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Full Length Research

Assessment of the impact of Oil Spillage on Soil in the Imo State Environment, Nigeria

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The study experimentally examined effects of oil spillage on the soils in Imo State, Nigeria. Data collection, six sites (Oru West &East, Ngor-Okpala, Obowo, Isiala Mbano, Ikeduru and Ezinihitte) reflecting oil spilled, and non- oil spilled areas. Soil samples collected from twelve random sample points per-plot at surface and subsurface depth of 0-15cm and 15-30cm. Fcal. generated analysed using ANOVA and Regression. Fcal.10.21 greater than F-Critical of 4.49 (F.cal>F.critical) at 0.05 level of significance, indicates that oil impacted soil are richer in soil chemical characteristics than non-impacted area. Multiple linear regression with correlation coefficient (r= 0.941) between depth at Orlu zone, Ngor-Okpalla (r= 0.845),Obowo(r=0.918),indicates strong and positive correlation between the two areas in terms of depth. Study revealed, the soils found in the area have high composition of silt, acidic and contains high amount of carbon. Organic carbon in oil impacted soil and at non-impacted area was lower and total hydrocarbon content (THC) value higher in comparison with the value at non- impact. Hypothesis shows oil impacted soils were richer in soil chemical characteristics than non-impacted soils with a calculated value 0.025.Study recommends frequent inspection of pipelines and replacement of worn-out pipes to avoid future oil spillages in the area.

Keyword: Assessment, Impact, Oil Spillage, Soil, Imo State.

INTRODUCTION

Nigeria, like other oil, producing countries, benefits as well as suffers from its positive and negative effects of crude oil drillings such as gas flaring (Ake, 1979; Adeniye at al., 1983). It is however undisputable that ever since the discovery of oil in Oloibiri in 1956, the Niger Delta environments has known no respites (Aaron, 2016). The major culprits are oil spills and gas flaring. As a result of equipment failure and sabotage, oil spills have become endemic and devastating in the Niger-Delta. Various activities in crude oil exploration, storage and transportation lead to spillage of oil to the environment (Nicollotti and Eglis, 2008). The spilled oil [pollutes soils and makes the soils to be less useful for agricultural activities with soil dependents organisms being adversely affected (Baker, 1970; Mackay, 1991; Gelowitz, 1995. Siddiqui and Adams, 2002). It has been reported that plants and soil microbes compete for the little nutrient available in soils that are not rich like that polluted with crude oil thereby suppressing the

