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Effects of Oil Spillage on Soil Fertility in Udu Local Government Area in Delta State

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Abstract

The study examines the effects of oil spillage on soil fertility in Udu Local Government Area of Delta State, with the aim of determining the effects of oil spillage on physical and chemical properties of the soils. Soil samples were collected from two experimental sites namely: oil polluted and non oil polluted plots in the study area. Sixteen (16) plots were marked out at 60m x 60m apart and subdivided into quadrants of 1m x 1m for data collection, soil samples were collected with most probable instruments and analysed for physical and chemical properties in the soil. The result from the analysis revealed that oil spillage has effects on soil fertility in Udu Area of Delta State. The study also revealed that oil spillage adversely affects crop productivity in the area. And the result from the t-test analysis showed t value of 4.863, indicating significant effects of oil spillage on soil fertility in Udu area of Delta state. The study recommended prevention of the occurrence of oil spillage as the best alternative. Others include cleaning up exercise and payment of adequate compensation to affected communities.

Key words: Oil, Spillage, Soil Fertility, Udu Area

Introduction

The exploration and exploitation of crude oil in the Niger Delta Region of Nigeria has ironically become a source of agony and disillusionment to the people of the region (Akpofure, 2000). Prior to the discovery of oil in commercial quantity in 1956 and its consequent exploitation, the Niger Delta Region presents a myriad of beautiful colours representing a distinction of rain forest, mangrove swamps, palm forests, a natural paradise bustling with both plants and animals, marine life and very suited environment for conservation as games reserves, tourism and so on (Yomere, 2000). But with the exploration of crude oil since 1956 the region has been given a completely different and noticeable feature in the area of gas flaring that dot the landscape, acid rain and ecological devastation (Yomere, 2000). However, far more reaching environmental destruction is oil pollution that resulted from oil spillage (Ischel and Sanford, 1997). Oil spillage is defined as the explosion or running out, upsurge flow of oil over an area on the earth surface or environment, due to both human and natural factors such as pipe burst, corrosion of pipes, over pressure, malfunctioning of equipments, sabotage and blow out (Madu, 2000). The resultant environmental problem arising from oil spillage is well pronounced in the area of soil fertility. Ekundayo (2007) in his study on oil spill site, observed germination delay and poor growth of plants in polluted soils using parameters such as plant heights, stem girth, ear height and leaf. Gbadegesin (1997) observed that apart from loss of farmlands, oil spill have led to extensive deforestation with no adequate replanting practice. This in effect has shortened the fallow periods, compound land use degradation and led to erosion of the top soil and consequently loss of soil fertility.

Soil is a major component of the environment, it’s a major resource of the earth with a lot of potentials, and it has been described by Ahn, (1978) as the basis of human civilization. The role of soil in food productivity cannot be over emphasized. It’s in recognition of this fact that Ashaye, (1978) described soil as the great provider of food which in turn is the bedrock of civilization.However in recent years, this valuable resource of the environment (soil) with precious biological diversity has been threatened by soil spillage with its attendant effects on soil nutrient reserves and crop yield (Dada, 2004). This is because the physical, chemical and biological properties of the soil is disrupted and its productivity of crops may decline with time and thus, threatening the fundamental role of soil as the principal source of essential elements of crop productivity (Areola, 1990).

Farming is the most important occupation in Udu Local Area of Delta State, and the farmers majorly cultivate cassava in the deforested plots in the area. In recent years, the yield from this agricultural product (cassava) has been decreasing, and the farmers have attributed the low yield to a marked fall in the nutrient content of the soil, as result of oil spillage. Because of the geometric increase in human population in the area, and the need to match the increase with enhanced food productivity, coupled with the depleted soil fertility status resulting from oil spillage in the area, it becomes necessary to assess the effects of soil spillage on the physical and chemical properties of soils in Udu area of Delta State.

Study area

The study area is located South Central part of Delta State in the South-South zone of Nigeria. It lies between latitude $4^0$30'N to $6^0$35'N and longitude $4^0$30E to $5^0$00'E. it is bounded in the North by Uvwie and Warri South Local government Areas, in the East and South by Ughelli South and Warri South West Local Government Areas respectively (see fig. 1).

The mean elevation of the area is between 20-40 meters above sea level. The area is largely drained by river Okpare in Ughelli South Local Government Area, from South to West and river Enerhen in the North (Aweto, 1998). In most cases whenever spillage occur in any of the communities under study, the river serves as the major means to aid the spread of the effluent among settlements along the river course.

