World Journal of Environmental Sciences & Engineering
Vol. 1, No. 1, January 2014, PP:1-21
Available online at http://scenrp.com/Journals.php

Research article

IMPACT OF OIL SPILL ON LAND AND WATER AND ITS HEALTH IMPLICATIONS IN ODU-GBORO COMMUNITY, SAGAMU, OGUN STATE, NIGERIA

OKOYE, CHINEDU.O. & OKUNROBO, LOVETTE.A.

Department of Environmental Management, Faculty of Environmental Sciences,

Nnamdi Azikiwe University, Awka, Anambra state, Nigeria.

+234 8036680344 ; +234 80181439134

E-mail; chinedubisi4@gmail.com

ABSTRACT

This paper examined the impact of oil spill on the physical environment (land, water) of Odu-Gboro community, Sagamu and its health implications. The incessant incidence of oil spill and the impairment of land and water resources and its effects on the people were the problems that informed this study. It identified the major causes of oil spill in the community; the presence of total petroleum hydrocarbon (TPH) in the environment; it determined the environmental impacts on land and water and it also identified the health implications of oil spill on the residents. Questionnaire, interview, field observation and laboratory analysis of soil and water were used. Primary and secondary sources of data were also applied. The sampling techniques were basically systematic and random sampling for the administration of questionnaire; and purposive for determining the spill site locations and collection of soil and water samples. Two hypotheses were formulated and tested statistically using the students T-test analysis and chi-square analysis. The findings showed that the main cause of oil spill is vandalism; TPH were present at the site with soil samples having the highest value (39.62mg/kg) compared to water (24.66mg/l); the environmental impact determined on land showed significant reduction in the soil heterotrophic microbial population compared to the control area also, significant reduction in soil fertility revealed in the bean seed germination experiment and health implications in the area were significant with regards to diarrhea, dermatitis, nausea, dysentery, conjunctivitis,

from medical records. A test of significant difference between water quality affected by oil spill and the control revealed there is a significant difference with regards to pH, EC, COD & BOD. It also revealed that there is no significant difference between soil quality affected by oil spill and the control area. This paper recommends a follow up in the health status of the people who have been consuming the polluted water; post signs around all site identified as contaminated; provision of adequate sources of drinking water for those whose drinking water supply is impacted; application of appropriate and sufficient inorganic NPK fertilizer to restore the carbon to nutrient ratios to the optimum required to stimulate and sustain microbial activity among others.

Keywords: Odu-Gboro, Environmental quality, Oil spill, Total Petroleum Hydrocarbon, soil, water

INTRODUCTION

The discovery of oil in 1956 transformed Nigeria's political economy and it has earned around $340 billion over the past 40years. The country's dependence on oil revenue is immense. It accounts for 90-95% of export revenue, over 90% of foreign exchange earnings and 80% of oil revenue (World Bank, 2005); (Inya, 1997). There is no doubt that the Nigerian oil industry has affected the country in a variety of ways at the same time. On the one hand, it fashioned a remarkable economic landscape for the country. However, on the negative side; petroleum exploration and production also have adverse effects on fishing and farming which are the traditional means of livelihood of the people of the oil producing communities. If the oil is considered in view of its enormous contributions to foreign exchange earnings, it has to achieve a remarkable success. On the other scale, when considered in respect of its negative impact on the socio-economic life and the environment of the immediate oil bearing local communities, and its inhabitants, it has left a balance sheet of ecological and socio-physical disaster (Achi, 2003).

More than four decades of oil exploration and production activities have left a severely degraded environment in Nigeria's Southern, Niger Delta oil region. Spills, which mainly occur through equipment failure, operational errors, or willful damage, have been identified as the main source of environmental damage in the region over time. According to National Mirror September 9, (2012) the petroleum pipeline of Nigeria National Petroleum Corporation (NNPC) which passes through Arepo, an Egba village in Obafemi- Owode Local Government Area of Ogun State was engulfed by fire as a result of vandals and about 93 persons died in the fire incident. Oil spill in Nigeria occurs as a result of sabotage, corrosion of pipe and storage tanks, carelessness during oil production operations and oil tankers accidents (Nwilo&Badejo, 2005). Other examples of oil spill in Nigeria includes: Shell Petroleum Development Corporation (SPDC) Forcados Terminal Tank in 1978 of about 580,000 barrels Texaco Funiwa-5 blowout in 1980 of about 400,000 barrels, and Abudu pipeline spill in 1982 of about 18,818 barrels (NDES, 1997). Major oil spill like the Jesse fire incident which claimed about a thousand lives and the Idoho oil spill in january 1998, in which about 40,000 barrels were spilled into the environment (Nwilo et al, 2000).

Oil spillage has a major impact on the ecosystem into which it is released. According to Agency for Toxic Substances and Disease Registry (ATSDR), (1991) when petroleum hydrocarbons is released directly to water through spill or leaks, the contain hydrocarbon fractions will float in water and form thin surface films. Other heavier fractions will accumulate in the sediment at bottom of the water, which may affect bottom-feeding fish and organisms. Some organisms found in the water (primary bacteria and fungi) may break down some of the petroleum hydrocarbon fractions. Petroleum released to the soil may move through the soil to the ground water. Individual compounds may then separate from the original mixture, depending on the chemical properties of the compound. Some of these compounds will evaporate into the air and others will dissolve into the ground water and move away and from the release area. Other compounds will attach to particles in the soil and may stay in the soil for a very

long time, altering the soil properties and composition of microorganisms like nitrifying bacteria present in the soil that helps in enhancing soil fertility.

Oil corporations in the Niger Delta seriously threaten the livelihood of neighboring local communities; due to the many forms of oil generated, environmental pollution is evident throughout the region; farming and fishing have become impossible or extremely difficult in oil affected areas and even drinking water has become scarce and not 90% safe because of the possibility of contamination. Malnourishment and diseases also appear common. According to Centre for Disease Control and prevention (CDC), 1999 crude oil's toxic ingredients can damage every system in the body: respiratory system, nervous system, including the brain, liver, reproductive/ urogenital system, kidneys, endocrine system, circulatory system, gastrointestinal system, immune system, hematopoietic system (blood forming), skin and integumentary system metabolism. Damaging or altering these systems causes a wide range of diseases and conditions. In addition, interfere with normal growth and development through endocrine disruption and direct damage to fetal tissue is caused by many crude oil ingredients (CDC, 1999). DNA damage can cause cancer and multigenerational births defects (EPA, 2011).

Consequently, humans of which Odu-Gboro community residents are not excluded, are affected by oil spillage from oil exploration and exploitation activities because it has resulted in environmental degradation; destruction of vegetation, livestock, ecosystems and ecological habitats. It has also led to loss of biodiversity of plants and animal species, it has led to loss of soil fertility which affects agricultural produce and this pose serious threat to man's meaningful living. However, according to Ofomota (1997) the human environment is the basis for economic, social and cultural development and it is important that the quality of our environment be maintained in a good state so as to ensure a high level of societal performance. Therefore, for the purpose of conservation and protection of the environment, the causes and measures to mitigate or prevent such environmental problem must be identified. It is based on this premise that this paper seeks to examine the impact of oil spill on land and water and it's health implications in Odu-Gboro community Sagamu, Ogun state.

