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Research Paper

Impact of Oil Spill on Edaphic Variables Near A Flow Station In Odagwa Etche, Rivers State.

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ABSTRACT
Oil spill pollutes not only the river but the environment including the soil, through sabotage; inadequate of non-functional production equipment and total corrosion of pipes and tanks. The current study investigated the presence and levels of total petroleum hydrocarbon contents (THC) on edaphic variables in an oil spill impacted area near a flow station in Odagwa Etche, Rivers State, Nigeria. Soil samples were collected with stainless hand auger from 0-15cm and 15-30cm stored in sterile aluminum foils and polythene bags from the five sampling points IMRC, IMR1, IMR2, IMR3 and IMR4. In which the unpolluted (control) was taken 3km away from spill site against the direction of flow of drainage. Descriptive statistics, Variation plots, Single factor ANOVA, means plots and Pearson correlation were used to analyze data. Total petroleum hydrocarbon content, pH, Electrical conductivity, Carbon/Nitrogen ratio, Average phosphorus and potassium ranged as follows: 17.20-8051.40 (2435.81 ± 924.50) mg/kg ,4.60-6.40 (5.52 ± 0.17), 28.00-78.00 (45.20 ± 5.52) µS/cm, 14.00-92.50 (47.09 ± 8.60),9.00-40.20 (24.72 ± 3.98)µg/g and 55.00-90.00 (68.56 ± 3.14)mg/kg respectively, whereas Organic carbon 0.70-5.16 (2.65 ± 0.48) %,Total Nitrogen 0.04-0.08 (0.06 ± 0.004)%, Sulphate 2.70-7.30 (4.80 ± 0.44)µg/g, Sodium (Na^+)0.20-2.40 (0.78 ± 0.19)mg/kg, Calcium (Ca^{2+}) 0.602.00 (1.30 ± 0.15)mg/kg, and Magnesium (Mg^{2+}) 0.60-2.00 (1.30 ± 0.15)mg/kg. THC correlated with organic carbon (r=0.750) and carbon/nitrogen ratio (r=0.641). The THC in impacted soil contributed significant difference (Sig.F=0.000) in edaphic variables across the sampling points at P<0.05. The textural classification of the soil revealed that sand dominated the soil profile 46.00-76.00 (59.20 ± 3.31) % and this could predispose the groundwater aquifer to pollution from surface point source. Government and oil companies should fund adequate projects that would ensure the reclamation of hydrocarbon polluted Agricultural lands, to educate individuals, cooperate bodies etc on how to use their natural resources efficiently.

Keywords: *Oilspill, Total Petroleum Hydrocarbon Content, Etche, Imo River, Edaphic variables.*

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I. INTRODUCTION

1.1 BACKGROUND OF STUDY

The thesis deals with the impact of oil spill on edaphic variables of soils in Imo River flow station that is in this context the oil spill pollutes not only the river but the environment including the soil. By this pollution is the introduction of harmful substances or products (contaminants) into the normal environment that causes adverse change. Pollution can take the form of energy or chemical substance such as noise, heat or light.

Forms of pollution

The major forms are.

Air pollution includes the release of particulates and chemical into the atmosphere. Such as carbon monoxide sulfur dioxide, chlorofluorocarbons

(CFC) and nitrogen oxides produced by industry and motor vehicles. Photochemical ozone and among are created as nitrogen oxides and

hydrocarbons react to sunlight.

Noise pollution which includes roadway noise, aircraft noise, industrial noise as well as high-intensity sonar.

Soil contamination which occurs when chemical is released by spill or underground leakage. The most significant soil contaminations are hydrocarbon, heavy metals, MTBE herbicides, Pesticides and chlorinated hydrocarbons Radioactive contamination which resulted from the 20th century activities in atomic physics such as nuclear power generation and nuclear weapon research manufacture and deployment.

Water pollution by the discharge of wastewater from commercial and industrial waste into surface waters discharges of untreated domestic sewage, and chemical contaminants such as chlorine from treated sewage release of waste and contaminants into surface runoff flowing to surface water.