The study area is part of Niger Delta and its underlain by sedimentary rocks, consisting mainly of yellow and white pebbles, clay and sandy clay occur in lenses (Aweto, 1998). There geological formation of Benin, Agbada and Akata formations occur in the area and they lay one below the other. The soil is deeply weathered, deeply leached, friable, and they lack distinct and well defined horizons. The soils has low silt and clay content, low cation exchange capacity and consequently low pH (Aweto, 1998)

The annual mean temperature is about 26^0C and the mean annual rainfall is 185mm with September being wettest month and January is the driest month. The relative humidity of the air is high with a range of 65-90% (Udo, 1990).

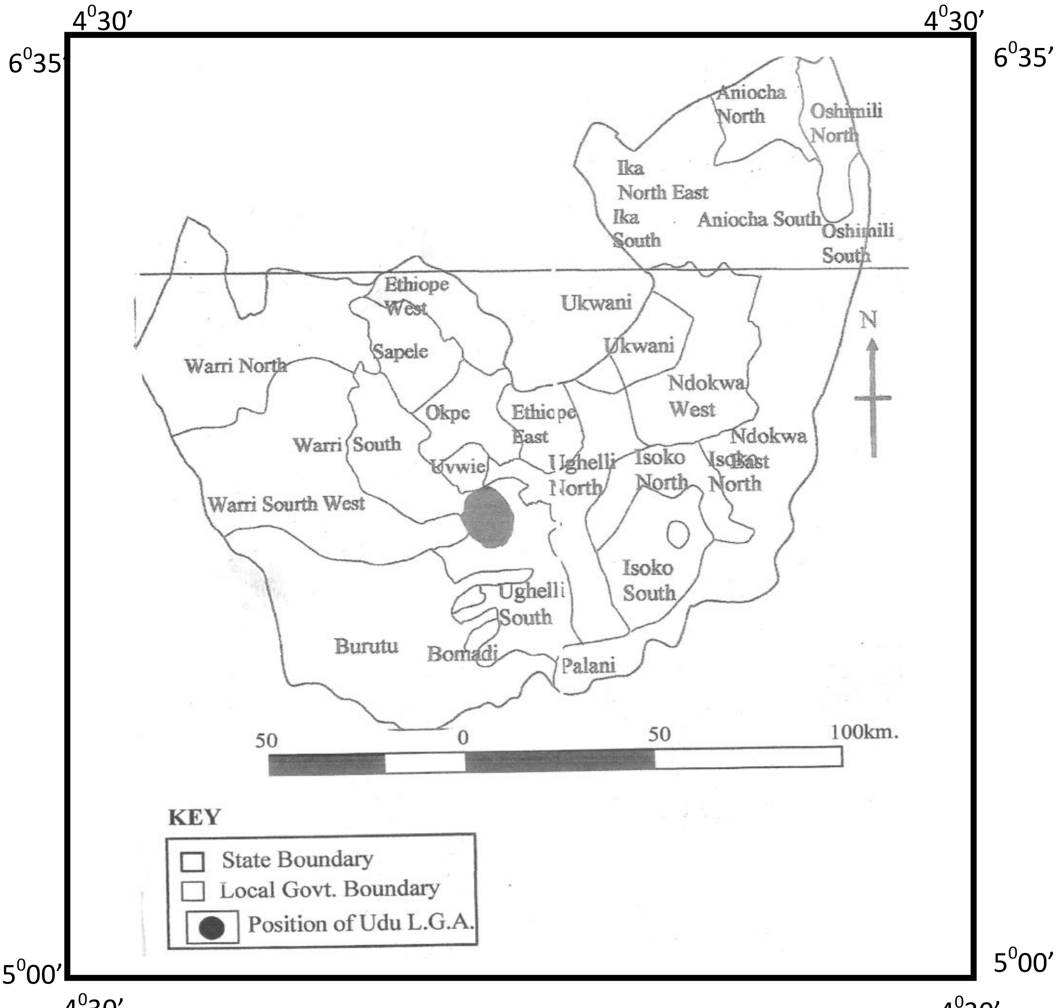

Fig. 1: Map of Delta State Showing the position of Udu L.G.A.
Source: Ministry of Lands, Survey and Urban Development, Asaba (2004)

The natural vegetation of the study area is the equatorial rainforest with evergreen forests that consists of three canopies of tree. The influence of man activities has reduced the forest mainly to secondary growth. With the concentration of oil activities in the study area, has repelled the presence of forest vegetation. The main trees found are Mahogany, Agba, Opepe and

Black Afara (Aweto, 1998). The predominant occupations of the people are farming, fishing and petty trading. Cassava farming served as the major food crop in the area. Other foods include: Maize, Yam, Pepper, Cocoyam and Vegetables. With frequent cases of oil spillage in the area especially in Ukpiovwin and Oghior, most farmers have abandoned their farmlands.

