ENVIRONMENTAL IMPACTS OF CRUDE OIL MINING IN NIGER DELTA.

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Abstract

Oil exploration and exploitation has been on-going for several decades in the Niger Delta. Four soil samples were collected from agrarian and mining areas in the study area and analyzed. These samples were analyzed for its physicochemical parameters based on soil texture, pH, exchangeable acidity (EA), organic carbon (OC), organic matter, nitrogen (N), calcium (Ca), phosphorus (P), potassium (K), Effective Cations Exchangeable Capacity (ECEC) and base saturation (BS). Based on the texture of all the soil samples, the soils are sandy loamy (SL), the pH values of the soils in Okoko are 6.39 and 6.51, and the pH values of soils collected at Warri are 6.44 and 6.49. The value of soil organic carbon was found to be 1.96 % and 2.79% in Koko while in Warri the organic carbon is 1.92% and 2.81% respectively. Organic matter contents in Warri ranged from 4.85 to 3.32%. The highest organic matter content in Koko soil sample is 4.81% while the lowest value is 3.39%. The ECEC values range from 9.6 to 10.71. The highest ECEC value was recorded by a soil sample from Koko area. Range of sodium was 0.139 to 0.157 mg/kg and potassium 0.189 to 0.246 mg/kg. Among the nutrients, available nitrogen was found to be 0.175 to 0.280%. Phosphorous was ranging from 40.9 to 61.6 mg/kg. Soil pH value ranged from 6.39 in Warri and 6.44 in Koko mining areas, the farm area in Warri was 6.51 and Koko farming area was 6.59. Soil pH is therefore rated slightly acidic to neutral in all the soils. Mining has disastrous impacts on the environment in the region and has adversely affected people inhabiting that region because the farm areas have more nutrients than the mining areas.

Keywords: Oil spillage, Niger Delta, Mining, Farmland

INTRODUCTION

Crude oil pollution is an inevitable consequence of oil exploration and exploitation activities both in oil producing and consuming areas due mainly to accidental discharge, human error, sabotage, transportation, natural causes (Agbogidi, 2010). Thus, it creates a negative effect on vegetation, both directly and indirectly. Nwilo (1998) presented data to show that 50% of oil spills in Niger Delta is due to pipeline corrosion, 28% sabotage, 22% to oil production operations and engineering drills.

Oil pollution in the Niger Delta has been a major source of concern to the people living in the crude oil-rich-areas. Oil spills adversely affect the nutrient level and fertility status of the soils, thereby affecting the growth of agricultural crops. In Nigeria, a substantial amount of crude oil is spilled annually. For example, The Department of Petroleum Resources estimated 1.89 million barrels of petroleum were spilled into the Niger Delta between 1976 and 1996 out of a total of 2.4 million barrels spilled in 4,835 incidents (The Daily Independent (Lagos), 2010) (approximately 220 thousand cubic meters). A UNDP report states that there have been a total of 6,817 oil spills between 1976 and 2001 (UNDP, 2006), which account for a loss of three million barrels of oil, of which more than 70% was not recovered. 69% of these spills occurred offshore, a quarter was in swamps and 6% spilled on land (UNDP, 2006).

On January 21, 2010, about 1,245 barrels of crude oil was spilled in Edo state following malfunctioning of the Nigerian National Petroleum Company equipment (Bamidele et al., 2007). The spill allegedly destroyed about 169,231 farmlands. Spillage of crude oil on soil makes it unsatisfactory for plant growth as a result of insufficient aeration of the soil as air is displaced from the spaces between the soil particles by crude oil. This affects the soil and its productivity in terms of the growth of crops. One of the environmental challenges posed by oil pollution is the alteration of the physical and chemical nature of the soils which subsequently affects the growth of plants (Department of Petroleum Resources, 1991). This alteration is achieved by many means including the reduction of the pH content of the soil. This affects the soil and its productivity in terms of the growth of plants.

