Physicochemical Characteristics of Water and Sediment from Udo Nde Stream in Usuk Ibiaku, Ibiono Ibom, Akwa Ibom State, Nigeria

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Abstract- ***The study evaluated the physical characteristics of water and sediment from Udo Nde Stream of Usuk Ibiaku in Ibiono Ibom Local Government Area of Akwa Ibom State, Nigeria. The American Public Health Association (APHA) and American Society for Testing and Materials (ASTM) standard methods were used to analyse the physical characteristics of water and sediment. The obtained results for water samples were pH ranged from 7.20 to 7.43, Temperature (28.00 ºC), Electrical conductivity from 18.58 to 21.56 µS/cm, Salinity (ND), TDS from 13.40 to 15.67 mg/L, DO varied from 6.15 to 6.23 mg/L, BOD ranged from 1.96 to 2.43 mg/L, Alkalinity varied between 7.84 to 8.23 mg/L, Total Hardness from 16.43 to 18.56 mg/L, Turbidity (ND), Nitrate from 0.52 to 1.23 mg/L, Chloride ranged from 8.03 to 8.42 mg/L and Phosphate from 0.01 to 0.02 mg/L. The results obtained for the sediment were pH varied between 6.52 and 6.98, Electrical conductivity from 9.43 to 10.78 µS/cm, Nitrogen ranged from 0.43 to 0.49 %, Potassium from 0.56 0.68 %, Phosphate from 8.43 to 9.54 mg/kg, Clay ranged from 56.24 to 58.09 %, sand from 36.68 to 37.10 %, Silt from 4.81 to 7.08 %, TOC varied between 0.67 and o.73 %) and TOM ranged from 1.08 to 1.32 %. It was observed that the result obtained were within the permissible limits of NESREA and WHO. The results showed that the water samples from the study area are fit for consumption and other domestic use.***

Indexed Terms- ***Contamination, Physicochemical Parameters, Pollution, Sediment, Water.***

I. INTRODUCTION

Water is essential for nature and humans alike. Surface waters are subjected to enormous pressures estimates indicate that in developing countries surface water may already be affected by severe pollution due to its easy accessibility to wastewater disposal. Pollutants in contaminated water, it is very difficult, costly, and often impossible to remove. In many countries of the world including Nigeria, good and sufficient drinking water has been a major challenge due to the fact that the supplied drinking water become contaminated with some toxicants which impart negatively on human [10]. The contaminants which include heavy metals, bacteria, virus, nitrate, etc. are found in supplied water as a result of improper disposal of waste from human, livestock, industrial discharges and improper treatment of the water before supply [18]. In most communities, streams water is the major source of drinking water.

Sediment is the loose sand, silt and other soil particles that settle at the bottom of a body of water. Sediment strata serve as an important habitat for the benthic macro invertebrates whose metabolic activities contribute to aquatic productivity [1]. Sediment is also the major site for organic matter decomposition which is largely carried out by bacteria. Important macro-nutrients such as nitrogen and phosphorous are continuously being interchanged between sediment and overlying water [1].

Meeting water quality expectations for streams and rivers is required to protect drinking water resources, encourage recreational activities and to provide a good

environment for fish and wildlife. Therefore, assessment of pollution status of rivers is of ecotoxicological importance. Of the aquatic ecosystem, water soluble wastes and other materials that are dumped, spilled or stored on the surface of the land or in sewage disposal pits can be dissolved by precipitation, irrigation [4].

Sediment sources in aquatic ecosystem include soil erosion, decomposition of plants and animals and discharge of effluents [19]. Wind and water help to carry these particles to rivers. Sediments are contaminated with different pollution from effluent discharges and run off into the river [16]. The percentage of silt and clay in river sediments can have impact on the structure of the biotic assemblage. Heavy metals are wide spread pollutants of great environmental concern as they are non-degradable, toxic and persistent with serious ecological ramifications [11].

