IMPACT OF OIL SPILLAGE ON THE WATER QUALITY OF ABULOMA RIVER IN PORT-HARCOURT, RIVERS STATE

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CERTIFICATION

We certify that this work **"IMPACT OF OIL SPILLAGE ON THE WATER QUALITY OF ABULOMA RIVER IN PORT-HARCOURT, RIVERS STATE"** was carried out by **OBINNA UGOCHI DORIS (Reg. No: 20085633398)** in partial fulfillment for the award of the degree of Master of Science (MSc). In Environmental Technology (Pollution Control) Option in the Department of Environmental Technology (SEET) of the Federal University of Technology Owerri. (FUTO).

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DEDICATION

This research work is dedicated to God Almighty for His guidance and protection throughout my studies.

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ABSTRACT

The activity of the oil prospecting companies in the study area is mainly that of crude oil extraction from the subsurface. As a result of these petroleum activities, there is a continuous destruction of aquatic lives – flora and fauna destabilizing the entire aquatic eco-system.

This study was focused on the impact of oil spillage on the water quality. Different physico-chemical parameters were analyzed, including Temperature, Taste, Colour, Odour, Total Dissolved Solid, Conductivity, Total Petroleum Hydrocarbon, Biological Oxygen Demand, Chemical Oxygen Demand, Total Suspended Solid, sulphate, Chloride, Alkalinity, phosphate and some heavy metals such as Lead and Iron. Result obtained showed that the Conductivity and the concentrations of Total Dissolved Solid, Sulphate, Chloride, and Total Petroleum Hydrocarbon (TPH) level all exceeded World Health Organization (WHO) standards. Other parameters fall below or within acceptable limits. In effect, the water from Abuloma River is unfit for human consumption. Some control measures such as BAT are recommended to reduce the impact of oil spill on the river for the benefit of rural communities in the area.

CHAPTER ONE

INTRODUCTION

1.2 BACKGROUND OF STUDY

Oil spillage is an unintentional release of liquid petroleum hydrocarbon into the environment as a result of human activities. They are usually mostly caused by accidents involving oil tankers, barges, refineries, pipelines and oil storage facilities. These accidents can also be caused by human mistake or carelessness.

In Nigeria, the causes of oil spill are lack of regular maintenance of the pipeline and storage tanks. Most pipelines from the flow stations are absolute being more than 20years old making them subject to corrosion and leakage. Some of these pipes are laid above ground level without adequate surveillance, exposing them to wear and tear and other danger Oyem (2001).

Other major causes of oil spill are discharge from sludge, protection test, drilling mud, well blowout gas flaring, equipment malfunctioning, accident from third party unknown, natural causes (rain, flood) and sabotage which involves bunkering by some unpatriotic Nigeria. They damage pipelines in the attempt to steal from them.

Oil spill into waterways has been extensive, often polluting drinking water and destroying vegetation. These incidents have become common and their enforcement between 1970 and 1980, and 1,581 incidents of oil spillage were documented in Nigeria.

Oil spill pollution constitutes a major threat to ground water and contributes to water poisoning and skin disease. Drinking water is also frequently contaminated and sheen of oil is useable in many localized bodies of water. If the drinking water is contaminated, even no immediate health effects are apparent, the numerous hydrocarbons and chemicals present in oil are highly carcinogenic. Spill to groundwater are potentially dangerous, the water becomes unpalatable and unfit for use when it contain crude oil or petroleum products in extremely low concentration, infiltration of spilled oil and other industrial waste pollutes the groundwater aquifer. The immediate danger of using or taking in crude oil contaminated water, food, and fish, is epidemic sickness. Communities with no alternative source of water supply, who are compelled to drink water from wells, open-stream, rivers, sea, are exposed to health hazards when oil spill occurs.

The quality of water required varies with the uses to which it is best put. Water is considered polluted whenever it is unsuitable for a specified purpose Odocha (1994). Water is a universal solvent and is vital to man's existence as it is or for drinking, food preparation, washing, industrial processes and irrigation. Water pollution can be defined as the release of pollutants into various water bodies such as ocean, seas, rivers, streams, lakes and springs. One of the pollutants that disturb us within this Niger Delta region is oil spillage, which leads to the destruction of aquatic animals and plants, water borne diseases, unemployment among the fishermen, and inadequate water supply for both domestic and industrial purpose. The major source of water pollution in Nigeria includes solid minerals, mining activities, industrial plants, decomposed domestic waste as well as petroleum mining operations.

The oil activities in the area have resulted to situations whereby complete polluted water is bequeathed to the children. The communities' shorelines have been washed away or eroded due to the high volume of deep sea exploration and exploitation activities. (Bisine, 2006).