The Nigerian National Petroleum Corporation places the quantity of petroleum jettisoned into the environment yearly at 2,300 cubic meters with an average of 300 individual spills annually. However, because this amount does not take into account "minor" spills the World Bank argues that the true quantity of petroleum spilled into the environment could be as much as ten times the officially claimed amount (Moffat and Linden, 2007).The known sources of environmental pollution from petroleum industrial operations worldwide include the following: transportation of petroleum products, operational discharge, oil well blow-outs, leakage of oil storage tanks and pipelines, refinery effluents discharged into the environment, natural oil seeps, industrial municipal wastes, urban and rural run off biosynthesis, atmospheric fall out, dry docking, terminal loading and other accidental discharge of waste oil (Abii and Nwosu, 2009). The aim of the study is to determine the impact of resources exploration (exploitation) on the parts of Niger Delta environment. The objectives of this research are:

i. To determine if there is significant relationship between resources exploitation and environmental impact.

ii. To ascertain the impact of resource exploitation on the Niger Delta region of Nigeria.

iii. To determine the physicochemical parameters of the soil (texture, pH, P, OC, OM, Ca, Mg, K, Na, EA, ECEC and BS).

METHODOLOGY

Sample Collection

Samples were purposely collected from agrarian and mining areas for this analysis. One of the samples was collected from Koko and another from Warri, in the mining site and out of mining site (farm land) both in Delta state. In collecting the soil samples, five spots were mapped out thoroughly cleared; a shovel was used to dig out soil in each mined area. The soils were taken to the laboratory and the crumps broken. This was done for soil in the mining areas and soil in the farm area both in Warri and Koko respectively. Each of the soil was spread in dehumidifier and allowed to dry for one week. The soil was analyzed for physico-chemical properties (Meindinyo and Agbalagb, 2012). Analysis of the soil samples was carried out using percentages and the result is presented in table 1.

Geology of the Study Area

The Niger Delta (Fig. 1), spanning about 70,000 square kilometers in the southern part of Nigeria, is the region in Nigeria through which the Niger Delta and Benue Rivers empty into the Atlantic Ocean. Niger Delta is one of the world largest Tertiary Delta systems and an extremely prolific hydrocarbon system. The Niger Delta clastic wedge formed along a failed arm of a triple junction system (aulacogen), developed during the breakup of the South American and African plates in the late Jurassic (Burke et al., 1972; Whiteman, 1982). In terms of stratigraphy, the Niger Delta consists of three main Tertiary formations: the Akata Shale, Agbada Formation and Benin Formation (Short and Stauble, 1967). 1) Pro-delta shales of the Akata Formation (Paleocene to Recent), 2) deltaic and paralic facies of the Agbada Formation (Eocene to Recent). Petroleum occurs throughout the Agbada Formation in the Niger Delta clastic wedge (Ajibola, 2004). 3) fluviatile facies of the Benin Formation (Oligocene-Recent). The Akata Shale is the oldest formation and represents a deep marine depositional environment while the Agbada and Benin Formations represent a near-shore and the active deltaic environments respectively (Adewunmi et al., 2016)). The delta proper began developing in the Eocene. From the Eocene to the present, the delta has prograded southwestward, forming a regressive deltas known as depobelts, which is the most active portion of the delta at each stage of its development (Doust and Omatsola, 1990). The depobelt is one of the largest regressive deltas in the world with an area of some 300,000 km^2 (Kulke, 1995), its volume and thickness are 500,000 km3 and 10 km respectively (Hospers, 1965, Kaplan et al 1994). This Niger delta petroleum system is known as Tertiary Niger Delta Akata –Agbada (Kulke, 1995).

Although the Niger Delta comprises only 7.5% of Nigeria's total land mass, it is inhabited at least by 25 million people representing over 40 ethnic groups and 250 dialects (Ordinioha and Brisibe, 2013). Nigeria is West Africa producer of petroleum with the Niger

Delta producing around 2 million barrels a day. Oil spillage is fallout of oil drilling. In Niger Delta region, with an estimated total of over 7000 oil spill incidents reported over 1 50-year period (Ordinioha and Brisibe, 2013). The Niger Delta's vast production, and subsequent spilling of crude oil has resulted in pollution of the region. Oil producing states in the region include: Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo, Rivers and recently Anambra State.