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growth of plants in such soils (Njoku et al, 2008). Oil exploration brought incessant oil spills and pollution which disrupted some of the traditional occupations of the people in Imo State. A direct fall out from this is that most people whose main occupations are farming have thus been deprived of their means of livelihood because of the polluted soil. Useable agricultural lands in the Niger Delta were reduced drastically since oil exploration started. Aaron (2016) argued that farmlands in the Niger Delta have been infertile and unproductive due to frequent oil spills that are never cleaned up properly. Oil spills have degraded most agricultural soils in Imo State and have turned hitherto productive soil area into wastelands. With increasing soil fertility due to the destruction of soil micro-organism, and dwindling agricultural productivity, farmers have been forced to abandon their lands to seek a non-existent alternative means of livelihood. Contamination of soils with crude oil and refinery products is becoming an ever-increasing problem, especially in the light of several breakdowns of oil pipelines and wells reported recently. Nonetheless, major points of soil pollution with refinery products are petrol stations, garages servicing cars and tractors, seaports areas, Nicollotti and Eglis (2008). It is undisputable that oil spill impacted lands do experience declining productivity in farming. The immediate effect is the destruction of crops in the long run; it reduces the nutrient value of the soil. It is discernible that farmers, whose farmlands are affected, have no alternative than to move to other areas as displaced persons; at least for a period. Thus, encouraging fragmentation, that follows leads to overuse of farmlands. For example, the bush fallow period of 3-5years in such cases has to be reduced to 1 year, or abandoned, as a result of oil spillages on the soil. This undermines the productivity of soil on which the plants thrives. Loss of soil fertility through loss of soil organic matter, leaching of nutrients, loss of the nutrient-laden topsoil, changes in soil-pH and reduction in cation exchange capacity are the major problems associated with oil spillage in the study area. Macro- and micro-organisms, as well as plant roots are harboured by the soil. It is one of the most dynamic sites of biological interactions in nature. During spillage, most of the biochemical reactions concerned in the mineralization of soil organic matter needed for plant growth is been lost. Oil is known to exert adverse effects on soil properties and plant community. Beyond 3% concentration, oil has been reported to be increasingly deleterious to soil biota and crop growth (Baker, 1976; Amadi, et al., 1993; Osuji et al., 2005). Oil spillage affects microbial activities in the soil, also adversely affecting plant growth, as well as detoxification of organic pollutants. Micro-organisms are useful in predicting the impact of a particular stress on the environment by their ability to respond to these adverse conditions through a change in their numbers (Ekundayo et al., 2015). Petroleum and refinery products penetrating soil cause its degradation (Sziomkpa, 1999). Once they enter an ecosystem, petroleum- based products initiate a series of processes, affecting both its biotic and abiotic elements of soil (Malachowka-Justsz et al., 2014). Although, physical clean-ups are usually carried out by companies if any spill does occur however, the lands are left bare, without adequate replanting to restore the environment to its natural or near-natural state, a problem also identified by Gbadegesin (2016), hence consisting a major problem as soil becomes exposed to consistent heating and contraction leading to leaching. It is against this background that there is need to study the effect of spillage on soil in Imo State, which is one of the States in the Niger Delta region. Thus, the following questions will be put forward in order to guide this investigation and they include; what is the extent of oil spillage in the study area? Does spillage affect the soil fertility? What are the soil components affected by oil? What are the methods by which these soils can be revitalized? This study therefore assesses the impact of oil spillage on soil in Imo State environments, so as to provide necessary answers to the questions raised.

AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to assess the impact of oil spillage on soil in the Imo State environment. The objectives are to;

1. Examine the soil chemical characteristics (THC, OC, Fe^{++}, pH CA,Pb) of oil impacted and non-impacted in the study area.
2. Determine the physical characteristics of soil impacted and non-impacted soils in the study area.
3. Proffer appropriate soil treatment and management measures.

Research hypotheses Statement;

1. Oil impacted soils are richer in soil chemical characteristics than the non-impacted soils.

2. The particle size characteristics of oil impacted and non-impacted soils do not vary considerably because they belong to the same soil formation.

3. There is a significant relationship between the impacted region and non – impacted region.

METHOD OF STUDY

This study adopted the experimental survey design. The survey involves the analysis of soil samples of both oil impacted and non-oil impacted soils in the sample areas in Imo State.

Sources and types of data

The data used in this study was derived from primary sources which is experimental. The experimental study will determine soil quality such as soil physical and chemical indicators (Doran and Parkins, 2004; Larson and Pierce, 2004). Soil sample (3g) from surface and sub-surface soil (0-30 cm depth) was collected from all the impacted and non-oil impacted area in the sample areas in Imo State.

Sampling Framework

The data needed was generated from, six (6) Local Governments out of the twenty six (26) local Governments in the study area (Imo State); three (3) Local Government Areas of oil impacted soils and three of non-oil impacted sites were sampled. This was done through the use of simple random sampling techniques. The soil samples were randomly collected at depths of 0-15 cm and 15-30 cm respectively from three impacted and three non-impacted areas. The impacted areas in the study included Oru East and West, Ngor-Opkala and Obowo Local Government. The non-impacted areas are Mbano LGA, Ikeduru Local Government Area and Ezinihitte-Mbaise LGA, see Figure 1; of sampled areas (impacted and non-impacted areas).

