were all downstream.

Each station was sampled twice a month for 12 months (May, 2008 to April, 2009). The concrete structure was close to the source and as such upstream stations were not sampled.

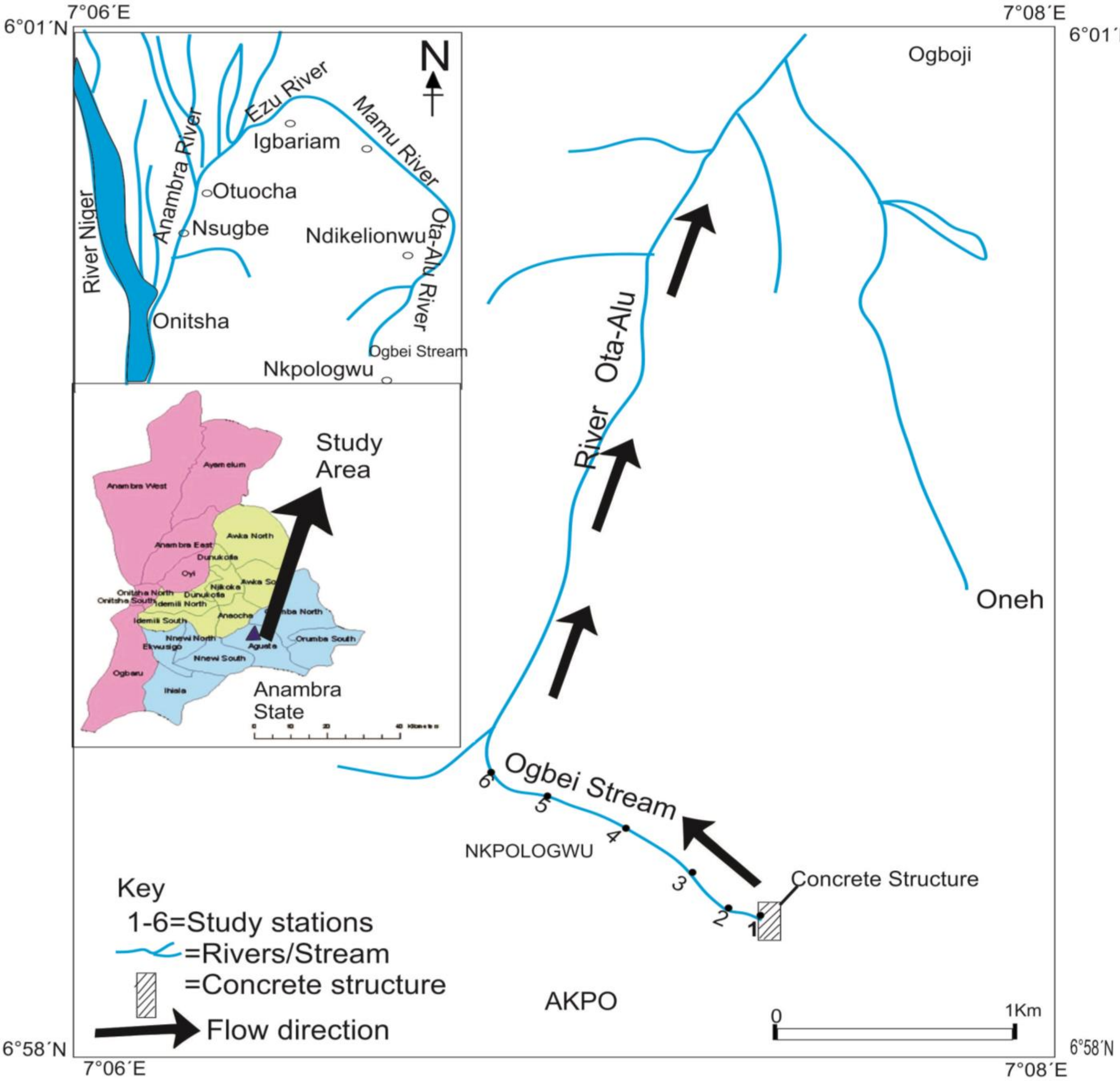

Fig. 1: Map of the Study Area

a). Station 1

Station 1 was the upper reaches. This station has a concrete structure erected at its anterior part. At this station there was a pool of water for soaking and sieving of cassava. Other human activities occurring in this station include soaking and washing of tapioca, washing of breadfruit, washing of clothes, marshing of bitter leaf, bathing, bank clearing deforestation, logging, farming, watering and cultivation of vegetables along the banks. Along the banks are green zones formed by aquatic plants such as Marantochola leucantha (Marantaceae), Elaeis guineensis "Palm tree" (Palmae), Costus afar "Okpete" (Zingiberaceae), Alchornea cordifolia "Xmas bush"(Bambusaeae), Anchormanes difformis "Arum" (Araceae) and Musanga cecropiodes "Corkwood" (Moraceae). Sand, organic matter, vegetable debris and leaves, heapsof refuse, wooden debris, silt and boulders are present and water flows fast. The velocity of water is high and light penetrates the station. The station is relatively straight.

b). Station 2

The station is not straight. Light also penetrates this station. It contains woody debris mixed with pebbles and organic matter. There were heaps of cassava peels along its banks. Activities in this station include cultivation of vegetables along the bank, washing of bread fruit and logging such as felling of Musa sapientium L. (Musaceae) tree stands to harvest mature plaintain fruits as well as felling of Oxytenanthera abyssinica (Bambusaeae) for building houses as well as farming. The macrophytes in this station include Costus afar "Okpete" (Zingiberaceae), Anthocleista voglii "Cabbage tree" (Loganiaceae), Lygodium microphyllum "fern" (Schizaeceae), Selaginellamyosurus "Club moss" (Selaginellaceae), Musa sapeintium L. "Plantain" (Musaceae), Echinocholacolona (Poaceae), Dialium guineense "Velvet tamarind" (Caesalpiniaceae) Marantochola leucantha (Marantaceae) and Alchornea cordifolia "Xmass bush" (Euphorbiaceae).

c). Station 3

