Assessment of Physical and Chemical Characteristics of Surface Water from River Niger, Illushi, Edo State, Nigeria

*OSEJI, M; UWAIFO, OP; OMOGBEME, MI

Department of Animal and Environmental Biology, Faculty of Life Science, University of Benin, P.M.B 1154, Benin City, Nigeria.
*Corresponding Author Email: Osejimacpherson@gmail.com

ABSTRACT: The physical and chemical characteristics of River Niger, Illushi an important fishing site in Edo State which is currently impacted by human activities, was investigated between the month of April and November, 2017. Surface water samples were collected from three (3) sampling stations covering a total distance of 2600metres from upstream to downstream, and a total of seventeen (17) physical/chemical parameters were investigated. Findings from this study revealed that Air temperature had an average mean value of 27±0.72 mg/L, Water temperature was 26.21±0.63 mg/L, the river was generally acidic with the average pH of 6.27±0.18, Turbidity was 107.28±30.9, Conductivity was 57.08±8.29, Total Dissolved Solid was 34.9±4.78, Total Suspended Solid was 71.7±21.17 mg/L, Alkalinity was 26.62±4.78 mg/L, Chloride was 17.29±1.41 mg/L, Hardness was 26.81±2.59 mg/L, Phosphate was 2.20±0.09 mg/L, Nitrate was 3.19±0.94 mg/L, Sulphate was 25.81±10.78 mg/L, Calcium was 8.69±1.74 mg/L, Magnesium was 2.66±0.39 mg/L, Dissolved Oxygen was 4.47±0.46 mg/L and Biochemical Oxygen Demand was 7.29±3.25 mg/L. This study depicts that turbidity, dissolved oxygen, biochemical oxygen demand, air, and water temperature were higher than the recommended limit for drinkable water. It, therefore, stresses the need for compliance of environmental laws to prevent the river from further deterioration.

Water is one of the most essential compounds that enable the survival of living organisms on earth (Akpofure *et al*., 2007). As one of the most valuable resources to man and living organism, water is essential for the sustenance of life on earth and this is exemplified by its diversified uses which include washing, irrigation, cooking and drinking. Thus, water is life and its quality is an essential measure of the quality of life (Oboh and Agbala, 2017). The freshwater resources of Nigeria constitute about 12.4% of its total surface area (Dimowo, 2013). One of the most recent problems in developing countries like Nigeria is the shortage of clean water, particularly in rural communities that rely on rivers as their main source of domestic water supply. The deteriorating quality of water threatens sustainable living in these communities and it is, therefore, a reason for worry (Omoigberale *et al*., 2013). Sadly, rivers are been polluted by indiscriminate dumping of sewage, waste from industries, agricultural waste and other human activities, which in turn, affect the physical and chemical characteristics of these water bodies (Koshy and Nayar, 1999). River Niger, Illushi, an important fishing site in Edo State is currently impacted by human activities such as waste deposits, boating activities and agricultural runoffs from neighboring farmlands where the application of fertilizers is a common practice. Availability of clean and safe supply of drinking water is a requirement for sustainable growth and development (Asonye *et al*., 2007). Thus, the quality of water influences the wellbeing of any population that uses it. Hence, an examination of water for physical and chemical characteristics is essential for public health studies (Chinedu *et al*., 2011). The purpose of this study was to ascertain the level of anthropogenic influence on River Niger, Illushi, Edo State, Nigeria, by investigating the physical and chemical characteristics of its surface water, and thus, provide baseline data on the water quality.

MATERIALS AND METHODS

Study Area: This study was conducted in River Niger, Illushi, Edo State, Nigeria. Illushi lies between latitude 6^0 $40'$ $14.4''$ and 6^0 $40'$ $26.9''$ North, and Longitude 6^0 $36'$ $53.8''$ and 6^0 $37'$ $49.3''$ East. It is 16 km from Ubiaja along Ubiaja/ Illushi old road. The climate of Illushi is tropical with the dry season running from November to April and it is usually marked with a cool harmattan dusty haze from the North East winds while the wet season runs from May to October with a brief dry spell in August