Method of Data Collection

The procedure adopted for collecting data involved the measurements and analyses of soil samples both in the oil impacted and non-oil impacted sites in the study sites. The soil samples were collected at surface (0-15 cm) and subsurface (15-30 cm) depths. In all a total of twelve (12) soil samples were collected at surface (0-15 cm) and subsurface (15-30 cm) depths from both the oil impacted and non-oil impacted sites. The samples from each site were labelled (A1-A2, B1-B2, C1-C2, D1-D2, E1-E2, and F1-F2) and placed in clean polythene bags and stored for analysis. Similar samples were also collected and placed in aluminium foil for hydrocarbon analyses. The collected samples were then used to investigate the temperature, pH, salinity, level of dissolved oxygen, oil and grease, hydrocarbon concentrations levels and organic matter contents of crude oil polluted soil with the soils from the surfaces and 15cm depths mixed together and the mixture used for the study of the above physiochemical feature.

Laboratory Analyses

In a heterogeneous environment, such as soil, there are certain factors which can give indication of the fertility of the soil. These include:

1. The particles size,
2. Organic carbon,
3. Total nitrogen,
4. Soil pH,
5. Available phosphorus and
6. Cation exchange capacity, which usually give indication of fertile soil. Thus, these physical and chemical properties of the soil provided all the essential mineral elements of soil, maintain soil fertility and the ability of the soil to hold and exchange cations.

All the soil samples collected except for bulk density were air dried at room temperature, passed through a 2mm sieve and analysed for, particle size composition by hydrometer method, organic carbon by chromic acid digestion method of Walkley and Black (1998); total nitrogen by regular micro-kjedhl digestion method Bremmar and Mulvanay (1998); available phosposrous by Brays PI solution of Bray and Kurtz (1994) and determined in accordance with Murphy and Riley (1999) procedures; soil pH

