Levels Of Total Hydrocarbon In Water And Sediment Of A Polluted Tidal Creek, Bonny River, Niger Delta, Nigeria

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Abstract: To ascertain the level of total hydrocarbon content (THC) in the Kua/Kinabere Creek, in Ogoni land – an estuary of the Bonny River, sub-surface seawater and surface sediment were collected from five sampling stations between March and August, 2012, for laboratory analysis. In the laboratory, standard analytical methods were adopted for the analysis of water and sediment samples. Concentration of THC in water and sediment varied from 15.6±1.86 – 23.4±2.55mg/l and 1,403±80.61 –3,755±113.14mg/kg respectively, The observed concentration of THC is far above the established permissible levels of 10mg/l in water and 30mg/kg in sediment and therefore poses a serious threat to the survival of marine organisms as well as other legitimate uses of the environment.

Key Words: Bonny River, Sediment, Tidal Creek, Total hydrocarbon content, Oil Pollution, Oil Spill, Environment

1 Introduction

Man, right from the day of his creation has continued to explore and exploit the environment – mostly for his own benefit. However, these activities of man, - in agriculture, industrial productivity, transport, health care delivery etc. have equally brought in its wake far reaching negative consequences such as pollution, that have threatened even his very existence on planet earth. The exploration and exploitation of crude oil and gas resources is no exception. Despite improved technologies in petroleum exploration and production techniques in the last few decades, several cases of avoidable accidents have occurred resulting in hydrocarbon pollution of the environment (both land and sea), in most of the oil producing countries including Nigeria. The petroleum industry according to [1] contributes greatly to aquatic environmental degradation and pollution. Oil from the petroleum industry enters the aquatic environment through several sources such as, fall outs from gas flaring, disposal of used lubrication oils, washings from oil tanks, leakages from marine vessels and out board engines, sabotage, erosion and run off from crude oil polluted lands, seepage, refinery effluents, rupture of ill maintained flow lines/installations, maintenance and engineering errors. Even after use by burning for fuel, the resultant gases contain un-burnt hydrocarbons discharged into air from which they can be washed by the rain and back to land and also into the sea 'unpublished'[2]. Braide[3] reported that about 9 million barrels of crude oil have been spilled in the Niger Delta since 1958. The Department of Petroleum Resources (cited in [4]) stated that between 1989 and February, 2000 a total of 536,858.84 barrels of crude oil where spilt in 2252 incidents. Out of the number the report observes only 23,003.84 barrels were recovered, while the principal portion of 513,854.98 barrels was lost to the environment. The general feeling of the people of the area however is that, oil spill incidence and quantity of oil spilt are grossly under reported particularly by official sources, this implies that the figures listed above could actually be a tip of the iceberg. A greater majority of these spilt oil get into the rivers, ocean, streams etc. directly or indirectly where a reasonable fraction either mixes with water or sink into the sediment, [5] causing severe damage to benthic organisms. According to [6] hydrocarbon pollution impairs the growth and development of marine organisms, causes fish, crustaceans and mollusks to acquire objectionable odour or flavor which reduces their market value and acceptability, ultimately it leads to death of both flora and fauna which is common in the Niger Delta [7]. Wright and Nebel[8] reported that the Sea Empress Spill of 1996 devastated the 20 million dollar fishing industry in the St. Georges Channel and rendered about 700 fishers jobless. The mangroves (as well as other aquatic resources) particularly of the Niger Delta are gradually but consistently being destroyed, principally by oil pollution caused by both legal and illegal prospecting and or refining. The need therefore to accentuate its protection, preservation and sustainability cannot be overemphasized. This paper thus takes a critical look at the levels of petroleum hydrocarbon in the sediment and overlying water of a typical Niger Delta estuary – with the intent of drumming up the much needed support (if need be) from the relevant authorities to commence remedial actions to save the ecosystem from total collapse.

