PHYSICAL IMPACT OF OIL SPILLAGE (A CASE STUDY OF GIDAN MUTUM DAY/KAFFIN KORO COMMUNITIES)

BY

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DECLARATION

I hereby declare that this project work titled "Physical impact of oil spillage a case study of Gidan Mutum Daya" is an authentic work-study carried out by me and has not been presented elsewhere for any form of award academically.

Mamven Mabel Nanya

Sign:.......................

Date:.......................

DEDICATION

The work is dedicated to my Dad and Mum, Mr. Johnson and Mrs Jummai Mamven who's constant support, understanding, love and ceaseless prayers saw me through this programme.

TABLE OF CONTENT

CHAPTER ONE

1.0 INTRODUCTION

Nigeria ranks as the sixth or seventh largest oil producing country in the world. While oil operation is assuming a pride of place in the Nigerian economy; its devastating impact on the environment cannot be underrated.

Owing to increase activities in the oil sector, there are more chances of oil pollution and devastation of land in oil locations and its environs.

Many of the operations of the petroleum industry are of very sensitive nature and of interest across national and international boarders. Interestingly petroleum products are not consumed in the locality or country of production but are usually conveyed through a network of pipelines to distant places.

The NNPC-PPMC distributes and markets the following products by means of roads (Tankers), sea, vessels, and pipelines.

Premier motor spirit, (PMS) (Petrol)

Automotive Gas Oil, (AGO) (Diesel)

Dual-purpose kerosene, (DPK) Aviation Turbine Kerosene Household Kerosene.

Generally, there are about 5,000km of pipelines crisscrossing the country for efficient distribution of oil products to all parts of the country (fig 1).

Basically the pipeline and depot network all over the country are categorized into five systems.

- System 2A (Product line from Warri depot through Benin and Oredepo terminating at Mosimi depot.)
- System 2B (Product line from Atlas cove through Mosimi to Lagos, Ibadan and Ilorin depot)
- System 2C (Crude line from Excravos through Warri, Abuudu, Lokoja, Abaji, Isom Sarkin Pawa to Kaduna.)
- System 2D (Product line from Kaduna through Zaria, Gusau to Kano)
- System 2E (Product line from Port Harcourt through Abba, Enugu, Markurdi)

Refined petroleum products are pass through these pipelines to depots strategically located from where product marketers lift by road to retail filling stations.

The most disturbing threat to regular supply and distribution of petroleum products to the Nigerian populace is the unwholesome and deliberate act of vandalization of the pipelines by unpatriotic citizens. The pipelines and product marketing company has recorded unprecedented attacks on oil pipelines at various segments along different pipeline systems. Other cases of pipeline breakage are due to corrosion or other natural cause. These incidence discharge reasonable quantities of crude and refined oil into the ecosystem.

The major environment hazards of the spillage of petroleum products according to Odiete (1999b) include

- The presence of petroleum hydrocarbons in soil, water and air.

- Health risk to people particularly from skin lesion and rashes and respiratory problems.
- Mortality of domesticated animals, aquatic and terrestrial fauna and flora
- Loss of biodiversity
- Loss of farms and economic crops
- Disruption of transport in inland water ways.
- Contamination of under ground water.
- Fire disaster.

1.2 STATEMENT OF PROBLEM

The NNPC-PPMC system 2C product line got raptured at KM 188 along 130m-Sarkin Pawa, within Gidan Mutum Daya and Kaffinkoro communities of Paikoro Local Government. Area of Niger State on 13th February 2001 releasing about fifteen thousand litres of petroleum product (kerosene) into the adjoining farmland and floodplains, appendix 3. this led to the destruction of the flora and fauna in the floodplain. The host communities dug holes, scooped and collected products into containers for their use and for sell. The pipelines over the years have experienced various forms of leakages resulting from corrosion of old pipelines and vandalisation.

1.3 AIM

To establish the physical impact that might arise due to the spillage of petroleum product kerosene and suggest remediative measure to correct the damage and avoid reoccurrence.

1.4 OBJECTIVES

a) To establish the extent of the area of land affected by the oil spillage.

b) To determine the effects produced by the pollution on the various environmental components i.e. vegetation, water, soil, air fauna.

c) To determine the danger pose to agronomic soil and crops.

d) To establish environmental baseline data to facilitate the identification of economic problems attributable to the operations of the pipeline in the area.

e) Make proposal for remediation of currently impacted soil and rehabilitation of the environment.

1.5 THE STUDY AREA

The Izom Sarkin – Pawa area is located between Latitude $9^0$35'30 and $9^0$3540"N and longitudes $7^0$03'40 and $7^0$35'50"E. it is a small sparsely populated area in Paikoro Local Government Area of Niger State. The area is typically a rural setting with few dotted thatched houses. It is bounded by Gidan Mutum Daya and Kaffin Koro communities. The spill site is within the Izom and Sarkin Pawa section around kilometer 188 of the Suleja – Kaduna pipeline route. The study site and it's environs are characterized by uneven landform consisting of rock outcrop in the northeastern part, two-way slope along the pipeline Right of Way, a depression with stagnant water and a stream (pic 3 & 8) flowing west to east direction and emptying into the Shallow River.

1.6 SCOPE OF WORK

The work comprises various aspects that were sewn up into chapters. The first chapter covers introduction, which deals with general introduction, aims and objectives, justification, problem statement and scope of the work.

Other aspects of the project are literature review to acquire background information on the history of oil spillage, methodology for field data gathering and laboratory analysis of samples of elements such as Soil, Water, Air quality flora and fauna, Soil And Water test for presence of; hydrocarbon, heavy metals, hydrocarbon degrading microbes, PH, Salinity,

Soil sample are tested for the presence of petroleum hydrocarbons and hydro microbiological degrader. Physiochemical parameters, (heavy metal will be tested)

WATER

Water samples are also analysed for

- physicochem parameterie
- Presence of hydrocarbon
- Heavy metals
- Microbial degraders.