Oil spill is the release of a liquid petroleum hydrocarbon into the environment especially marine areas due to human activity and in form of pollution. The term is usually applied to flow station (or marine) oil spill where oil is released into ocean coastal waters, but spills may also occur on land (environment).

Oil spills may be due to releases of crude oil from tankers offshore platforms, drilling of wells as well as spills of refined petroleum products as such as gasoline, diesel and their by-product, heavier fuels used by large ships such as bunker fuel or the spill of any oily refuse or waste oil in the environment. Many flow stations in oil –producing communities in Nigeria especially Etche Rivers State in the Niger delta have been suffering from the aftereffects of oil spillage. The accidental discharge of petroleum product on soil or water surfaces is termed oil spill. Oil – spill pollution has been hazardous and problematic worldwide (Vincent, 1980). The Nigerian National Petroleum Corporation (NNPC) in 1986 reported that a total of about 5,000 barrel of crude oil was spilled from Nigerian Agip oil company (NAOC) pipeline near Oshika in rivers state in august 1983 (IPS, RUST,1986). Analysis of the oil sample from the affected environment showed that the organic content of the soil in polluted area was slightly higher and there was also slight increase in soil acidity. Recorded incidence of oil spill near a flow station show that a lot of problem have arisen because of it. A lot is being spent by affected countries in the cleaning of spills. United States of America for example spends millions of dollars in the control and cleaning of oil spills (API 1975) lives have been lost because of disease caused by oil spill issues in Nigeria have been very contentious with local communities in needed for the sources, extent, and responses to contamination in affected areas to be controlled.

Risk assessments have emerged because of worldwide interest in different aspects of hazards.

Asserts that involves the identification of hazards, estimating the threats may pose to humanity and the environment and the evaluation of such risk in a comparative perspective (Mitchell 1989).

Etche, an oil producing community in Rivers State has had several incidences of oil spill in the environment. Property worth of millions of naira has been lost because of these spillages.

Oil spill in the environment is a common event in Nigeria and occur due to several causes including.

i. Sabotage 28% and ii. Oil production operation (21%) of the spills being accounted for by inadequate of non – functional production equipment.

iii. The largest contribution to the oil spill total corrosion of pipes and tanks, in the rupturing or leaking of production infrastructures that are describes as "very old and lack regular inspection and maintenance a reason that corrosion accounts for such a high percentage of oil spill is that as a results of the small size of the oil fields in the Niger Delta there is an extensive network of pipelines between the fields as well as numerous small network of flow lines the narrow diameter pipe that carry oil well heads to flow stations allowing many opportunities for leaks in on shore areas most pipelines and flow line are laid above ground.

Sabotage is performed primarily through what is known as "bunkering" whereby the saboteur attempts to tap the pipeline. In the process of extraction sometimes the pipeline is damaged or destroyed. Sabotage and theft through oil siphoning has become a major issue in the Niger River Delta States as well as contributing to further environmental degradation damaged lines may go unnoticed for days and repair of the damage pipe takes even longer oil siphoning has become big business, with the stolen oil quickly making its way into the black market.

While the popularity of selling stolen oil increase, the number of deaths is increasing December 2006 more than 200 people were killed in the Lagos region of Nigeria in an oil line explosion.
Nigerian regulation of the oil industry is weak and rarely enforced allowing in essence the industry to self regulate. Oil spillage has a major consequence and impact on the ecosystem into which it is released and may constitute ecocide. Immense tracts of the mangrove forest which are especially susceptible to oil have been destroyed. An estimated 5 to 10% of Nigerian mangrove ecosystems have been wipe out either by settlement or oil. The rainforest which previously occupied some 7,400km^2 of land has disappeared as
well.
Spill in populated areas destroying crops and aquacultures through contamination of the groundwater and soils. The consumption of dissolved oxygen by bacteria feeding on the spilled hydrocarbons also contributes to the death of fish. In agricultural communities often a year's supply of food can be destroyed
instantaneously.