This study is therefore aimed at assessing the physical characteristics of surface water and sediment from Udo Nde Stream in Usuk Ibiaku, Ibiono Ibom, Akwa Ibom State, Nigeria to assess the level of contamination in the water.

- Study Area

The study was carried out in Udo Nde Stream in Usuk Ibiaku, Ibiono Ibom, Akwa Ibom State, Nigeria The sampling locations lies between Latitude 05º 09' 57.7" N and Longitude 007º 534.4'' E for Station I, Latitude 05º 09' 55.8'' N and Longitude 007º 53' 306'' E for Station II. The stream (surface water) is located downstream of the spring water. It is characterized by moderate flow and a vast flood plain. The activities that take place here include bathing, washing of cloths and farming.

II. MATERIALS AND METHODS

- Samples Collections

The samples of surface water and sediments were collected in two stations from Udo Nde Stream in duplicate using washed and air-dried polyethylene containers and polyethene bags respectively. Amber bottles were used to collect samples for Biochemical oxygen Demand (BOD) and Dissolved Oxygen (DO). The samples were placed in a cooler with ice blocks to avoid contamination of the samples and were moved to the laboratory.

- Preparation of Samples

The water samples were properly labelled, stored in the refrigerator at a temperature below 4 ºC before the analysis. The samples in the amber bottles were stored at a temperature of about 20 ºC for five days before analyzing for the biochemical oxygen demand (BOD_5). The sediments samples were air-dried, ground and sieved using a 2mm mesh size sieve.

- Analysis

In water sample, some of the physicochemical parameters such as pH, temperature, DO and turbidity were examined in situ. The pH of the water samples was measured immediately at the point of collection using a Digital pH Meter (Model 6 PFCE). The digital pH meter was switched on and allowed to stand for few minutes. It was then standardizing with a buffer solution. The probe of the pH meter was introduced into a beaker containing 100 ml of the water sample and the measurement was taken at a stable reading, duplicate reading was taken and the average was recorded. The probe of the meter was rinsed with distilled water after each measurement before taking another measurement. A mercury in-glass thermometer was used to measure the temperature of the water sample at the point of collection. The bulb of the thermometer was immersed in a beaker containing 100 ml of the water samples. The thermometer was held for about 3 – 5 minutes at a stable reading and was recorded in degree centigrade (ºC). Standard methods of analysis [7], were used to examine all the physicochemical parameters of the water and sediment samples. Analysis of sediments was performed to determine total nitrogen (N), phosphorus (P), and potassium (K). Other parameters included grain size, pH, electrical conductivity, and organic matter content. The organic matter content may be estimated by first establishing the organic carbon present in a soil sample, after which the value is multiplied by a constant value of 1.724 [2]. The rapid wet oxidation method was used to determine the organic carbon (OC) in the sediments. The total organic carbon was multiplied by a factor of 1.724 to obtain the organic matter (OM) content in the sediments. Phosphorous and potassium were determined using the ICP-OAS

method, while Kjeldahl method was determined nitrogen content [8].

III. RESULTS AND DISCUSSION

The results of the physical characteristics of water and sediment samples from Udo Nde Stream are presented in Table 1 and Table 2 respectively. The obtained results for water samples were pH ranged from 7.20 in station 1 to 7.43 in station 2, Temperature was 28.00 º C in both stations, Electrical Conductivity from 18.53 µS/cm in station 2 to 21.56 µS/cm in station 1, Salinity and Turbidity were not detected in any of the Stations. TDS varied between 13.40 mg/L in station 2 and 15.67 mg/L in station 1, DO ranged from 6.15 mg/L in station 1 to 6.23 mg/L in station 2, BOD ranged from 1.96 mg/L to 2.43 mg/L, COD from 3.40 mg/L to 3.70 mg/L, Total Hardness varied between 16.43 mg/L in station 2 and 18.56 mg/L in station 1, Nitrate, Chloride and Phosphate ranged from 0.52 mg/L to 1.23 mg/L, 8.03 mg/L to 8.42 mg/L and 9.84 mg/L to 10.78 mg/L respectively. The results for sediment samples were pH values ranged from 6.52 to 6.98, Electrical Conductivity from 9.43 µS/cm to 10.78 µS/cm, Nitrogen and Potassium ranged from 0.43 % to 0.49 % and 0.56 % to 0.68 % respectively, Phosphates varied between 8.43 mg/kg to 9.54 mg/kg, Clay, Sand and Silt were ranging from 56.24 % to 58.09 %, 36.68 % to 37.10 % and 4.81 % to 7.08 % respectively. The organic carbon (TOC) were from 0.67 % to 0.73 % and Total organic matter (TOM) from 1.08 % in station 2 to 1.32 % in station 1.