Stream and other bodies of water are sampled for fishes, plankton and benthos and analysied for species richness.

Air quality are determined mainly by none methane hydrocarbon vapour, suspension of heavy metal

Detailed socio-economic studies of the local human community for land, demographic, occupation, income, and health by means of questionnaires claims of adverse environmental and health impact are ascertained.

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

The effect of oil spillage on the Nigeria Environment have been reported by very many investigators such as Ekekwe (1981), Ekweozor and Snowden (1985), Afolabi *et al* (1985), *Odu et al* (1985) and Idoniboye and Andy (1985).

Amajor (1983) observed that when oil spillage occur on land, such as the Ejamah-Ebubu oil spill incident near Eleme, Rivers State in 1970 which was not cleaned, farmlands and swamps were heavily impacted, the soils were no longer fit for farming. He also observed that lighter and low molecular weight hydrocarbon evaporated and intermediate and heavier fractions permeated into the soil. In a related finding Odu et al 1985 observed that when crude oil is spilled on land the light fractions evaporates, the remaining greasy oil penerate slowly into the soil and are slowly biodegraded. Oil degrading bacteria in oiled soils such as Azobacter and Beijierinckia became more abundant while nitrifying bacteria such as Nitrosomonas became reduced in number (Odu et al 1985).

Orubima (1983) observed that in the Nigerian National Petroleum Corporation (NNPC) Spillage at Owa and Abudu in Edo State in 1982, the farmlands in the immediate vicinity were completely oil-logged and all economic crops such as seedlings of yam and cassava were scorched to death and the farmlands remained barren for months after the spill incident.

Oil spill damages the thin layer of fertile soil that covers most of the earth's land surface. In a balanced ecosystem this layer is continually maintained by the various nutrient cycles and activities of decomposers and soil organisms. Certain changes occur when soils are polluted. These range from poor wetability, loss of soil structure. These changes affect mostly growth of plants, with the severity increasing with the level of oil in the soil. Other changes are poor aeration, toxicity and loss of soil nutrient (McGill 1976).

Aeration could be viewed from two perspectives: first the topsoil becomes sticky thereby blocking the pores through which air from the atmosphere enters the soil. Secondly, when the oil film covers the surface, anaerobic respiration results. These could be due to the increase in oxygen demand by microbes, and this is mostly required in the decomposition of hydrocarbons within the given area (Odu, 1981, Deliana et a1 979). The oil displaces water, air and occupies the natural pores of the soil. Powell (1977) observed that the volatile components of the soil fraction evaporates when they are at their drying stages and at the same time make the bigger oil fragments to stick together in aggregated forms.

Baker (1978) pointed out that oil in sediment is not attached or degraded unless an oxygen source is available. This accounts for the fact that reducing environment (anaerobic) preserves all the original hydrocarbons several years after an oil spill.

McGill (1976) and Powell (1977) studied the interaction between soil microorganisms and oil, and reported that it has an active equilibrium with the soil system, and are most sensitive to changes, such that there is an increase in the number of extraneous carbon source, such as crude oil into the environment.

Oil spill leads to substantial increase in microbial activities of the soil. This leads to their increased nutrient demand resulting in a competition between plans and micro-organisms (McGill 1976). The competition, Odu (1981) observed are more detrimental to plants than micro-organisms because they occupy sites immediately around the plans root hairs thus extracting nutrients from soil solution before they are taken by plants roots.

Odu (1981) showed that there is an initial lethal effect on certain microbes, which may be followed by an increment in their population due to the degradation of the crude oil by the microbes for building new cells thereby growing. He further observed that oil degrading microorganisms are everywhere in Nigerian soils, especially in the oil producing areas. The degradation process is facilitated if the soil within the given area is properly aerated and nutrients not lacking in supply. The reports of Hunt et al (1973) on four different oil spills from a 1007 km-long pipeline in Alaska in 1956 and 1968 revealed that extensive vegetative kill result from oil pollution. Even after 15 years, the reports showed that there was little vegetative recovery in many areas. They reported that all trees and plant along and within the flow path were killed.

Knako (1981) and Odu (1981) demonstrated that the growth and development of plants are adversely affected by crude oil pollution. The effects would range from wilting, chlorosis, tissue and cell maceration, blotching, marginal necrotic spots to collapse and eventual death of the plants. Unavailability of water and mineral nutrients to plants due to crude oil pollution has been reported by Banker (1970), Amakiri and Onofeghara (1983) and Ezeala (1987). These authors submitted that crude oil could enter into the intercellular spaces of plant and interfere with the water uptake and gaseous exchange of the cells. Such a condition could result in a situation of physiological drought and gradual suffocation. This will lead to reduction in chlorophyll content, yellowing of the leaves (chlorosis), cessation of growth and eventual decay of plants.

Note that all these physiological disorders in the plants result in the weakening of the plants and increase their susceptibility to attack by plant pathogenic organisms. An epidemic can result from such situations. Reduction in chlorophyll content will undoubtedly affect the photosynthetic activities and overall productivity. It is imperative from the on going that crude oil pollution even as small as 0.5ppm as reported by Ezeala (1987) is detrimental to plant growth and development. Some water-soluble fractions, particularly aromatic compounds are toxic to acutely lethal in concentrations of a few parts per million (ppm) and chronically lethal in sub lethal concentrations in parts per billion (ppb) although plants and animals vary widely in their sensitivity (Clark, 1982). The water-soluble fractions depress phytoplankton photosynthesis, respiration and growth, kill or cause developmental abnormalities in zooplankton and the young stages of many aquatic organisms (Powel et at, 1985). Oil on the surface of water limit gaseous exchange and entangle and kill surface organisms and coat the gills of fishes.