1.2 STATEMENT OF THE PROBLEM
The widespread incidences of oil spills caused by the corrosion of pipes, tanks leakages infrastructures decay and sabotage in Niger delta areas especially Etche in Rivers State result in many instances of soil and water contamination. The disposal of organic and inorganic wastes on agricultural soils, wastewaters and wastes from everyday operation at outlet has contributed to the pollution of water and soil.
In general, oil spills present problem that affects the economic activities, human health, conservation of natural resources, the ecology, and the aesthetic values of the areas.

1.3 AIM AND OBJECTIVES
The aim of this research is to determine the presence and levels of Total petroleum hydrocarbon content of soils in odagwa, Etche Rivers State considering the following objectives.
To determine total petroleum hydrocarbon (THC) contents in the soils of the study area.
To determine the other edaphic variables in the study area.
To determine the influence of crude oil on the edaphic variables.
To determine possible spatial variations in levels of the edaphic variables.

1.4 JUSTIFICATION
This study is timely because there is need for knowledge on the control of oil spills on soil or water and for a better understanding of the remedial measure that may be required after oil spillage.

1.5 SCOPE AND DELIMITATION
The study focused on the evaluation of the impact of oil spill on edaphic variables of soils in the Imo River flow station in Odagwa Etche, Rivers State. It was carried out in May 2012. In doing this, trace metals such as Ca^{2+}, Na^{+}, $SO^{2-}{}_{4}$, Mg^{2+}, K^{+} as well as other physicochemical parameters such as pH, sulphate ions, phosphate ions, total nitrogen, organic carbon and Electrical conductivity were determined in soil samples collected on the spill site.

1.6 SIGNIFICANCE OF STUDY
The significance of this study cannot be over overemphasized, especially in the face of increasing industrialization and urbanization in the environment.
Consequently, results from this study could serve as;
A guide to highlight the hazards or dangers associated with oil spill on Agricultural soil.
A means to draw government's attention to enforce legislation on oil spill guidelines as regards the Shell Petroleum Development Company (SPDC) and other companies.
A medium to provide relevant data to the companies as a basis for advising their management to install an effective, functional, and efficient oil spill remedial method in preference to the current management method used.
A medium to suggest a good way of protecting oil pipelines which could serve as a reference in improving the economy of the country.
A means to provide necessary information to government health workers in a bid to policing a sound and healthier environment for the people of Etche and the State in general.

II. LIMITATION OF STUDY
The major limitations of this study:
To have direct access to the spill point
Cost of laboratory analysis
Interacting with the local community dwellers
Transportation cost

III. MATERIALS AND METHODS

3.1 DESCRIPTION OF STUDY AREA

The Imo River flow station in odagwa, Etche Local Government Area is located at the North-Eastern part of Rivers State, Nigeria lies within the coordinates shown in (fig.3.3). Etche is bounded in the North by Imo State, eastwards by the Imo River, then Omuma L.G.A while Obio-Akpor and Oyigbo in the south, Ikwere L.G.A is found at the westward.

3.1.1 GEOLOGY

Geographically, the study area falls under the alluvium type of soil that is a mixture of silt and sands that belong to the quaternary period.

3.1.2 CLIMATE

The area features a tropical continental and the tropical maritime air mass. The general rainfall distribution pattern in Etche area exhibits the double maxima phenomenon with the two peaks occurring in June/July and September/October.

Annual mean rainfall of the area is about 3450mm with temperature ranging between 25.4°C-29.6°C. the temperature range modifies the study area with the rainforest vegetative cover predominating (Nwaogu, 2001).