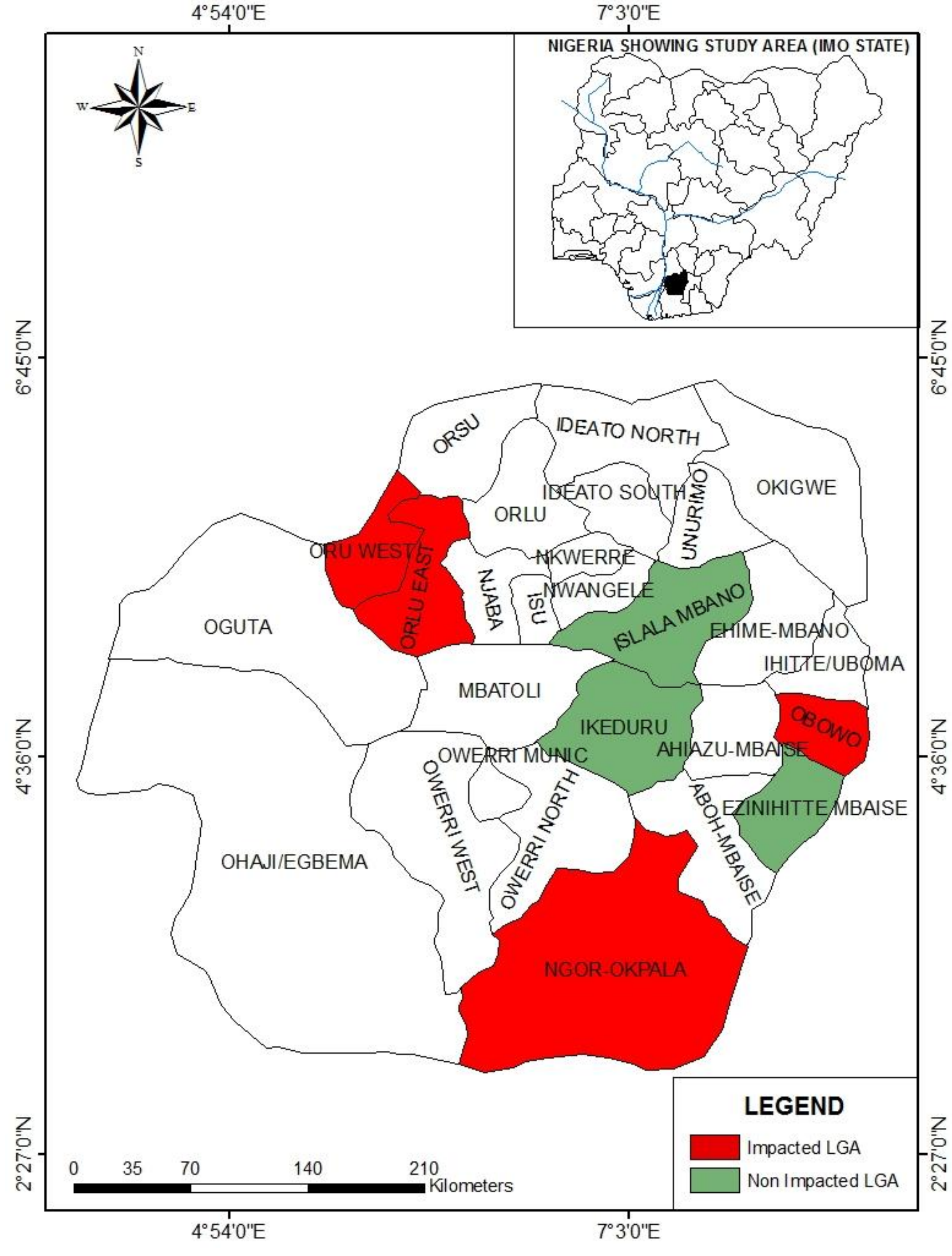

Figure 1. Map showing Sampled Areas (impacted and non-impacted areas) Imo State, Nigeria.

determined potentiometrically in distilled water using soil to water ratio of 1:1 (Bates, 1994); cation exchange capacity value will also be determined by using ammonium acetate (NH_4OAC) leachate method; and consecration of metals-lead, cadmium nickel and chromium in the soil helped to be determined by the Atomic Absorption (AAS). These listed elements have been proven to be

Table 1. Soil Impacted Site in some LGAs in Imo State.

Aeration	Dept.	Soil types		
		Sand	**Clay**	**Silt**
Oru-East/West	0-15	12.1	29.50	39.43
	15-30	7.40	31.30	46.80
Ngor-Okpala	0-15	12.3	38.27	41.31
	15-30	8.1	30.00	43.10
Obowo	0-15	11.98	25.10	29.0
	15-30	7.37	31.78	40.80
Non Impacted Sites				
Ngor Okpala	0-15	10.9	37.42	51.7
	15-30	9.4	38.77	51.83
Ikeduru	0-15	8.15	30.71	47.3
	15-30	8.45	33.60	47.90
Ezinilitte Mbuise	0-15	9.49	30.10	41.3
	15-30	7.50	32.50	43.5

physiologically essential to plants growth, hence the effects of oil spillage on these elements in determining the physiochemical properties of soil in Imo State. However, there is the need to determine the status of these elements in the laboratory in assessing the fertility level of the soil, vis-a-vis the effect of oil spillage on the soil fertility status. See Table 1, for the different soil types in the study area.

Soil particle size

The soil particle size refers to the proportion of sand, silt and clay in the soil. It also refers to the ability of the soil to hold and respond to fertilizer application.

Apparatus

The apparatus to be used includes Beaker, Stirrer, Measuring cylinder, Hydrometer (soil), Reagents;

1. 100 g of soil sample weighed and put in a beaker.
2. 50ml of 3% NaOH solution added to soil sample and stirred.
3. Solution poured into measuring cylinder and filled with water.
4. Solution stirred and corked in a cylinder
5. Readings taken from soil hydrometer and recorded.

Quality Control

1. NaOH solution added and stirred at interval of 5 minutes and left for 30 minutes to digest soil samples.
2. Solution poured into cylinder after one hour.
3. Cylinder shaken for 1 minute.
4. Readings taken twice and recorded.

Soil pH

Soil pH is a measure of the Hydrogen ion concentration in the soil. It is a very important soil property as it controls the amount of nutrients available to plants. The level of concentration of the ions determines whether the soil is acidic or alkaline or neutral as the case maybe.

Table 2, shows the rate of pH the soil of impacted region, both for soil depths of 0-15cm and 15-30cm.

