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ENVIRONMENTAL IMPACT ASSESSMENT ON PETROLEUM CONTAMINATED SOIL IN EASTERN OBOLO

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Abstract: **This study focuses on hydrocarbon soil characterization of selected farmlands in Eastern Obolo L.G.A. of Akwa Ibom State, Nigeria. The objectives include soil sampling, laboratory analysis for petroleum contamination, and impact rating of the pollutant on the environment. The methods employed were field sampling and Gas Chromatography (GC) analysis. Results obtained indicate that soils in the study area are contaminated, with total petroleum hydrocarbon (TPH) having a value of 19.28ppm. BTEX and PAH contaminants were however not detected. The rating of 40% in the study area reveals a critical impact on the environment. An obvious loss of biodiversity and loss of land use for agricultural purpose were observed. Soil remediation is recommended to restore land use for farming and other economic ventures. There should be strict enforcement of the Environmental Impact Assessment requirements for projects in the Nigerian oil and gas sector. Companies should mandatorily conduct regular environmental study to monitor the status of air, land and water so as to ensure that pollutants do not accumulate in the environment.**

Keywords:**environmental impact assessment, Eastern Obolo, TPH, PAH, BTEX**

I. INTRODUCTION

Soil is a very important natural resource that is obtained from weathering processes [22, 17]. Soil is made up of minerals and organic matter [12, 17]. Soil benefits us in a great number of ways including farming and warehousing of vast biodiversity [13]. Because of this great importance attached to soil, the Food and Agricultural Organization (FAO)'s revised World Soil Charter requires that national governments implements laws and regulations that discourage accumulation of contaminants and are also to remediate contaminated soils [17]. Soil can be said to be polluted if it has presence of substances or chemicals present at some amount higher than normal and having tendency to have adverse effect on components depending on it [17]. Soil contaminants could be petroleum hydrocarbons (PHCs) derived from crude oil or refined petroleum products [22, 21]. The hydrocarbon components present in crude oil are parafins (Methane, Ethane, Octane), Naphthenes (Benzene, Toluene, Xylene), and PAH (Naphthalene, Anthracene, Benzopyene) [2]. Soil total petroleum hydrocarbon (TPH) includes gasoline, diesel, heavy oil, and lubricating oil [11]. PHCs may destroy the aesthetic by inducing offensive odor, taste or appearance in environmental media [22]. Many of the Petroleum hydrocarbon pollutants are carcinogenic, mutagenic, immunotoxic and neurotoxic [20, 2].

Eastern Obolo is an oil rich local government located in the Niger delta fringe of Nigeria between Imo and Qua Iboe River estuaries and lies between latitude 4°28` and 4°53` North and longitudes 7°50` and 7°55` East. It is bounded in the North by Mkpat Enin LGA, North East by Onna, and West by Ikot Abasi, South East by Ibeno LGA and in the South by the Atlantic Ocean [9]. Oil has brought both positive and negative impacts on the communities being extracted. Benefits include employment, construction of good roads, electricity, provision of schools/educational facilities, pipe borne water and hospital/health care centre [15]. The negative impacts include soil infertility[4], oil spill, forest destruction, gas flaring, water pollution, air pollution, open defecation, ground water contamination, soil acidity and biodiversity loss [6, 9],

An Environmental Impact Assessment (EIA) Report assesses all actions that will result in a physical, chemical, biological, cultural, social modification of the environment as a result of the new project/development [5]. The term 'environmental assessment' describes a technique and a process by which information about the environmental effects of a project is collected, both by the developer and

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from other sources, and taken into account by the planning authority in forming their judgements on whether the development should go ahead [8]. In Nigeria, it is a regulatory requirement that the proponent of a major project submit an EIA study report for approval before project execution [14].

