# ASSESSMENT OF CRUDE OIL SPILLAGE ON SOME SOIL PARAM ETERS IN IYEDE COMMUNITY, ISOKO NORTH, NIGER DELTA AREA

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**Abstract**

The incessant oil spillage in the oil producing area of the Niger Delta has led to a downturn in the composition of soil nutrients and soil structure as a result of soil pollution. The aim of the work was to assess the heavy metal concentration in oil polluted soil in the Isoko area of the Niger Delta. Composite samples were taken from three different sites, two from the polluted area and a control sample 100 feet away from the spill area. The physicochemical properties of the soil samples ranged from 1.61 to 3.54 pH, 32.55 to 63.05 mg/L for electrical conductivity, 9.53 to 20.52 °C and 5.44 to 15.55 % moisture content respectively. Total organic carbon, redox, sulphate, chloride, nitrate, and nitrite range from 0.49 to 1.40 %, 56.49 to 115.05 mV, 11.99 to 25.77 mg/kg 23.80 to 49.29 mg/kg, 1.35 to 3.47 mg/kg, and 0.02 to 0.08 mg/kg respectively. The heavy metal concentration in the oil spillage soil was K (68.93 to 84.58 mg/kg), Pb (0.95-1.33 mg/kg), Cd (0.05-0.06 mg/kg) and Cu (1.81-2.66 mg/kg). The control samples had K (140.11 mg/kg), Pb (0.51 mg/kg), Cd (0.01 mg/kg), and Cu (1.14 mg/kg). Sites outside of the control samples had higher nutrient levels and lower quantities of harmful metals than the contaminated area.

**Keywords:** Heavy metals, Hydrocarbon content, Crude oil spill, Niger Delta

## INTRODUCTION

Oil spills occur as a result of failure of the oil drilling machinery, human error, natural disasters, carelessness, deliberate acts or mistakes; vandalization of pipelines or indirectly through the burning of fuels (Jacqueline and Fingas, 2016). An unintended release of liquid petroleum hydrocarbon into the environment is known as an oil spill which occurs as a result of human activities (Aghalino, 2000). Other causes are corrosion of pipelines and tankers which accounts for 50% of all spills, sabotage, oil production operations, inadequate or nonfunctional production equipment (Mbachu, 2006)). Oil residuals have caused some major changes in the soil's chemical properties. These have affected the means of livelihood of the inhabitants of the area. The effects of oil spill on the environment and its habitats can be catastrophic: as they can kill plants and animals, pollute air and water and the soil. The extensive study of crude oil contamination for the past few decades has been a major subject because of the way it frequently occurs and the challenges occasioned by them. In many industrialized countries, the use of land is impeded by soil pollution from a variety of sources. Decisions on clean up, management or set aside of contaminated land are based on various considerations, including human health risks, but ecological arguments do not have a strong position in such assessment (Uchegbu, 2002). Oil spills unto land are relatively common, and about 3,500 spills per year was recorded in Canada between 1989 and 1995 although most were relatively small (Environmental Canada, 1998). Soil takes time to form in space and time. It is believed that processes which affect soil formation are additions and losses (Brady and Weil, 1999). When crude oil spills on land, a process of addition has been initiated, which affects the formation of the soil time factor is put into place (Hans 1994). The extensive activities associated with crude oil industries increase the probability of major oil spills on land. The occurrence of minor oil spills are already too numerous (Cairns and Buikema 1984). Oil spills on dirt and land have the tendency to contaminate the environment and kill plants and animal life. Left unattended, it will migrate through the soil to the nearest water supply. Spilled oil on ground prevents absorption by the soil which can choke the plants**.** The effects of oil pollution also vary widely according to the history of spillage, the nature of locality and the state of the biota (Aghalino, 2000). Hence, this study titled assessment of crude oil spillage on some soil parameters in Iyede community, Isoko North of Niger delta.