2 Materials and Methods

The study area – Kua-Kinabere creek, in Ogoni land is a mangrove wetland, an estuary of the Bonny River serving as transportation channel or route and is notorious for oil activities including illegal oil bunkering and or refining.

Fig. 1 *Map of the Niger Delta area showing the study area in Ogoni land.*

Prior to commencement of sampling, a reconnaissance visit was paid to the study area during which five (5) sampling stations were identified. Two replicate samples were collected from each station for six (6) months (March to August). The geographical location of the various sampling stations obtained with a hand-held Global Positioning System (G.P.S) instrument (GARMIN EXTREX) are, (STN 1) N $04^0$40.017', E $007^0$14.081'; (STN 2) N $04^0$40.506' E $007^0$13.577' (STN 3)N $04^0$40.699' E $007^0$14.800' (STN 4) N $04^0$41.184' E $007^0$14.199' and (STN 5) N $04^0$41.169' E $007^0$14.256'. Water sample was collected from the sub-surface at each station in glass bottles and covered with foil paper. Sediment samples were collected from the upper 10cm of sediment in each of the sampling stations and were wrapped in aluminum foil. Samples were stored in an ice chest before transporting to the laboratory for analysis.In the laboratory samples were stored in refrigerator prior to analysis, so as to preserve its integrity. In the Laboratory sediment samples were air dried for four days after which it was macerated and then sieved through a 1µm for total hydrocarbon determination. 5.0g each of the sieved sample was later extracted with two 25.0ml portion of toluene. The sieved samples were shaken on a Stuart flask shaker for 10 minutes. The extracts were later filtered into 50.0ml flasks and made up to the 50.0ml mark with toluene. Total hydrocarbon from the water samples were extracted with 30.0ml toluene for three consecutive times and later made up to 100ml. The absorbances of the filtrates were measured spectrophotometrically at 420nm with spectrophotometer 4ID [9], [10]. The concentration was calculated from the calibration graph on dry weight basis. Appropriate blanks were run throughout the procedure.

3 Results and Discussion

Table 1: Mean values of Total Hydrocarbon Content in surface Water

STATION PERIOD	**1**	**2**	**3**	**4**	**5**
March	20.5±3.11	19.4±2.55	18±2.26	19.2±2.40	20.1±2.12
April	21.10±2.97	18.7±1.98	17.20±1.84	20.10±2.26	22±2.40
May	22.6±2.40	20.8±2.26	18.9±1.98	20.7±1.98	21.2±2.12
June	21.4±2.26	19.7±1.98	17.9±1.70	21.1±2.97	20.5±2.26
July	23.4±2.55	20.7±2.26	16.7±1.90	21.7±1.98	19.1±1.98
August	20.1±2.40	18.7±1.70	15.6±1.56	18.7±1.98	16.1±1.70

Table 2: Mean values of Total Hydrocarbon Content in Sediment

STATION PERIOD	**1**	**2**	**3**	**4**	**5**
March	3,620±130.11	1684±82.02	2752±89.10	1426.5±101.12	3312±181.02
April	3672±106.07	1726±110.31	2876±142.84	1489±118.97	3469±108.89
May	3522±87.68	1644±86.27	2509.5±139.3	1403±80.61	3065±96.17
June	3660±94.75	1708±73.54	2611±87.68	1626±60.81	3004±100.41
July	3775±113.14	1890±74.95	2550±96.17	1560±57.98	3100±97.58
August	3559±110.31	1989±70.71	2497±94.34	1878±79.20	2996±94.75