Apparatus: Beaker, distilled water, stirrer/glass rod, pH meter.

Procedure;

1. 1g of dry soil sample weighed and grounded into powder.
2. 40g of potassium dichromate weighed and put in a conical flask + 1 litre distilled water.
3. 10ml of prepared solution in (2) added to the grounded soil sample.
4. 140gm of iron (II) sulphate weighed and acidified with 15ml of concentrated sulphuric acid.
5. Solution titrated against ammonium sulphate expected to change the colour greenish
6. Ferrous indicator added to solution for a change in colour to greenish pink and reading taken.

Total nitrogen in soil:-Nitrogen is a primary requirement in the determination of crop yield and quality. It is required in large amounts in the soil for plant growth.

Phosphorus in Soil:-Phosphorus plays an important role in plants metabolic processes. It enables the plant to develop: and hence a relatively large quantity of Phosphorus is needed for plants growth.

Table 2. pH of oil impacted sites and non – impacted site on the soil sampled areas**.**

Oru-East/West	A1	0-15	6.79
		15-30	6.56
	A2	0-15	5.33
		15-30	5.04
Ngor-Okpala	B1	0-15	6.23
		15-30	5.04
	B2	0-15	5.97
		15-30	5.18
Obowo	C1	0-15	4.93
		15-30	5.11
	C2	0-15	6.20
		15-30	5.39
Islala Mbano	D1	0-15	5.49
		15-30	5.42
	D2	0-15	5.89
		15-30	5.61
Ikeduru	E1	0-15	5.89
		15-30	5.61
	E2	0-15	5.01
		15-30	5.11
Ezinilitte Mbuise	F1	0-15	5.34
		15-30	5.11
	F2	0-15	5.34
		15-30	5.42

Apparatus: Micro-flask (750ml), Distilled Water, Pipette, (750ml) flask,(500ml) Erlenmeyer flask.

Cation Exchange Capacity and Exchangeable Bases: This is the ability of the soil to hold and exchange cations (Calcium, Potassium, Sodium and Magnesium) for plant growth. The degree of exchange is dependent on the nature of minerals and level of organic matter in the soil. Thus, when gas is flared the particles dissolve in the soil solution and changes to ionic forms which affects the growth of plant

Data Analysis

The data were analysed using statistical technique such as table, and Simple Regression Analysis, also the SPSS software since the volume of data generated is very large.

RESULTS

Soil Characteristics of Oil Impacted and Non-Oil Impacted

Table 3, shows the particle size analysis of soils in oil impacted area of Imo State. The basic soil type at 0-15cm depth from the three ranges from 11.98% - 12.30% of sand, 25.10% - 38.27% of clays and 29.00% - 41.31% of silt; while soil sample at 15-30cm depth in the same locations ranges from 7.37% - 8.1% of sand, 30.00% - 31.78% of clay and 40.80% - 46.80% of silt. However, the soil type in Imo State contains more of silt. The oil pollution altered physical soil properties, lowering porosity and increased resistance to penetration and hydrophobility and aggregates soil particles in plaques (Ekundayo et al., 2015).

Table 4, shows the particle size analysis of soils in Non-Oil Impacted area of Imo State. The basic soil types at 0-15cm depth from the various locations ranges from 8.15% - 10.9% of sand, 30.10% - 37.42% of clay, and 41.30% - 51.7% of silt, while the soil type at 15-30cm depth ranges from 7.50% - 9.4% of sand, 32.50% - 38.77% of clay and 43.50% - 57.83% of silt.

Table 5; shows the acidity level of the soil in oil impacted areas. The soil pH measures the level of soil acidity or alkanity in a solution or substance. Thus, the soils at depth of 0-15cm in sample point A1 and A2 are more acidic than that of 15-30cm depth. In sample point B1 and B2, soils at 0-15cm are more acidic than that of 15-30cm, while soil in sample point C1 and C2 at 0-15cm and 15-30cm and both slightly in nature. This corresponds with the works of Osam, et al (2017) stating that top surface soils is more acidic in nature than the in-depth soils. Table 6, shows the acidity of soil in the non-oil impacted area of Imo State. Thus, the soil at depth of 0-15cm in sample D-F shows an acidity/alkanity rate of 5.34 – 5.69 which indicating that acidity level of soil in the area is very low. The sample is applicable to soil in depth of 15 – 30 cm. Furthermore, Table 7; shows the different sample points, sample depths and the different chemical properties of soil of oil impacted sites in the study area.

