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The Role of Structural Characteristics of Soft Sediment on Absorption of Total Hydrocarbon Content (THC) and Physicochemistry Due to Human Induced Pollution in The Lower Bonny Estuary, Rivers State, Nigeria.

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Abstract: The role of structural characteristics of soft sediment on absorption of total hydrocarbon content (THC) and physicochemistry due to human induced pollution in the lower bonny estuary were studied in a bid to measure the danger of human actions along the catchments on the estuary. Samples were collected and analyzed from five sampling stations representing fuel depot site, garbage dump, fishing spots, living quarters and an upstream station far removed from direct human impacts (control). Sediment samples were collected for six months representing wet and dry seasons. Samples were analyzed for THC, Organic Carbon, phosphate (PO_4), Electrical conductivity (EC), and pH. Sediment particle was also determined by the hydrometer method. Result from the investigation reveal that there were significant seasonal differences in measured parameters ($p<0.05$). pH and THC and EC in wet season>dry season. While Organic Carbon and PO_4 in wet season < dry season. Sample stations did not show any significant difference ($p>0.05$). Soil sediment analyses reveal that percentage of sand in sediment was uniform throughout the wet and dry season and all sample stations. Clay content was constant in all stations in dry season but fluctuated in the wet season between stations. Silt content in sediment fluctuated between stations in both wet and dry seasons. THC and physico-chemical parameters did not have any direct correlation with sediment characteristics.Station 5 (control) revealed lower values in almost all measured. parameters compared to other stations, implying greater ecological stability in the control station. The findings of this work is suggestive of the fact that Bonny estuary is under a subtle threat from land-based activities.

Key Words: Sediment, Hydrocarbon, Physico-chemistry, Bonny Estuary, Nigeria.

I. Introduction

The Niger Delta is the economic bread basket of Nigeria. It provides over 90% of the entire earning for the country and a remarkable amount of its energy needs. It is constantly inundated with industrial activities of oil majors, exploring and exploiting its massive crude oil and gas reserves. The water ways therefore support a massive amount of marine transport moving throughout its fragile ecology.

The Bonny estuary is an example of such water bodies in the Niger Delta. Situated in the east of the Niger Delta, Bonny estuary is a thoroughfare to numerous amounts of industrial activities and commercial endeavour. On its shore are located tank farms, a veinous network of pipelines, flow stations, crude oil loading bay, living quarters and offices, condensation plants, liquefied natural gas and waste dumpsites. All these structures, facilities and activities located in the river catchments contribute organic and inorganic additions into the river that slowly degrade and alter the natural conditions of the water.

Frequently, organic and inorganic compounds in water are integrated into particles and later dumped on the sediment bottom and finally sink or re-surface in water column where they may modify the ecological state and system harmony [1]. However, the quality and quantity of the pollutant implicated in water will depend on the type of activity in the river catchment, the seasonal variation and the substrate characteristics of the receiving water body.

Polluted water can pose a serious threat to the survival and well being of aquatic organisms including fish health. As the lower Bonny estuary provides a readily available example of such a receiving water body, there is a critical need to monitor its chemical characteristics and substrate characteristics. This will provide useful information as regards its ecological health. This is

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fundamental because Bonny estuary supports a productive fishery that provides food and livelihood for people in the Niger Delta and far beyond.

II. Materials and Methods

2.1 Study Area

The lower Bonny River is found in the Niger Delta., south east of Nigeria. The Bonny River system is a combination creeks and creeks-lets and large number of connected rivers. The Bonny rivers system has the most extensive tidal magnitude of all the river systems in the Niger Delta and the most smitten by tidal fluctuations [2].

2.2 Sampling Stations and Schedule

Five sampling stations were identified and established. Stations 1-4 are within the area of direct impact, while station 5 served as the control area due to its location upstream. Samples were obtained for three months each during the wet and dry seasons at each sampling station.

Table 1: Sampling stations in the River Catchment

S/N	STATIONS	Description of Sampling Stations
1	Station 1	Petroleum product dumps site along the Bonny Estuary
2	Station 2	Refuse dump site along the Bonny Estuary
3	Station 3	Fishing settlement along the Bonny Estuary
4	Station 4	Area behind residential Units in Bonny Estuary
5	Station 5	Located up-stream far removed from human interference

2.3 Sample Collection

Sediment samples were collected within the littoral zone using a soil auger then packaged in Aluminum foil and stored in cool conditions for transport to the laboratory.