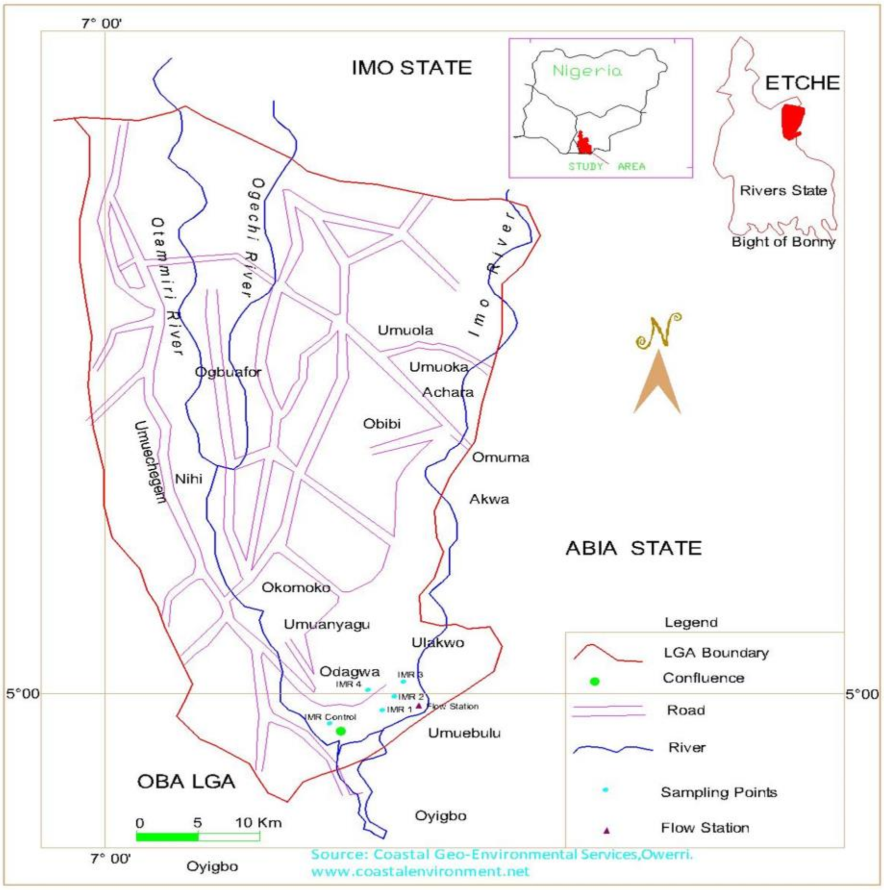

Fig 3.3: Map showing Odagwa Etche Rivers State

3.4 STATISTICAL ANALYSIS

The descriptive statistics was used to present mean, standard error, minimum and maximum values as well as range of data. The Pearson correlation was used to explore the influence of THC on edaphic variables of impacted soils. The one-way analysis variance (ANOVA) was used to test homogeneity in mean variance of edaphic variables while the post hoc means plot were used to detect structure of group means. Variations plots were used to illusidate spatial variation.

IV. RESULTS

4.1 LEVELS OF EDAPHIC VARIABLES

The levels of edaphic variables in the impacted soil in the Imo River flow station are shown in Appendix 1. The levels of Electrical Conductivity (EC)
(Range=50.00µS/cm), Total Petroleum Hydrocarbons (THC)
(Range=8034.20mg/kg) and Carbon-Nitrogen Ratio (Range=78.50) had very wide variations.pH, EC and THC varied from 4.60-6.40 (5.52 ± 0.17), 28.00-78.00
(45.20 ± 5.52) µS/cm and 17.20-8051.40 (2435.81 ± 924.50) mg/kg respectively (Table 4.1). Organic C,Total N,C/N ratios and Average P varied as follows; 0.705.16 (2.65 ± 0.48) %,0.04-0.08 (0.06 ± 0.004)%,14.00-92.50 (47.09 ± 8.60) and 9.00-40.20 (24.72 ± 3.98)µg/g respectively. Sulphate, K^+ ,Na^+,Ca^{2+} and Mg^{2+} varied as follows:2.70-7.30 (4.80 ± 0.44)µg/g,55.00-90.00 (68.56 ±
14)mg/kg,0.20-2.40 (0.78 ± 0.19)mg/kg,0.60-2.00 (1.30 ± 0.15)mg/kg, 0.60-2.00 (1.30 ± 0.15)mg/kg,respectively. Sand, Silt and clay compositions varied as follows: 46.00-76.00 (59.20 ± 3.31) %, 4.00-27.00 (15.80 ± 2.68) % and 16.00-
46.00 (25.00 ± 2.52) %respectively.