# MATERIALS AND METHODS

## Soil Composite Sampling

Six soil samples; 0-15 cm (Topsoil) and 15-30 cm (Subsoil) deep were collected from designated sampling sites in Iyede community, Isoko North Delta State, Nigeria for analysis.

### SOIL PREPARATION FOR CHEMICAL ANALYSES

Soil composites for physiochemical and heavy metals were air dried, ground using a clean ceramic pestle and mortar, sieved through a 2 mm sieve and stored in airtight clean plastic bags. The pH of soil samples was determined electronically. Oxidation reduction potential in the soil was determined electronically with a ORP meter using standard method ASTM D4972. Electrical Conductivity (EC) of the soil samples was determined electronically with a glass electrode conductivity meter using standard method USEPA 9050A. The temperature of soil sample was determined with a mercury glass thermometer using standard method APHA 2550B. Soil moisture content was determined using Oven drying method according to standard method-ASTM 2216-98. The total organic carbon in soil was determined using finely divided and sieved soil sample by the chromic acid wet oxidation method of (Walkley and Black 1973). Sulphate in soil sample was determined colorimetrically with a UV-VIS Spectrophotometer according to ASTM D516. Nitrate in soil sample was determined by brucine-colorimetric method using a UV-VIS Spectrophotometer according to USEPA 352.1. The chloride content was determined titrimetrically using Mohr's Argentometric method as described in ASTMD512. Nitrite in the soil sample was determined by colorimetric method using a UV-VIS Spectrophotometer according to ASTM D3867.

## Analysis of Heavy Metal Using FAAS

Certified heavy metal standards were prepared by diluting 1000 mg/L stock solution of the individual elements (Cu, Cd, Pb, K.). A minimum of five standard working solutions were prepared from heavy metal stock solution. The calibration working solutions ranged between 0.1 mg/L to 10 mg/L. Soil digests were aspirated into the flame atomizer via the capillary tube attached to the nebulizer unit of the FAAS (air-acetylene flame was applicable, at flow rates of 2 l/min for the fuel and 10 l/min for the oxidant. The wavelengths for Cu, Cd, Pb, K. analysis were 324.8, 228.8, 217.0 and 766.5 nm respectively.