This station is slopy and flooded. It is characterized by sand, mud and organic matter. Farming is among human activities occurring in this station. Riparian buffer zones (Stream side forests) in this station include Pteridium aquilinum "Fern" (Dennstaedtiaceae), Selaginella myosurus "Club moss" (Selaginellaceae), Landolphia dulcis "Vine tree rubber" (Apocynaceae), Echinochola colona "Grass" (Poaceae), Anthocleista vogelii "Cabbage"(Loganiaceae), Elaeisguineensis "Palm tree" (Palmae), Costus afar "Okpete" (Zingiberaceae), Scleria boivinee "Sedge" (Cyperaceae) and Marantochola leucantha (Marantaceae). Lumbering is the main human activity occurring in this station.

d). Station 4

The substratum is a mixture of sand, and pebbles. This station which has pools of water is very much flooded. Macrophytes present include Pandanus candelabrum (Pandanaceae), Alchornea cordifolia "Xmas bush" (Euphorbiaceae), Mucuna pruriens "Cowitch" (Fabaceae), Treculia africana "Bread fruit" (Moraceae), Sclera boivinee "Sedge" (Cyperaceae), Elaeis guineensis "Palm tree" (Palmae), Aspilia africana "African marigold" (Maranataceae). Human activities in this station include bathing and lumbering. Little light penetrates this station due to close canopy cover shaded by macrophytes.

e). Station 5

The station contains sand, mud and organic matter. The substratum is a mixture of sand, mud and organic matter. Macrophytes present include Marantochola leucantha (Marantaceae), Abrus precatorius L. "Crab's eye" (Papilionaceae), Pandanus candelabrum (Pandanaceae),Elaeis guineensis "Palm tree" (Palmae), Oxytenanthera abyssinica (Bambusaeae), Andropogon guyanus"Grass" (Poaceae) and Anthocleista vogelii "Cabbage tree" (Loganiaceae), Dissotis theifolia (Meslastomataceae), Acio barterii (Chrysobalanaceae) and Mucuna pruriens "Cowitch" (Papilionaceae) which form an over- handing vegetation often disturbed by human activities. As a result light penetrates this station. Among the human activities in this station were lumbering, bush clearing and collection of Pandanus candelabrum (Pandanaceae) for mat production. Water flow in this station is slow.

f). Station 6

Both sand, mud, organic matter, sediment and rocks occurred in this station. The base of the banks are swampy. It is relatively straight. Vegetation in this station include Pennisetum ramosum "Grass" (Poaceae), Cyperus papyrus "Sedge" (Cyperaceae), Marantochola leucantha (Marantaceae), Elaeis guineensis "palm tree" (Palmae), Calopogonium mucunoides (Papilionaceae), Alchornea cordifolia "Xmass bush" (Euphorbiaceae), Sebacea erecta (Rubbiaceae), Costus afar Okpete" (Zingiberaceae) and Dissotis theifolia (Melastomataceae). Little light penetrate this station. Lumbering, cultivation and watering of vegetables along banks and dredging of sand are among the main human activies in this station.