Table 4.1. Edaphic Variables of Soils Impacted by Oil spill in the Imo River Flow station. Rivers State. May 2012.

Sampling Points	Depth (cm)	pH	EC (µS/cm)	THC (mg/kg)	(%)		C/N ratio	Av. P	SO_4^{2-}	K^+	Na^+	Ca:2+	Mg^{2+}	(%)		
					Org	Total		(µg/g)	(mg/kg)					Sand	Silt	Clay
IMR1	0-15	4.6	68	6449.50	5.16	0.08	64.5	40.2	4.1	90.0	2.4	0.8	1.9	50	25	25
	15-30	5.0	40	4672.40	3.70	0.04	92.5	28.6	2.7	71.5	0.5	0.6	1.1	46	27	27
IMR2	0-15	5.1	33	1045.80	3.80	0.06	63.3	40.0	5.1	77. 5	0.5	1.5	3.5	76	8	16
	15-30	5.4	28	858.20	3.40	0.05	68.0	38.0	4.5	68.0	0.5	0.8	2.1	68	10	22
IMR3	0-15	5.7	38	584.50	1.06	0.07	15.1	22.2	6.5	62.5	0.2	1.5	2.0	67	12	21
	15-30	5.9	31	255.90	1.63	0.05	32.6	9.0	5.0	60.2	0.8	1.2	1.9	60	16	24
IMR4	0-15	5.7	39	8051.40	3.90	0.06	65.0	31.5	4.0	68.9	0.6	1.6	1.8	55	20	25
	15-30	5.3	35	2400.80	1.90	0.05	38.0	16.2	3.3	55.0	0.6	1.2	2.2	50	4	46
IMR C	0-15	6.4	78	22.40	1.25	0.07	17.9	11.0	7.3	70.3	0.9	2.0	2.8	70	9	21
	15-30	6.1	62	17.20	0.70	0.05	14.0	10.5	5.5	61.7	0.8	1.8	L5	50	27	23

Coordinates of Imo River 1 Flow station: Easting 05° 24.401', Northing 10° 83.75'

4.3 SPATIAL VARIATIONS IN LEVELS OF EDAPHIC VARIABLES

Spatial variations were observed in the levels of edaphic variables measured across the sampling locations and depths. At 0-15cm depth, minimum levels pH (4.6), Organic Carbon (1.06%), SO_4^{2-} (4.00µg/g) and Mg^{2+} (1.80mg/kg) where recorded in IMR 1, IMR 3, IMR 4 and IMR 4 respectively (Fig 4.1). however, their respective maximum levels at the same depth (6.40, 5.16%,7.3µg/g and 3.5mg/kg) were recorded in IMR control, IMR 1, IMR control and IMR 2 respectively. At 16-30cm depth, minimum levels pH(5.00), organic carbon
(0.70%), SO_4^{2-} (2.70µg/g) and Mg^{2+} (1.10Mg/kg) were recorded in IMR 1,IMR C,IMR and IMR 1 respectively (fig 4.1). However, their respective maximum levels at the same depth (6.10, 3.70%,5.50µg/g and 2.2 Mg/kg) were recorded in IMR C, IMR 1, IMR C and IMR 4 respectively. At 0-15cm depth, minimum levels
EC (33.00µS/cm), C/N ratio (15.1µg/g), Average P (11.00µg/g) and K^+ (62.5Mg/kg) were recorded in IMR 2, IMR 3, IMR C and IMR 3 respectively (Fig
2). However, their respective maximum levels at the same depth (78.00µS/cm, 65.00µg/g and 90mg/kg) were recorded in IMR C, IMR 4, IMR 4 and IMR 1 respectively. At 16-30cm depth, minimum levels EC (28.00µS/cm),C/N ratio
(14.00µg/g), Average P (9.00µg/g) and K^+ (55.00mg/kg) were recorded in IMR 2,IMR C,IMR 3 and IMR 4 respectively (fig 4.2). Their respective maximum levels at the same depth (62.00µS/cm, 92.50µg/g and 71.50mg/kg) were recorded in IMR C, IMR 1, IMR 2 and IMR 1 respectively. At 0-15cm depth, minimum levels Na^+ (0.20mg/kg), Ca^+ (0.80mg/kg) and Total N (0.06 and 0.06)% were recorded in IMR 3,IMR 1 and IMR 2,4 respectively (Fig 4.3).however their maximum levels at the same depth (2.40mg/kg,2.00mg/kg and 0.08%) were recorded in IMR 1,IMR C and IMR 1 respectively. At 16-30cm depth, minimum levels Na^+ (0.50,0.50)Mg/kg, Ca^{2+} (0.6mg/kg) and Total N (0.04%) were recorded in IMR (1,2),IMR 1 and IMR 1 respectively (Fig 4.3).