## RESULTS AND DISCUSSION

Table 1: Physicochemical Parameters

| | Mean ± SD Composite | | | Median Composite | | | Maximum Composite | | | Minimum Composite | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parameters | 1 | 2 | Control | 1 | 2 | Control | 1 | 2 | Control | 1 | 2 | Control |
| pH | 3.54 ± 2.09 | 2.58 ± 2.32 | 1.61 ± 1.91 | 4.52 | 2.61 | 0.78 | 4.71 | 4.71 | 4.46 | 0.41 | 0.41 | 0.41 |
| Electrical conductivity (µs/cm) | 63.5 ± 39.86 | 43.49 ± 42.20 | 32.55 ± 41.82 | 75.5 | 35.4 | 13.5 | 95 | 95 | 95 | 8.14 | 8.14 | 8.14 |
| Temperature (°C) | 20.52 ± 12.09 | 14.97 ± 13.45 | 9.53 ± 11.43 | 26.6 | 15.4 | 4.55 | 26.6 | 26.6 | 26.6 | 2.4 | 2.4 | 2.4 |
| Moisture content (%) | 15.55 ± 10.06 | 10.15 ± 9.02 | 5.44 ± 5.46 | 17.5 | 8.52 | 2.95 | 25 | 21.3 | 13.6 | 2.26 | 2.26 | 2.26 |
| Total organic carbon (%) | 1.40 ± 0.95 | 0.85 ± 0.71 | 0.49 ± 0.50 | 1.45 | 0.75 | 0.25 | 2.5 | 1.66 | 1.23 | 0.23 | 0.23 | 0.22 |
| Redox(mV) | +115.05 ± 68.47 | +84.18 ± 77.1 | +56.49 ± 69.98 | 143 | 81.3 | 25.9 | 161 | 161 | 161 | 13.2 | 13.2 | 13.2 |
| Sulphate (mg/kg) | 25.77 ± 17.12 | 15.80 ± 14.94 | 11.99 ± 14.95 | 27.9 | 12.7 | 5.08 | 43.3 | 34.3 | 34.3 | 3.92 | 3.46 | 3.46 |
| Chloride (mg/kg) | 49.29 ± 30.59 | 32.62 ± 30.54 | 23.80 ± 29 82 | 58 | 27.7 | 10 | 74.4 | 68.4 | 68.4 | 6.72 | 6.72 | 6.72 |
| Nitrate(mg/kg) | 3.47 ± 2.12 | 2.38 ± 2.10 | 1.35 ± 1.46 | 4.15 | 2.15 | 0.7 | 5.14 | 4.76 | 3.54 | 0.46 | 0.46 | 0.46 |
| Nitrite(mg/kg) | 0.08 ± 0.06 | 0.06 ± 0.06 | 0.02 ± 0.02 | 0.09 | 0.04 | 0.02 | 0.14 | 0.14 | 0.05 | 0.01 | 0.01 | 0.01 |
| Potassium (mg/kg) | 84.58 ± 73.88 | 68.93 ± 67.97 | 40.11 ± 52.39 | 117 | 69.6 | 21.6 | 137 | 137 | 117 | 0 | 0 | 0 |
| Lead (mg/kg) | 1.33 ± 0.84 | 0.95 ± 0.87 | 0.51 ± 0.53 | 1.59 | 0.81 | 0.28 | 2.01 | 2.01 | 1.3 | 0.17 | 0.17 | 0.17 |
| Cadmium (mg/kg) | 0.06 ± 0.07 | 0.05 ± 0.07 | 0.01 ± 0.01 | 0.05 | 0.02 | 0.01 | 0.16 | 0.16 | 0.03 | 0.01 | 0.01 | 0 |
| Copper (mg/kg) | 2.66 ± 1.57 | 1.81 ± 1.59 | 1.14 ± 1.31 | 3.19 | 1.81 | 0.54 | 3.9 | 3.27 | 3.1 | 0.35 | 0.35 | 0.35 |