Ho1: Oil impacted soil are not richer in soil chemical characteristics than the non-impacted soil. From the ANOVA Table 8, the f-cal of 10.21 is

Table 3. Soil Particles Percentage.

Location	Dept.	Types of Soil		
		Sand	**Clay**	**Silt**
Oru-East/West	0-15 15-30	12.1 7.40	29.50 31.30	39.43 46.80
Ngor-Okpala	0-15 15-30	12.3 8.1	38.27 30.00	41.31 43.10
Obowo	0-15 15-30	11.98 7.37	25.10 31.78	29.0 40.80

Table 4. Particle Size Percentage of Non-Oil Impacted Sites.

Location	Dept.	Types of Soil		
		Sand	**Clay**	**Silt**
Islala Mbano	0-15 15-30	10.9 9.4	37.42 38.77	51.7 51.83
Ikeduru	0-15 15-30	8.15 8.45	30.71 33.60	47.3 47.90
Ezinihitte – Mbaise	0-15 15-30	9.49 7.50	30.10 32.50	41.3 43.5

Table 5. Soil Mean pH in the Oil Impacted Area.

Sample Point	Depth		$\bar{x}$
A1 A2	0-15 0-15	6.79 5.33	6.06
A1 A2	15.30 15-30	6.56 5.21	5.89
B1 B2	0-15 0-15	6.23 5.97	6.10
B1 B2	15.30 15-30	5.04 5.18	5.11
C1 C2	0-15 0-15	4.93 6.20	5.57
C1 C2	15.30 15-30	45.11 5.39	5.25

Table 6. Soil Mean pH in the Non-Oil Impacted Area.

Depth	Sample Point		
	D	**E**	**F**
0 – 15cm	5.69	5.45	5.34
15 – 30cm	5.52	5.36	5.27

Table 7. Chemical Properties of Soil of Oil Impacted Area.

			Chemical and Nutrients Properties of Soil (Mg/Kg)								
Experiment Area	**Sample Points**	**Sample Depth**	**THC**	**OC**	**NO_3**	**PO_4^3**	**Ca^-**	**Cd**	**Fe**	**Ni**	**PD**
Oru-East	A_1	0 – 15	13.10	1.11	1.30	10.00	2.10	120.15	14.00	0.51	1.60
		15 – 30	13.29	1.16	1.35	10.03	2.09	127.90	13.75	0.29	1.65
	A_2	0 – 15	12.28	0.09	1.26	10.26	2.11	121.30	14.01	0.09	1.56
		15 – 30	11.39	1.01	1.30	10.15	2.30	125.30	14.06	1.21	1.61
Agor-Okpala	B_1	0 – 15	15.69	0.11	1.29	10.11	2.13	120.15	13.51	0.31	1.60
		15 – 30	14.01	0.91	1.30	10.24	2.26	120.19	13.26	0.56	1.64
	B_2	0 – 15	17.10	0.07	1.36	10.21	2.45	121.5	14.09	0.21	1.62
		15 – 30	16.31	1.15	1.61	10.27	2.30	130.5	14.53	1.31	1.58
Obowo	C_1	0 – 15	16.90	1.12	1.33	10.19	2.29	135.01	13.08	0.91	1.57
		15 – 30	15.81	1.05	1.39	10.13	2.12	129.01	13.91	0.36	1.59
	C_2	0 – 15	17.19	1.89	1.22	10.17	2.69	126.91	14.91	1.56	1.58
		15 – 30	16.302	1.07	1.31	10.11	2.13	130.50	13.00	0.10	1.65
Islala Mbano	D_1	0 – 15	15	3.14	1.60	13.04	5.11	158.17	17.31	1.11	3.57
		15 – 30	14.78	2.21	1.65	11.23	4.23	144.12	14.99	1.16	2.06
	D_2	0 – 15	15.01	1.41	1.56	10.55	3.33	141.27	15.34	0.09	1.99
		15 – 30	14.93	1.73	1.59	11.00	2.34	150.11	16.24	1.22	2.34
Ikeduru	E_1	0 – 15	15.20	0.93	1.61	11.39	2.77	146.18	15.82	1.38	1.69
		15 – 30	14.01	1.01	1.60	10.61	2.65	151.25	15.67	1.58	1.74
	E_2	0 – 15	15.11	1.44	1.64	11.36	2.38	149.19	15.81	1.64	2.33
		15 – 30	15.03	1.22	1.54	10.39	3.12	155.26	14.82	1.37	2.13
Ezinitte-Mbuise	F_1	0 – 15	14.82	1.67	2.29	10.48	2.96	158.77	15.59	1.17	2.33
		15 – 30	15	1.13	1.77	10.05	2.76	145.61	15.03	1.22	1.71
	F_2	0 – 15	14.90	1.42	2.43	11.03	2.43	152.33	16.33	2.03	2.32
		15 – 30	15.21	2.11	2.27	10.18	2.55	139.41	15.49	0.63	1.60