Refined petroleum products, like crude oil, kill aquatic and terrestrial plants and animals by asphyxiation/smothering effect of particular concern are gills of fish aquatic birds and wild life. Plankton is destroyed thus disrupting aquatic food chains. Some components of the refined petroleum products such as benzene ethyl benzene, toluene, xylene and the group collectively refered to as polycyclic aromatic hydrocarbons (PAH) are mutagenic and teratogenic (Odiete 1999a).

In October 1998 or earlier, a 16" pipeline conveying refined petroleum fuel north words from Warri refinery had busted at a concrete pit, a deep block valve area of the route, at Jesse near Sapele, in Delta State. As in all other places where there was burst PPMC Pipelines, the villagers became oil prospectors digging holes in fuel-soaked sand and burying Jerrycans to collect the leaky fuel. Collecting such spilled fuel is like sitting on a keg of gunpowder. One casual strike of a match and boom!! People, domesticated animals vegetation and crops are razed down in a few minutes. At Jesse more than a thousand people were roasted alive (Guardian, 1998, The News, 1994) Ore in Ondo State, Mosimi in Ogun State, Benin in Edo State and Isialangwa in Imo State are among other places where such fatal fire incidents had previously occurred killing people (The News 1998).

Yet, a more recent oil spillage is reported in the National Interest newspaper to have left not less than hundred and ten persons now battling with lives at various hospitals in Sapele Delta State. The devastation caused by a massive oil spillage, which occurred recently in January 2002 at Ethiope, was also disastrous. National Interest paper of 18th January 2002 reported that the spilled condensed crude oil floated on a large, trees, and shrubs were burnt. Most affected were the fishermen and the inhabitant whose means of likelihood have been badly affected.

Most of the worst oil spills occur accidentally during collusion of ships on high seas, ballasting and loading or off loading lading. There are instances when spillage occurs during tank cleaning and bunkering transfer. Engr. G.O Uduchi in his speech delivered on the 25th of March 1999 on environmental pollution in control routine spills from low level discharges from slightly leaking pipes than serious accidental spills arising from ocean lines or blow outs. He said gusher is a rare phenomenon occurring one in every thousand well drilled; for instance in the United State of America.

Natural seeps occurring beneath the sea are not also a common occurrence but they have been known to occur along the coast of Califonia. In Nigeria the most common cause of oil spillage is from vandalization activities and rupture for bursting of old pipes due to corrosion. Adekunle and Foster 1985 defined severity of oil spills and categorized them into four thus:

i. Minor spills – any discharge of oil less than twenty barrels in inland waters or less than two hundred and fifty barrels on land, offshore or coastal water. That does not pose a threat to the public health and welfare.

ii. Medium spill – any discharge of oil of twenty-five or two hundred and fifty barrels inland waters or two hundred and fifty to two thousand five hundred barrels on land, offshore and coastal waters.

iii. Major spills – any discharges of spill over two hundred and fifty barrels inland waters. A spill of lesser volume that poses a threat to the public health or welfare may be classified as a medium or major spill depending upon its degree of impact.

iv. Disaster – any uncontrolled well blowout pipeline rapture or storage tank facility that posses and immanent threat to the public health or welfare.

The emphasis on public health and welfare in this definition deserves special attention. Accidental spills cause immediate, local and obvious effect; for instance when an oil vessel accidentally hits a rock on the high sea and gets damages the impact is usually immediate and obvious.

Some of the worst oil spills documentation by Udeuhi are.

1. AMOCO CADIZ tanker spill in the first major world tanker accident in 1967, when the Torrey Canyan ran to the seven stone rocks in South West Coast of England. The vessel was not only completely wrecked but it also lost its cargo of one hundred thousand tons of crude oil to the sea. In what was known as the second world largest accidental tanker spill, the Amoco Cadiz accidentally lost

a cargo of twenty two thousand tons of crude in 1974. when the mehila grounded in the straight of Magallan, it lost only fifty thousand tons, fortunately, the ship and the reminder were Salvaged.

When crude oil ocean tankers explode on the high seas, they often cause widespread oil spillage resulting in conflagration causing extensive damage to marine and estuarine life, degrading coastal lines and beaches. The AMOCO CODIZ disaster was said to be an example of this. Two other instances of such disasters recorded are the explosion that occurred in the French tanker.

BETELGEUSE, alongside of gulf oil terminal in Bantry Bay Eire in 1979 in which fifty one persons lost their lives comprising some crew, a technician and employees of the terminal, and one of the worlds largest oil spills ever reported in the Guardian of 12th June, 1986, the spill resulting from a ruptured rusty lake bad pipeline owned by the LAGOVAN oil company was reported to have spelt tragedy for about ten thousand families apart from incalculable damages done to marine ecology leading to the death of millions of fish.

Udeuh recorded that between 1974 and 1979, about four thousand, one hundred and fourteen significant world oil spill in ports and sea were recorded of these three thousand, seven hundred and twenty two occurred in sea ports while the remaining cases were on the high seas.

In Nigeria from 1976 to 1984, while total production was 5.76 billion barrels, a total of 1,548 spills were recorded, making an average of one hundred and seventy two per year.
In the Guardian of 23rd February 1999, Nigeria National Petroleum Corporation reported some forty-seven cases of spills mostly attributed to vandalization.