One of the major oil induced water pollution is oil spillage. With the expansion of oil production, the incidence of oil spill as source of water pollution, canalization and waste discharge into fresh water swamps and into the sea are other sources. In an attempt to shorten travels time and improve access to oil field and production facilities oil companies have constructed canals that in some cases have caused salt water to flow into fresh water zones destroying fresh water ecological system.

Oil spillage has a major impacts on the ecosystem into which it is released. Spill in populated area often spread over a wide area, though the consumption of dissolved oxygen by bacteria feeding on the spilled hydrocarbons also contributed to the death of fishes. The disturbance of the ecosystem by pollution from oil can lead to the poisoning of myriads of food chain which will produce cancer on a wide scale in a food of man, several other disturbances in the physical and biological environment, including the death of mangrove trees and severe coastal erosion that endanger the stability of the environment.

Oil spillage increases the availability of toxic elements in the soil to the detriment of the host plants, and certain nutrients and minerals required for proper growth of plants are paralyzed. A heavily polluted soil remains infertile for about three or more years until the soil losses its toxic affect by degradation. The duration of the oil in the soil is a function of many variables, such as the type of crude, level of pollution, the climate of the area and control method like plough fertilizer application.

Oil spills pose a major threat to the environment in Nigeria if not checked or effectively managed, they could lead to total destruction of the ecosystem, especially in the Niger Delta where oil spills have become prevalent. Life in this region is increasingly becoming unbearable due to the ugly effect of oil spills, and many communities continue to groan under the degrading impact of spill (Oyem, 2001).

1.2 AIM AND OBJECTIVES OF STUDY

The aim of the study is to investigate the impact of oil spillage on the water quality of Abuloma River. In order to achieve this aim, the study must gear towards arriving at the following objectives:

I. To determine the concentration level of oil pollutants in the river.,
II. To establish the potability of water in the study area with respect to domestic/industrial needs,
III. To determine the impact on flora and fauna and proffer solution of impact on the water;
IV. To compare the physical and chemical quality of water with FEPA/WHO Standards.

1.3 SIGNIFICANCE OF STUDY

The importance of this study world over and Nigeria in particular are as follows.

I. It will be of use to government to give a more effective policy on the oil exploration and exploitation in the area;
II. It will check the activities of the oil companies working in the area;
III. It will provide remedies for the control of eutrophication of river in improving water quality;

IV. It will serve as an important information for other researcher in oil pollution/spillage;

V. It will help the public to know the source of this oil spillage, means of devising measures to avert the hazards or curtail as well as cleaning up, prevention and their means of control method,

VI. It will help industries to be aware of environmental dangers caused by oil spillage and ways to abate it technologically.

VII. It will ensure the protection of the recurring water body and the aquatic organisms dwelling in the water.

1.4 SCOPE OF STUDY

This study will focus on knowing the impact of oil spillage from Abuloma River and the emphasis will be on the water quality. In order to carryout this study and know the effect or impact which the oil spillage has caused on the water quality. A lot of variables will be studied such as Temperature, conductivity, total dissolved solid, Total suspended solid, odour, colour, taste, COD, BOD, TPH, pH, sulphate, phosphate, iron, and alkalinity with the view to establishing their levels at various points of analyses and their impact on health as well as comparing the values obtained with FEPA/WHO Standards .

1.5 RELEVANCE OF STUDY

Nigeria economy is dependent in oil and there is no hope of reducing the activity of oil production in the shortest possible time. The relevance of this study lies on:

I. It provides and identifies solution to problems of oil spillage discharge in Abuloma River;

II. It helps to create awareness of the danger of oil activities on the aquatic environment of water body such as Abuloma River;

III. It helps the public to eradicate some of the deleterious effects that might be harmful to living organisms or hazardous to human health and capable of hindering oil activities, farming and impairment of quality of seawater;

IV. It helps the public to be aware of diseases arising from water pollution by oil;

V. It gives an up- to- date information on the nature and pollution level as a result of oil spillage discharge into the river.

1.6 METHODOLOGY

The method adopted in this study includes:

I. Field observation.

II. Collection of water sample from three specific sample locations. The distance of the sampling is 100 meters apart.

III. Conduction of laboratory analysis of the water samples using the following equipment such as: atomic? absorption spectrophotometer, Gas chromatograph, conductivity meter, suntex temperature meter, pH meter, thermometer, portable Autoclave used for sterilization, colorimetric, us means dilution, gravimetric,

IV. The obtained data were subjected to description station head analysis.

CHAPTER TWO

LITERATURE REVIEW

2.1 CRUDE OIL EXPLORATION AND EXPLOITATION

The exploration and exploitation of crude oil in the Niger Delta has resulted to a number of environmental problems in the region. The environmental problems relating to oil operations in the region are examined. Since 1956 when the first oil well was drilled at Oloibiri in the present Bayelsa State over 1,481 oil wells have sprang up, producing from about 159 oil fields. There are more than 7,000 kilometers of pipelines and flow lines and 275 flow stations operated by more than 13 oil companies (UNDP Report, 2006).