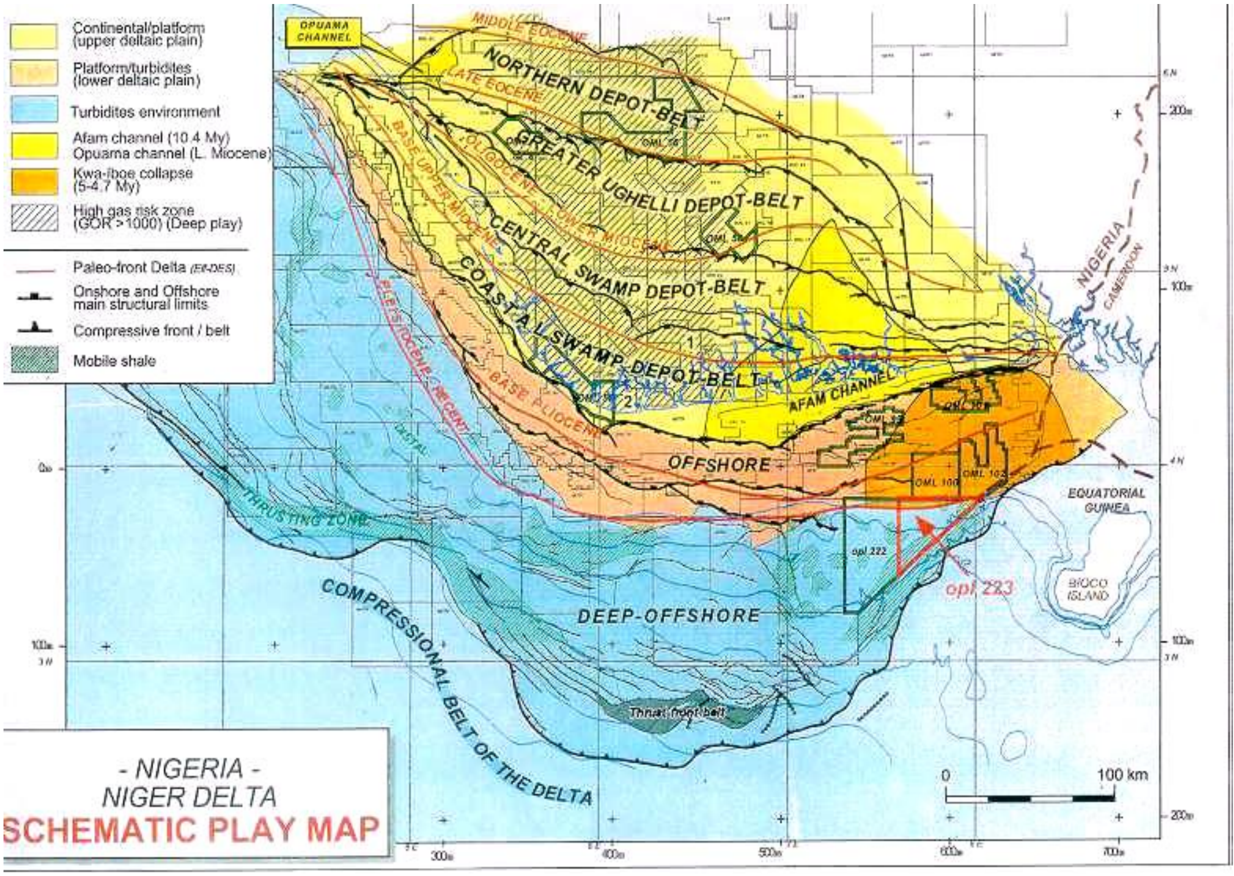

Fig 7: Play map of the Niger delta showing depobelts (Tuttle et al., 1999).