The Jesse incident in Delta State illustrates this assertion. Some of the oil spills that have occurred in Nigeria are;

1. The FUNIWA WELL No. 5 oil well blow out of 17th January 1980 in the Niger Delta is a case of accidental cause of oil pollution resulting from a well blow out during completion of operation by the semi-submersible drilling rig known as SEDCO 135c. The ninety-five persons on board were successfully evacuated but the blowout could not be stopped until 30th January when the wells caught fire which lasted for forty-six hours. Incidentally, the onset of the fire effectively terminated the flow of oil from the blowout to the sea. The disaster lasted twelve days and fourteen hours, between 146,000 to 2000,000 barrels of crude were lost. In addition the SEDCO 135c got completely destroyed in the inferno (pipeliners January 1999).

Probably second to none in the Nigerian oil history is the FORCADOS Terminal Spill in July 1978. While the Ranami Abah Technical committee set up by the Rivers State Government estimated that 420,941, barrels were lost during the twenty-one days of blowout, about 570,000 barrels were believed to be actually spilled. Messrs Ulho and company, Nig. Ltd. (TOPCON) was reported to have recorded 200,000 barrels in twelve days.

The ABUDU pipeline oil spillage of 2nd November 1982! Another interesting study of a different dimension, was caused when a pay loader belonging to Brunelli construction company, a subsidiary of CIMI-Montubi company, accidentally ripped a hole in NNPC 16 inches underground pipeline (system 2c Warri to Kaduna) between Owa and Abudu in the former Bendel State thereby spilling 18,818 barrels of crude oil in nearby streams and fresh water springs with adjoining farmlands being polluted. Compensation to the tune of N1,395,818.76 was estimates then (pipeliners sept 1987).

In recent times there have been more frequent leakages of pipelines of the pipeline and product marketing company (PPMC) in many parts of the country. At the Takwa bay NNPC Atlas cove in July 1997, the Atlas cove – Ejigbo pipeline laid several feet in the sandy soil more than twenty years ago burst gushing out an estimated ten thousand litres of refined petroleum products per hour into the mangrove swarm forest near Ebute-oko in Etiosa Local Government Area of Lagos state and the same pipeline burst in another place further north in the Badagry creek at Ilado and Agbado near Sanky village in Amino Odofin LGA (Tell 1997, Odute 1999b). The sandy soil became socked with fuel, which flowed into inland water ways. The mangrove was completely destroyed killing all crabs periwinkles (sea animals, snails, fish and plants etc).

The villagers and other people from far and near organized to collect the fuel by dipping deep holes in the sand and collecting accumulated fuel. Some fuel floating from the water surface was collected for brisk business by selling the fetched fuel in the "black" market. It was lucrative business during the dark das of the ABACHA regime when fuel scarcity was a regular daily feature.

CHAPTER THREE

MATERIALS AND METHODS

3.1 FIELD DATA GATHERING

A Consultation with PPMC staff and some Gidan Mutum Daya/Kaffin Koro residents was undertaken. Several levels of consultation were carried out within the context of a social impact; encompassing in house and public and institutional sectors of the local economy. There was great assistance and cooperation from the local residents in giving information about the community.

Consultation also covered meeting with the station superintendent at Izom PPMC pump station, Mr. L. N. Garba who narrated a history of the spillage.

Field Work lasted for 2days for both socio economic investigation and field data acquisition.

3.2 ECOLOGICAL DATA ACQUISITION

This phase involved fieldwork and the acquisition of ecological data for surface and groundwater, soils, vegetation/wildlife, sediment, benthic organisms, as well as microbial organisms, and air quality.

The field research involved the acquisition of baseline ecological data, which were carried out using the following procedures:

3.2.1 *Sampling Procedure and Handling*

Sampling points were established based on the landforms and hydrological characteristics of the area along the pipeline Right of Way and in relation with the product spill point.

3.2.2 *Surface Soil*

Morphological characteristics of surface soil was done by visual observation and feeling by hand. A soil Auger, sample and hand trowel were used for sampling to ensure that reproducible units of soil samples were collected from depths of 0-15cm and 15-60c. Soil samples were obtained from three different designated sampling points around each location to make a composite. This ensured a high quality representative data collection.

Soil samples were collected in appropriately labeled and sealed polythene bags in accordance with the quality assurance criteria as contained in the Environmental Guidelines and Standards (DPR, 1991) for the Petroleum Industries.

Samples for microbiological analysis were collected in labeled sterile MacCartney bottles and preserved in the field under 4^0C in coolers containing ice chips. Samples for physico-chemical analysis were air-dried in a dust free environment.

3.2.3 *Surface Water*

Surface water samples from the river was collected using a one-litre water sampler. appendix 4:

Samples for hydrocarbon analysis were collected in glass bottles. Samples for heavy metal analysis were acidified to PH 2 using nitric acid in a separate set of sample bottles. Samples for microbiological analysis collected in sterile glass bottles and stored in ic-packed containers and later in the refrigerator. appendix 4:

3.2.4 *Sediment*

Composite sediment samples were collected using a stainless hand trowel. Pic 2:

3.2.5 *Air Quality*

Ambient air quality parameters (volatile organic carbon, Sox, NOx, Cox, etc.) were measured in-situ using Gastella Aerosol Monitor.

3.3 LABORATORY ANALYSIS

3.3.1 *Testing for Physio-Chemical Quality Parameters*

Samples collected for physio-chemical analysis were spread on a certified filter paper in ventilated area. The samples were air-dried for 48 hours. Sediments/soil aggregates were gently broken into smaller pieces by mortar and pestle to past through a 3mm screen. Particles larger than 2mm were dischaiged. The following standard procedures were employed for investigating the physical and chemical properties of soil.