STATEMENT OF THE PROBLEM

Oil spill pose a major threat to the environment in Nigeria. If not properly checked or effectively managed, could lead to total annihilation of the ecosystem, especially in the Niger Delta and neighboring communities where oil spills have become prevalent. Life in Odu-Gboro community is increasingly becoming unbearable due to the high effects of oil spills like wise other affected communities; they continue to groan under the degrading impacts of spill. Field observation shows that crops such as cassava, coco-yam, and plantain plantation have been destroyed, water has been polluted and vegetation have also been affected. Also, the mechanism of the soil properties has changed. These may be traceable to the oil spill in the community.According to Uchegbu (2002), the problem inherent in oil spills is wide spread in their effects and long lasting in duration. The effects of oil spills throughout the world may be the same since the vegetation; water bodies, soil and ground water are affected.This study has become very imperative due to the environmental degradation occasioned by oil spill in Odu-Gboro community. Therefore, this study seeks to examine the impact of oil spill on their land and water and to consider its health implications.

AIM AND OBJECTIVES

The aim of this study is to examine the environmental impact of oil spill on land and water of Odu-Gboro community Sagamu, Ogun state and its health implications with a view to proffer some ameliorative measures.In other to achieve the stated aim, the following objectives were pursued.

1. To identify the major causes of oil spill within the study area.
2. To identify the presence of Total Petroleum Hydrocarbon (TPH) in the environment (soil, water).
3. To determine the environmental impact of oil spill on land and water within the study area.
4. To identify the health implications of oil spill on the residents.

RESEARCH HYPOTHESES

Ho: There is no significant difference between the water quality in the study area (Odu Gboro) and the control area (Agbele).

Ho: There is no significant difference between the soil quality in the study area (OduGboro) and the control area (Agbele).

STUDY AREA

This study covers Odu-Gboro community, Sagamu Local Government Area which is located along the Mosimi-Ibadan Pipeline Rights Of Way (ROW) owned by NNPC (Nigeria National Petroleum Corporation) (Fig 3).The study area Odu-Gboro is located in Sagamu Local Government Area of Ogun state. It is bounded by Odogbolu Local Government Area, Lagos state, Ikenne Local Government and ObafemiOwode Local Government in the east, north and west respectively (Fig 2).Odu-Gboro is located in the moderately hot, humid tropical climatic zone of Southwestern Nigeria. There are two distinct seasons in the state, namely the rainy season which lasts from March/ April to October/November and the dry season which lasts for the rest of the year, October/November till March/April. The temperature is relatively high during the dry season with the mean around 30c. the harmattan brought in thenorth easterly winds from December- February, has ameliorating effects on the dry season, high temperature –low temperatures are experienced during the rains, especially between july and August when the temperature could be as low as 24℃.Odu-Gboro has two main rock types. These are the basement complex rocks of the precambian age which are made up of the older and younger granites in the northern parts, and the younger and older sedimentary rocks of both the tertiary and secondary ages in the southern parts. Tertiary sediments are unconsolidated sandstones, grits with mudstone band and sand with layers of clay.Odu-Gboro has a wide area of undulating lowlands belonging to the coastal sedimentary rocks of western Nigeria. There are scattered hills that are interfluves between the different river valleys. Odu-Gboro is well drained by these streams and rivers, much of which dry up during dry season.Their major cashcrop is kolanut. Food crops such as cassava, melon, maize and yam are however grown as supplement. The people of Odu-Gboro community are predominantly farmers but now they also engage in retailing. Major economic activities are found around the major roads alignment and junctions. Most of the premises for economic activities are rented and the thriving businesses include the food, farm yields, and clothing. A significant proportion of people commute out of the area to other parts for their employment.

CONCEPTUAL FRAMEWORK

The impact of oil spill can best be understood when one understands the concept of environmental quality. Quality has been defined as conformance to requirements. Environmental qualities are conformance to the basic requirement of a wholesome land, water and air resources (Agarwal, 2002). According to Johnson (1997) Environmental quality is a set of properties and characteristics of the environment, either generalized or local, as they impinge on human beings and other organisms. It is a measure of conditions of an environment relative to the requirements of one or more species and or any human need or purpose. The reckless and unsustainable utilization of the environment has brought human kind so perilously close to total extinction. Man is so much obsessed with and possessed of consumerism that our ecosystem has undergone many ramifications and diversification, its pristine glory and vigor,

vitality and utility has been completely lost.Exploitation of crude oil resources have led to oil spills on land and water resources. Pollution of land and water has affected both flora and fauna that inhabit those parts of the ecosystem. Oil spills have led to death of aquatic lives, loss of vegetation, health of workers and residents in communities and neighbouring communities have been affected, Marine wild life that live near the surface of water have also been affected. The cases of Exxon Valdez oil spill in 1989, the BP oil spill in the Gulf of Mexico in 2010 and oil spill in Odu-Gboro community are typical examples. So the quality or composition of the environment changes directly or indirectly as a result of man's activity such that it becomes unfit for any purpose. Thus, deterioration of the quality of the environment will affect human health and well being and therefore becomes a threat to human security. Environmental management is one of the neglected areas of management in many parts of the world, Nigeria inclusive. Therefore, there is a vehicle through which organizations can learn to become more sensitive to the needs of a sustainable environment by attaining the Environmental, Health and Safety (EHS) elements (basic principles) which are management leadership; commitment and accountability; risk assessment and management; facilities design and construction; information and documentation; personnel and training; operations and maintenance; management of change; third party services; incident investigation analysis; community awareness and emergency preparedness; product and supply chain stewardship; assessment and improvement (PPG EHS management system, 2007); Because it safe guards natural resources and is compatible with sustainable development. Environmental quality management is important and since the environment is vast, the implementation of the strategies in achieving environmental quality requires an integrated environmental management system that takes into account of all stakeholders to play their parts.

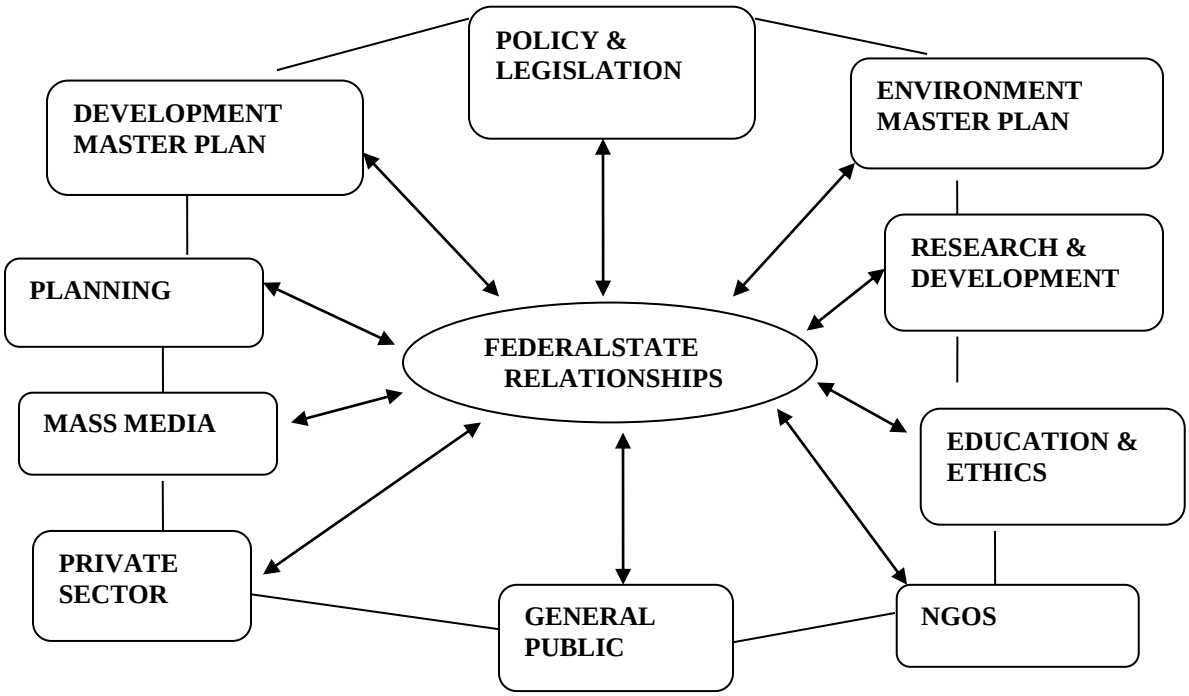

Fig 1: integrated environmental management system, (Jamaluddin Md. Jahi, 2001)

Management of the environment should be carried out in an integrated manner (fig1) because there is no single action taken that will result in any reciprocal action or response. However, in the management system there should

always be monitoring and review of the success or failure of the management strategies applied to ensure a balance between environment and development and likewise ensuring human security.