2.4 Sediment Quality / Sediment Analysis

Sediment samples were analyzed for pH, organic carbon, total hydrocarbon content (THC), electrical conductivity (EC), available phosphorus and particle size

2.5 Physicochemical Analysis

2.5.1 pH

Sediment pH were determined using a pH meter using a 1:1 soil to water ratio sample. A pH meter was used to determine the actual pH.

2.5.2 Organic Carbon

The Walkley black method as described by Walkey and black [3] was used to determine Organic carbon in soil.

2.5.3 Total Hydrocarbon Content (THC)

Sediment samples for total hydrocarbon analysis was air-dried, homogenized and ground. Toluene was extracted by shaking 10g of sediment sample with 20ml of toluene and the oil extracted determined in spectrophotometer at 420mm wavelength. Oil concentration in the sample was calculated using standard factor and the absorbance [4].

2.5.4 Electrical Conductivity

Electrical conductivity in the sediment sample was determined using the Lovibond conductivity / TDS meter (TPE Cn12).

2.5.5 Available Phosphorus

The Bray/Kurtz's method was employed to determine available phosphorus in the sample. 2.5g of sediment sample was weighed and placed in a 100ml plastic bottle. Twenty millimeters extracting solution was added and stirred for a minute in a horizontal

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shaker, and an adequate amount of extract was filtered. One millimeter of the extract was added and stirred and then left to stand for 1hr. The degree of light penetrance was measured in the spectrophotometer at a wave length of 720nm using the blank as a reference.

2.6 Particle Size Analysis

The hydrometer method as described by Bonjoucos [5] was used for determination of particle size in this study.

III. Result

3.1 Sediment Parameters

3.1.1 pH

pH values in sediment ranged from 4.60 ± 0.03 in station 4 to 6.34 ± 0.15 in station 2 in the dry months of January and April 2009. While the wet months May and June recorded mean PH value of 5.31 ± 0.13 in station 4 to 7.16 ± 0.06 in stations 1. The wet season had higher pH values than the dry season.

3.1.2 Electrical Conductivity

Electrical conductivity value ranged 1673 ± 249 µs/cm in station 1 and 2453 ± 169µs/cm station 5 in the dry months of January and April 2009, while the wet season had a mean value of 2069 ± 70 µs/cm in station 4 and 3427 ± 39 µs/cm in station 3.

3.1.3 Organic Carbon

Organic Carbon value ranged from 0.66 ± 0.90 in station 1 and 2.6 ± 0.53 in station 3 in the months of January and April while the months of May and June recorded the mean value of 0.11 ± 0.01 in station 5 and 0.35 ± 0.04 in station 1.

3.1.4 Total Hydrocarbon Content

THC value ranged from 26.32 ± 3.54 in station 1 and 235. 64 ± 6.46 in station 4 in January and April. while wet season had a mean value of 35.21 ± 0.71 in station 4 and 339.74 ± 2.12 in station 3.

3.1.5 Phosphate

Phosphate value ranged from 0.59 ± 0.25 in station 3 and 5.84 ± 0.51 in station 1 in the months of January and April, while the wet season had a mean value of 0.35 ± 0.00 in station 4 and 2, 2.17 ± 0.08 in station 1 and 2 respectively.

3.2 Sediment Characteristics

3.2.1 Clay

The mean clay content for the sediment ranged from 12% to 25% for the entire study period in all the stations. In the dry season (January and April) the percentage of clay in the sediment was same in all sampled station (20%). The wet season had a percentage clay value of 25% in stations 1, 2 and 5 and 12% and 13% respectively in station 3 and 4.

3.2.2 Silt

The mean silt content of the surface sediment ranged from 16% in stations 2, 3 and 4 and 31% in station 1 for the wet season. January and April in the dry season recorded mean values of 8% in station 2 and 31% in station 3.

3.2.3 Sand

The mean sand composition throughout the study was the same for all stations in both the wet and dry seasons respectively (20%).