C. Sampling and Physico-Chemical Analysis of Water Sample

Water sample were collected from each study station twice monthly for a period of one year (May 2008 – April 2009). The samples were transported to laboratory for analysis. Temperature, current/water velocity, depth, transparency, conductivity and pH were determined in-situ using mercury-in-glass thermometer, a weithed cork and an L-tube, secchi disc, conductivity meter, Hanna pH meter (Modern H196107) respectively. All other parameters were determined in the laboratory. While dissolved oxygen and total alkalinity were determined using titrimetric methods according to APHA (1998), nitrate-nitrogen and sulphate-phosphorus were respectively determined by colorimetry (APHA, 1998) and Stannous chloride method (APHA, 1976). Total dissolve solids were determined by evaporation method.

D. Statistical Analysis

Data Were analyzed using SPSS version 20.0. Analysis of variance was performed and where difference is significant, Duncans New Multiple Range Test (DNMRT) was used to separate station means. Transparency was analyzed using t-test.

III. RESULTS

The mean results of the physical and chemical characteristics of Ogbei Stream in relation to stations is summarized in Table 1.

A. Variations in Physical and Chemical Characteristics of Ogbei Stream in Relation to Stations

The results of the physical and chemical properties of Ogbei Stream in relation to stations is shown in Table 1.

The mean air temperature fluctuated from 27.0-31.8°C. The highest mean value of 30.49±0.17°C (range 28.3-31.8°C) was recorded in station I (Table 1). This value which was similar to the mean value in station 4 was significantly different ($p<0.05$) from the values recorded in all other stations. The lowest mean value of 29.27±0.21°C with range 27.0-30.7°C) was recorded in station 6 (Table 1).

The mean water temperature of the stream was highest in station 1 (29.07±0.11°C) with a range of 28.0-29.8°C (Table 2). This value differed significantly ($p<0.05$) from the values recorded for all other stations. The lowest mean value of 27.67±0.15°C (range 26.3-28.9°C) recorded in station 6 which differed significantly ($p>0.05$) from stations 1 and 4, was not significantly different ($p>0.05$) from the values of all other stations.

The highest mean value (0.34±0.02 ms^{-1}, range 0.24-0.55 ms^{-1}) of current velocity was recorded in station 1 followed by station 3 (0.32±0.01 ms^{-1}, range 0.25±0.41 ms^{-1}). Although these values were similar ($p>0.05$), the mean value in station 1 was significantly different ($p<0.05$) from the values of all other stations.

The depth values ranged between 0.19-0.56 m. The mean values of 0.26±0.01 m, 0.34±0.01 m, 0.41±0.07 m, 0.38±0.01 m, 0.42±0.01 m and 0.28±0.01 were recorded for stations 1, 2, 3, 4, 5 and 6 (Table 1). The mean values recorded in station 5 which was similar to the mean value recorded in station 3, was significantly different ($p<0.05$) from the values recorded for all other stations.

The overall mean transparency was 28.05±0.93 cm with a range of 14.00-40.00 cm. The highest mean transparency value of 30.36±0.98 cm (range 20.50-40.60 cm) was recorded in station 2 while the lowest mean value of 25.71±1.45 cm (range 14.00-37.90 cm) was recorded in station 3 (Table 1). T-test performed between values for the two stations at 0.05 level of significance showed that values were significantly different ($p<0.05$). Transparency was not determined in stations 1, 4, 5 and 6 due to exposure of stream bed to light.

The result showed that the conductivity of Ogbei Stream was low. The mean conductivity values at all the stations showed that the highest mean value of 0.06±0.06 µmhos/cm was recorded in station I. Data analysis showed that there was no significant difference ($p>0.05$) in the mean values recorded at all the stations.

The overall pH range of 4.30 – 7.50 with a mean value of 5.47±0.52 was recorded in the study. Mean pH values observed in all the stations showed that the highest mean value (5.55±0.12, range 4.70-6.70) was recorded in station 2. There was no significant difference ($p>0.05$) between this value and the values obtained in all other study stations (Table 1).