3.3.2 <u>*PH in Soil /Sediment*</u>

PH was determined in 1:2. 5-specimen water suspension ratio using a laboratory PH-meter. 10gm of soil/sediment were taken in cups and each of the cups. 25ml of distilled water were added and stores for 5mins after shaking. It was allowed to equilibrate after the PH was measured. The meter was standardized at PH4, PH7 and PH10 using standard buffer tablets.

3.3.3 <u>*Total Nitrogen*</u>

Total Nitrogen in soil was determined by regular Kjeldahl method as describe by Jackson (19970). 0.5g of samples that has passed through to mesh sieve were taken in a digestion tube. Two (2) tablets of selenium and four (4) tablets of sodium sulphate (Na_2SO_4) were added. The mixture was moisture with a few drops of water, followed by the addition of 30ml of conc. Ha_2SO_4 and swirled gently. The digestion block at about 370^0 C until and enough of 10% NaCl was added to make the solution alkaline and then it was distilled into 20ml of boric acid indicator and titrated with O.IN HCL. The % content was calculated as follows:

$$\%N = \frac{TxMx14x100}{\text{Wt. Of soil used}}$$

T = Titral value

M = Morality of HCL

3.3.4 *Determination of Heavy Metal is Sediment, Soil and Water*

About 5g each sample (soil sediment) accurately weighed (as received) and quantitatively digested in 50ml of dilute (50/50 v/u) hydrochlorine acid. The slurry formed was stirred for 6 hours. The resulting mixture was filtered and filtrate received in a 100ml with distilled water. The resulting thoroughly mixed solution was aspirated into a flame of the Atomic Absorption Spectrophotometer. The absorbance shall be determined for the various metals using the corresponding lamps these metal.

3.3.5 *Analysis of Plankton*

Standard method after Dakshini and Soni (1982), Cos (1975) was adopted. The collected water samples for Plankton studies shall concentrated and adjusted to 5ml and at least 5 drops from each sample bottle shall be examined under a M20 wide compound microscope for minimum of three transects per drop a suggested by Dakshini and Soni (1980). They density of the various plankton species was composed by calculating average cells (+ 5%) per transact as described by vollenweider (1969). To aid identification of diatoms, sub sample from each original sample was acid until the solution becomes colourless (Cox 1975). The composite tax was identified by comparison to previously named specimens and appropriate texts.

3.4 MICROBIOLOGICAL ANALYSIS

3.4.1 Media Preparation

The following media was prepared and used for the isolation of microorganisms for both water sediment and soil samples.

1. Nutrient agar (oxide)

2. Potato Dextrose agar (oxide)

3. Deoxychlolate citrate agar (oxide)

4. Maclonkey agar (Difeo)

5. Hydrocarbon (Bonny light) salts minerals media

Isolation of Microorganisms

3.4.2 *Heterophic Bacteria and fungi*

These were isolated from the samples by adopting standard plate techniques (SPDS) as follows: Planting of 0.1 ml of appreciate dilutions of samples an nutrient agar for bacteria and potato dextrose agar plates were inculcated in three treatments each replicated three times as follows.

(i) Plates incubated at 37^0c

(ii) Plates incubated aerobically at 30^0c and

(iii) Plates incubated aerobically at 37^0c for 2 – 3 days

for the potato dextrose agar, plates after inoculation, they shall be incubated aerobically at 300c for 3 – 6 days. These were three replicates of this treatment. Agar plates of the selective media (see above) were similarly treated but incubation was carried out at 370c for 2 – 4 days except where otherwise state.

3.4.3 *Isolation of Total Hydrocarbon Degrading Bacteria and Fungi*

Two complimentary experimental methods were adopted as follows:

- Plating out o. ml of appropriate dilutions on a minimal salt medium containing crude oil (Bonny Light) as the sole carbon and energy source. Two sets / treatments were prepared for each dilution plated out; one set was incubated aerobically under carbon dioxide atmosphere at 370c for 14 – 12 days. In each set / treatment there were three replicates.

- In second series the method essentially will involve inoculating 0. ml aliquots of samples into minimal salt agar medium and then supplying the carbon source (crude oil) in a vapor state originating from soaking filter paper suspended at the lid of petri-dish. The cultures were incubated as stated above for 14 – 21 days.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 SEDIMENT CHARACTERISTICS

The sediment is the ultimate sink for all substances that find their way into the marine environment. It is therefore expected that the concentrations of various elements should be quite higher in the sediment than in the surface water. Sediments are preferred in being used as indicators of heavy metal pollution of an aquatic system because the concentrations of harm and toxic substances are of many orders of magnitude higher in sediments and biological tissues than in water since the water concentrations may vary with seasonal fluctuations.

TABLE 4.1: Heavy Metals Content Of The Soils

ample Titles	Fe (mg/g)	Zn (mg/g)	Mn (mg/g)	Pb (mg/g)	Cr (mg/g)	Gg (mg/g)	As (mg/g)	Cu (mg/g)	Ni (mg/g)
S_1	28.36	18.34	2.16	<0.003	<0.002	<0.001	0.086	0.0086	<0.001
S_2	35.17	17.16	1.38	<0.003	<0.002	<0.001	0.041	0.041	<0.001
S_3	38.25	16.38	2.34	<0.003	<0.002	<0.001	0.035	0.035	<0.001
S_4	15.38	14.17	2.11	<0.003	<0.002	<0.001	0.025	0.025	<0.001
S_5	21.36	38.34	1.96	<0.003	<0.002	<0.001	0.034	0.034	<0.001
S_6	27.18	16.17	1.75	<0.003	<0.002	<0.001	0.016	0.016	<0.001
S_7	28.36	18.18	1.48	<0.003	<0.002	<0.001	0.028	0.028	<0.001
S_8	31.15	28.24	1.25	<0.003	<0.002	<0.001	0.041	0.041	<0.001
S_9	33.28	29.38	1.14	<0.003	<0.002	<0.001	0.031	0.031	<0.001
S_{10}	30.18	38.14	0.98	<0.003	<0.002	<0.001	0.021	0.021	<0.001
S_{11} (Control)	24.25	24.16	0.84	<0.003	<0.002	<0.001	0.002	0.002	<0.001
S_{12} (Control)	21.16	21.38	0.78	<0.003	<0.002	<0.001	0.004	0.004	<0.001

Sediments usually provide a reservoir for heavy metals. Researchers have showed that nearly all the metal content in aquatic environs reside in the sediments with only a very small fraction in the biota. In most cases the sediment hold over 99% of the metals present in the system (Bower, 1979).