Table 1: Physicochemical Parameters of Surface Water

Parameter	STN 1	STN2	Mean±STD	NESREA	WHO
pH	7.20	7.43	7.32±0.16	6.0-8.5	6.5-8.5
Temp. (ºC)	28.00	28.00	28.00±0.00	40	40
EC (µS/cm)	21.56	18.53	20.04±2.14	1000	1000
Salinity (mg/L)	ND	ND	ND	200	250
TDS (mg/L)	15.67	13.40	14.54±1.61	500	500
DO (mg/L)	6.15	6.23	6.19±0.05	10	5-10
BOD (mg/L)	2.43	1.96	2.20±0.33	6	5
Alkalinity (mg/L)	7.84	8.23	8.04±0.28	30	10
COD (mg/L)	3.40	3.70	3.55±0.21	600	200
Hardness (mg/L)	18.56	16.43	17.49±1.50	500	500
Turbidity (mg/L)	ND	ND	ND	5	5
Nitrate (mg/L)	0.52	1.23	0.88±0.50	40	50
Cl (mg/L)	8.03	8.42	8.23±0.23	250	250
P (mg/L)	0.02	0.01	0.02±0.01	3.5	0.50

The mean concentrations of the pH (7.32 ± 0.16) were within the National and International Standard limits range of 6.5 to 8.5 [14 and 22]. The pH of 7.32 ± 0.16 was agreed compared to the value of pH (7.24 ± 0.09) recorded for surface water in the determination of physicochemical parameters and heavy metals levels of surface and ground water of Ibiaku Osuk community in Akwa Ibom State, Nigeria [13] and was higher compared with the pH values of 6.75 ± 0.89 - 7.07 ± 1.07 in the stations recorded in the evaluation of physicochemical characteristics of surface water from Orashi River, Rivers State, Southern Nigeria [9]. The mean concentrations of electrical conductivity (EC) of 20.04 ± 2.14 µS/cm was below the National and International Standard limits and was also low compared with the values of EC (9690.33 ± 1112.78 µS/cm) as recorded in the determination of levels of physicochemical parameters in water samples of New Calabar River, Rivers State, Nigeria [20].

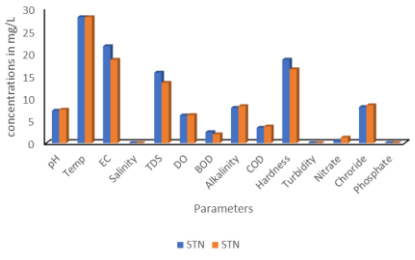

Figure 1: Concentrations of Physical Characteristics of Water

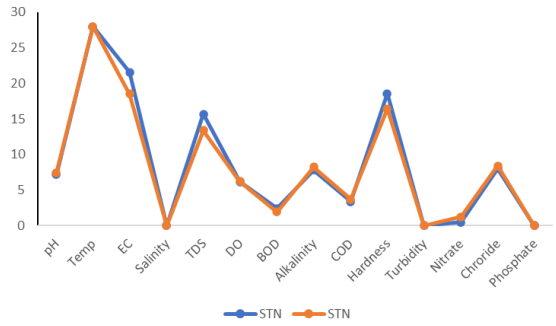

Figure 2: Plot of concentration of physical characteristics of water.