however, their respective maximum levels at the same depth ((0.80,0.80mg/kg),1.80mg/kg and (0.50,0.50,0.50%)) were recorded in IMR (3,C),IMR C and IMR (2,3,4,C) respectively. At 0-15cm depth, minimum levels Sand (50.00%),Silt (8.00%) and Clay (16.00%) were recorded in IMR 1,IMR 2 and IMR 2 respectively (Fig 4.4). furthermore, their respective maximum levels at the same depth (76.00,25.00 and (25.00,25.00))% were recorded in IMR 2,IMR 1 and IMR (1,4) respectively. At 16-30cm depth, minimum levels Sand (46.00%),Silt (4.00%) and Clay (22.00%) were recorded in IMR 1,IMR 4 and IMR 2 respectively (Fig 4.3). however, their respective maximum levels at the same depth (68.00,(27.00,27.00) and 27.00)% were recorded in IMR 2,IMR (1,C) and IMR 1 respectively.

4.4. TEST OF HOMOGENEITY IN MEAN VARIANCE OF EDAPHIC VARIABLES

The test homogeneity in mean variance of levels of the edaphic variables across the sampling locations revealed significant difference (sig.f=0.0000) at $P<0.05$ (Appendix 2). A post-hoc ANOVA structure of group means revealed that at IMR 1 (Fig. 4.5), IMR 2 (Fig. 4.6), IMR 3 (Fig. 4.7) and IMR 4 (Fig. 4.8) the levels of Total Petroleum Hydrocarbons (THC) contributed the observed difference (22.40).

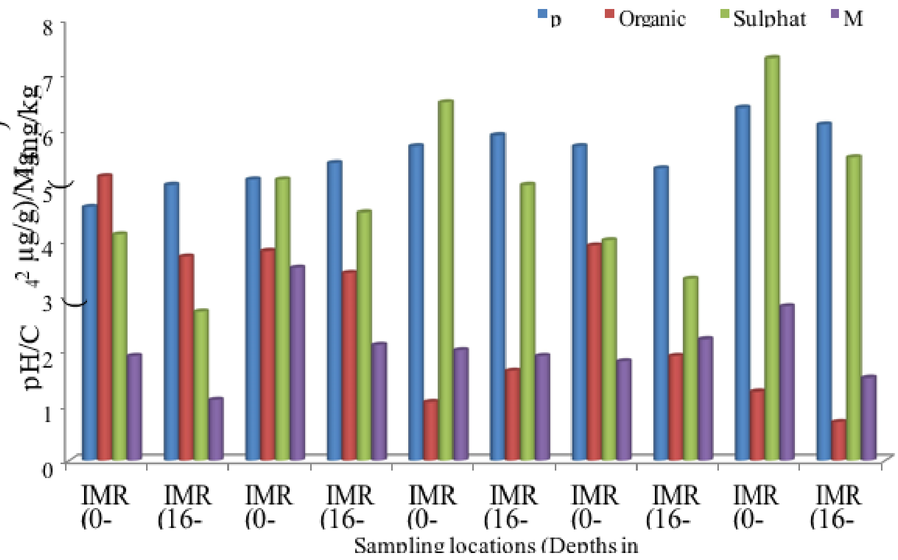

Fig. 4.1. Spatial variations in levels of pH, organic C, sulphate, and Mg ions impacted by oil spill at the Imo River