There is need to regularly monitor selected industrial sites in which oil and gas activities are carried out in order to measure deviation in environmental indices against standard. This study investigates the level of petroleum contamination on suspected farmlands in Eastern Obolo, quantifies the amount, and evaluates the impact on land use. The range of hydrocarbon that was analyzed in the soil include total petroleum hydrocarbon (TPH), Benzene, Toluene, Ethylbenzene, Xylene (BTEX), and polycyclic aromatic hydrocarbon (PAH). Gas chromatography employed for the study ensures a reliable quantitive assessment of the measured petrochemicals. The result obtained from the study is expected to serve as a baseline data of the hydrocarbon soil characteristic of the area. It will arouse consciousness on the part of oil companies operating in the area to be more environmentally responsible. It will help the petroleum regulatory body to ascertain the level of environmental compliance by these companies. A sound environmental management system is always necessary if a company desires to fulfil the requirements expected of it in implementing an EIA compliance program.

II. MATERIALS AND METHODS

2.1 Materials

Soil auger, polythene sampling bag, n-hexane (99%, LobaChemePVT Limited, India), methylene chloride (100%, SydneySolvents, South Pennith), anhydrous sodium sulphate (99%, LobaChemePVT Limited, India), ortho-Terpenyl (99%, Sigma-Aldrich, Germany), sonicator, Teflon-lined screw cap vial. All chemicals were of analytical grade.

2.2 Methods

2.2.1 Soil sampling

Soil was sampled at Ibon Okwan Ede village in Iko Town, Eastern Obolo L.G.A, Akwa Ibom State, Nigeria, the host community of Sterling Oil Exploration and Energy Production Company Ltd and Iko Petroleum Products Jetty. The study area is located at Latitude 4°32'2''N and Longitude 7°61'1''E. The Iko Community hosts the largest Oil Fields, that is, Utapate Oil Fields and a Flow-station in the OML 13 Cluster. Fifty (50) composite soil samples were taken from different farmlands in the study area. The soils were sampled up to depths of 0 - 15cm and 15 - 30 cm using soil auger, and mixed together to form a composite. This location was chosen because it has been a hub of oil and gas activities in Akwa Ibom State in recent years.

2.2.2 GC Analysis of the Soil Sample

The soil was characterized using Agilent 6890 GC-FID and Agilent GCMS 6890-5975B. This was done by following US EPA 3550 Standard. Extraction solvents of n-hexane and methylene chloride were prepared in the ratio 3:1. 10g of aliquot of well mixed sample was measured into a solvent rinsed beaker. Wet samples were dried with anhydrous sodium sulphate until particles were loosed. The anydrous sodium sulphate was the drying agent for the sample. 20ml to 50ml of the solvent was mixed with the sample. The mixture was spiked with ortho-Terpenyl, shaked in a vortex mixer for 1 - 5 min and placed in a sonicator for 5 - 10 min at about 70°C. The extraction was done with a glass wool and anhydrous sodium sulphate. The extract was transferred to a Teflon-lined screw cap vial ready for analysis.