*Corresponding Author Email: Osejimacpherson@gmail.com

known as August break. The inhabitants of Illushi rely on River Niger as their domestic water supply, and the people are actively engaged in fishing and farming. Three sampling stations were selected for this study based on human activities in these areas. Station 1 is 1100 meters upstream of station 2 while station 3 is 1500 meters downstream of station 2 (Fig 1). The anthropogenic activities observed in station 1 include washing of clothes, bathing, washing of

motorcycles and farming at the river bank. In station 2, bathing, clothes washing, washing of harvested rice, and transportation of goods and humans with boats were the activities observed place during the period of sampling. In station 3, transportation with boats, dumping of waste materials generated from the market and processing of local rice at the bank of the river were the human activities observed within this region during the sampling period.
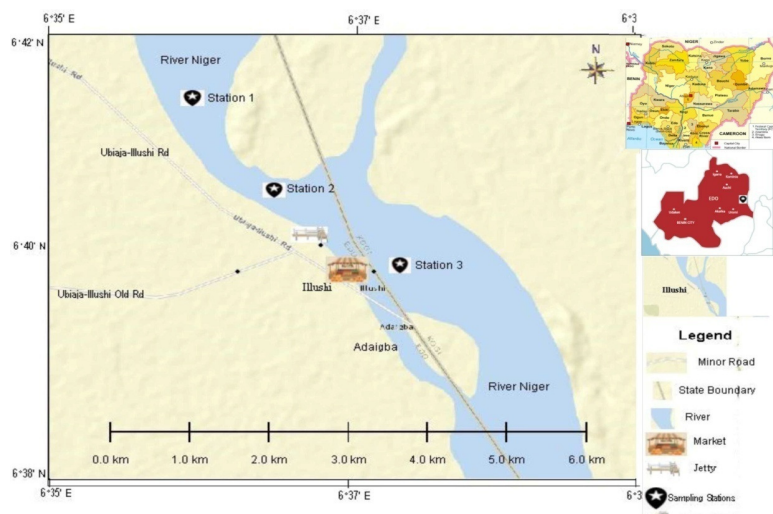

Fig. 1: Locations of sampled stations in the study area

Sample Collection: Samples were collected once a month for the period of eight months (April to November 2017). 1litre polyethylene bottles were used to collect water samples at 30 cm depth beneath the water surface according to the standard method (APHA, 2005). Prior to their use, the bottles were thoroughly washed and rinsed with deionized water. Dissolved oxygen (DO) and Biochemical oxygen demand (BOD) bottles (250 ml) were used to collect water samples for dissolved oxygen and biological oxygen demand respectively. Precautions were taken to minimize the risk of contaminating the samples as they were being transported to the laboratory. The *in-situ* measurement was carried out using a pH meter for pH, TDS/Conductivity meter for electrical conductivity. Dissolved Oxygen and Biochemical Oxygen demand were estimated using Winkler's method. The BOD was carried out after 5 days of incubation at 20°C. The other physical/chemical characteristics were examined using standard method (APHA, 1998).

Data Analysis: Data obtained from this study was statistically analyzed using the Statistical Package for Social Science (SPSS) version 16. Inter-station comparison was done using Analysis of variance (ANOVA) and Duncan Multiple Range (DMR) test

was performed to determine the point of significant difference.

RESULT AND DISCUSSION

A summary of some physical and chemical characteristics of surface water from River Niger, Illushi, Edo State recorded from April to November, 2017 is presented in Table 1. Among the physical and chemical characteristics investigated, water temperature, conductivity, total dissolved solids, alkalinity and phosphate showed significant difference between the stations, while air temperature, pH, turbidity, total suspended solids, chloride, hardness, nitrate, sulphate, calcium, DO, BOD and magnesium showed no significant difference ($p > 0.05$) between the stations. In general, air temperature ranged from 24 to 30 ^{0}C, the mean air temperature recorded in stations 1 and 2 were slightly higher than the permitted limit, while that of station 3 was lower than the permissible limit of 27^{0}C (WHO, 2004). Water temperature is an important factor for aquatic organisms to thrive, as it affects the rate of photosynthesis which aquatic organism needs to flourish. Water temperature ranged from 22 to 30^{0}C. Mean water temperature in stations 1 and 2 were lower than the permissible limit, while that of station 3 was slightly higher than the permissible limit. The

high water temperature recorded in station 3 could be due to low vegetation cover and degree of exposure to solar heat (WHO, 2004). Oboh and Agbala (2017) recorded water temperature range of 29.5^0C to 32.67^0C in River Siluko.