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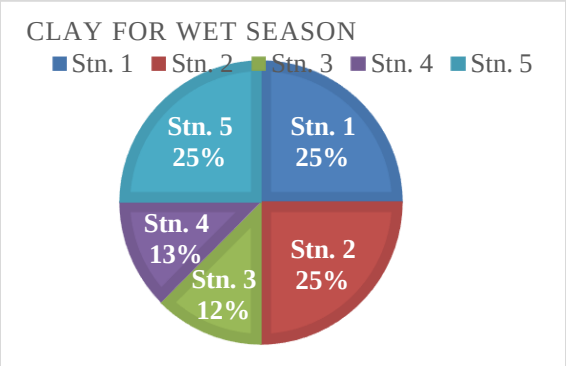

Figure 1: Percentage Clay for Wet season

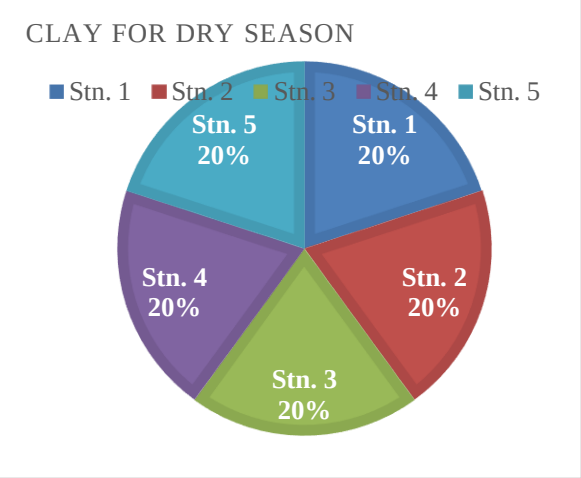

Figure 2: Percentage Clay for and Dry Season.

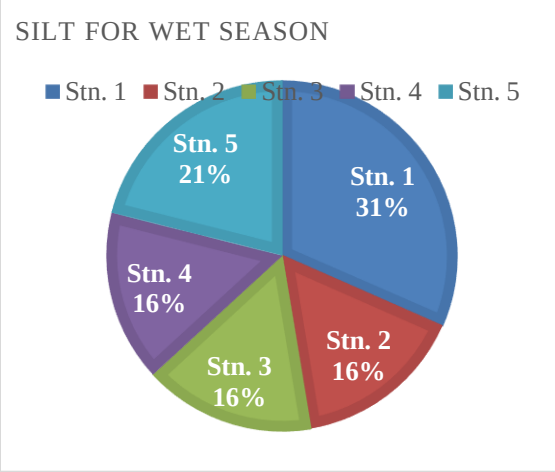

Figure 3: Percentage Silt for Wet season.

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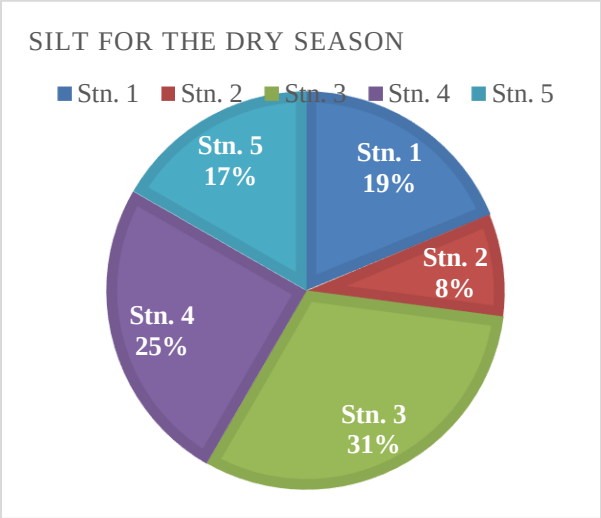

Figure 4: Percentage Silt for and Dry Season.

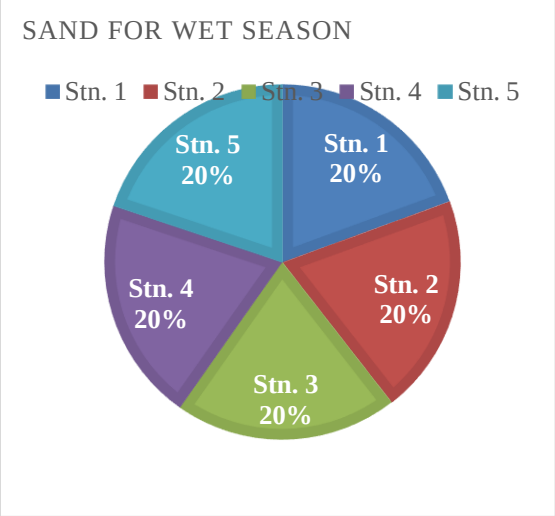

Figure 5: Percentage Sand for Wet season.