Crude oil has been defined as mineral fossil that is, a deposit of oil from the remains of plants and animals that have been submerged in the earth's crust for a long period of time. Such deposits are being collected in a reservoir, deep in the crust. They are sometimes found mixed up with gas or may be separated from the gas which cases are found on the surface of the crude oil. (Anikpo, 1976).

Crude oil became readily available about 100 years ago and has been in widespread use only within the present century but even at the height of the recent so called energy crisis, it was being transported in greater quantities and larger carriers to industry. Although, it was first used solely as a source of kerosene (paraffin) for domestic lighting to replace the already dwindling supply of whale oil and by 1939 also provided the fuel for most forms of transportation. (Essien, 1988)

After the Second World War, consumption grew by leaps and bounds as oil began to be used instead of coal in electricity generation and as s basic raw material of chemical industries particularly when the post war demanded for electrical appliance and synthetic plastics of all sorts accelerated dramatically. Both the nature and scale of tankers transporting crude have altered in a way that they increased the incidence of serious pollution since most refined products tend to be less troublesome.

In Niger Delta, crude oil exploration activities have caused pollution hazards from accidental oil spillage or oil pipeline vanadalization. Quite often, these hazards reach disaster proportions as witnessed in 1999 Jesse Delta State oil pipe burst causing fire disaster that consumed about 1000 people, in addition to large seal environmental destruction. Similar disaster occurred in 2003 in Isukwuato area of Abia State (Umoh, 2004). Conflicts that have arisen from the environmental impact of oil production activities in the Niger Delta area have made development of the region difficult.

Crude oil exploration and exploitation has over the last four decades impacted disastrously on the socio-physical environment of the Niger Delta oil-bearing communities, massively threatening the subsistent peasant economy and the environment and hence the entire livelihood and basic survival of the people. While oil extraction has caused negative socio-economic and environmental problems in the Niger Delta, the Nigerian state has benefited immensely from petroleum since it was discovered in commercial quantities in 1956. There is no doubt that the Nigerian oil industry has affected the country in a variety of ways at the same time. On one hand, it has 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 traditional means of livelihood of the people of the oil producing communities in the Niger Delta, Nigeria. (Gbadegesin, 1997)

Crude oil is a mixture of 100 or more hydrocarbons, sulphur compounds, and a range of metals and salts in smaller quantities. In addition, a variety of other toxic pollutants are typically generated during oil drilling and production operations, including drilling fluids, drilling cuts, and treatment chemicals that contains heavy metals, strong acids, and concentrated salts. These include polycyclic aromatic hydrocarbon (PAH) compounds (e.g. benzo@pyrene) and volatile organc compounds (e.g..benzene and its derivatives), toxic and carcinogenic substances that pose a threat to human health (Ntukekpo, 1996).

Odogwu (1981) opined that the majority of pollution that has occurred over the period of oil exploration within the country were as a result of equipment failure to lift crude oil which accumulated foe as much as 5% of annual pollutions. Baath et al (1980) opined that with the activities involved in oil exploration and exploitation, there is evidence to suggest that acid rain affect the functioning of soil micro organisms in water break down turn over.

2.2 ADVERSE EFFECT OF CRUDE OIL SPILL ON LAND

Gas pipelines have also caused irreparable damage to lands once used for agricultural purposes. They are often laid above ground and run directly through villages, where oil leaks have rendered the land economically useless. The offshore rigs and oil port facilities have seriously damaged the tropical rain forest in the Niger Delta mangrove vegetation (Hutchful, 1985).

Oil spill contamination of the top soil has rendered the soil in the surrounding areas unsuitable for plant growth by reducing the availability of nutrients or by increasing toxic contents in the soil (Gary, 2003). Gas flaring; on the other hand, has been associated with reduced crop yield, and plant growth on nearby farms and disruption of wildlife in the immediate vicinity (Fekumo, 2001).