Table 1: Summary of physical and chemical characteristics of surface water in River Niger from April 2017 to November 2017

Parameters	Station 1 $\overline{X} \pm SD$	Min	Max	Station 2 $\overline{X} \pm SD$	Min	Max	Station 3 $\overline{X} \pm SD$	Min	Max	P-value
Physical properties										
Air Temperature (0C)	27.38±0.59	25	30	27.38±0.70	24	29.5	26.25±0.85	24	30	P>0.05
Water temperature (0C)	25.25±0.37[b]	24	27	25.69±0.88[b]	22	29	27.69±0.63[a]	25	30	**P<0.05**
Chemical properties										
pH	6.38±0.17	5.6	7.1	6.25±0.20	5.2	7	6.2±0.18	5.3	6.9	P>0.05
Turbidity (NTU)	167.38±49.18	35	433	85.35±29.87	14	243	69.12±13.65	28	140	P>0.05
Conductivity(us/cm)	75.62±8.42[a]	50	110	56.88±13.66[a]	10	110	38.75±2.79[b]	30	50	**P<0.05**
TDS (mg/l)	50.03±6.51[a]	26.5	84.8	33.13±6.57[b]	5.3	58.3	21.54±1.26[b]	15.9	26.5	**P<0.01**
TSS (mg/l)	109.6±33.5	22	288	57.19±19.58	11	162	48.31± 10.45	21	106	P>0.05
Alkalinty (mg/l)	42.12±3.86[a]	20	58	17.75±5.40[b]	6	54	20± 5.074[b]	4	44	**P<0.01**
Chloride (mg/l)	18.54±1.45	14.1	24.7	17.22±1.40	10.6	21.2	16.11±1.38	10.6	21.2	P>0.05
Hardness(CaCO3)(mg/l)	31.13±2.16	24	42	23.94±2.78	14	35	25.38±2.82	16	38	P>0.05
Phosphate (mg/l)	5.36±2.57[a]	0.25	19.9	0.65±0.14[b]	0.16	1.41	0.61±0.07[b]	0.29	0.88	**P<0.05**
Nitrate (mg/l)	4.94±1.89	0.59	15.4	2.72±0.51	0.88	5.22	1.92± 0.40	0.5	3.49	P>0.05
Sulphate (mg/l)	34.31±8.72	3	75	28.88±19.09	5	162	14.25±4.53	5	43	P>0.05
Calcuim (mg/l)	11.84±2.97	4.01	28.1	6.67±1.09	2.41	12.02	7.56± 1.15	1.6	11.2	P>0.05
Magnesium (mg/l)	3.33±0.66	1	6.8	2.62±0.25	1.5	3.4	2.04±0.25	1	3.4	P>0.05
DO (mg/l)	3.99±0.35	2.54	5.21	4.14±0.50	2.4	6.1	5.30±0.52	3.1	7.5	P>0.05
BOD (mg/l)	8.05±1.52	0.8	12.5	7.94±2.35	1.2	21.3	5.89±1.42	1.5	13.5	P>0.05

Note: p > 0.05 indicates no significant difference. p < 0.05 indicates significant difference. p < 0.01 indicates highly significant difference.

The pH range from 5.2 to 7.1 across the stations and all the stations had mean pH below 7, which indicates that the river is slightly acidic. The pH recorded in the three stations was lower than 6.6 to 8.5 recommended by WHO (2004). This study is in line with the study conducted by Andem *et al.* (2012) in Ona River. Turbidity is the determination of the muddiness or opaqueness of water and it is usually influenced by the total number of materials that are present in the water (Oboh and Agbala, 2017). Turbidity (14 to 433 NTU) was relatively high. The river was generally turbid as the turbidity values obtained in all the stations was higher than 5 NTU recommended limit (WHO (2004). This may have been influenced by phytoplankton in the open surface water (Chinedu *et al.*, 2011). The conductivity range of 10 to 110 µs/cm was observed across the 3 stations. The higher conductivity recorded in station 1 is as a result of a nutrient load of surface runoffs from farms as well as washing of nutrient-rich groundwater and solution of salts from inundated agricultural land at the bank of this station. Conductivity in this study is however below the recommended limit of 500 µS/cm by WHO (2004). The mean conductivity value recorded in this present study is lower than 3752.74 µS/cm recorded in New Calabar River (Agbugui and Deekae, 2014). Total Dissolved Solids (TDS) ranged from 5.3 in station 2 to 84.8 mg/l in station 1 and the high TDS in Station 1 is due to anthropogenic activities such as washing of motorcycles, washing of clothes, bathing and runoffs which may have brought in particles from the surrounding land. The average TDS in the study area was, however, lower than the permissible limit (WHO, 2004). Solids in water are undesirable, for they degrade the quality of water, inhibit the photosynthetic process and reduce the utility of water (Ogbeibu and Anagbaso 2004). Total Suspended Solids (TSS) ranged from 11 to 288 mg/l across the stations. Waste disposal and surface run-offs are the sources of TSS. The result obtained from this present study is contrary to the study conducted by Ofonmbuk *et al.* (2014) in Ediene stream. The monthly alkalinity values ranged from 4.0 to 58.0 across the three stations. The high alkalinity in station 1 is as a result of runoffs which carries allochthonous organic materials from farmlands at the bank of this station into the river. The mean value of alkalinity recorded in this present study was higher than 13.75 mg/l recorded by Francis (2011) in new Calabar river freshwater section but lower than the value recorded in Woji creek (Davies *et al.*, 2008). The highest mean chloride (18.54 mg/l) was recorded in station 1 and the lowest mean chloride was recorded in station 3. Chlorides occur naturally in rocks, other sources of includes fertilizers, sewage, and livestock wastes. The mean chloride recorded in all the stations was lower than WHO (2004) limit. A similar range was reported elsewhere in Edo state, Nigeria (Imoobe and Koye, 2011; Anyanwu, 2012). Hardness values ranged from 14.0 mg/l in station 2 to 42 mg/l in station 1. The hardness of water is the measure of the concentration of the multivalent cations, primarily it is equivalent to the calcium and magnesium concentrations of the water (Ababio, 2007). Epidemiological investigations have demonstrated a