Table 8. Impacted / Non Impacted.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	48.715	1	48.715	10.21	0.025
Within groups	31485.867	16	1967.867		
Total	31534.582	17			

Table 9. Independent Sample Test.

		Levene's Test for Equality of variances		t-test for Equality of means				
		F	**Sig.**	**T**	**Df**	**Sig. (2tailed)**	**Mean difference**	**Std. error difference**
Impacted/non impacted	Equal variances assumed	.944	.338	-.601	34	.552	-3.04889	5.07114
	Equal variances not assumed			-.601	32.802	.552	-3.04889	5.07114

greater than f-critical of 4.49 (f-cal > f – critical) at 0.05 level of significance. Also, the significant value of 0.025 ($p < 0.05$) indicates a significant impact. Based on the above, the null hypothesis is rejected. Therefore, Oil impacted soil are richer in soil chemical characteristics than the non-impacted soil.

ANOVA

Ho2: There is no significant difference between the particle size of oil impacted and non – impacted soils of the same formation.

From the Table 9 above, the t – calculated of 0.601 is higher than the t-critical of -2.12. Also, the significant value of 0.338 ($p>0.05$) indicates an insignificant difference. Based on the above, the null hypothesis is accepted. Therefore, there is no significant difference between the particle size of oil impacted and non – oil impacted soils of the same soil formation.

Ho3: Contingency Table 10 (a) and (b); there is no significant relationship between the different impacted areas with depth.

By-comparism, linear regression Table 10 (a) and (b) above, the correlation coefficient (r = 0.941) between depth at Orlu zone, Ngor Okpala (r = 0.845), Obowo (r = 0.918) indicates a very strong and positive correlation. This implies that, the depth of the impacted soil depends largely on locations. The coefficient of determinant (r^2) further indicates that 88.5% of the depth of pollution can be explained by Orlu East, 71.4% of the depth of pollution can be explain by the extent of pollution at Ngor Okpala area, and 84.3% of the levels of depth can be explained by the extent of pollution by Obowo areas. The overall coefficient at determination ($r^2 = 0.936$) showed that 93.6% of the depth of pollution can be explained by different oil impacted areas tested.

Findings of the Research

The hypotheses stated were tested using Analysis of Variance (ANOVA) for the test of homogeneity of chemical properties of soil and multiple regression analysis with the aid of Statistics Package for Social Sciences (SPSS) version 17. The following are the major findings;

1. The soils found in Imo State have high composition of silt which might be due to the effect

Table 10. (a) Correlation.