The mean values of DO (6.19 ± 0.05 mg/L), BOD (2.20 ± 0.33 mg/L) and COD (3.55±0.21 mg/L) were all below the National and International standard limits for drinking water. The values of DO (6.19 ± 0.05 mg/L) in the study was higher compared the value of DO (5.90 ± 0.35 mg/L) and the values of BOD (2.20 ± 0.33 mg/L) and COD (3.55 ± 0.21 mg/L) were low compared with the values of BOD (12.21 ± 2.31 mg/L) and COD (18.27 ± 3.50 mg/L) as recorded in the determination of the concentrations of physicochemical parameters and trace metals in the New Calabar River [15]. The results of the study revealed that the mean concentrations of TDS, Alkalinity, Total Hardness, Nitrate, Chloride and Phosphate in the water samples were below the permissible limits [22]. The mean value of TDS (14.54 ± 1.61 mg/L) in the study was high compared with the value of TDS (7.38 ± 0.55 mg/L) in the determination of physicochemical parameters and heavy metals levels of surface and ground water of Ibiaku Osuk community in Akwa Ibom State, Nigeria [13]. The high concentrations of suspended and dissolved solids may be hazardous to aquatic creatures because they reduce water quality, hinder photosynthetic activities, and eventually result in a rise in bottom silt and a decrease in water depth. The degree of contamination in water maybe as a result of higher quantity of TDS present in the water.

Table 2: Physicochemical Parameters of Sediment

Parameter	STN 1	STN 2	Mean±SD	NESREA
pH	6.98	6.52	6.75±0.32	6.5 – 8.5
EC	10.7	9.43	10.11±0.9	-
(µS/cm)	8	0.49	5	-
N (%)	0.43	0.68	0.46±0.04	-
K (%)	0.56	8.43	0.62±0.08	10
P	9.54	58.0	8.89±0.78	-
(mg/kg)	56.2	9	57.16±1.3	-
Clay (%)	4	37.1	1	-
Sand (%)	36.6	0	36.89±0.2	2
Silt (%)	8	4.81	9	-
TOC (%)	7.08	0.73	5.94±1.60	
TOM	0.67	1.08	0.70±0.04	
(%)	1.32		1.20±0.16	

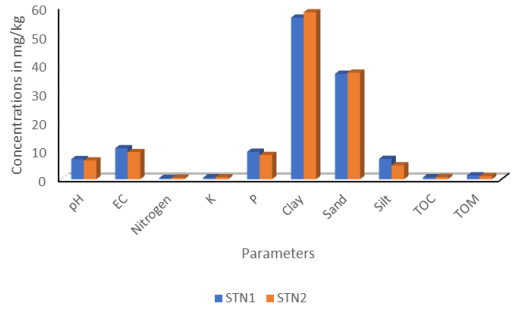

Figure 3: Concentrations of physical characteristics of the sediment

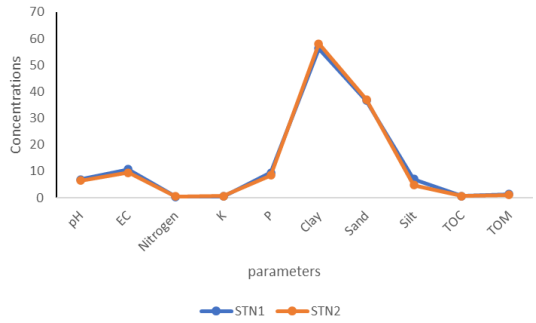

Figure 4. Plot of concentrations of physical characteristics of the sediment

In this study, the mean concentrations of Alkalinity (8.04 ± 0.28 mg/L) and Total Hardness (17.49 ± 1.50 mg/L) were similar compared with the values of 8.42 ± 0.37 mg/L and 18.74 ± 1.17 mg/L for Alkalinity and Total Hardness respectively in the determination of physicochemical parameters and heavy metals levels of surface and ground water of Ibiaku Osuk community in Akwa Ibom State, Nigeria [13]. The values of Alkalinity and Total Hardness were lower compared with the values if Alkalinity (39.00 ± 0.65 mg/L) and Total Hardness (5024 ± 1543mg/L) and also the means concentrations values of Nitrate (0.85 ± 0.50 mg/L) in the study were higher compared with the values of Nitrate (0.48 ± 0.20 mg/L) and Phosphate (0.02 ± 0.01 mg/L) was low compared with the value