Mean dissolved oxygen concentration varied slightly across the stations. Station 5 had the highest mean value (5.12±0.13 mg/l) while station 1 had the lowest mean value (4.78±0.14 mg/l). These values which were significantly different ($p<0.05$) from each other were not significantly different ($p>0.05$) from the values of other stations (Table 1).

Mean values recorded for alkalinity in Ogbei Stream during the study which ranged from 0.01 – 20.10 mg/l$CaCO_3$varied in the study stations (Table 1). Stations 1 and 6 had the highest and the lowest mean values of 5.00±1.06 mg/l$CaCO_3$ and 4.38±0.89 mg/l$CaCO_3$ respectively. There were no significant difference ($p>0.05$) in the mean values recorded in the six stations (Table 1).

The hardness observed in this study ranged from 0.00 – 23.10 mg/l $CaCO_3$. The overall mean value was 4.88±0.37 mg/l$CaCO_3$. The highest mean value of 5.76±1.21 mg/$CaCO_3$ (range 0.20-23.10 mg/l $CaCO_3$) was recorded in station 4 while the lowest value of 4.46±0.90 mg/l$CaCO_3$ (range 0.00-16.40 mg/l$CaCO_3$) was recorded in station 1. The mean values recorded at all the stations were not significantly different ($p>0.05$) (Table 1).

Table 1: Summary of Results of Variations in Physical and Chemical Characteristics According to Stations, Ogbei Stream (May 2008 – April, 2009)

	STATIONS						
Parameter	**1**	**2**	**3**	**4**	**5**	**6**	**Annual mean**
Air temperature (°C)	30.49±0.17^{a} (28.3-31.8)	29.48±0.20^{cd} (27.3-30.8)	29.78±0.17^{cd} (28.0-31.8)	30.35±0.15^{ab} (28.6-31.7)	29.95±0.15^{bc} (28.2-30.9)	29.27±0.21^{d} (27.0-30.7)	29.89±0.08 (27.0-31.8)
Water temperature (°C)	29.07±0.11^{a} (28.0-29.8)	27.72±0.20^{c} (26.0-29.5)	27.78±0.17^{c} (25.9-29.5)	28.50±0.19^{b} (26.8-29.8)	28.09±0.69^{bc} (27.5-29.0)	27.67±0.15^{c} 26.3-28.9	28.14±0.08 (25.9-29.8)
Current/Water velocity (ms^{-1})	0.34±0.02^{a} (0.24-0.55)	0.29±0.02^{bc} (0.18-042)	0.32±0.01^{ab} (0.25-0.41)	0.24±0.01^{de} (0.13-0.36)	0.22±0.01^{e} (0.13-0.36)	0.27±0.01^{cd} (0.15-0.38)	0.28±0.01 (0.13-0.55)
Depth (m)	0.26±0.01^{d} (0.19-0.36)	0.34±0.01^{c} (0.24-0.44)	0.41±0.07^{ab} (0.35-0.49)	0.38±0.01^{b} (0-29-0.47)	0.42±0.01^{a} (0.35-0.56)	0.28±0.01^{b} (0.20-0.38)	0.35±0.01 (0.19-0.56)
Transparency (cm)	-	30.36±0.98$^{\bullet}$ (20.50-40.60)	25.71±1.45$^{\bullet}$ (14.00-37.90)	-	-	-	28.05±0.93 (14.00-40.00)
Conductivity (µmhos/cm)	0.06±0.06^{a} (0.01-0.11)	0.05±0.08^{a} (0.01-0.17)	0.05±0.08^{a} (0.01-0.16)	0.05±0.06^{a} (0.02-0.12)	0.05±0.01^{a} (0.01-0.11)	0.05±0.10 ^{a} (0.01-0.11)	0.05±0.00 (0.01-0.17)
pH	5.45±0.15^{a} (4.30-7.50)	5.55±0.12^{a} (4.70-6.70)	5.48±0.12^{a} (4.60-6.40)	5.48±0.12^{a} (4.70-6.60)	5.38±0.13^{a} (4.50-6.50)	5.50±0.12^{a} (4.60-6.60)	5.47±0.52 (4.30-7.50)
Dissolved oxygen (mg/l)	4.78±0.14^{b} (3.03-5.95)	4.95±0.10^{ab} (3.85-5.85)	5.01±0.05^{ab} (4.02-5.25)	5.09±0.10^{ab} (4.01-6.80)	5.12±0.13^{a} (4.02-6.95)	4.96±0.07^{ab} (4.03-5.22)	4.99±0.04 (3.03-6.95)
Alkalinity (mg/l $CaCO_3$)	5.00±1.06^{a} (0.02-20.10)	4.60±0.95^{a} (0.01-15.50)	4.45±0.99^{a} (0.02-16.40)	4.44±0.88^{a} (0.02-13.20)	4.73±0.96^{a} (0.02-13.60)	4.38±0.89^{a} (0.06-13.60)	4.60±0.38 (0.01-20.10)
Hardness (mg/l$CaCO_3$)	4.46±0.90^{a} (0.00-16.40)	4.56±0.67^{a} (0.30-11.40)	4.93±0.85^{a} (0.20-14.50)	5.76±1.21^{a} (0.20-23.10)	4.66±0.88^{a} (0.20-16.50)	4.94±0.90^{a} (0.20-19.30)	4.88±0.37 (0.00-23.10)
Nitrate-nitrogen (mg/l)	0.04±0.41^{a} (0.30-5.70)	0.03±0.05^{a} (0.00-0.09)	0.03±0.05^{a} (0.00-0.07)	0.03±0.05^{a} (0.00-0.06)	0.03±0.05^{a} (0.00-0.10)	0.03±0.05^{a} (0.00-0.06)	0.04±0.07 (0.00-1.01)
Phosphate-phosphorus (mg/l)	3.73±0.27^{a} (0.30-5.70)	3.78±0.32^{a} (0.30-6.30)	3.73±0.28^{a} (0.30-6.00)	3.47±0.32^{a} (0.30-5.50)	3.59±0.31^{a} (0.30±5.70)	3.72±0.36^{a} (0.50-8.40)	3.67±0.13 (0.30-8.40)
Total dissolved solids (mg/l)	1.47±0.62^{a} (0.06-12.40)	1.28±0.50^{a} (0.07-11.00)	1.40±0.56^{a} (0.01-11.70)	1.35±0.48^{a} (0.08-10.50)	1.33±0.48^{a} (0.10-8.80)	1.77±0.58^{a} (0.08-12.0)	1.44±0.22 (0.09-12.40)