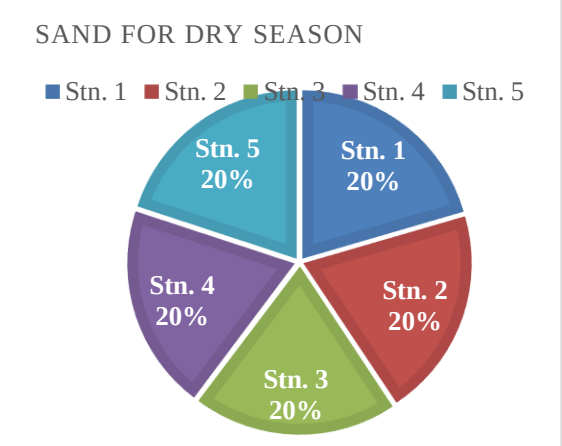

Figure 6: Percentage Sand for Dry Season.

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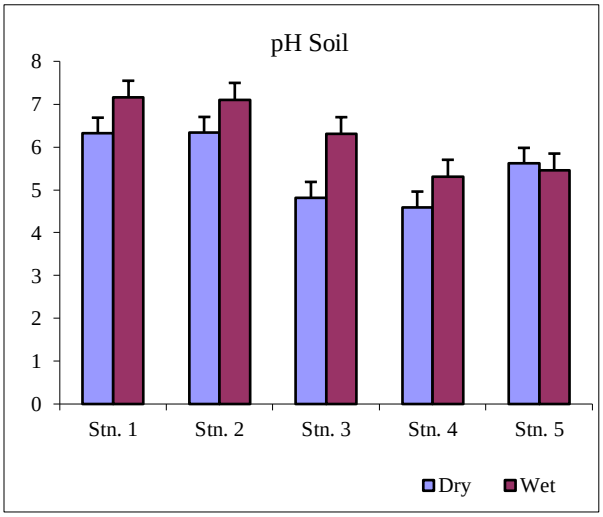

Figure 7: Seasonal Soil pH

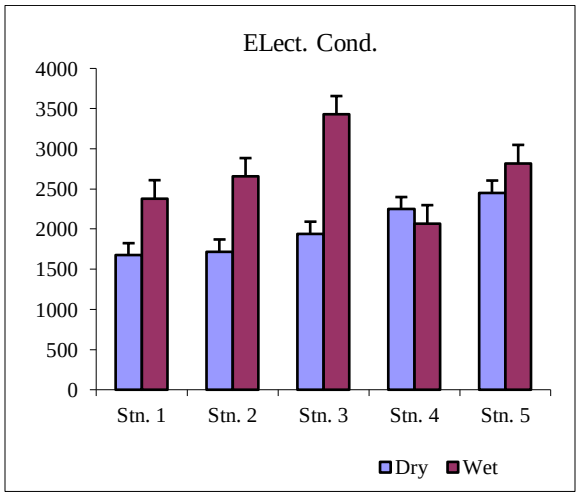

Figure 8: Seasonal Electrical Conductivity.

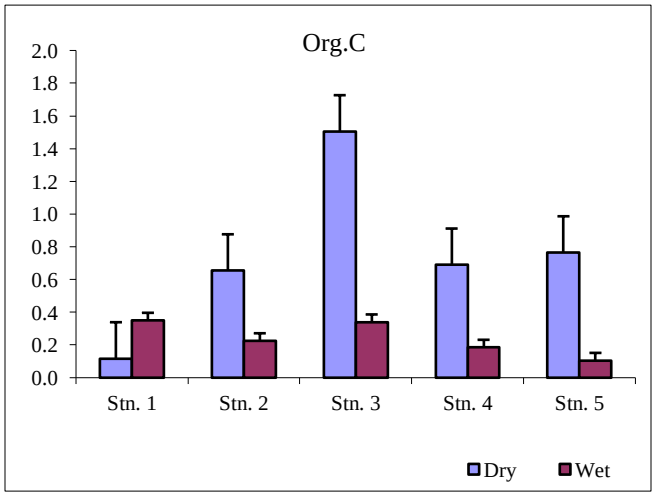

Figure 9: Seasonal Organic C in soil.