Fig 2: Map showing Shagamu Local Government Area

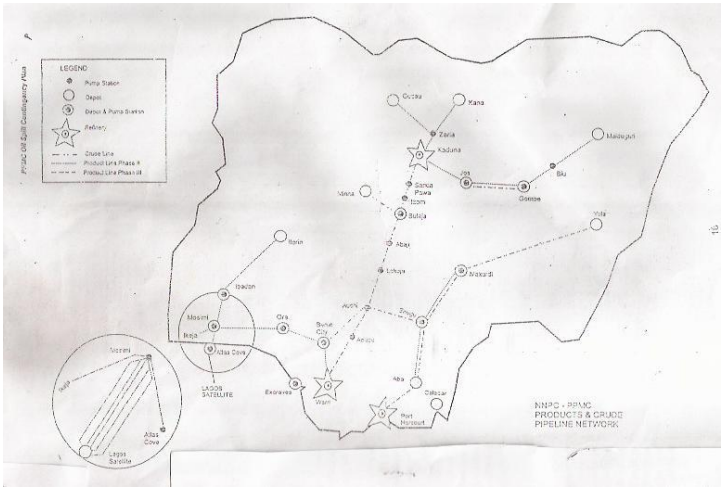

Fig 3: A map showing NNPC pipeline network (Nigeria) revealing the Mosimi-Ibadan Pipeline Right of Way

METHODOLOGY

Survey design and experimental design was used to derive information used for the study. The survey design involved, questionnaire method and interview which were employed in collecting information on the impact of oil spill on land, surface water and health of Odu-Gboro community, Sagamu, Ogun state. Experimental design was mainly concerned with laboratory analysis of the physio-chemical parameters of the soil samples and water samples. Microbial analysis and bean seed germination analysis of the soil samples also, TPH analysis of soil and water extract was carried out because they are the data needed to determine oil spill's impact in the community. A total of six sampling points for soil and water each were identified and samples were collected using purposive sampling technique and systematic technique along with random sampling technique was employed in the administration of questionnaire. The sampling size was determined from the population using Taro Yamane's statistical distribution techniques. A total number of approximately 56 questionnaireswere distributed and 95% was returned. Also medical personnel were interviewed as regards the health of the people in the community. Soil samples were collected using a hand dug soil auger at surface (0-15cm) and were then put in sterilized bags and labeled before finally taken to the laboratory for analysis. The collection of surface water sample was done using the grab sampling method. The samples were collected in thoroughly clean 5 litre plastic containers, which were rinsed with distilled water before collection.

Table 1: Sampling order in Odu-Gboro and Agbele sites

Sampling location	Sampling points (water and soil)	Sampling depth for soil (cm)	Sample description for soil	Sample description for water
Odu-Gboro (study area)	S1	0-15	Dark gray in colour, oily smell	Dark brown in colour, oily smell
	S2	0-15	Dark gray in colour, oily smell	Light brown in colour, oily smell
	S3	0-15	Dark brown in colour, oily smell	Oil sheen, faint oily smell
Agbele (control area)	S1	0-15	Dusky red in colour, odourless	Clear, odourless
	S2	0-15	Dusky red in colour, odourless	Clear, odourless
	S3	0-15	Dusky red in colour, odourless	Clear, odourless

The physio-chemical parameters of soil studied include pH, moisture content, % organic carbon and % organic matter. The physio-chemical parameters of water studied include pH, temperature, electrical conductivity (EC), total suspended solids (TSS), total solids (TS), dissolved oxygen (DO), chemical oxygen demand (COD) and biological oxygen demand (BOD). In addition TPH analysis of soil and water extracts, microbial analysis of heterotrophic bacteria and fungi of soil samples and analysis of bean seed germination were also studied. Analysis of all the parameters were conducted using different methods as briefly discussed below.

Determination of Total Petroleum Hydrocarbon concentration in soil and water extracts

Gas chromatography was used to determine the TPH concentration in soil extract and water extract. Liquid-liquid extraction method was used for water and soxhlet extraction (EPA method sw-846 35 40) which is a very efficient extraction process commonly used for semi volatiles was used for soil.

Determination of soil pH

10g of the sample was weighed into a test tube and 10ml of distilled water was added. Allow to stand for 30 mins and stir occasionally with a glass rod or on the orbital shaker. Insert the electrode of the pH meter (previously calibrated) into the partly settled suspension and measure the pH. Do not stir the suspension during measurement.

Determination of soil moisture content

A constant weight of watch glass was obtained and therefore, 15g of sample was weighed into the watch glass, and transferred into the oven for 1hr at 110℃. The samples were cooled inside a desicator for 30mins before a constant weight of the sample and watch glass after heating and cooling was recorded. Moisture content is estimated as:

$$\% \text{ moisture content} = \frac{[w_1 - (w_3 - w_2)]}{w1} \times 100$$

Where $\mathbf{w_1}$= weight of sample; $\mathbf{w_2}$= constant weight of watch glass and $\mathbf{w_3}$= weight of sample + watch glass after heating and cooling.

Determination of % organic carbon and % organic matter

0.2g of each air dried soil sample was put into a conical flask and 10ml of 1N potassium dichromate solution $K_2Cr_2O_7$ was added and swirled gently to disperse the sample in the solution. 20ml of concentrated tetraoxosulphate (vi) acid was added rapidly, into the flask and swirled gently until sample and reagents were mixed and finally swirled vigorously for about a minute. The flask was allowed to stand in a fume board for 30 mins. Three to four drops (3-4) drops of the indicator were added and the solution titrated with 0.5N $FeSO_4$ to maroon colour. A blank determination was carried out to standardize the dichromate (Nelson and Somers, 1982). % organic carbon and % organic matter were calculated as follows:

$$\text{TOC}(\%) = \frac{(\text{m, e, } K_2\ G_2\ O_7 - m_2\ e_2\ FeSo_4) \times 0.003 \times 100 \times f}{\text{G of air dry soil}}$$

F = correction factor = 1.33
M_1 = normality of $K_2\ G_2\ O_7$ used = 1
e_1 = volume of $K_2\ G_2\ O_7$ used = 10ml
m_2 = normality of $FeSo_4$ used = 0.5
e_2 = Titre value for each titration
g = weight of sample taken
% organic matter in soil = % organic carbon x 1.729
Mg/l organic matter in soil = % organic matter x 10
Total organic matter (TOM)(%) = TOC (%)x 1.729

Determination of water pH and Temperature

Micro processor, pH meter probe was dipped in distilled water after the first buffer the probe of the meter was inserted again until calibration was finished. The pH electrode was then inserted in the samples simultaneously and their corresponding readings were recorded accordingly. Beaker, DO meter and distilled water were used to determine the temperature of each sample. The DO meter was switched on and allowed to self calibrate after which was probe then dipped into distilled water already in a beaker removed and then cleaned. The probe was then dipped

into the water sample; a stable value displayed on the LCD of the DO meter was recorded as the temperature in degree Celsius.