RESULTS AND DISCUSSION

The soil particles were predominantly sandy loamy as presented in table 1. The soils of Koko were more acidic than that of Warri. The high acidity may be as a result of mining activities in Koko. A low pH value ranged from 6.39 in Warri and 6.44 in Koko mining areas, the farm area in Warri was 6.51 and Koko farming area was 6.59 indicating that the mining areas were slightly acidic while in the farm area the pH is almost neutral with 6.51 in Koko and 6.44 in the mining area. The higher pH value in the mining areas could be due to mining activities in the area. Phosphorus content were high in Warri soils than Koko soils. The higher percentage of sand and clay resulted in sandy clay textural classification of the soil. The soils have very low percentage of silt particles (11.8) in Koko and highest proportion of sand particles (78.4) in Koko. This may contribute to soil erosion in the rainy season. Phosphorus is required for plant growth but less of it is found in Koko soil, this may be due to leaching of nutrients in the mining areas.

The phosphorus (p) is found in soils both in organic form and an inorganic (mineral) form and its solubility in soil is low. Phosphorus were high in Koko mining area (43.3 mg/kg) and in farm area is (61.60 mg/kg) higher than Warri mining and farm areas which were 40.9 and 60.9 mg/kg respectively. Nitrogen (N) is ubiquitous in the environment. It is one of the most importance plant nutrient and forms some of the most mobile compounds. Nitrogen in Warri mining area is very low which 0.182% is while in farming area is 0.280% which is also low for plant growth. The low content of nitrogen in the mining area could be the reason why plant crops there were yellowish in color there (Sangita, 2020). Farmers in this area complained that since after the mining exploitation, they started having this experience on their plants. The same experience is also applicable to Koko area where phosphorus values where 0.175 and 3.266 respectively. Potassium (K) is an essential nutrient in the soil and also for plant growth, it helps in physiological process of plant such as protein synthesis and maintenance of plant water balance (Wodaje and Alemyehu, 2015). It is classified as a macro nutrient because plant takes up large quantities of potassium during their life cycle. Potassium in Warri mining area was I69 mg/kg and farm area was 0.246 mg/kg which is very poor capacity. While in Koko mining area it was 0.174 mg/kg and farm area was 0.246 mg/kg. There was high base saturation and low exchangeable acidity. Organic Carbon (OC) is most abundant at the surface of soil and the sediments where detritus is deposited and the basis for soil fertility (Johnson et al., 2008; Sangita, 2020). Most of it is derived at aerobic photosynthesis. In Koko mining area, the OC was 1.96% and in Warri was 1.92% indicating efficiency of OC and this could be as a result of the mining activities there. In the farming area of both Koko and Warri, the OC were 2.79% and 2.81% respectively indicating that the mining activities has a negative impact on the soil.

Organic Matter (OM): refers to large source of carbon - based compounds found within natural and engineered, terrestrial and aquatic environment. It is important in the movement of nutrients in the environment and plays a role in water retention of the surface of the planet. From the table, the Koko and Warri mining areas had 3.39% and Warri 3.38 % organic matter indicating low percentage of organic matter and this could be because of the presence of compound from the crude oil which has a very big negative impact on the soil. Koko, had 4.81 and Warn 4.85 showing that mining has a negative impact on the soil. Exchangeable Acidity (EA) refers to the amount of cations, aluminum, and hydrogen occupied on the CEC. The exchangeable acidity in Koko and Warri mining areas were high 0.72 $Cmolkg^1$ and 0.80 $Cmolkg^1$ respectively. While in the farming area of Koko was 0.36 $Cmolkg^1$ and 0.40 $Cmolkg^1$ in Warri area which is low. The high in the mining area could be the droplets of crude oil in the soil. Effective Cations Exchangeable Capacity (ECEC); is defined as the total amount of exchangeable cations, which are mostly Sodium, Potassium, Calcium and Magnesium. It is a critical soil parameter because it gives insight into soil storage of nutrient (Ulery et al., 2017).The high rate in ECEC in both Koko and Warri 10.65 and 10.71 in the mining areas is attributed to the mining activities over there. Soil with Ec value less than 4 soil type is normal (Sangita, 2020). In the farm area, though was high but could not be compared to that of mining areas of both places. High conductivity value of soil is attributed to high electrical conductivity value and also the presence of high metallic content (Sani, 2012).