relationship between the hardness of drinking water and the risk of cardiovascular disease, growth retardation, reproductive failure (Sengupta, 2013). Hardness values recorded in all the stations were lower than the limit (WHO, 2004). Phosphate mean of 5.36 mg/l was recorded in station 1, 0.65 in station 2 and 0.61 mg/l in station 3. The significantly higher phosphate recorded in station 1 may be as a result of the leaching of fertilizers residues from the farm at the bank of this station into the River by runoffs. Phosphate occurs naturally in rocks and is introduced into rivers as the water flows through the rocks. Excessive phosphate leads to a reduction in dissolved oxygen and an increase in eutrophication. The mean phosphate in the 3 stations was lower than the permissible limit (WHO, 2004). The result from this study is similar to the study conducted by Imaobong *et al.* (2012), but contrary to the study carried out by Osimen *et al.* (2015). The highest nitrate (4.94 mg/l) and sulphate (34.31 mg/l) mean were recorded in station 1 and the lowest means nitrate of 1.92 mg/l and sulphate of 14.25 mg/l were recorded in station 3. The sources of nitrate are municipal waste, refuse dump, decaying plant and animal materials. The mean nitrate in the 3 stations was lower than the permissible limit (WHO, 2004). This present study is contrary to the study conducted by Iyiola (2014). Though there was no significant difference ($p > 0.05$), the high sulphate in station 1 is as a result of agricultural activities such as the application of fertilizers which are transported by runoffs into the river (Essien-Ibok *et al.*, 2010). The mean sulphate in the 3 stations was lower than the permissible limit (WHO, 2004). 0.01 – 26.60 mg/l was recorded by Okorafor *et al.* (2013). Calcium ranged from 1.60 in station 3 to 28.10 mg/l in station 1. Magnesium ranged from 1.0 to 6.8 mg/l across the stations. Calcium and Magnesium are among the most common minerals found in rocks and as such, they occur in waters and their salts are important contributors to the hardness of water. Calcium is required for bone and teeth formation. Magnesium mean value was lower than WHO, (2004) limit. The least mean for Dissolved Oxygen (3.99 mg/l) was observed in station 1, while the highest mean (5.30 mg/l) was recorded in station 3. The low DO in station 1 could be due to the enormous amount of organic loads from the surrounding farmlands which require a high level of oxygen to break down. The mean DO in stations 1 and 2 were lower than the permissible limit while that of station 3 was higher than the limit (WHO, 2004). The DO range value recorded in this study is similar to 0.58 – 10.00 mg/l recorded by Ikongbeh *et al.* (2014) in Lake Akata. Biochemical Oxygen Demand (BOD) is a measure of the amount of oxygen required by micro-organism to break down organic matter in 1 liter of water (Clair *et*

al., 2003). It is used to determine the pollution strength of wastewater. BOD which had the least mean (5.89 mg/l) in station 3 and the highest mean (8.05mg/l) in station 1. The mean BOD recorded in the 3 stations were higher than the permissible limit (WHO, 2004). The mean BOD values recorded in this present study is lower than 405.57 mg/l recorded in Ona River by Andem *et al.* (2012).

Conclusion: This study has shown that turbidity, dissolved oxygen, biochemical oxygen demand, air and water temperature of River Niger, Illushi, Edo State, Nigeria were higher than the recommended level for drinkable water, during the period of this study. This, therefore, stresses the need for compliance of environmental laws to prevent the river from further deterioration.

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