The concentration of THC in the different sampling stations throughout the period of study (Tables 1 and 2) showed spatial and temporal trends of variation in both water and sediment. The lowest and highest concentration of THC in water throughout the period of sampling were gotten in stations 3 and 1 (except in April) respectively, while that of sediment was generally in decreasing order of magnitude stations 1> 5 > 3 >2 > 4, thus indicating differences in the severity of impact. The values of THC in surface water gotten in this study fluctuated from a low of 15.60±1.56mg/l obtained at station 3 in the month of August to a high of 23.40±2.55 gotten in the month of July at station 1. The values of THC gotten in this investigation is significantly higher than the 8.81mg/l, 2.85mg/l and 2.83mg/l gotten at the point of discharge, downstream and upstream of the point of discharge respectively by [11], and [12] who reported a range of 0 – 1.87mg/l in Elechi Creek – an area far removed from oil and oil related activities. Similarly, it is also higher than the reported values of oil and grease in the waste waters from the Port Harcourt Refinery [13]. Elsewhere, [14] also recorded a low THC range of 1.4 – 21.8mg/l in the coastal waters of Malaysia. However, the mean concentration of THC in water reported by [15] ranging from 0.5 – 36.7mg/l and that of [9] which varied from 4.07±1.44 – 45.71±8.86mg/l with a mean of 23.60±4.37 are somewhat comparable to the values obtained for this study. On the contrary the mean value of THC 149±81.11mg/l recorded by [16] in the coastal areas of South Eastern Nigeria is significantly higher than the observed values of THC in the present study. This could be attributed to the fact that water samples for this investigation were collected shortly after an oil spill incidence, when the bulk of the petroleum product are still suspended in the water column. Concentration of THC in the sediments of the study area varied from 1403±80.61 to 3775±113.14 mg/kg, (Table 2) this is closely related but slightly lower than the 400 – 6205 reported by [15] from the Upper reaches of the Sombreiro River another seriously impacted area, hosting flow-stations, manifolds and wellheads and a network of pipelines that transport petroleum products. Results from another oil impacted area – the New Calabar River revealed a much lower but elevated value of THC ranging from 112.30±17.07 – 657.30±95.14 [9]. A similar result was also recorded by [16], [17] who reported mean THC concentration values of 339.2±245.7µg/g in the South Easter Nigeria and 528.25µg/g gotten in the Upper Bonny River respectively. In the streams of Ibadan a non –oil producing area [18] reported a mean of 219±229 mg/kg for six different streams and river sediments. In the east coast of Peninsular, Malaysia [14] recorded a much lower range of THC 0.79- 20.0mg/kg. The mean concentration of THC in water and sediment showed a significant variation, (Table 1&2), with the value in sediment generally higher than that in water. This can be attributed to the fact that heavier fractions of petroleum hydrocarbon typically pass through the water column and settle to the bottom [19] while others mixes with water and penetrates to the underlying sediment [5]. Generally, the lighter fraction aromatic hydrocarbons evaporate rapidly, particularly during periods of high wind and wave activity, [19]. This therefore confirms the submission of [9] that sediments are better indicators of pollution than water. The observed levels of THC in surface water in all sampling stations throughout the period of study was higher than the maximum permissible limit of 10mg/l for inland waters set by the [20], [21]. This could cause oxygen deterioration by reduction in gaseous diffusion through the surface film of oil with far reaching implications for the flora and fauna of the affected area, [22]. Similarly, the elevated values of THC in sediments recorded in this investigation may be responsible for the observed “moribund state” of mangrove vegetation in the study area, and is in agreement with the record of [23], that oil (spills) can have adverse effects to both sub-tidal and intertidal vegetation. Intertidal organisms such as periwinkles and mudskipper are very vulnerable to oil pollution since their habitat are susceptible to coating with oil and may be smothered in the event of heavy oil drifting ashore [9]. With the high level of THC in the environment - both water and sediment is likely to be ingested or absorbed by pelagic and benthic organisms (such as planktons, crustaceans, crabs, periwinkles and fish) respectively, which can easily ingest or absorb it, and pass it on (with its attendant health risk) along the food chain to top predators including man. This therefore calls for proactive action from environmental regulators and or oil industry players to save the aquatic biota, maintain desirable water qualities as well as enthrone environmental sustainability.

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