Determination of water conductivity (EC_W)

This is the numerical expression of the water's ability to conduct electric current. Beaker, conductivity meter was used. Temperature of the sample was adjusted near 25℃ and the conductivity cell was washed out with a portion of the sample and was filled completely ensuring that no air bubbles adhered to the electrodes. And then we proceeded according to the manufacturer's instruction. Result was expressed as simens per meter (s/m).

Determination of Total Suspended Solids (TSS)

Total suspended solids were determined using spectrophotometric method which was done at room temperature. 10ml of each sample was measured into separate beakers which was now transferred into the 10ml curvette after which it was placed into the spectrophotometer and at the specific wavelength region (630nm region usually inputed manually). Distilled water was used as blank and is always used to zero the spec for each measurement to be taken.

Determination of Total Solids (TS)

Crucible dessicator, water sample, silica gel, analytical balance and oven were used in determining TS. Crucibles were washed clean evaporated and dried in an oven at 105℃ after which was then weighed. 50ml of the water sample was measured into the weighed crucible and then placed in an oven to evaporate to dryness at temperature of 105℃ after which was cooled in dessicator. After cooling the crucibles were reweighed using the analytical balance to obtain final mass. Results by calculation:

Total solids (mg/l) = $w_2 – w_1$ x 20,000

For 50ml of sample

W_1 = initial weight of crucible after drying

W_2 = final weight of crucible + sample after drying

Determination of Dissolved Oxygen (DO)

The measurement of oxygen dissolved in a sample must not be less than 2mg/l because if there is no or less oxygen in a particular sample, it means life cannot take place in it and also it shows that there are micro organisms or particles in it. The DO meter was calibrated first; the distilled water was put in the DO meter before putting in the water sample each. And then measurement was noted down.

Determination of Chemical Oxygen Demand (COD)

Portable spectrophotometer was used. It is a rapidly measured parameter used to determine the pollution strength of domestic and industrial waste. COD valves, beakers, pipette, curvette (10ml), distilled water, water samples, COD reactor and potable (u-v visible) spectrophotometer was used to determine COD. 0.2ml of the sample was measured using a 1ml pipette into the super high range valve to give the proffered colour change (orange). The valves so used were then taken to the COD reactor where they were placed into the COD reactor valves at temperature of 150℃ for 2hrs. After heating, the valves were cooled and then taken to the spec for COD measurement. The wavelength specified and fixed for COD measurement was inputed (435 mm) and COD measurement of each sample was taken in (mg/l).

Determination of Biological Oxygen Demand (BOD)

Amber reagent glass bottles (1litre) for BOD samples; It was sealed to exclude air bubbles and sent to the laboratory for 5days incubation and analysis.

Enumeration of heterotrophic bacteria and fungi in soil

Total heterotrophic bacteria and fungi count was determined using the spread plate method on nutrient agar (Sigma Aldrich) according to APHA (1998) for bacteria and potato dextrose agar was used for fungi. Soil suspension was prepared by 10 fold serial dilutions with 1g of soil and then 10-5 dilution was spread on the plate. The cfu of heterotrophs was counted after incubating at 28℃ for 18hrs. The result was expressed as cfu/g.

Analysis of bean seed germination

This involved using a viable bean seed, soil sample, water and containers. Also making sure the conditions of germination which are optimum were met (optimum atmospheric temperature, sunlight, water). Four different samples were collected and the bean seed was then observed for fourteen days which is the time period for germination and growth into seedling.

Identification of the major cause of oil spill in the community

Questionnaires were distributed to the respondence in order to solicit information on the major cause of the spill in their community.

Identifying the health implications of oil spill on the residents

Questionnaires were distributed to residents of the community so as to identify the most likely health problem they are suffering from and that which is prevalent as a result of the spill. Interviews were conducted for medical personnel within the vicinity and medical records were used.

Statistical analysis

Student T-test and chi-square analysis were used to test if the parameters of the surface water in the study area and the control area; and that of soil in the study area and the control area were statistically significant.

RESULTS

Results are presented in the form of pictures, percentages and charts.

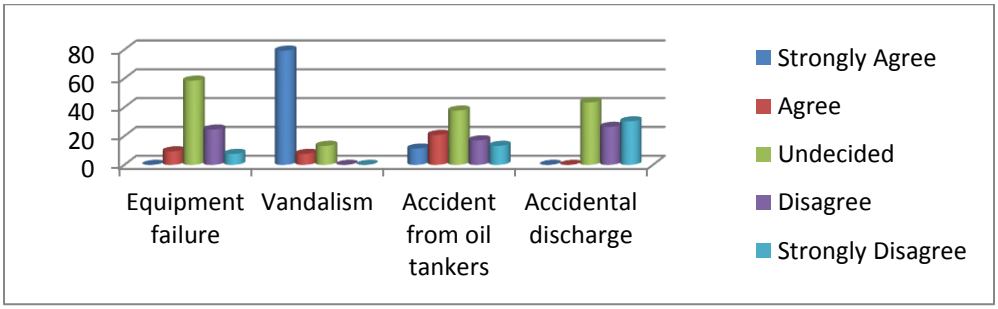

Fig 4: shows respondents response on the cause of oil spill in Odu-Gboro community.

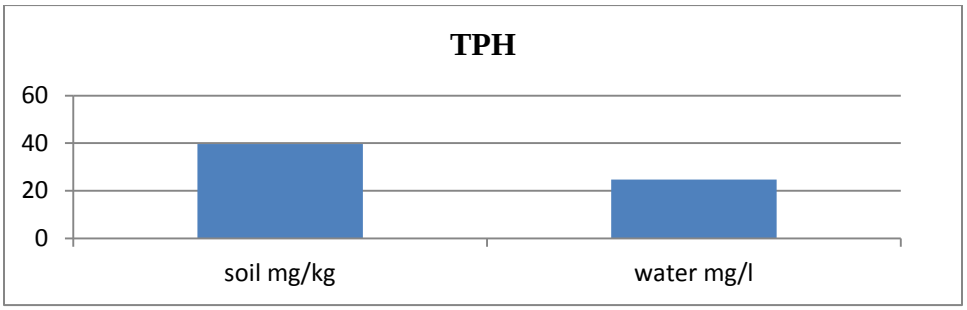

Fig 5: shows the mean concentration of TPH in soil and water

Table 2&3 and fig6&7 below shows result on the average values of the physiochemical parameters investigated in the study area of soil and water also their control.

Table 2: Average analytical result of surface water

Sample location	pH	Temp (℃)	EC (uscn)	TSS (mg/l)	TS (mg/l)	DO (mg/l)	COD (mg/l)	BOD (mg/l)
Study area	8.16	25	34.23	193	636	1.00	202	67.67
Control area	6.25	22.67	12.60	23.67	98.67	5.27	19.33	15.67

Table 3: Average field data for soil

Sample location	pH	Moisture content	% organic carbon	%organic matter
Study area	5.35	2.62	44.50	78.46
Control area	6.56	5.13	58.38	98.94

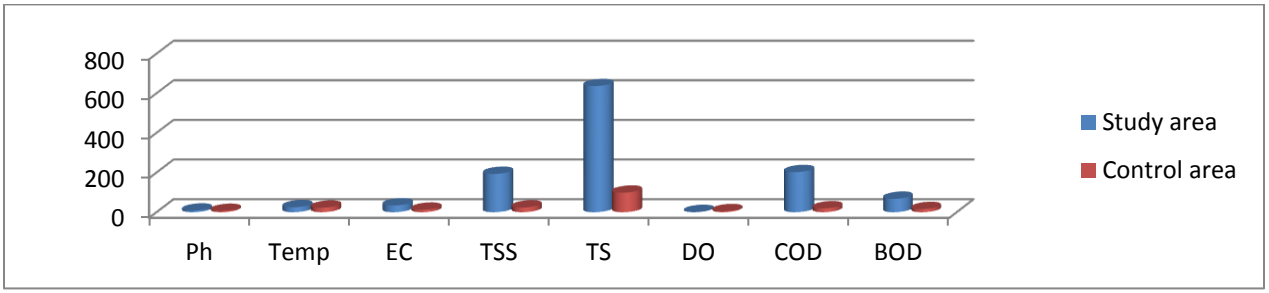

Fig 6: shows average values of the physiochemical parameters analysed in both study area and control area.