III. RESULTS AND DISCUSSION

3.1 Result

3.1.1 Petroleum Contamination of Eastern Obolo Soil

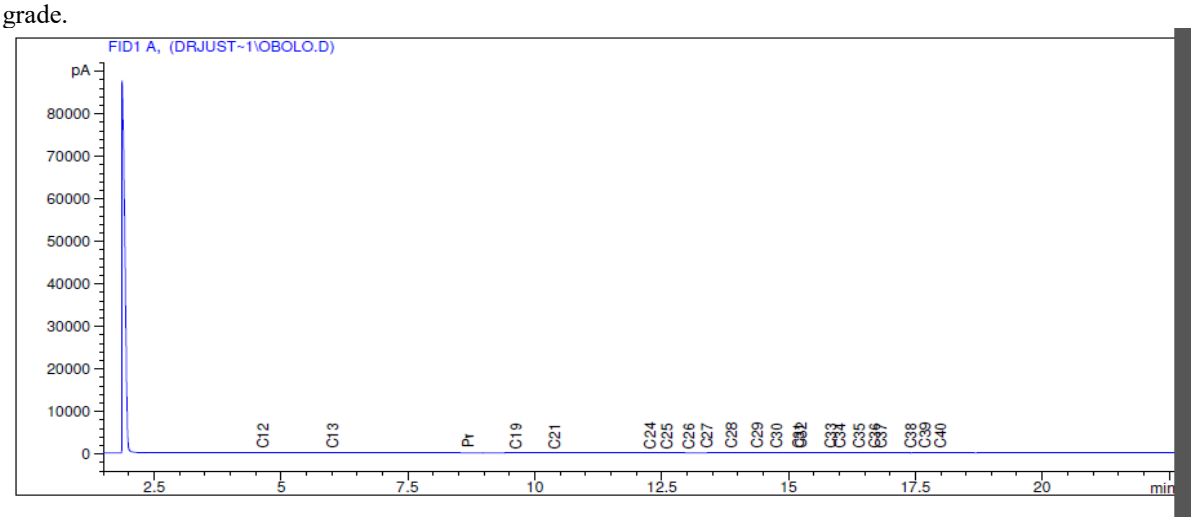

Fig. 1: TPH Value for Eastern Obolo Soil

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Table 1: TPH spread in Eastern Obolo Soil

Group name	Retention time (Minutes)	Amount (ppm)	Percentage composition
C12	4.643	0.0425928	0.220883
C13	6.022	0.157260	0.815537
C17	8.703	0.0254141	0.131795
C19	9.632	0.0274301	0.14225
C21	10.391	0.0250205	0.129754
C24	12.284	0.0288374	0.149548
C25	12.599	0.0523174	0.271313
C26	13.037	0.0450655	0.233706
C27	13.392	0.2460000	1.275734
C28	13.896	0.117086	0.607198
C29	14.397	0.473497	2.455514
C30	14.774	0.578394	2.999501
C31	15.195	0.528295	2.739692
C32	15.264	0.296606	1.538173
C33	15.831	0.222151	1.152056
C34	16.016	1.64047	8.507334
C35	16.402	2.58010	13.38017
C36	16.707	1.40345	7.278169
C37	16.834	2.61249	13.54814
C38	17.413	2.45614	12.73733
C39	17.706	3.26741	16.9445
C40	17.998	2.45698	12.74168
TOTAL		**19.28301**	