The mean (±S.E.) values with the same superscript on the same row are not significantly different from each other at $p > 0.05$.
* The figures in parenthesis show range in station samples of the species
T-test was used to compare transparency because data was collected only from Stations 2 and 3
┼Transparency was not determined in Stations 1,4, 5 and 6 due to exposure of streambed to light
• Significant difference at $p < 0.05$

Nitrate-nitrogen which ranged from 0.00 – 0.01 mg/l with annual mean value of 0.04±0.07 mg/l. The mean values for all the stations revealed that station 1 had the highest mean value of 0.07±0.41 mg/l while stations 2, 3, 4, 5, and 6 had the lowest mean values of 0.03±0.05 each (Table 1). Data analysis showed that there was no significant difference ($p>0.05$) in the mean values of nitrate-nitrogen recorded in all the stations.

The mean phophate-phosphorus values of all the stations showed that station 2 had the highest mean value (3.78±0.32 mg/l) of phosphate-phosphorus. The lowest value (3.47±0.32 mg/l) was recorded in station 4. The mean phosphate-phosphorus values recorded at the six study stations were not significantly different ($p>0.05$) (Table 1).

Total dissolved solids range from 0.09 – 12.40 mg/l in the study. The mean total dissolved solids recorded at the various stations varied between 1.28±0.50 mg/l (range 0.07-11.00 mg/l) in station 2 and 1.77±0.58 mg/l (range 0.08-12.00 mg/l) in station 6 (Table 1). These values were not significantly different ($p>0.05$) from each other and from the values of all other stations.

IV. DISCUSSION

The summary of physical and chemical characteristics of Ogbei Stream is presented in Table 1. The water temperatures recorded in the study stations during the study were generally lower than the air temperatures. Water temperature consistently followed the ambient temperature.

The highest mean water temperature recorded in station 1 may be due to the concrete structure erected in this station. Concrete structure and impoundments have been reported to cause changes in temperature (Vannote *et al*., 1980; Ibemenuga, 2015), substrate and water quality (Armitage, 1984; Ogbogu and Akinya, 2001).