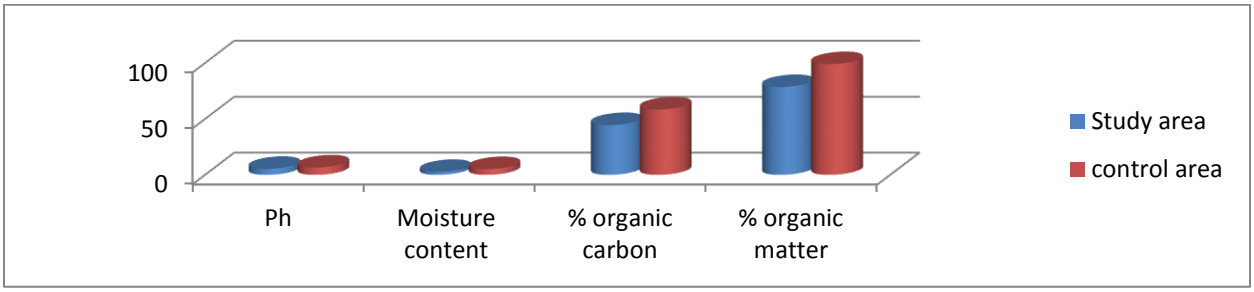

Fig 7: shows average field data for soil

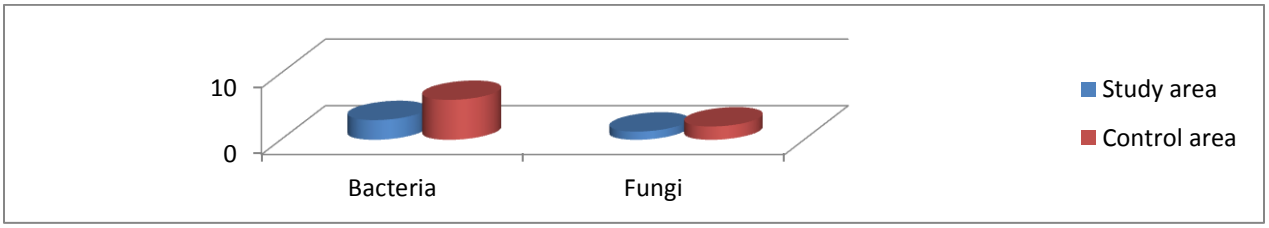

Fig 8: shows mean values of heterotrophic bacteria and fungi in impacted soil and control area.

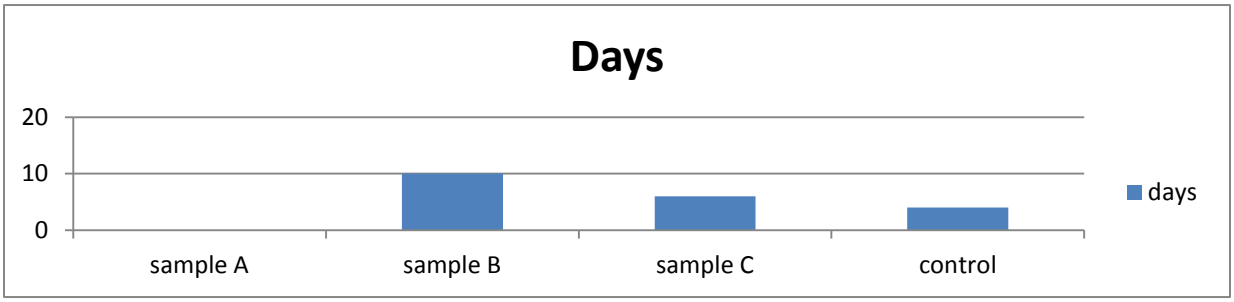

Fig 9: bean seed germination analysis of soil samples from both impacted soil and control.

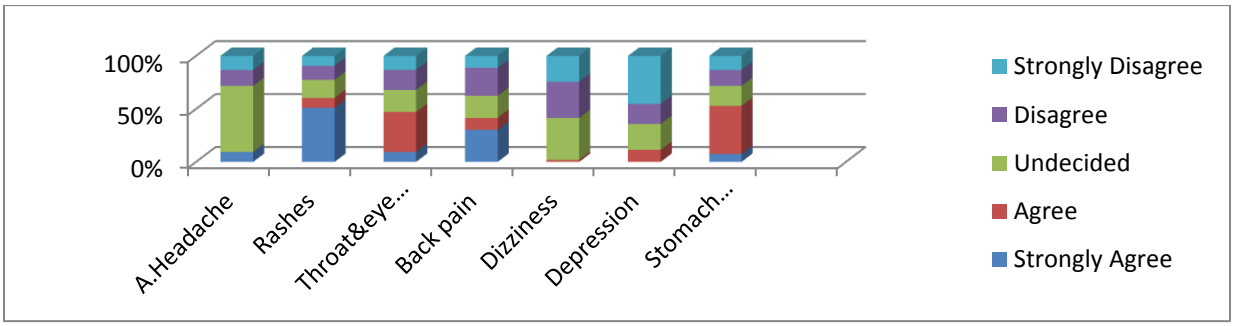

Fig 10: percentage response on health of respondents as a result of the spill.

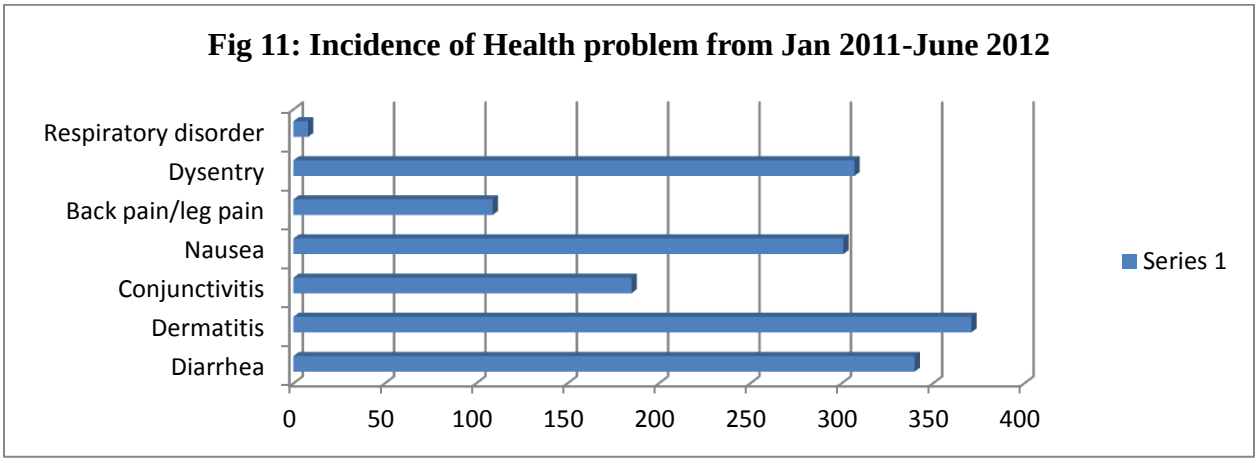

Fig 11: above shows the incidence of health problem amongst the local people of the study area from jan 2011- june 2012.