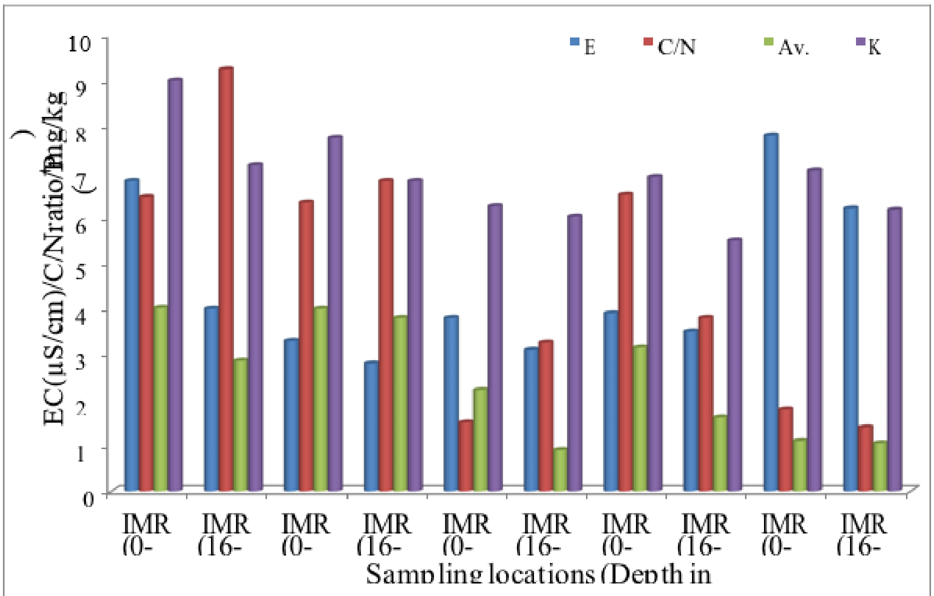

Fig. 4.2. Spatial variations in electrical conductivity, C/N ratio, available P in soils impacted by oil spill at the Imo River Flow station

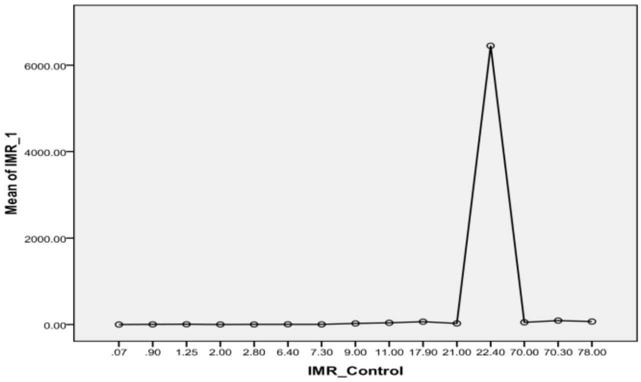

Fig.4.5. Means Plot in Levels of Edaphic Variables between the Control Location and IMR_1

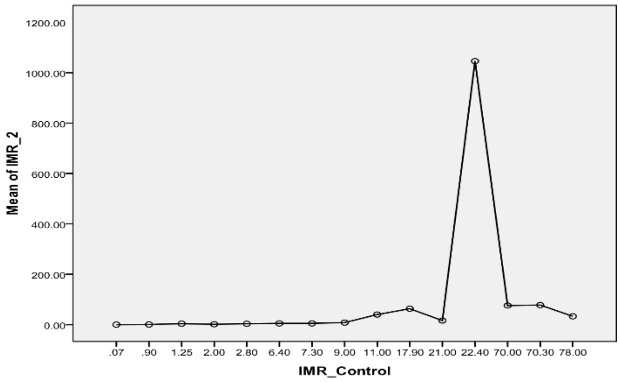

Fig. 4.6: Means Plot in Levels of Edaphic Variables between the Control Location and IMR _2