Current varied at the study stations.The relatively high flow velocity recorded in Station 1 could be due to the direct effect of the concrete structure erected at Station 1. The flow velocity observed at Station 3 could be associated with the nature of the slope of the stream bed as well as flood influx. The adverse effects of increased stream flow downstream of concrete structures on aquatic organisms in addition to the possible changes, couldimpact on the morphology of the stream bed (Baxter and Glaude, 1980; Edokpayi and Osimen, 2002). Current velocity within any stretch of a running water depends also on the shape of the channel and has a regular pattern in a transverse section (Maitland, 1978).

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Depth varied widely with changes in water levels in the study stations. Station 1 with the lowest mean depth value (0.26±0.01 m) was significantly different ($p<0.05$) from the mean values of all other stations.The least mean depth recorded in Station 1 may be attributed to factors such as construction of concrete structure and evaporation caused by deforestation and logging. This agreed with the observation of Ibemenuga and Inyang (2007) that depth was high where there were no human activities.

There was no measure of transparency at Stations 1,4, 5 and 6 throughout the study period due to reduced depth as well as exposure of their bottoms to light. There was a significant difference in the transparency values recorded in Stations 2 and 3. Although sediment deposition decreased downstream, Station 2 was relatively more transparent than Station 3. The lower value recorded in Station 3 may be due to influx of sediment and debris via flood from the catchment area. Catchment disturbance that results in fine sediment inputs into streams has been identified as a major contributor to the degradation of freshwater habitat (Kreutzweiser *et al*., 2005; Achionye-Nzeh and Bello, 2006). Factors such as agricultural tillage, urbanisation, mining, road and house construction and logging activity are among factors that result in sediment inputs and deposition in water bodies (Achionye-Nzeh and Bello, 2006). Turbid flood and runoffs decrease light penetration (Ayoade *et al.*, 2006). Suspended solids causing turbidity are important in altering light penetration (Maitland, 1978). The higher mean transparency value recorded in Station 2 (30.36 ± 0.98 cm) could be attributed to lower depth as a result of sediment deposition from the construction site at Station 1. Flooding could be responsible for the increased depth in Station 3. According to Maitland (1978) materials removed from the bed by current are mainly carried along in suspension, but heavier particles may actually be rolled along the bottom, thereby causing further erosion and scouring.

Conductivity was approximately with slight variation in station 1, and stations 2, 3, 4, 5 and 6. Generally the ionic content of the stream was low. While Stone and Thomforde

(2014) suggested an acceptable range of 30 – 5000 μs/cm, OATA recommended >250 μs/cm as suitable for fish production. Conductivity measures salinity in aquatic ecosystems. The level of conductivity in water gives the amount of ionisable substances dissolved in it, such as phosphates, nitrates and nitrites which are washed into streams and ponds after fertilizer is applied to surrounding fields or are present in effluent from sewage-treatment installations (Slingsby and Cook, 1976).

There was slight variation in pH concentration at the study stations. The acidic-alkaline range of 4.30 – 7.50 observed in the study fell within the recommended range 6.5 – 9.0 (Boyd and Lichtkoppler, 1979) and 5.0 – 9.5 (Stirling and Philip, 1990) gave as suitable for aquatic life. Data analysis comparing the six stations showed no significant difference ($p>0.05$). The pH values recorded were stable at the study stations. The stability of the stream pH may be attributed to the fact that most of the hydrogen ions are allochthonous, thus the stream pH was unresponsive to the cycles in the input of precipitation, surface runoff and garbages.

Temporal and spatial variations in dissolved oxygen were observed in the studied stations. Peak value (5.12±0.13mg/l) was recorded in Station 5 and the lowest value (4.78±0.14 mg/l) in Station 1. The dissolved oxygen levels observed here were higher than those reported for Barnawa Stream (Emere and Nasiru, 2007), Ogun river and Calabar river (Offem *et al*., 2011). Generally, oxygen content was higher downstream than upstream. The least level of dissolved oxygen observed at Station 1 may be due to high oxygen demand by the micro-organisms during the breakdown of dead organic matter and high temperature occasioned by deforestation and concrete structure. Ugwu and Mgbenka (2006) indicated that the concentration of dissolved oxygen in water was greatly affected by decayed organic matter. Low levels of dissolved oxygen causes anaerobic decomposition of organic matter in water forming noxious and toxic substances such as hydrogen sulphide (H_2S) and methane (CH_4) (DPRM, 2000; Awoyinka *et al*., 2008).