Plate 1:showing visible product and destroyed vegetation.

Plate 2: showing visible oil sheen on surface water down stream in Odu-Gboro community

Plate 3:Showing experiment on bean germination on both impacted soil and control (3-1)

DISCUSSION

Major cause of oil spill in the community

The major cause of oil spill in Odu-Gboro community was identified through the response of the respondents from the questionnaires distributed. Vandalism which is an act of sabotage had the highest percentage (79.3%) compared to equipment failure, accident from oil tankers and accidental discharge during pipeline repairs (fig 4). Amakiri (2005) laments the loss of biodiversity, alteration of habitats and deforestation that is associated with petroleum exploitation related vandalization. The vandalization which is quite extensive in the region opens up previously pristine and inaccessible ecosystem to illegal logging activities.

Total Petroleum Hydrocarbon (TPH)

TPH in soil and water was determined through the analysis of soil and water extracts. The term TPH is generally used to describe the measureable amount of petroleum based hydrocarbons in the environment. TPH results simply shows that petroleum hydrocarbons are present in sampled media. From the mean concentration it was observed that the contaminated soil has a higher TPH value (39.62mg/kg) compared to surface water (24.66mg/l) (fig 5). This result confirms the presence of hydrocarbon in the environment. Measured TPH values suggest the relative potential for human exposure, and therefore, the relative potential for human health effects. According to Agency for Toxic Substance and Disease Registry (ATSDR), (1999) the compounds in some TPH fractions can also affect the blood, immune system, liver, spleen,kidney, developing foetus and lungs. Certain TPH compounds can be irritating to the skin and eyes. One TPH compound (benzene) has been shown to cause cancer (leukemia) in people. The international Agency for Research on cancer (IARC, 1996) has determined that benzene is carcinogenic to humans. Some other TPH compounds or petroleum products such as; benzo(a)pyrene and gasoline are considered to be probably and possibly carcinogenic to humans based on cancer studies in people and animals. One TPH compound (n-hexane) can affect the central nervous system in a different way, causing a nerve disorder called “peripheral neuropathy” characterized by numbness in the feet and legs, and in severe cases, paralysis swallowing. Some petroleum products such as gasoline and kerosene causes, irritation of the throat and stomach, central nervous system, depression,difficulty in breathing and preumonia from breathing liquid into the lungs. However, for the fact that some TPH fractions are persistent pollutants and are present in water and soil signifies the sure intake of the substances through the roots of plants and presence in the fruits of the plants with higher tendencies for bioaccumulation in aquatic biota spells serious concern. The presence of TPH in the soil serves as a reservoir for

PAHs leached into the ground water and as runoff into surface water. Its presence indicates the exposure of humans to health problems.

Soil pH

The pH of the oil impacted soil (5.35) was lower than the control area (6.56) (table 3& fig 7). The presence of oil may have had some direct impact in lowering the pH, it is also more likely that production of organic acids by microbial metabolism is responsible for the difference. The pH is not only essential for determining the availability of many soil nutrients but also in determining the fate of many soil pollutants, their breakdown and possible movement through the soil. Therefore, pH in the range of 4.9-5.1 might have implications on nutrient availability in the oil polluted soils. It is known that strongly acidic soils (pH 4-5) usually have high concentrations of soluble aluminium and manganese, which are toxic to many plants; nitrogen fixation and decomposition activities are also known to be hindered in strongly acidic soils (Alexander, 1969; Obi, 1976; Manahan, 1994).

Soil moisture content

The moisture content of the oil impacted site appeared to have a low moisture content (2.62) compared to the control area (5.13) (table3 & fig 7). Soils develop severe and persistent water repellency following contamination with crude oil (Osuji et al, 2006a). So the reduction in moisture content of the oil impacted site can be attributed to the inability of water to penetrate the soil as one of the features of oil is that it is a water- repellent. Oil spill on the land usually sinks into the soil through the soil pores thereby blocking the pores and tends to a marked reduction of water percolation. The influence of oil has been shown by (Akinlabi, 1981) who found out that the oil pollution in soil (top 0.4m)affect the equilibrium and gravitational movement of soil minerals in solution. This makes it impossible for plants roots to absorb the minerals, thus rendering the soil infertile.

% organic carbon and %organic matter contents

The total organic carbon of oil impacted soil is 44.50mg/kg and the control area 58.38mg/kg while that of organic matter contents of the contaminated soil is 78.46mg/kg and the control 98.94mg/kg (table3 &fig 7). The value of the control area in % organic carbon and organic matter contents appeared to be higher than the oil impacted soil. According to Adinna et al, 2003 oil increases the carbon content of soil thereby worsening the nitrogen situation by increasing the carbon/nitrogen ratios. So organic matter content/organic carbon should normally increase following the addition of such levels of carbonaceous substances but results obtained here shows that there is rather a reduction in organic carbon and organic matter contents of the polluted soils. This might be that 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 microflora (Osuji and Onojake, 2004; Osuji and Okale, 2005).

Water pH

The pH of the impacted water (8.16) appeared to be high which is alkaline in nature while that of the control appeared to have a low pH which is acidic in nature (table2 &fig6). According to Frank (2006), a high pH level means that the water is turning more alkaline because the water is lacking enough co_2 (carbon dioxide). Any water with live plants particularly needs co_2 in order to keep the plants alive. If there is co_2 crash, then soon an oxygen crash will occur, which will kill the fish and plants. Optimal pH range for sustainable aquatic life is pH 6.5-8.2 (Murdock et al, 2001). Water that is too acidic or too alkaline can be detrimental to human health and lead to nutritional disequilibrium and this was demonstrated in a Swedish well water study which found both pH extremes to be problematic (I Rosborg et al, 2002). Alkaline water tend to raise the alkalinity of the stomach, which will

buffer stomach's acidity and impair its ability to digest food as low stomach acid is one of the most common causes of ulcers. This can open the door for parasites in small intestine and protein digestion may suffer. It also means man might get fewer minerals and nutrients overtime (Mercola, 2011). Alkalinity is potentially a problem because it is antibacterial, so it could potentially disrupt the balance of body's beneficial bacteria (Vorobjeva et al, 2004). Changes in pH in water bodies can affect the availability and toxicity of constituents such as trace metals, non-metallic ions such as ammonium and essential elements for example, selenium (SAWQG, 1996a).

Water temperature

The temperature of the study area appeared to be higher (25℃) than the control area (22.66℃) (table 2& fig 6). According to (EPA,1976; Forstner and Wittlman, 1979) increase in temperature could be due to increase in rate of chemical reaction and nature of biological activities. Since temperature is one of the factors that govern the assimilative capacity of the aquatic system. Water temperature plays a significant role in affecting physical, chemical and biological process in water bodies and thus the concentration of many variables (ANZECC, 1992).

Water electrical conductivity

Electrical conductivity in water (EC_W) is a measure of salinity and the extent to which water is able to conduct an electric current. It is expressed as micro Siemens per centimeter (us/cm) and, relates to the concentrations of total dissolved solids (TDS) or salts in a specific water body (Chapman &Kimstach, 1992; Taylor, 1993; Liston & Maher, 1997). These salts typically include such cations as sodium, calcium, magnesium and potassium, and anions such as chloride, sulphate, and bicarbonate (Masters, 2004). The electrical conductivity of water in oil impacted area were higher (34.23) than the control area (12.60) (table 2 & fig 6). The conductivity of most freshwaters ranges from 10 to 1000us/cm (Chapman &kimstach, 1992). Moreover, higher values of EC_W significantly affect the use of water for irrigation and drinking purpose (Hart et al, 1990; Chapman &Kimstach, 1992).

