International Journal of
Science and Engineering Investigations vol. 6, issue 64, May 2017
ISSN: 2251-8843

Sediment Characteristics of Oruku River, Ota, South Western, Nigeria

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Abstract- A baseline study of Oruku River was performed to determine the physical and chemical characteristics (pH, TOC, PSA and heavy metals) of the sediments. Twenty (20) sediment samples were collected in four batches of sampling and analysed to ascertain a possible contamination of the river sediments. Particle size analysis (PSA) of the sediment revealed that they were all sandy sediments except for SD1 and SD2 that were sandy loam sediments with values ranging from 79.70±6.28% to 96.15±1.39%. The average %TOC (Total Organic Carbon) in the sampled sediments ranged from 2.67±2.23 to 6.32±4.07%. Analysis of heavy metal content showed average Zn level of 15.094±20.90 to 35.969±29.76mg/L.

Keywords- *Sediments, Total Organic Carbon, Particle Size Analysis*

I. INTRODUCTION

Sediments are a natural part of a stream, lake or river and the type and amount found in streams are influenced by the geology of the surrounding area [1]. Sediments can enter streams alongside a reach or from upstream via the myriad smaller interconnecting streams that form a river network within a catchment area. Though this is a natural process of a functioning freshwater ecosystem, human activities around a waterway (such as dam or road construction or land use change from native forest to pasture) can greatly increase the amounts of sediments that enter the system. Sediments in rivers provide a natural buffer system and an important habitat for aquatic organisms [2]. Their variable physical and chemical properties make them act as source and sink of nutrients in an aquatic system and also provide a record of the rivers' pollution history [3-5]. Oftentimes, rivers are recipients of industrial effluents as they are directly discharged into them. As a result, various kinds of hazardous and toxic substances have been found, including trace elements to accumulate in sediments of such rivers. Industrial effluents disposal is not the only pathway of introduction but also includes terrestrial runoff, leachates carrying chemicals originating from numerous urban, industrial, and agricultural activities, as well as atmospheric deposition [4,6,7]. The study area houses several industries amongst which are iron and steel industries, food and beverage industries, etc. These industries generate liquid wastes (effluents) which are discharged (treated or untreated) through dug gutters into the nearby Oruku River. The contaminants in the effluents will over a period of years accumulate in the river sediments. This thus necessitates the analysis of the sediments to evaluate the pollution status.

II. MATERIALS AND METHODS

A. Description of Study Area

River Oruku is located in Ado-Odo/Ota local government, Ota, Ogun state in South-western, Nigeria and originates from Mopin Community and runs through Iyesi and Ijaba communities and adjourns to the Owo River. The industrial estate is also located in the capital of this same local government area. Ota is at $6^{o}41'00''$ $N3^{o}41'00''E$ to the north of the local government area.

B. Sediment sampling and pre-treatment

A total of twenty (20) sediment samples were collected as grab samples at five different locations in four batches of sampling. They were collected in polyethylene bags labelled SDM1 to SDM5 and later air-dried, grinded and sieved with 2mm sieve and preserved in polyethylene bags prior to analysis.

C. Laboratory analysis

Sediment samples were analysed for the following properties: pH, TOC, PSA and heavy metals according to APHA standard method of analysis [8].

III. RESULTS AND DISCUSSION

Table 1 presents the results of this study. Particle size analysis helps in determining the availability of oxygen in the soil or sediments, mobility of water into or through sediments and the case of root penetration. The average of %silt values of the sediments ranged from 1.45 ± 0.41 to 9.85 ± 3.36%. SDM2 recorded highest average %silt of 8.85±3.66% and SDM3 recorded the lowest average %silt of 1.45±0.41. The average %clay values ranges from 2.25±1.71 to 14.50±5.93% while average %sand ranged from 79.70%±6.28 to 96.15±1.39. The overall particle size analysis average results showed that SDM3, SDM4 and SDM5 were all sandy sediments with the following order of decreasing %sand: SDM4>SDM3>SDM5. However, SDM2 (77.95±7.73%sand) and SDM1 (79.70±6.28%sand) were sandy loam sediments.