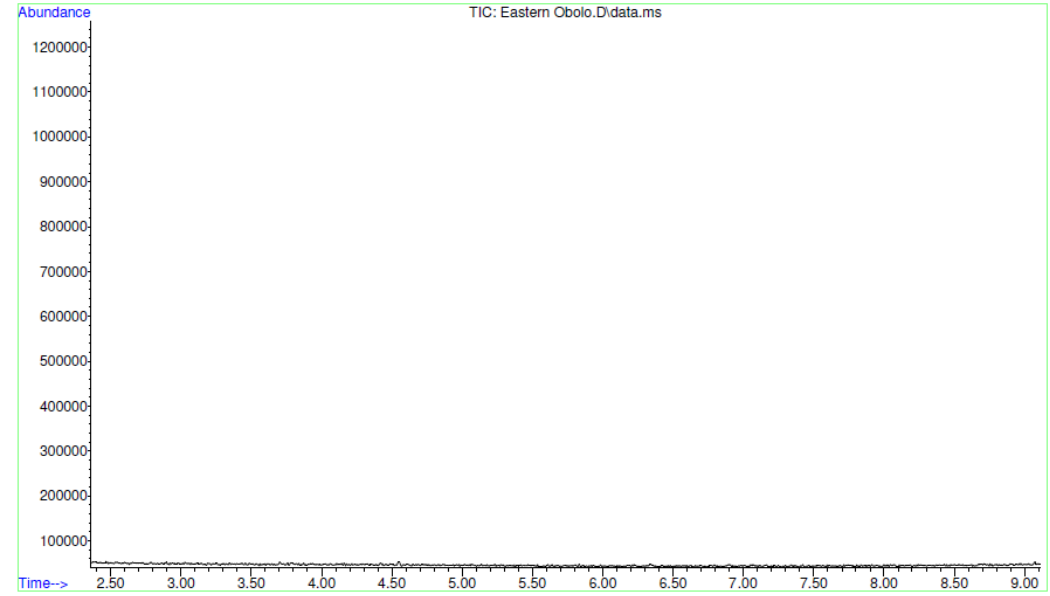

Fig. 2: BTEX Result for Eastern Obolo Soil

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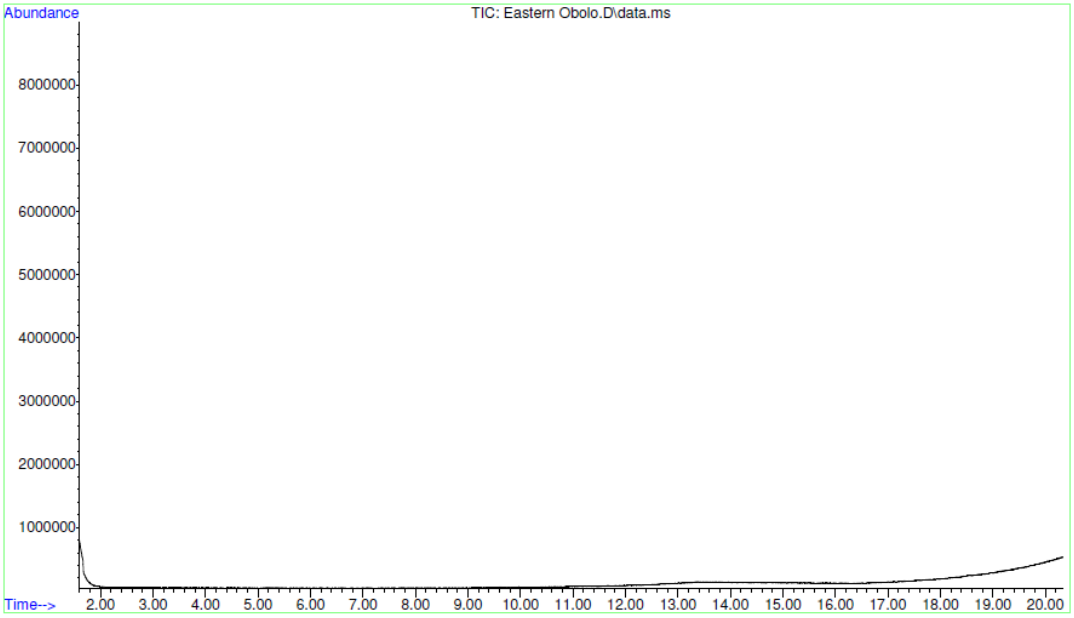

Fig. 3: PAH for Eastern Obolo Soil

3.1.2 Envrionment Impact Rating

Table 2 Environmental Impact Rating method

SCORE	RATING	REMARKS
0	Outstanding negative impact	Not Acceptable
1	Very negative impact	Not Acceptable
2	Negative impact	Critical
3	Average positive impact	Critical
4	Moderate positive impact	Acceptable
5	Outstanding positive impact	Acceptable

Table 3 Environmental Impact Score Sheet

S/N	Environmental Aspect	Impact Score
1	Land use (Agriculture)	2
2	Abnoxious chemicals in soil	2
3	Loss of biodiversity	2
4	Environmental health	2

3.2 Discussion

3.2.1 Environmental Impact of Petroleum Contamination on Eastern Obolo Soil

3.2.1.1 Hydrocarbon soil characterization

As required by the petroleum regulatory authority, all oil installations (drilling, production, refining, depot, and retail outlets) are expected to perform routine monitoring of their liquid and solid effluent at least monthly or as directed by the Department of Petroleum Resources. Parameters to be evaluated should include TPH, BTEX, and PAH, and the value shall not exceed total hydrocarbon content (THC) of 10mg/L any day [5].

Figures 1 to 3 reveal that soils at Eastern Obolo have petroleum contamination, indicated by the total petroleum hydrocarbon (TPH) value of 19.28mg/kg. The hydrocarbon spread in the contaminated soil is shown in Table 1. Results presented in figures 2 and 3 indicated that BTEX and PAH were not detected at the study area. This is likely due to the fact that BTEX has low molecular weight and are mostly found in lighter products. PAH on the other handis easily mobile in the environment. A guide to classifying the extent of TPH contaminiation was given by Inyang et.al [10]: unpolluted (10 - 15mg/kg), slightly polluted (15 - 50mg/kg), moderately polluted (50 - 200mg/kg), and heavily polluted (> 200mg/kg). This shows that the area is slightly polluted.