Alkalinity is the capacity of water to neutralize acid (Tubonimi*et al*., 2010). The low alkalinity level observed in the study which is similar to the observations of Edokpayi and Osimen (2002) may be attributed to low lime content of underlying rock type. The alkalinity range (0.01 – 20.10mg/l$CaCO_3$) obtained in this study fell within the OATA (2008) recommended range of 25 – 100 mg/l$CaCO_3$. Total alkalinity level of 20 – 200 ppm are typical of fresh water stream and a total of 100 – 200 ppm will stabilize the pH level in a stream. Level below 10ppm, indicate that the system is poorly buffered, and is very susceptible to changes in pH from natural and human-cause source (Kigbu and Mohammed, 2014).

The highest increase in hardness in station 5 may be due to addition of calcium and magnesium salts. Calcium and magnesium carbonate often occurring together, are prominent sources of ions which in solution, constitute to the hardness of streams, however, sulphates, chlorides and other compounds may also contribute to total hardness (Reid and Wood, 1976).

The mean value (0.04±0.07 mg/l) of nitrate-nitrogen recorded in the study was lower than WHO (2011) standard of 40 mg/l.Variations in the nitrate-nitrogen of water at the study stations were similar with slight spatial differences. The highest mean nitrate-nitrogen value recorded at Station 1 may be related to human activities particularly deforestation, erection of concrete structure and bank clearing in addition to bathing, laundry and farming with fertilizer, etc and presence of organic matter. Thus the lower but equal mean values recorded downstream could be due to more human activities occurring in Station 1.The nitrate-nitrogen content of Ogbei Stream is low probably due to assimilation by phytoplankton. Algae utilize nitrate in oxygen - depleted conditions, using it as electron acceptor and donor during oxidative photophorylative means of energy generation (Isabelle and Walter, 1979; Moyle, 1979; Kawo, 2005). Thus, nitrate was found to be less abundant than phosphate, for which reason it may therefore be suggested that nitrate could be a limiting nutrient (Kawo, 2005) in the productivity of Ogbei Stream.High concentration of nitrate in drinking water is toxic (Umavathi *et al*., 2007; Ikongbeh *et al*., 2014).

The more phosphate laden in Stations 1, 2, 3 and 6 may be associated with farming and constant bank erosion. Hansen (1971) and Barton (1977) showed that erosion of unprotected banks along a stream course increased suspended sediments in the stream by five fold. Nearly all phosphate reaching streams in agricultural areas do so through bank erosion (Hynes, 1970).

Phophate-phosphorous is a mineral nutrient that is essential for all forms of life (Common Wealth of Australia, 2002).Although a relatively minor constituent, phosphorus is often the most important nutrient relative to productivity in aquatic ecosystems (Boyd, 1982). Therefore aquatic systems with high concentration of phosphate in muds is more productive than aquatic systems with low concentrations of phosphorus in muds.

Total dissolved solids are naturally present in streams. The amount of total dissolved solids in rivers and streams varies with local geography (Hynes, 1970). The total dissolved solids mean value for the study(1.44± 0.22 mg/l, range 0.09 - 12.40 mg/l), was lower than the 1200 mg/l level suggested to be harmful to fisheries production (Palmer and O'keefe, 1990).

The annual range of total dissolved solids recorded in the present study was relatively low when compared to the range of 206.00 – 282.00 mg/l obtained by Ahaneku and Animashaun (2013)in Asa River. The more sediment laden in station 6 may be attributed to the organic matter from swampy banks and farmlands.Total dissolved solid contents of waters differ according to the type of soils, the stream drains, as well as the water entering it. Thus streams receiving run-off from boggy and some tropical rain forest areas do not have much mineral content. Hynes (1970) indicated that streams in such areas have very low mineral contents, not many times that of rainwater, and they tend to be even more acidic than rainwater because of base exchange with the organic soil and the loss of such cations as were originally present. He explained further that they are often brownish because of dissolved organic matter.

V. CONCLUSION

The study revealed that concrete structure impact on water quality characteristics of Ogbei Stream. Like dams concrete structures increase temperature, alter flow regimes, disturb riparian vegetation thereby increasing sit and sand deposition as observed in this study especially in station 1 where the concrete structure is located.

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