Petroleum exploration and exploitation has passed a serious environmental threat to the study area. The two communities under study are located among the two oil fields. Utorogu Oil field and Abura Oil field. Utorogu Oil field belonging to Shell Petroleum Development Company (SPDC) which was established in 1961 and Abura Oil field belongs to National Petroleum Development Company (NPDC) established in 1974. There is also a flow station that serves as a collating center to all oil wells in the area.

There are networks of gas and pipelines that crisscross the inhabitants' farmlands from various oil well heads to the flow station. There are also other important companies in the area. They include: The Delta Steel Company (DSC) Ovwain/Aladja and Utorogu Gas Plant etc.

Materials and Methods

Soil samples were collected from oil polluted plots, and other sets of soil samples were collected from non oil polluted plots, that served as control. The two locations in the study area were each stratified into four divisions. 16 equidistance plots, 8 each from oil polluted and non oil polluted plots were marked out at 60m x 60m apart from which soil samples were collected for a period of six months. The plots were further divided into quadrant of 1m x 1m, and soil samples were randomly collected from a predetermined depth of 0-10cm layer from the top soil being the threshold of cassava cultivation. A total of 16 soil samples were collected with eight (8) soil samples each from oil polluted and non polluted plots. The mean of these soil samples were determined and used for the study. The soil samples collected were placed in a labeled polythene bags for easy identification, before taken to the laboratory for further processing and analysis.

Soil bulk density was estimated from samples collected from oil polluted and non polluted plots and was determined on cores (Black, 1965). The soil samples were immediately weighed before transportation to the laboratory for oven drying at 150^0C for 24 hours and re-weighed. Bulk density was then calculated as an oven dry mass (mg) per volume (m^3). Total porosity values were calculated from the bulk density figure using an assumed particle density 2.65cm^3 (Vomocil, 1965). With the exception of soil samples collected for bulk density determination, all other soil samples were air-dried at room temperature and passed through a 2mm sieve and analysed for particle size composition by hydrometer method (Bouyoucos, 1962). Organic carbon by chromic acid digestion method (Walkley and Black, 1934), total nitrogen by regular micro-kjeldahl method, and available phosphorus by Bray P1 method. Soil pH was determined potentiometrically in distilled water using a soil ratio of 1:1 (Bates, 1964).

The student t-test was adopted to ascertain if a significant difference exist between the two set of soils from oil polluted and non polluted plots in Udu Area: this was done with the view of determining the effect of oil spillage on soil fertility.

Result and Discussion

Data collected are presented in the table below.

Table 1: Mean of physico-chemical properties of soil under oil polluted and non oil polluted plots.

	Oil polluted plots		Non Oil polluted Plots		Loss
Soil properties	Range	x	Range	x	
Sand%	91.9 – 92.7	92.4	84.6 - 90.3	86.9	5.5
Silt %	4.1 8.5	6.6	8.6 - 9.2	9.0	2.4
Clay %	3.6 – 4.1	3.9	9.5 - 8.5	6.5	2.6
Bulk density (g/cm^3)	1.73 - 1.82	1.30	1.29 - 1.36	1.23	0.07
Total porosity %	60.12 - 63.35	60.27	63.6 - 65.8	64.72	4.45
Soil pH (in water)	4.67 - 5.74	5.11	5.09 - 5.14	5.32	0.21
Organic carbon %	1.41 - 1.461	1.4	3.87 - 6.24	4.69	0.17
Total hydrogen %	0.45 - 0.68	0.56	0.34 - 0.50	0.52	0.04
Available phosphorus (ug/g)	2.64 - 2.98	2.81	2.63 - 2.89	2.84	0.03
CEC	2.97 - 3.98	3.2	4.0 - 4.8	4.4	1.2

Source: field survey, 2012.