of Phosphate (0.69 ± 0.02 mg/L) as recorded in the assessment of physicochemical parameters and heavy metal levels in surface water and sediment of Mgbuodohia River, Port Harcourt, Nigeria [5].
The zero values of Salinity and Turbidity observed in the study showed that there is no dissolved salts present in the water and also showed the clear nature of the water. Chloride values in the sampled stations varied from 8.03 – 8.42 mg/L. The mean concentrations of chlorides (8.23 ± 0.23 mg/L) observed in the stream were lower than the stipulated limit of 250 mg/L in drinking water by NESREA and WHO. The concentrations of chlorides in the Udo Nde Stream at the time of analysis were higher than the value observed in Orashi River, Rivers State, Southern Nigeria [9], and those of Nde, [13], in surface water of Ibiaku Osuk community in Akwa Ibom State, Nigeria.

The mean values of pH in the sediment samples was 6.75 ± 0.32 which were within the ranged of 6.5 to 8.5 of national standard limit [14]. The pH values obtained for the sediment in the study was agree with the values obtained by Allois et al, [6] in the physicochemical properties of bottom sediments in Maruba Dam Reservoir, Machakos, Kenya. The conductivity means values of 10.11 ± 0.95 µS/cm obtained in the study was lower compared with values of conductivity (266.21 ± 151.63 µS/cm) recorded in the assessment of physicochemical characteristics of sediment from Nwaja Creek, Niger Delta, Nigeria [3] and also low compared with the values obtained for conductivity by Okaa & Ogu, [17] in the study of the physicochemical analysis and seasonal variations of sediment and water samples from selected surface waters in Anambra State, Nigeria.

The mean nitrogen, potassium and phosphorus contents of the Udo Nde Stream sediments were o.46 %, 0.62 % and 8.89 % respectively. The values of nitrogen and potassium were high and phosphorus were low compared with values of 0.12 %, 0.46 % and 12.809 mg/kg obtained for nitrogen, potassium and phosphorus respectively by Allois et al, [6] in the physicochemical properties of bottom sediments in Maruba Dam Reservoir, Machakos, Kenya. The nitrogen content in bottom sediments provides critical information about the quality of sedimentary organic These values were quite low compared to one-component or even multicomponent fertilizers. The level of macronutrients in the reservoir suggests increased anthropogenic activity in the catchment area [12]. The total organic carbon values ranged from 0.67 % - 0.73 % with the mean concentrations of 0.70 ± 0.04 %. The obtained values of organic carbon were low compared with the value of organic carbon (0.98% - 4.58%) recorded in the study of the assessment of physicochemical characteristics of sediment from Nwaja Creek, Niger Delta, Nigeria [3]. The organic matter in the sediment samples ranged from 1.08 % - 1.32 %. The values were low compared with the values obtained for organic matter in the study of the physicochemical properties of bottom sediments in Maruba Dam Reservoir, Machakos, Kenya [6]. With regards to sediments, organic matter is described as a reservoir for nutrients where it holds and binds them together, thereby ensuring that they are not permanently available. The high content of protein in organic matter results from the activities of aquatic organisms and the decomposition of plant and animal remains [21].

CONCLUSION

The physical characteristics of surface water and sediments samples of Udo Nde Stream were analyzed and the results obtained showed that all the parameters were below and within the National and International standard limits. The results showed that the Udo Nde Stream is fit and suitable for consumption. It is therefore recommended that the physical parameters of the water should be monitoring regularly in order to check the water quality in case of development of activities in the area.

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