		Depth	Orlu	Ngorokpala	Obowo
Pearson Correlation	Depth	1.000	.941	.845	.918
	Orlu	.941	1.000	.962	.971
	Ngorokpala	.845	.962	1.000	.907
	Obowo	.918	.971	.907	1.000

Table 10. (b) Model Summary.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	Df1	Df2	Sig. F Change	
1	.968[a]	.936	.840	12.34671	.936	9.765	3	2	.094	2.331

a. Predictors: (Constant), Obowo, Ngor-okpala, Orlu

b. Dependent Variable: Depth

of a nearby stream and land filling by relatively coarser soil.

2. The soils found at the impacted areas are acidic and contain high amount of carbon which is attributed to the oil spillage. Alternatively, the observed slight acidity level of soils could have been responsible for the poor utilization of the nutrients in the growth medium.
3. The organic carbon in the oil impacted soil in the various locations is low because the spilled oil impaired the metabolic processes that would have facilitated the agronomic addition of organic carbon from the petroleum hydrocarbons by reducing the carbon-mineralizing capacity of the micro flora.
4. The total hydrocarbon content (THC) value is higher in comparison with the value of the control and this result indicates that the THC of the oil-spilled soils was higher than that of the control in both the surface and sub-surface soils (Osam et al., 2017).
5. The phosphorous, Nitrogen, Calcium, Iron, Nickel content are affected by the oil spill affecting the soil quality and soil physical properties.
6. According to the hypothesis the calculated value is more than (>) critical value, meaning rejecting the null hypothesis and accepting the alternate.

DISCUSSION

This study examined the effects of oil spillage on the soils in Imo State, Nigeria. The method of research was experimental. The soils found in Imo State have high composition of silt which might be due to the effect of a nearby stream and land filling by relatively coarser soil. Table 5 in this research shows the acidity level of the soil in oil impacted areas. The soil pH measures the level of soil acidity or alkalinity in a solution or substance. Thus, the soils at depth of 0-15cm in sample point A1 and A2 are more acidic than that of 15-30cm depth. On the other hand In sample point B1 and B2, soils at 0-15cm are more acidic than that of 15-30cm, while soil in sample point C1 and C2 at 0-15cm and 15-30cm and both slightly in nature. Using the ANNOVA test for hypothesis 1; Ho1: Oil impacted soil are not richer in soil chemical characteristics than the non-impacted soil. From the ANOVA Table 8, the f-cal of 10.21 is greater than f-critical of 4.49 (f-cal > f – critical) at 0.05 level of significance. Also, the significant value of 0.025 ($p < 0.05$) indicates a significant impact. Based on the above, the null hypothesis is rejected. Therefore, Oil impacted soil are richer in soil chemical characteristics than the non-impacted soil. According to the hypothesis the calculated value is more than (>) critical value, meaning rejecting the null hypothesis and accepting the alternate.

RECOMMENDATIONS

The following recommendations are made:

1. Continuous inspection of pipelines by oil industries to ascertain worn-out equipment for immediate replacements.
2. Oil companies should train their spillage intervention remediation team and equip them with modern bioremediation technology which is environmental friendly.
3. Culprits of pipeline sabotage or bunkering should be prosecuted.
4. Government and oil companies should carry out enlightenment campaign to sensitize and educate the citizenry on the effect of crude oil spillage on soil property and food production.
5. There should be a constant environment monitoring, assessment and evaluation to determine the level of damage that is done by oil spillage and other oil pollutions on the environment as a whole.
6. The creation of regional spill response centres would help in managing oil spill problems. The centres will use oil spill models for combating oil spill problems.
7. The petroleum industry should work closely with government agencies, universities and research centers to combat the menace of oil spill incidents.

CONCLUSION

The study, has shown that oil spillages has caused negative impact on the environment especially in the area of study, which ranges from its effect on the physical to chemical and effect on soil. Apart from affecting the chemical properties of the soil, it also resulted to poor soil fertility or nutrient in the area. However, it is worthy to note that spillage affects agricultural and economic activities of oil host communities in Nigeria. Therefore, both the government and the oil companies should keep up to the challenges of monitoring, evaluating and managing the oil drilling environment for a sustainable environmental development.

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