Table 1 showed the mean values of physico-chemical properties of soils under polluted and non polluted plots in Udu area of Delta State. The mean values of sand, silt and clay are 92.4%, 6.6% and 3.9% for oil polluted plots, while those of non oil polluted plots are 86.9%, 9.0% and 6.5% for sand, silt and clay respectively. This distribution shows that soils under polluted and non polluted plots are predominantly sandy, and texturally homogeneous. This is to be expected since the soils are derived from the same parent material (Aweto, 1998). The mean values for bulk density and total porosity are 1.30g/cm^3 and 60.27% in oil polluted plots while those of non oil polluted plots are 1.23g/cm^3 and 64.72%. This distribution shows that soil under non polluted plots have better physical status than those under oil polluted plots; because they are less dense or compact and more porous. This is presumably because in non polluted plots, grasses grow in tussocks and have greater cover than the polluted plots (Aduayi, 1985). The variation might also be due to tillage prior to cultivation leading to organic matter diminution before spillage occurred (Aweto, 1998).

The implication of reduction in porosity value in oil polluted plots, leads to a lower permeability that results in loss of soil nutrients and deterioration in soil physical status. The mean value of pH for oil polluted plots is 5.11 while that of non oil polluted plots is 5.32. The lower pH observed in oil polluted plots implies that oil spillage affects soil nutrients such as calcium and magnesium than those of non polluted plots (Bongfen, 2006). While the high value of pH observed in non polluted plots can be attributed to occasional burning of the forest (Bongfen, 2006). The mean value of organic carbon and total nitrogen for oil polluted plots are 1.4% and 0.56% while that of non polluted plots are 4.69% and 0.52%. The greater cover of non polluted plots could have made much impact with regards to addition of more organic matter to the soil because of occasional burning of the forest during dry season, while leaves and stems are left to decay into the soil, and this breast up organic matter in the soil. While the lower value of organic matter observed in oil polluted plots implies a deteriorating effect of spillage on the soil. Organic matter accumulates more in the first 20cm of the surface soil, and its conventional to aim at soil organic matter of between 1.5-5% to maintain soil fertility (Aduayi, 1985). Since the observed value of organic matter in oil polluted plots falls below the conventional standard to maintain soil fertility, it clearly shows that oil spillage have effect on soil properties. This observation is in line with the findings of (Ugboma, 2012).

While the difference in total nitrogen between oil polluted and non polluted plots arise probably because the trees and grass species in non polluted plots makes greater demands of nitrogen, as against polluted plots that are left bare after spillage. This result is expected because the presence of trees and grasses in non polluted plots makes greater demand of nitrogen than bare plots resulting from oil spillage. This result corroborates the findings of (Ekundayo, 2007).

The mean values of available phosphorus and CEC for oil polluted plots are 2.84ug/g and 4.4 (me/g). The distribution of phosphorus shows that the value obtained in oil polluted plots is lower than that of non oil polluted plots. This indicates that oil spillage have effect on phosphorus. This result is in line with the findings of (Vine, 2003). While the distribution of CEC showed that oil polluted plots have lower value, and this can be attributed to the fact that a substantial part of the soil are seen leached away during cropping before spillage. This result corroborates the findings of (Ugboma, 2012). Generally, the CEC of both oil polluted and non polluted plots are low in Udu area, as it falls below the required range of 12-25 me/100g as asserted by Aduayi, (1985).

Table 2: Pair Sample Statistics.

	Mean	Std. Deviation	Std. error	95% confidence interval of differences		t	df	Sig. (2-tailed)
				Lower	Upper			
Pair 1 Polluted	16.24	6.443	2.415	9.678	24.61	24.61	6.841	0.001
Non-Polluted	35.62	4.328	1.627					

Table 2 shows the mean value of non polluted plots as 35.62 (SD=4.328), while that of oil polluted plots is 16.24 (SD=6.443) indicating effects of oil spillage on soil fertility in oil polluted plots. The table further showed that the calculated t- value of 6.841 is greater than the critical table value of 4.863 at $p < 0.05$ and thus, the model is significant. The result reveals that oil spillage has a significant effect on soil fertility in Udu area of Delta State, Nigeria.

Conclusion

The study has examined the effects of oil spillage on soil fertility in Udu area of Delta State, Nigeria. The study revealed that oil spillage has a significant effect on soil fertility, and this has adversely affected crop productivity in the area. The study recommended prevention of occurrence of oil spillage as the best alternative towards achieving sustainable environment. But in case of occurrence, affected communities should be properly cleaned up, and adequate compensation should be fully paid to affected communities.

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