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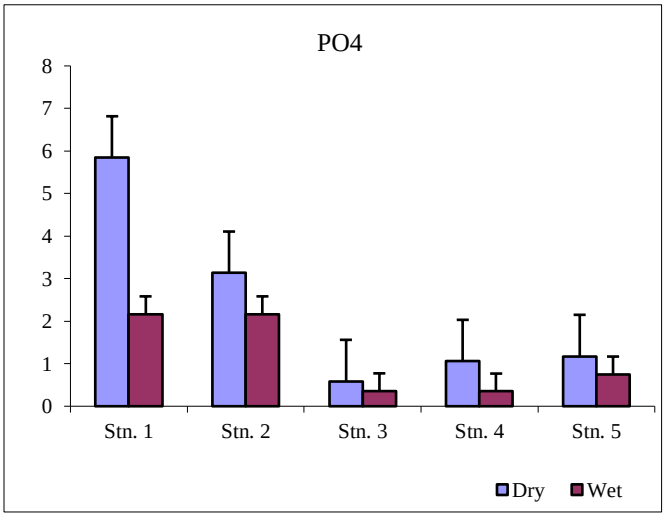

Figure 10: Seasonal PO_4 in soil

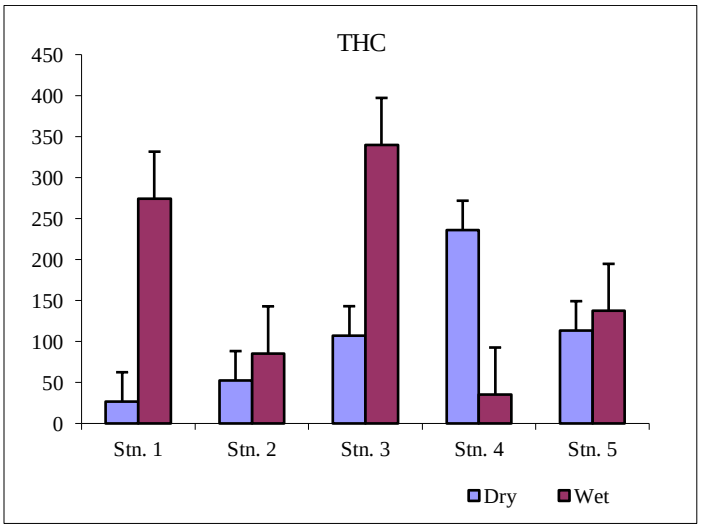

Figure 11: Seasonal Variation of THC in Soil

Table 2: Correlation Analysis of Physicochemical Parameters in Soil (Dry season)

Parameters	pH	Org. C	Ec	PO43-	THC
pH	1				
Org. C	-0.65226	1			
Ec	-0.57763	0.27029	1		
PO43-	0.809386	-0.82312	-0.71776	1	
THC	-0.86402	0.303017	0.700209	-0.70756	**1**

Table 3: Correlation Analysis of Physicochemical Parameters in Soil (wet season)

Parameters	pH	Org. C	Ec	PO43-	THC
pH	1				
Org. C	0.687048	1			
Ec	0.118984	0.267332	1		

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PO43-	0.859202	0.294535	-0.25724	1	
THC	0.40845	0.774354	0.670331	0.012059	**1**

3.3 Discussion

pH concentration in the sediment samples reveal higher values in stations 1, 2 and 3 in the wet season where there are oil dumps, garbage dump site and fishing activities respectively. THC

in the dry season, organic carbon was lowest in station 5 (located upstream) due to lack of human interference and highest in station 1 (oil dump site for sale of refined petroleum products).

Electrical conductivity was lowest in station 1 (oil dump) during the dry season and highest in station 5 (upstream). Electrical conductivity was also lowest in station 4 (Housing estate) and highest in station 3 (fishing activities) in the wet season.

Phosphate was lowest in station 4 (housing estate) and highest in station 1 and 2 (oil dump and refuse dumpsites respectively).

Soil sediment analyses reveal that the percentage of sand in sediment was uniform throughout the wet and dry season and all sample stations. Clay content was constant in all stations in the dry season and fluctuated in the wet season between stations. Silt content in sediment fluctuated between stations in both wet and dry seasons. THC and physico-chemical parameters did not have any direct correlation with sediment characteristics. Station 5 (control) exhibited lower values in all measured. parameters comparative to other stations. This suggest better environmental stability in the control station. The findings of this work, imply that Bonny estuary is under mild threat resulting human activities in the river catchment

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