Data obtained for the study are presented in Table 4.1 from the results the concentration of chromium, mercury and nickel was below instrument detectable limit of 0.00lug/g. The ranges of the other heavy metals (in ug/g) are presented below:

- Iron: 28/17 – 52.17
- Zinc: 21.18 – 25.34
- Manganese: 4.18 – 6.17.02 l
- Lead: 1.15 – 2.18
- Copper: 0.112 – 0.180

The recorded values of heavy metals are within natural occurrences levels in soils. There is therefore, no threat of heavy metal toxicity in the area as a result of product spill.

4.2 HYDROCARBON IN SEDIMENT

A thorough investigation of the product spill site revealed the results of Total Hydrocarbon Content presented in Table4.2. A very thorough evaluation of the results *vis a vis* the general background levels obtained under natural conditions and in comparison with DPR acceptable limits showed that most of the surface soils and sediment samples were higher than naturally occurring concentrations of THC.

TABLE 4.2: Total Hydrocarbon Results for the Core Soil Samples

Sample Title	THC mg/kg	Ph
C_1 (0.2m)	5.51	-
C_1 (0.5m)	61.83	6.2
C_1 (1m)	12.29	6.8
C_2 (1m)	5.13	6.8
C_3 (1m)	45.95	7.3
C_4 (1m)	51.42	7.8
C_5 (1m) Control	5.24	6.8

According to Massond et al. (1996) THC values greater than 50ugg-1 in sediment are possible only in moderately petroleum-polluted environment.

From the results generated the concentration of hydrocarbon in the sediments range from 2.92 and 57.52ug/g). With the exception of samples SD1 and SD2 collected where the spill took place, the rest samples had levels of hydrocarbon considered very insignificant and is reflective of an area that has not been polluted as the range is below the recognized biogenic status of 50ug/g (Concave 1972). The generally insignificant levels of hydrocarbon in both soil and sediment after about a year of spill in the area are attributed to the volatile nature of kerosene. Several researches have reported that the components of kerosene are easily lost or evaporated from the environment under tropical temperatures.

TABLE 4.3: Chemical Properties of Sediment

ple s	Fe (mg/g)	Zn (mg/g)	Mn (mg/g)	Pb (mg/g)	Cr (mg/g)	Hg (mg/g)	Cu (mg/g)	Ni (mg/g)	THC (mg/g)	pH
	45.68	21.38	4.18	2.18	<0.002	<0.001	0.143	<0.001	21.79	6.2
	28.17	22.14	4.32	1.34	<0.002	<0.001	0.138	<0.001	57.52	6.2
	38.46	23.16	4.18	1.34	<0.002	<0.001	0.126	<0.001	10.43	6.2
	45.38	24.18	5.16	1.15	<0.002	<0.001	0.141	<0.001	7.96	7.8
	52.17	22.19	4.38	1.84	<0.002	<0.001	0.134	<0.001	15.58	7.8
	38.36	25.34	5.16	1.46	<0.002	<0.001	0.114	<0.001	13.58	7.0
	37.16	24.14	6.17	1.37	<0.002	<0.001	0.180	<0.001	6.16	6.8
	34.34	21.18	4.28	1.45	<0.002	<0.001	0.112	<0.001	2.92	7.8.

4.3 PHYSICO CHEMISTRY WATER

4.3.1 pH

The pH of water also affects transformation processes among the various forms of nutrients and metals and influences the toxicity of pollutants consisting of acids changes in pH will affect all other physicochemical parameters of the water including aquatic life. Extreme pH values causes stress to fish and other aquatic organisms (GEMS, 1992).

The pH of the surface water samples range between 7.0 and 9.0. The results of laboratory and in-situ analysis (Table 4.4) showed that most of the samples have their pH within the range of 6.5 and 8.5 and therefore fall within both DPR and Federal Ministry Of Environment for surface waters. The petroleum product spill that occurred in the area may not have influenced the pH range obtained in the area as Ademoroti (1996) reported that the range of pH in most natural tropical waters is between 6.0 and 9.0.

4.3.2 Conductivity

The electrical conductivity of water is its ability to carry electric current, which in turn is related to the total concentration of ions, their mobility, valence and their relative concentration. For natural waters, conductivity ranges from 50 to 1500us/cm (GEMS, 1992). The conductivity of the surface water samples ranged from 104 to 544us/cm. The conductivity range (Table 4.4) obtained for the waters are within the permissible limits of 900us/cm (Fed. Mins. Environment) and 1500us/cm for natural waters.

4.3.3 Salinity

Salinity is a measure of the concentration of hydrogen ions dissolved in water. The salinity varied from 3.8 and 200mg/1. These values are reflective of no saline water bodies (Table 4.4).