Calcium (Ca); Calcium plays essential role in plant nutrient and soil health. It helps in composition of Plant's protoplasm and cell wall. Calcium associates with organic acids and carbohydrates (Mahajan and Billore, 2014). In Koko and Warri mining areas calcium content were 5.2 Mg/Kg and 6.8 Mg/Kg respectively indicating low percentage of calcium due to mining activities causing yellowish of plant. In the farm areas, the plants were greenish in color.

Magnesium (Mg): This is a constituent of chlorophyll and an essential nutrient for crop production (Ugwa et al., 2022). It is also active in the metabolism of phosphorus, a deficiency rarely yield but reduce the nutritional value of the crop. Magnesium concentrations were deficient in all the samples. This confirms the farmer's complaint both in Koko and Warn, the poor yield of crops in the mining areas compare to the farming areas. Base Saturation (BS) is calculated as the percentage of the CEC occupied by Base cations.

Table 1: Result of Physicochemical Properties of Soil Samples Collected from Koko and Warri in Delta State.

Location	Lab No	Sample	Sand (%)	Silt (%)	Clay (%)	Texture (%)	pH ($H_2$0)	P (Mg/Kg)	N (%)	OC (%)	OM (%)	Ca (Mg/Kg)	Mg (Mg/Kg)	K (Mg/Kg)	Na (Mg/Kg)	EA Cmol kg[1]	ECEC	BS (%)
Koko	1A	Mining	76.4	10.8	12.8	SL	6.39	43.3	0.175	1.96	3.39	6.8	2.8	0.174	0.139	0.8	10.71	92.56
Koko	2A	Farm	76.4	10.8	10.8	SL	6.51	61.6	0.266	2.79	4.81	5.2	3.2	0.246	0.156	0.36	9.16	96.09
Warri	1B	Mining	76.4	10.8	12.8	SL	6.44	40.9	0.182	1.92	3.32	7.2	2.4	0.169	0.165	0.72	10.65	93.28
Warri	1B	Farm	78.4	10.8	10.8	SL	6.49	60.9	0.280	2.81	4.85	4.8	4.0	0.246	0.157	0.40	9.6	95.87

SL- Sandy Loam

Both Koko and Warri soil were sandy. The sandy clay classification of the soil could be as a result of the parent material of the soil. pH range from 6.39 in Koko mining area to 6.51 in Koko farming area. The low pH in Koko mining area could be attributed to the mining activities in the area. Phosphorus was high in the farming area of Warri (60.9 Mg/Kg) and Koko (61.6 Mg/Kg) than in their mining areas which have 43.3 Mg/Kg and 40.9 Mg/Kg respectively. Phosphorus is highly needed in the soil. The percentage of Nitrogen was low in both places. The low percentage of Nitrogen could be attributed to the mining activities. Nitrogen is needed in the soil, so the low percentage of Nitrogen would to poor yield of farm products. The values of Potassium and Sodium were too low. The low values of Potassium, Sodium and Nitrogen show that these soils were poor in soil nutrients, which could be attributed to the crude mining. The farm areas have more nutrients than the mining areas. Crude oil mining impacted negatively to the soils of both Koko and Warri.

Conclusion

Based on the findings, the researchers concluded that there is a significant relationship between resource exploitation and environmental impact in parts of this Niger Delta Region of Nigeria such as: oil spillage which degraded the land leading to loss of Mangrove forest, depletion of fish population, water hyacinth invasion, natural gas flaring and loss of habitat. This information will help the farmers to know amount of fertilizers to be added in soil to make production. Koko mining area needs addition of fertilizer that is enriched with potassium. To remedy this situation, government should enforce laws and hold oil companies accountable for their actions and this will reduce the risk of contamination greatly and help to clean up the spills.

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