Total Suspended Solids & Total Solids

The total suspended solids (193mg/l) and total solids (636mg/l) of the oil impacted area were relatively higher than the control area 20.33mg/l and 98.67mg/l (table 2 & fig 6). Increase in TSS and TS could be attributed to the ability of oil to attract particulates. Tully Jnr et al, (2000) in their study discovered that oil spills first form a thick layer of oil on the surface of water. Also a large percentage of the oil spill gets emulsified and solidified along with sea shore, changing to sand, rock and stone Michele et al, (2000).

Dissolved Oxygen

The analysis of dissolved oxygen (DO) is used to measure the amount of gaseous oxygen dissolved in the water, which is crucial for all forms of aquatic life as o_2 plays an influential role in nearly all chemical and biological processes within water bodies (Chapman &Kimstach, 1992). Values of dissolved oxygen in the oil impacted area were low (1.0mg/l) compared to the control area with (5.27mg/l) (table2 & fig 6); DO in the oil impacted area is lower than that of the control area. Typically DO levels less than 2mg/l will kill fish (Hertz et al, 1975). Chapman and Kimstach (1992) noted that DO concentrations below 5mg/l adversely affect the functioning and survival of biological communities and below 2mg/l may lead to death of most fish. Oxygen is soluble in water and it tends to be less soluble as temperature increase.

Chemical Oxygen Demand

The chemical oxygen demand (COD) is commonly used to measure the susceptible levels of oxidation of the organic and inorganic materials existent in water bodies as well as in the sewage and industrial effluents. The COD of surface water in oil impacted area appeared to be higher (202mg/l) than the control area (19.33mg/l) (table2 &fig 6). The concentration of COD observed in unpolluted surface water remain around 20mg/l or less, while values are normally greater than 200mg/l in effluents (Chapman and Kimstach, 1992). It is noted that COD measurements are usually higher than the BOD measurements (Masters, 2004).

Biological Oxygen Demand

The BOD is used to read the level of biochemically degraded organic matter or carbon loading in the water (Chapman and Kimstach ,1992; Liston and Maher, 1997). The BOD of the study area had a higher value (67.66mg/l) compared to the control with (15.67mg/l)(table2 & fig 6). Unpolluted waters typically contain BOD values of 2mg/l or less, while raw sewage could have a BOD value of about 600mg/l (Chapman &Kimstach, 1992). Chattopadhyay et al, 1988 opined that the addition of significant quantities of crude oil to any water body causes an immediate rise in BOD due to the activities of hydrocarbon degraders and the blockage of oxygen dissolution. This appears true with the result from the analysis carried out in Odu-Gboro community as there is reduction of DO and BOD when compared to the control area.

Enumeration of heterotrophic bacteria and fungi in soil

Enumeration of heterotrophic bacteria and fungi in soil was also carried out to confirm oil spill impact on soil microbial population. It was observed that the density of total heterotrophic bacteria for the control area was high (6.00) compared to the polluted area 2.96x 10^4cfu/g while the density of total heterotrophic fungi for the control area was higher 2.00x 10^4cfu/g than the polluted area 1.23x 10^4cfu/g (fig 8). High heterotrophic microbial count in the control area is an indication of normal microbial growth and activities in the undisturbed soil. While the decrease experienced in the polluted area could be linked to the influence of oil spill in the soil, which had altered the activities of many soil microbes and eventual death of many due to high acidity/ alkalinity. However, heterotrophic organisms contribute to good soil quality and help to maintain soil fertility by breaking down the organic matter and nutrient fixation in the soil. More so, areas in the polluted soil where high microbial population was experienced can be linked to the influence of bioremediation known as hydrocarbon degraders. And a decreased microbial diversity could disrupt ecosystem dynamics leading to a less robust organic matter mineralization.

Analysis of Bean seed germination

Plate 3 shows the experiment on bean seed germination analysis and fig 9. The bean seed germination analysis was carried out by the use of bean seed so as to confirm oil spills impact on soil fertility which was observed for a period of 14 days. The result at the end showed that soil fertility reduction as a result of spill is positive. Sample A had no growth at all while sample B and C had abnormal growth due to the low active organic matter content as a result of the concentration of oil spill in the polluted area under study and the control had a normal growth. This shows that site highly contaminated with oil cannot be conducive for plant growth and those that are not highly contaminated could give room for growth but on the long run there is possibility of stagnant growth, once the soil composition and nitrifying bacteria have completely been altered and compounds have been absorbed by plants. According to Aina and Adedipe, 1991 soil fertility is said to be the capacity of the soil to support the growth of plants on sustained basis under given conditions of climate and other relevant properties of land. Soil fertility could be loss through loss of soil organic matter, leaching of nutrients, loss of the nutrients-laden top soil, changes in soil pH, reduction in cation exchange capacity, salinization, water logging and other forms of soil degradation these are major problems associated with agricultural productivity in the oil producing and neighbouring communities in Nigeria.

Health implications of oil spill on the residents

The percentage responses on health of respondents as a result of the spill (fig10) showed that rashes 50.9%, stomach disorder 45.3% and throat & eye irritation carried the highest percentage response. While the incidence reports on the health problem prevalent in the community from medical records (Jan 2011- June 2012) showed that diarrhea (340), dermatitis (371), conjunctivitis (185), nausea (301), back pain/leg pain (109) and dysentery (307) are the common health problems and they are associated with oil spill in the community. According to Omofonmwan and Odia (2009) respiratory problems, coughing up blood, skin rashes, tumours, gastrointestinal problems, different forms of cancer and malnourishment were commonly reported ailments in many oil communities.

Discussion on statistical analyses

Table 4 &5 below shows the statistical analyses of data for hypothesis I& II

Table 4: statistical analysis of data for hypothesis I

parameter	X_1	X_2	S^2_1	S^2_2	$T \propto /_{2(0.025)}$	t_{cal}	Decision rule
pH	8.16	6.52	0.0277	0.5188	2.776	3.8435	SD
Temp	25	22.67	0	6.3334	2.776	1.6036	NSD
EC	34.23	12.60	15.1234	5.2300	2.776	8.3042	SD
TSS	193	23.64	70933.5	12.3334	2.776	1.1011	NSD
TS	636	98.67	698034	662.3334	2.776	1.1134	NSD
DO	1.0	5.27	0.0650	7.2733	2.776	2.7302	NSD
COD	202	19.33	10.500	44.3334	2.776	42.7268	SD
BOD	67.66	15.67	50.3334	20.3334	2.776	10.7121	SD

S1- variance for study area, S2- variance for control, SD- significant difference, NSD- no significant difference, t_{cal}- calculated student T-test, t_{tab} - critical value

Table 5: statistical analysis of data for hypothesis II

O	E	O-E	$(O-E)^2$	$(O-E)^2 / E$
5.35	5.20	0.15	0.0225	0.0043
6.56	6.71	-0.15	0.0225	0.0034
2.62	3.38	-0.76	0.5776	0.1709
5.13	4.37	0.76	0.5776	0.1322
44.50	44.91	-0.41	0.1681	0.0037
58.38	57.97	0.41	0.1681	0.0029
78.46	77.44	1.02	1.0404	0.0134
98.94	99.96	-1.02	1.0404	0.0104
				0.3412

The data generated were subjected to statistical analysis in order to further confirm the findings made. In doing this the student T-test statistical tool was used to test the first hypothesis postulated which revealed a significant difference between the water quality of the oil spill site and the water quality of the control area with regards to pH, EC, COD & BOD at 0.05 level of significance. While the chi-square statistical tool was used to test the second hypothesis postulated which then revealed no significant difference between the soil quality of the study area and the soil quality of the control site. Considering that the calculated value at (0.05) which is 0.341 is less than the tabulated which is 7.815. Although the values of the control site parameters seems to be higher than the study area. The researcher therefore deduces that the different observed values did not show any significant difference statistically.