TABLE 4.4: Physico-Chemical Characteristics of the Surface Water

Sample Titles	THC (mg/1)	Conductivity (us/cm)	Salinity mg/1	PH
SW_1	0.127	104.02	11.54	7.2
SW_2	0.036	288.8	63.0	7.0
SW_3	0.045	544.0	200	8.8
SW_4	0.073	462.0	100	9.0
SW_5	0.727	323.0	100	8.2
Control	0.086	280.0	3.86	7.6

4.3.4 Heavy Metals

The surface water concentrations of heavy metals were generally very low to trace. From the results obtained for this study; cobalt, mercury, nickel, arsenic and copper, had concentrations below 0.025ug/g in the entire area. The ranges for iron, zinc, manganese and lead were 4.34 – 72.16, 0.28 – 0.46 and 0.15 – 3.46ug/l respectively. These concentrations are similar to values reported in the continental waters as well as within the coastal waters of Nigeria (Kings et at 1975, Courant et al 1985)

4.3.5 Total Hydrocarbon Content (THC)

The concentration of total hydrocarbon content was 0.036 to 0.727mg/l in the surface waters of the area (Table 4). The results show that the THC levels were generally below 1% in all the samples. The low concentration of hydrocarbon contents is reflective of natural environment that has not been polluted. Concave (1972) reported that the natural recognized biogenic status of THC is 50ug/1. THC values lower than this are considered very insignificant and is reflective of an area that has not been polluted with respect to hydrocarbons. The Expedite response given to cleaning the product spill have been responsible for the results of low hydrocarbon in the waters. The time laps between spill and assessment, which is longer than one year could also account for the observed trend. Most of the volatile components have been lost by evaporation and natural recovery process has taken place.

TABLE 4.5: Heavy Metals Concentrations of the Surface Water Samples

Sample Titles	Fe (mg/1)	Zn (mg/1)	Mn (mg/1)	Pb (mg/1)	Cr (mg/1)	Hg (mg/1)	Cu (mg/1)	As (mg/1)	Ni (mg/1)
SW_1	56.38	38.34	0.46	3.16	<0.002	<0.002	0.025	<0.001	<0.001
SW_2	72.16	48.15	0.28	3.46	<0.002	<0.002	0.018	<0.001	<0.001

SW_3	4.34	56.34	0.35	0.15	<0.002	<0.002	0.016	<0.001	<0.001
SW_4	8.17	46.14	0.41	1.46	<0.002	<0.002	0.014	<0.001	<0.001
SW_5	56.38	48.24	0.38	1.36	<0.002	<0.002	0.002	<0.001	<0.001

4.4 MICROBIOLOGY OF SOIL

4.4.1 Heterotrophic and Hydrocarbon Degrading Bacteria

The results of the total heterotrophic bacteria and the percentage of hydrocarbon degrading bacteria over the total heterotrophic bacteria are as shown in Table 6.

The Total hetrotrophinc bacteria (THB) and the hydrocarbon degrading bacterial (HUB) count ranged from 2.28 x 106 to 3.26 x 107cfu/ml and 3.192 x 103 to 4.305 x 106cfu/ml respectively. Generally the distribution and abundance of the total heterotrophic microbial population in the study area showed normal microbial count population in hydrocarbon impacted system (Wakama et al. 1989).

With no microbial baseline data for comparison in the study area it is important to note that the distribution of total hydrocarbon micro-organisms over the total heterotrophic microbial population in excess of 1.0% is considered a significant hydrocarbon impact on the environment.

High concentrations of hydrocarbon utilizing bacteria and fungi are pointers to significant level of pollution of the area by hydrocarbon. The relatively high counts of these organisms especially in soil samples SS 1 and SS 2 collected from the area that was most impacted by the product spill are reflective of the moderately polluted environment by petroleum products.

Table 4.6: Total Heterotrophic Bacteria and Hydrocarbon Degrading Bacteria Population in the Study Area

Sample Locations	Total Heterotrophic Bacteria	Hydrocarbon Degraders	% Degraders
SS_1	$2.87 X 10^7$	$4.305 X 10^6$	15%
SS_2	$3.26 X 10^7$	$3.912 X 10^6$	12%
SS_3	$1.96 X 10^7$	$1.568 X 10^6$	8%
SS_4	$4.38 X 10^6$	$3.066 X 10^5$	7%
SS_5	$5.16 X 10^6$	$2.58 X 10^5$	5%
SS_6	$2.84 X 10^6$	$1.136 X 10^5$	4%
SS_7	$4.18 X 10^6$	$1.188 X 10^5$	0.85%
SS_8	$2.87 X 10^6$	$3.55 X 10^4$	0.85
SS_9	$3.45 X 10^6$	$1.234 X 10^4$	0.43
SS_{10}	$2.28 X 10^6$	$1.587 X 10^4$	0.46
SS_{11}	$2,28 X 10^6$	$3.192 X 10^3$	0.14

For this study the result of microbial studies can be summarized into three categories depending on the degree of impact, thus

- No hydrocarbon impact = 0 – 0.40%
- Low petroleum oil impact = 0.5 – 0.9%
- High / significant hydrocarbon impact = $\geq$ 1.0%

PHYTOPLANKTON STUDY

ytoplanktons are micro-plantlike organisms that live on the upper surfaces of surface waters. ytoplankton is known to be adversely affected by oil spill. The effects include inhibition of osynthesis, disruption of memberane properties, retardation of the absorption of nutrients, etc. these fects culminate in reducing phytolplankton population and diversity.

unts of the Phytoplankton and Zooplankton in the surface waters of the area are presented in Table The dominant phytoplankton groups differed between the study locations. Most of the location owed poor species diversity and low density. Also the zooplankton of the study area showed paucity species and extremely low density. These are attributed to anthropogenic influences and disturbance the environment, including the spilled hydrocarbon pollution.

ble 4.7: Counts of the Phytoplankton and Zooplankton (No./Dm^3)