V. DISCUSSION, SUMMARY AND CONCLUSION

5.1 DISCUSSION

The Total petroleum hydrocarbons impacted important edaphic variables significantly especially the organic carbon and nitrogen ratio, their correlation is significant at $p<0.05$ and their values were 0.750 and 0.641 respectively (Table 4.2). The carbon: nitrogen ratio was observed to have been widened by the presence of crude oil in soils (Amadi and Bari, 1992). The oil spill coming from the crude oil caused alteration of the physiochemical properties of the soil such as in Agriculture that is crude oil altered the physiochemical properties which are

termed edaphic variables in this study. The $Mg^{2+,}$ Ca^{2+} and SO_4^{2-} availability reduced and affected by oil spill in the polluted soils. Which also have been reported by Landon (1991). Total Nitrogen increased with crude oil pollution, signifying higher Total Nitrogen values and was noted that organic carbon positively correlated with Total Nitrogen Unamba (1982) found a positive correlationship between organic carbon and Total Nitrogen In soils. Available P. has been noted to be limiting in oil spill polluted soils (Ladousse and Trainer, 1991, Amadi and Bari, 1992, Amadi et al., 1993). Higher values of organic carbon in crude oil polluted soils have resulted from the increased hydrocarbon content of oil polluted soils and similar finding has been reported by Ogaji et al., (2005). In this study the contaminated soils has been shown to have adverse effect on physiochemical properties of the soil. Soil reaction otherwise known as soil pH determines the actual fate of many soil pollutants (Brady and Weil, 1999). The pH increased with the range of about 4.60-6.40 which is high shows that crude oil polluted soils affects soil effective cation exchange capacity,as effective cation exchange capacity increased with increased pH (Singer and Munns,1999). Ogaji et al. (2005) also reported increase in soil pH with crude oil pollution. Considering the pH of the soil shows but in water and salt solution, the pH increases generally with crude oil pollution also similar situation was reported by Toogood et al., (1977), and they reported that crude oil tends to buffer the soil to a neutral pH (Ellis and Adams,1961).the increase in pH with crude oil contributes to the higher nitrogen value obtained in contaminated soil and the relationship between soil pH and carbon: nitrogen ratio reported by Toth, (1978) to be a positive one.

5.2 SUMMARY

The increase in pH affected the soils' ability to effect cation exchange capacity. The wide range variation between THC, organic carbon and carbon; Nitrogen ratio were recorded. Spatial variations in levels of edaphic variables were observed among the physiochemical properties measured across the sampling locations and depths were recorded. Homogeneity in mean variance of edaphic variables revealed significant difference at $p<0.05$.

5.3 CONCLUSION

It was found that oil spill on soil in Imo flow station Odagwa Etche L.G.A affected the edaphic variables in the soil properties which is evident in the wide range of THC, carbon and nitrogen that was high enough not to support growth of Agricultural crops.

5.3 RECOMMENDATION

i. Government and oil companies should fund adequate projects that would ensure the reclamation of hydrocarbon polluted Agricultural lands, to educate individuals, cooperate bodies etc on how to use their natural resources efficiently. ii. Government should create public awareness of environmental implication of oil spill in the country.

The land use Decree of 1976 should be abrogated and replaced with a more equitable and less cynical legislation that recognizes land and natural resource ownership rights.

Special courts should be set up to adjudicate on environmental disputes in order to eliminate the observed negative and detrimental effects of oil spill pollution that is crude oil in the state should be minimized to acceptable minimum standard as it is practiced by the same multinational oil and gas companies in other parts of the world (Otton, Zielinski, Smith, Abbott and Keeland, 2005).

The regulatory agency (DPR) should ensure compliance of the specified standards by the oil companies.

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