The TPH detected in the studied community was higher Utapate field EIA studies. EIA studies at Utapate field revealed a mean TPH of 0.12mg/kg, BTEX of 0.02mg/kg, and PAH of 0.02mg/kg [14]. The TPH value was above 0.44mg/kg and 1.08mg/kg recorded in soils within Uyo [1]. The contamination was below 270mg/kg and 830mg/kg of Qua Iboe River sediment [10].Other related works have TPH of between 1063mg/kg to 1651mg/kg in soil samples in River State [3]. TPH of between 7 - 318mg/kg at several points in the South South region of the Niger Delta [16]. TPH values of 24000 ± 0.01mg/kg, $69,991 \pm 0.01$mg/kg, $15,990 \pm 0.98$mg/kg respectively in soil samples at crude oil spill sites in Abia State [7]. TPH in soil at a petroleum depot in central Taiwan was between 3000mg/kg to 8000mg/kg [11]. Total hydrocarbon contents at selected petroleum products depot in Calabar, Cross River State, Nigeria were: Dozzy (50,153-87,712) mg/kg; EPZ (48,663-76,425) mg/kg; NNPC (41,295-69,947) mg/kg and Control (498-829) mg/kg [19]. This comparatively high value of TPH detected in the study area is a pointer to how contaminated this studied industrial location is. The result obtained competes with those in literature indicating the level of pollution in the study area require attention. The presence of the TPH could likely be the reason why agricultural crops hardly thrive in the area studied.

EGASPIN target TPH value of 50mg/kg and intervention level of 5,000mg/kg [10, 18] apply to oil spill sites. Related standards are Mexican standard for TPH is 2000mg/kg and Italian standard 50mg/kg [18].

3.2.1.2 Environmental Impact Rating

Table 2 depicts the rating parameters and grading system used to measure the degree of occurrence and impact of some environmental indices that has been impacted by the petroleum soil contamination at the study area. The method is a qualitative technique which rates the degree of impact by total merit score. Rating scoring below 40% are classified not acceptable. Between 40 - 60% are classified as critical. Above 60% is acceptable. Based on the identified chemicals present in the studied soils, a qualitative assessment of the impact on the environment as presented in Table 3 gave a rating of 40% revealing a critical impact of the petroleum contaminants on the environment. An obvious loss of biodiversity and loss of land use for agricultural purpose were observed.

3.2.1.3 Mitigation measures

An important element of the enviromental impact assessment process is to prevent or reduce the significant impacts of development by the use of mitigation measures. This involves impact containment as well as sound environmentalmanagement plan. To mitigate the above identifiedenvironmental impacts, effluent discharge should be controled and monitored. Effluents should be properly treated and channeled in order not to mix with surrounding than the value obtained by NPDC at the
vegetation. Effluents should be properly channeled to a proper separator for treatment before discharge. The effluents should have no visible oil sheen as at the time of discharge. Used oil should be stored in drums and labeled to enable proper control.

IV. CONCLUSIONS

Research on the environmental profile of petroleum impacted soil still remains relevant in order to ensure sustainable development. Environmental impact assessment is a viable tool in ensuring that we hand over cleaner land, air, and water to generation yet unborn.

This study has established that Eastern Obolo soil, like every soil in the Niger Delta region of Nigeria is contaminated with petroleum. This is evident in the total petroleum hydrocarbon present in the study area. The presence of petroleum pollutant in the soil is a leading factor responsible for the low agricultural utilization of the soil which has resulted in the low production of crops in oil industries' host communities. There is an urgent need for remediation of the soil in order to restore it to its usage for agricutural purpose. Beyond preliminary environmental impact assessment statutorily required by proponents in the oil and gas sector, companies should be made to regularly publish environmental data of the soil, water, and air of the community they operate. All sectors handling petroleum and petroleum products in Nigeria should be made to be environmentally responsible as all streams of the petroleum sector have the potential of impacting on the environment.

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