Conclusion

The presence of oil spill in our environment contributes significantly to the degradation of our environment. The survey design and analysis revealed that the physiochemical parameters of the study area (Odu-Gboro) and their health have been affected due to the incidence of oil spill in the area. The oil company should therefore make concerted effort to address this issue by carrying out proper clean up and remediation.

Recommendation

Oil spilled into the environment causes pollution to surface and underground water with dangerous consequences to human health, animals and underground organisms. An oily sheen is still present on the water surface of Odu-Gboro community. This same water is used by local community for bathing, domestic purpose, and in some cases drinking. Information should be made available to local people about locations that are dangerous for drinking, or bathing due to the presence of hydrocarbons. Effective action is needed to clean up the existing contamination and to prevent further release of hydrocarbon into the environment because of its consequences. However, when it comes to finding lasting solutions to improve the environment situation in Odu-Gboro community, all roots, causes need to be addressed. At the technical level, measures have to be taken to clean up the contamination and restore the environment. And at a more strategic level, action is needed to prevent a report of this tragedy in the community. This now leads to emergency response on the following measures:

- People who have been consuming this polluted water their health status should be followed up.
- Signs should be posted around all site identified as contaminated warning the community not to walk through or engage in any other activities at the sites.
- Adequate sources of drinking water should be provided to those household whose drinking water supply is impacted.
- Stimulation of the indigenous microbial growth by cultivating the soil to distribute the nutrients and lime applied and to aerate the treatment zone.
- A campaign to bring to end illegal oil activities. It should be a joint initiative between the Oil Company, Ogun state and local authorities.
- Preventive surveillance should be undertaken by a team consisting of oil industry representative and environmental agencies, together with an appointed local community representative.

References

[1] Achi, C. Hydrocarbon Exploitation, Environmental Degradation and Poverty. The Niger Delta Experience: Diffuse pollution conference,Dublin. (2003).

[2] Adinna, E.N, Ekop, O.B &Attah, V.I. Environmental Pollution and Management in the tropic. Snap press Ltd Enugu(2003). pp124-283

[3] Agarwal, S.K.Environmental Management.New Concepts.Eco Informatics. Vol. 1 . (2002).(35): A.P.H publ. Corp. Ansari, Darya Gunji, New Delhi.

[4] Agency for Toxic Substances Disease Registry(ATSDR) Toxicological Profile for Total Petroleum Hydrocarbons (TPH).US Department of Health and Human Services, Attanta, GA. USA (1999).www.atsdr.cdc.gov/Toxprofiles/tp123-p.pdf.

[5] Akinlabi, O.A. Effect of oil Industrial Activities in the North April oil Field.Federal Ministry of Housing and environmental publication Vol. 5W.L(1981)..; pp4-1

[6] Centers for Disease Control and Prevention (CDC) Crude oil health hazards. (1999).http://www.cdc.gov/niosh/topic/oilspillresponse /studies.html

[7] Chattopadhyay, G.N; Saha, PK; Gosh, A &Karmakar, H.C. A study on Optimum BOD levels for fish culture in waste water Ponds Biological Wastes, 25(2), (1988). pp79-85.

[8] DrMecola Water pH(2011)..www.mercola.com

[9] Environment Protection Agency (E.P.A). Quality Citeria for Water Use (1976)E.P.A 440, 1a –76-023, Environ Agency, watch.

[10] Environmental Protection Agency Crude oil Health Hazard.(2012). http://www.epa.gov/

[11] Forster U &Wittlman G.T.W. Metal pollution in the aquatic environment, Berlin, Spinger –Verlag. (1979).

[12] Frank Indivigho The everything Aquarium book. (2006).

[13] Hertz, G.R, Hugger, R.J & Hill, J.M.Behaviour of Mn, Fe, Cu, Zn, cdandPb. Discharged from a waste water Treatment Plant into an Estuarine Environment,WaterResearch, 9.(1975), pp631-636.

[14] International Agency for Research on cancer (IARC) Cumulative Cross Index to IARC Monograph on the evaluation of carcinogenic risks to humans. International Agency for Research on cancer. 66(1996).:pp487-514.

[15] Inya, A.E. The Nigerian State oil Exploration and community interest:Issues and perspectives. University of Port Harcourt, Nigeria. (1997).

[16] I Rosborg, et al Inorganic constituents of well water in one acid and one alkaline area of south Sweden. Lund University, Lund, Sweden water; Air & soil pollution (2002). (2003) 142.261-277

[17] Jamaluddin Md. Jahi, "Pengurusanalamsekitar di Malaysia: dari Stockholm ke Rio de(2001).Janeiro danseterusnya".SyarahanPerdanaJawatanProfesor, UniversitiKebangsaan Malaysia. Bangi: PenerbitUniversitiKebangsaan Malaysia, 75 pp.

[18] Johnson, D.L; Ambrose, S.H; Bassett, T.J; Bowen, M.L; Crummey, D.E;Isaacson,J.S; Johnson, D.N; Lamb, P; Sand, M & Winter Nelson, A.E. "Meanings of environmental terms".Journal of Environmentalquality.26(1997)..pp25812589.doii10.21341.jeq1 997.00472425002600030

[19] Michele.LWrabel& Paulette Peckol Effects of Bioremediation on Toxicity and Chemical Composition of No.2 Fuel oil : Growth Responses of the Brown Alga FucusVesiculosus. Marine Pollution Bulletin, 40(2), (2000). pp135- 139.

[20] Murdoch, T; Cheo. M & O' Laugh link Stream Keeper's Field Guide: Watershed Inventory and Stream Monitoring Methods.Adopt. A. Stream Foundation,Everett, WA(2001). pp297.

[21] National mirror Arepo pipeline fire: How vandals prevented removal of 93 dead bodies(2012)..www.nationalmirroronline.net.

[22] Nwilo, P.C; Peter, K.O &Badejo, O.T. Sustainable Management of oil spill incidents along the Nigerian Coastal Areas. Electronic Conference on Sustainable Development Systems.CEDARE. (2000).

[23] Nwilo, P.C &Badejo, O.T. Oil spill problems and management in the Niger Delta. International oil spill conference, Miami, Florida, USA. (2005).

[24] Ofomata, G. "The oil industry and the Nigeria Environment".Environmental Review Vol 1, (1997). No.1, February.

[25] Omofonmwan, S.I &Odia, L.O Oil exploitation and conflict in the Niger Delta Region of Nigeria.Kamla-Raj. Journal of Human Ecology 26(1(2009).): 25-30

[26] Osuji, L.C; Adesiyan, S.O &Obute, G.C. Post Impact Assessment of oil pollution in Agbada west plain of Niger Delta Nigeria: Field reconnaissance and total extractable hydrocarbon content. Chem.Biodiv.1 (10) (2004).: pp1569-1577.

[27] Osuji,L.C; Iniobong, D.I; Ojinnaka, C.M Preliminary investigation of Mgbede-20 oil polluted site in Niger Delta, Nigeria. Chem. Biodiv.3(2006).:568-577.

[28] PPG EHS Management System, (2007).

[29] Tully Jnr, Mode- selective control of surface reactions science.Yale dept of chemistry(2000). .www.chem yale.edu/faculty/tully.html.

[30] Uchegbu , S.N Issues and strategies in Environmental Planning and Management in Nigeria. Enugu: published by spotlite publisher (NIG). (2002).

[31] Vorobjeva, N.V et al The bacterial effects of electrolyzed oxidizing water on bacterial strains involved in hospital infections.Artificial organs vol 28, issue 6, (2004). 590-592

[32] World Bank World Development Report: A better investment climate for everyone. (2005).