Heavy metals are frequently present in acidic soil. The pH of the soils in this investigation varied slightly but not significantly, with Composite Sample 1 measuring 3.54 ± 2.09, Sample 2 was 2.58 ± 2.32, and the Control was 1.61 ± 1.91. The soils are all slightly acidic, but since the control is also acidic, the acidity cannot be totally attributable to the oil spill. The heavy precipitation that results in the loss of cation and subsequent replacement by hydrogen ions (H+) is what causes the usual acidity of the soils in the Southern Nigeria (Ngobiri et al., 2007). The samples' average electrical conductivity were 32.55, 41.82 and 63.5 39.86 (µs/cm). Talukdar also stated in 2012 that electrical conductivity reduces linearly as crude oil contamination percentage increases. Additionally, some liquids' dielectric constants, such as oil and used chemicals are different from those of regular water. Since organic substances like crude oil cannot conduct electrical current very efficiently and the control sample has a greater EC value, the variance in EC values explained by Osuji and Nwoye (2007) were not likely due to a direct influence of oil spillage. Climate-related factors affect the temperature and moisture content of the soil. Values for the moisture contaminated were sample 1 (15.55 %) and sample 2 (10.15 %). The control sample was (5.44 %). Also, the presence of crude oil might have no effect on the temperature of this soil, with composite 1 of the contaminated sample having a temperature of 20.52 °C and composite sample of the control having a temperature of 9.53 °C. The mean TOC values obtained using the Walkley Black test method demonstrate a diminishing relationship, with sample 1 having the highest value (1.40±0.95 %), sample 2 coming in second (0.85±0.71 %), and the control sample having the lowest (0.49±0.50 %). These might have been impacted by the hydrocarbons that were present in the sample 1 & 2 sampling regions. Redox Potential (mV) of the various samples ranged from +115.05(mV) and +84.18(mV) with the control sample having the lowest value at +56.49(mV). Redox Potential (mV) levels between -300 and +900 are advised. According to several writers, dry soils have an Eh above +380 mV and waterlogged soils below +350 mV. (Pearsall and Mortimer, 1939). It is obvious that Redox Potential Eh affects how bacteria grow. Heintze advocated utilizing variations in soil Eh to describe groupings of microorganisms as early as 1934. (Heintze 1934). Changes in Eh are directly connected with bacterial growth (Kimbrough et al., 2006). In anaerobic soils, microbial and enzymatic activity is negatively associated with Eh (Kralova et al., 1992). The Redox Potential (mV) readings are below recommended levels, which may be due to operations involving crude oil in the region. It is impossible to overstate the significance of nutrients for plants (Owolagba et al., 2009). Nitrogen molecules, such as chlorophyll, plant proteins, and nucleic acids, are essential for plant growth. Key nutrients for plants also include phosphorous compounds. They are a crucial component of the nucleo-proteins that regulate cell division and development in plant cells. Deoxyribonucleic acid, the mark for genetic pools and inherited traits of living species, also include a significant amount of phosphorus. It also plays a role in the adenosine triphosphate transport and storage of energy in plants. Sulfur oxides produced by the burning of fuels sourced from plants, such as wood, coal and oil are dissolved by rainfall. Sulfur is derived by the mineralization of organic materials, particularly weathered soil, in acidic soils. Additionally, plants have therapeutic value since they have been utilized to treat a variety of medical ailments (Oduola et al., 2010; Fowotade et al., 2017; Onyije et al., 2012; Avwioro et al., 2010). The Composite Sample 1 had the highest mean value of sulphate at (25.77 ± 1.199 mg/kg, whereas sample 2 had a mean value (15.80±14.94 mg/kg ) that was greater than the mean for the control sample (11.99±14.95mg/kg) of the polluted soil. This may be linked to their functions as essential soil nutrients that support plant growth; however, when crude oil contaminates soil, it introduces bacteria that destroy these nutrients, explaining their high value in the composite control sample. The composite samples' Nitrate and Nitrite values have slightly increased because of oil spills, heavy metals from crude oil are released into the environment. The concentrations of heavy metals in samples 1, 2, and the control were as follows: K, 171.60, 136.55, 117.2 mg/kg; Pb, 1.88, 2.01, 1.30 mg/kg; Cd, 0.07, 0.16, 0.02 mg/kg; and Cu, 3.90, 3.27, 3.10 mg/kg. Acidic soil is prone to contain heavy metals because of crude oil pollution, polluted composite samples were found to have higher concentrations of heavy metals.

## CONCLUSION

The menace of crude oil spillage and contamination of our environment are a big challenge that must be addressed.

## REFERENCES


Aghalino, S.O (2000). Petroleum exploration and the agitation for compensation by oilmineral producing communities in Nigeria I.J. Environ. Policy issues, vol.1.11.

Aghalino, S.O., 2000. Petroluem exploration and the agitation for compensation by oil mineral producing communities in Nigeria. J. Environ. Policy Issues, Vol. 1: II.

APHA Standard methods for examination of water and waste water. America public health association, 2005.

ASTM D 4972-13. (2001.) Standard Test Method for pH of soils. ASTM International, WestConshohocken, PA.C1A/3. 2013.

ASTM (1998). Standard test method for laboratory determination ofwater (moisture) content of soil and rock by mass, D 2216.Philadelphia: American Society for Testing and Materials

Avwioro O.G, Iyiola S, and Enoghayin E.E (2010) Effects of some Nigerian antimalarial medicinal plants on glucose levels in Wistar rats. Archives of app lied science research 2(3): 112-116

Baird J. (2010). "oils shame in Africa". Newsweek: 27.