Taxonomic Unit	SW_1	SW_2	SW_3	SW_4	SW_5
Phytoplankton					
Cynophyceae	28	15	35	18	28
Chlorophyceae	97	100	112	96	110
Bacillariophyceae	100	112	116	109	145
Other Algae	28	56	38	14	18
Total	253	283	301	237	301
Zooplankton					
Rotitera	-	-	-	-	-
Protozoa	38	50	27	16	35
Crustacea	-	-	-	-	-
Insecta	18	15	35	26	16
Total	56	65	62	42	51

During the screening and scooping exercise, ranking of observed impacts was carried out on a scale of A-E, and interpreted as follows:

A = Very low impact [insignificant]

B = Low impact ["]

C = Moderate impact [Significant]

D = High impact ["]

E = Very High Impact ["]

Informed by the results of this screening exercise the environmental components that are most affected by the oil spill were investigated in detail.

Table 4.8: Environmental Components and Impact Indicators

Environmental Components	Impact Indicators
Surface Water properties	Heavy metal concentrations, Hydrocarbon content, Microbial population (hydrocarbon utilizing bacteria and fungi),
Soil/Land-use and agricultural Resources	Heavy metal concentrations, Hydrocarbon content, Microbial population (hydrocarbon utilizing bacteria and fungi), Landuse pattern.
Terrestrial Ecological Resources (Vegetation)	Loss of Biodiversity,
Fisheries, Macrophytes, Benthic Fauna	Diversity, Abundance, Productivity, Catch/Yield.

e areas where the impacts are mostly felt are the following; and are shown in appendix 1,2,3,

WATER QUALITY

The area of active spill (i.e. Pic. 2) are devoid of vegetation as the land is completely bare. However, this may not be completely attributed to the spill because there had been recent bush burning in the area, even though the bush burning may have been escalated by the residual remains of the spilled product.

The process of spill containment and recovery of the product have led to increased burden or stress on the soil. The movement of men and materials to check the spill exerted much pressure on the soil resources. The land was unduly exposed and disturbed thereby aggravating soil loss. The holes made by the host communities in the process of recovering the product have become impairment to efficient and effective use of the land resources. These holes may also aggravated the threat of soil erosion at the peak of rains.

In all about 2.5 hectares of land within suffered low to moderate resource losses.

Interaction with farmers and a few members of the host communities clearly portrayed the fears and concerns of the people. They are generally afraid of the spilled product poisoning the land. They have therefore avoided farming and fishing on the immediate environment of the spill. Some of the local farmers also attributed the burning of the field to the incidence of the spill.

CHAPTER FIVE

SUMMARY CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

The increase activities in the Nigerian oil sector has greatly disturb the social and economic activities of areas affected by the consequent spillage of oil on their environment.

The problem of oil spillage is a constant threat to the socio economic well being of communities where oil installations are located.

Common causes of pipeline leakages and oil spills in Nigeria have been attributed to the non-maintenance and vandaliasation of oil installations by unpatriotic citizens.

The vulnerable communities are expose to socio-economic dangers of which include destruction of farmland, crops, fishes destruction of human settlement and livelihood through fire disaster, pollution of fresh water for human and animal consumption and many more.

A case study of oil pipeline break occurred at Gidan Mutum Daya Kaffin Koro (a community near an oil pipeline right of way) and spilled about 15,000 liters of kerosene oil product into nearby stream and adjoining farmland within the community in February, 2001.

ield study carried out about a year after the spillage occurred involved sampling of water, soil and quality. Also interview with the member of the community reveal the lost of some crops sugarcane ntation and the disappearance of fish in the stream during the last season.

ult from the field and samples collected indication the presence of hydrocarbon and hydrocarbon rading bacteria which is an indication of the presence of petroleum product in some area.

sheen were also visible in some part of the stream. A greater proportion of the area was however affected by the spillage.

only source of water for domestic use was affected and some part of the farmland.

CONCLUSION

sampling and field assessment time, about one year after the oil product spill in Gidan Mutun Daya a, natural restoration of some impacted areas has progressed, the fuel odour was still perceived in ie site. The spilled fuel was still visible as a sheen on the water surface in the upper part of the am.

major adverse effect of the oil spillage on the community was on the water quality and to a lesser ent its effects on their crops. Though there are no significant threats to the environment by the lage or pipeline operation, there is need to further minimize some of the impacts in specific sites n the spill site and guaranty quality environment.

RECOMMENDATIONS

following recommendations shall be implemented by the PPMC for the full restoration and ntenance or sustenance of a quality environment in the area.

The area shall be ploughed to improve the aeration of the soils and thereby enhance the neation of oxygen into deeper depths of the soils. The top 6 to 9cm of the soils shall be properly d.

Artificial compound fertilizers shall be added to improve the fertility status of the soil within Block 1 in order to increase the microbial activity in the area thereby facilitating the degradation of the remaining hydrocarbons. The addition of nutrient sources that are rich in nitrogen and phosphorus, which are known builders of protoplasm will increase bacteria population.

The sediment sampling locations (SD1 and SD2) within Block 1 of the studied area which showed hydrocarbon and heavy metal concentrations relatively higher than other locations and above permissible limit shall be excavated to about 3 to 6cm of the surface and mixed with the soil for aeration and enhanced microbial degradation.

The PPMC shall organize awareness campaign especially for the Gidan Mutum Daya and Daffin Koro communities of Paikoro Local Government Area of Niger State. At these campaign meetings the findings of the study shall be communicated to them. Their fears of toxicity and poisoning of the soil and crops shall be allayed.

mers and fishermen shall be encouraged to return to farm on the land, and fish in their waters. se activities should be guided by strict monitoring of the farm product and fish catches to be put in ce by PPMC.

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