Total organic carbon (TOC) in sediments can have its origin either from organic matter from natural sources such as plant materials deposited on sediments or anthropogenic inputs to aquatic systems. The average %TOC in sediments ranged from 2.67±2.23 to 6.32±4.07%. SDM1 recorded the highest average %TOC of 6.32±4.07% which is an indication of presence of higher amount of organic matter in the sediments which may be from natural or anthropogenic sources.

The average pH values ranged from 5.03±0.10 to 7.78±0.76. The pH values were found to be decreasing at each sampling point in the order of SDM5>SDM4>SDM3>SDM2>SDM1. Aquatic organisms are affected by pH because most of their metabolic activities are pH dependent [9]. Optimal pH range for sustainable aquatic life is pH 6.5 – 8.2 [10]. Sediments sampled at SDM4 and SDM5 had average pH values of 6.146±0.30 and 7.78±0.76 respectively and could be said to be within the optimal pH range.

TABLE I. SEDIMENT CHARACTERISTICS OF ORUKU RIVER

Sample ID/Parameter	SDM1	SDM2	SDM3	SDM4	SDM5
% Silt	5.80±0.37	8.85±3.36	1.45±0.41	1.60±0.37	3.85±2.80
% Clay	14.50±5.93	11.20±4.44	3.40±0.99	2.25±1.71	2.50±1.57
% Sand	79.70±6.28	79.95±7.73	95.15±1.39	96.15±1.97	93.70±4.11
% TOC	6.32±4.07	3.90±2.72	3.11±2.45	3.58±2.49	2.67±2.23
pH	5.03±0.10	5.23±0.38	6.18±0.33	6.43±0.30	7.78±0.76

Overall average heavy metal levels in sediments were generally high except for Co and Cd that had average level range of 0.639±0.77 to 3.394±2.62mg/kg. The average level of Zn (15.094±20.90 to 35.969±29.76mg/kg) was higher than that obtained for other heavy metals. As documented in earlier research [11, 12], the heavy metal levels in the surface water of the same river (recipient of industrial effluents) and the effluents being discharged were lower than that obtained for the river sediments. High level of heavy metals in the sediments can be attributed to accumulation of heavy metals from the surface water over a period of time and these can be accumulated in aquatic organism present in the water bodies.

TABLE II. AVERAGE HEAVY METAL LEVELS ORUKU RIVER SEDIMENTS

Sample ID/Parameter	SDM1	SDM2	SDM3	SDM4	SDM5
Zn(mg/Kg)	33.238±32.66	35.969±29.76	15.094±20.90	27.993±22.52	22.343±15.85
Pb(mg/Kg)	17.681±13.91	28.513±28.12	8.506±5.96	10.950±9.76	9.581±8.58
Cr(mg/Kg)	11.750±2.07	10.925±4.99	12.988±9.26	9.088±4.59	13.169±4.51
Co(mg/Kg)	2.300±1.65	3.394±2.62	0.639±0.77	1.706±2.74	1.006±1.26
Cd(mg/Kg)	0.450±0.37	0.631±0.49	0.281±0.23	0.363±0.33	0.388±0.38
Ni(mg/Kg)	12.313±6.17	11.800±7.97	3.275±1.46	7.081±7.72	3.513±2.03
Cu(mg/Kg)	8.331±5.13	10.869±8.72	2.769±1.30	4.931±4.91	3.281±1.97

The sediment characteristic of Oruku River was investigated in this study. It was observed that the sediments were mostly sandy and sandy loam types. Based on the pH values of the sediments analysed, the water source is safe for aquatic life. However, the accumulated heavy metal levels were above limits of proposed effluent discharge standards. This may not be a threat at the long run if the industries in the study area continue treating their liquid wastes. The organic load of the sediments especially at the river source (SDM1) which is closer to residential homes is an indication that residents have a part to play in either increasing or reducing the pollution level of the water bodies.

ACKNOWLEDGEMENT

My utmost thanks goes to Almighty God for life and sustenance. I also appreciate the time and effort my supervisor, Dr. E.U. Etim spent in guiding me. I say thank you to my family for their support and also to my mentor, Prof. (Mrs) Monioluwa Olaniyi of the Department of Pure and Applied Sciences, National Open University of Nigeria.

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