Black, C.A (ed.) (1965) Methods of Soil Analysis Agronomy No.9, Part 2 American Society of Agronomy, Madison, Wisconsin.

Brady, N.C and Weil, R.R (1999). The Nature and Properties of Soils. New Jersey: Prentice Hall, Upper Saddle River, P.29.

Cairns, J; Buikema, A.L, (1984) Restoration of Habitats Impacted By Oil Spills. Crude oils spill image.

Fowotade A.A, Fowotade A, Enaibe B.U, Avwioro O.G (2017). Evaluating Toxicity Profile of Garlic (Allium sativum) on the Liver, Kidney and Heart Using Wistar Rat Model. International Journal of Tropical Disease & Health 26(2): 1-12

Hans Jenny (1994). Factors of soil formation, a system of quantitative pedology. New york: McGraw-Hill, USA. Pp. 37: 29-38.

Heintze S.G (1934). The use of the glass electrode in soil reactionand oxidation-reduction potential measurements. J AgricSci (24):28–41

Jacqueline M, and Fingas (2016.) Chapter 7 oil spills:" causes, consequences, prevention and countermeasures". Crawley, Gerard M (ed). Fossil fuels. Marcus enterprise LLC, USA & University of South Carolina, USA. O.160.

James, M.J. and A. Wild, 1975. Soils of the West African Savanna. Tech. Commun., 55: 218-218

Kimbrough DE, Kouame Y, Moheban P and Springthorpe S (2006). The effect of electrolysis and oxidation-reduction potentialon microbial survival, growth and disinfection. Pollut 27:211–221

Kralova M, Masscheleyn P.H and Patrick W.H Jr (1992) Redoxpotential as an indicator of electron availability for micro-bial activity and nitrogen transformations in aerobic soil. ZMikrobiol 147:388–39

Mbachu D (2006).The poverty of oil wealth in Nigeria’s Niger-Delta ISN security watch

Ngobiri, C.N., A.A. Ayuk and I.I. Awunuso, (2007). Differential degradation of hydrocarbon fractions during bioremediation of crude oil polluted sites in niger delta area. J. Chem. Soc. Nig., 32: 151-158.

Oduola T., Bello I.S., Idowu T.O., Avwioro O.G., Adeosun O.G and Isa LO (2010) Histopathological changes in Wistar albino rats exposed to aqueous extract of unripe Carica papaya North American Journal Medical Science 2:(5); 234-237

Onyije FM, Avwioro O.G and Waritimi E.G (2012). Evaluation of nephrotoxic effect of bauhinia monandra on the kidney of alloxan induced diabetic rats. Journal of Pharmacy and Clinical Sciences. 4:7-9

Osuyi. L.C, Egbuson. Ojinnaka. C.M (2015). Chemical radamation of crude inundated soils from Niger Delta, Nigeria. Chem. Ecol. 21 (1): 1-10.

Owolagba G.K., Avwioro O.G., Oduola T, Adeosun O.G., Enaowho T.M., Wilson J.I. and Ajumobi KO (2009) Histological observations of 24 h oral administration of the extract of Sorghum bicolor on albino rats. Journal of Cell and Animal Biology 3: 001-003

Pearsall W.H and Mortimer C.H (1939) Oxidation-reduction poten-tials in waterlogged soils, natural waters and muds. J Ecol27:483–501

Talukdar, D.K and Saikia, B.D.(2012.) Improvement of Strength of Crude Oil Contaminated Soil.

Uchegbu, S.N. (2002) Issues and Strategies in Environmental Planning and Management in Nigeria. Published by Spothle Publisher (Nig) 27 Ochi St. Achara Layout – Enugu

U.S. Environmental Protection Agency (1993) Understanding Oil Spills and Oil Spill Response. Publication No. 9200.5 – 105.

Walkley, A. and I.A. Black (1934). An Examination of the Degtjareff Method for Determining Soil Organic Matter and Proposed Modification of the Chromic Acid Titration Method. Soil Sci.