Oil leaks are usually from high pressure pipelines, and therefore spurt out over a wide area, destroying crops, artificial fish ponds used for fish farming, "economic trees" (that is economically valuable trees, including those growing "wild" but owned by particular families and other income-generating assets. The area not most conspicuous with poverty, malnutrition and disease. Even a small spill can thus wipe out a year's food supply for a family, with it wiping income from products sold for cash. The consequences of such loss of sources of livelihood can range from children missing school because their parents are unable to afford the fees, to vitiation destitution. Even if the land recovers for the following year, the spills have consequences over a much longer period for the families directly affected. Bill Knight (1998)

Several farmers interviewed by Human Rights Watch affected by spills appeared dazed and particularly unable to take in the consequences of a recent spill or estimate the costs beyond a simple statement that they had no idea how they would now manage. Nevertheless, big spills can still have a significant; in tidal salt water areas, where fishing ground tend to be open, individual families are less likely to be totally wiped out, while spills in any event disperse more quickly.

Oil pollution according to IPS (1990) is a result of the alteration in soil/water natural composition as a result of contamination by crude oil or a sudden change in natural soil/water processes with concomitant net detrimental effects on soil biota, composition, quality, fertility and crop performance. If spillage is within tolerable threshold of most soils, such soil and environment cannot however be regarded as polluted.

Omuta (1985), on investigating the land use pattern and environmental decay in Isoko Local Government Area (LGA) of Bendel State, observed that the most visible way in which petroleum production has affected the environment is through vegetal destruction via the construction of camp sites, flare sites, drilling rigs, flow stations, saver pits, the laying of pipelines etc. Vegetal re-growth problem also exist due to the effect of cement left in the soil as a result of the cementing of the oil well site during exploration and exploitation. In the same vein, the ecosystem and the aesthetics of the environment are destroyed during the laying of the pipelines.

Spilling of petroleum products on agricultural land is capable of rendering such land unproductive. Field laboratory studies by group of soil scientist revealed that the contamination of soil with petroleum hydrocarbons has pronounced effects on plant growth. This is because, oil deposited on leaves of plants penetrates into the leaves and causes yellowing and completes shedding of their leaves respectively. Odu (1981).

Odudu (1992) argued that exploration and exploitation of oil resources, however valuable to the nation, have adverse effects on values of landed properties and farmlands. For example, oil spillage can destroy farmland and sometimes where fire occurs may completely destroy lives and properties.

According to Ray et a1 (2004) the challenges posed by oil exploitation to agriculture is that it hinders growth at the macro and micro economic levels, decreases rural savings and severely depletes the level of skilled manpower due to death and morbidity in Africa's agriculture and rural sectors.

Tekpe (1998) holds that any land that has been affected by oil spillage is completely rendered useless in as much as the land remains dry and without grasses. He further stressed that much spillages seeps deep into the soil and destroyed the nitrogen and other manure in the soil that would have resulted in fertility. An example of such land is the koro koro west where a mass of land is left bare for several years after an oil spillage.

Tekpe (1998) also, hold that oil spillage has led to the destruction of both cash crops and food crops and on aquatic environment which had boosted the economy of the peasant farmers of mogho in the early fifties before the discovery of oil wells in the area. He further stressed that the flare of gases has brought yam beetle which eats up the tubers of plated yam thereby making the farmers labour to be in vain.

2.3 ADVERSE EFFECT OF CRUDE OIL SPILL ON AIR

Nigeria flares more gas than any other country in the world. About 75% of total gas production in Nigeria is flared, and about 95% of the "associated gas" which is produced as a by-product of crude oil extraction from reservoirs in which oil and gas are mixed. Flaring in Nigeria contributes a measurable percentage of the World's total emissions of green house gases; due to the low efficiency of many of the flares much of the gas is released as methane (which has a high warming potential), rather than carbon dioxide. (World Bank, 2006)

Many communities in the Niger suffered greatly from gas flares, which cause acid rain, which corrodes the metal sheets used for roofing (Hutchful, 1985). One study of flares in the Niger Delta, found that air, leaf and soil temperatures were increased up to eighty or one hundred meters. The species composition of vegetation was affected in the same area, this leads to food security problem. In other cases, inefficient technology in the flares means that many of them burn without sufficient oxygen or with small amounts of oil mixed in with gas, crating soot that is deposited on nearby land and buildings, visibly damages the vegetation near to the flare (Akpe, 2003).

Massive exploration of crude oil generated gas is continuously burnt in the environment as flares due to pure technology. Flaring can be described as wasteful burning of crude oil associated gases, which in turn produces enormous quality of greenhouse gases that contribute immensely to increase the global warming, causes severe economic and ecological impacts on the immediate oil producing communities. Isichei and Stanford (1976) noted that plant growth is generally suppressed due to effects of gas flares, which diminishes the value of agricultural productivity. Omuta (1985) in the same vain noticed that flares generate tremendous heat, which makes plant growth and man's activity in conducive in areas where it is carried out.

Odu (1989) observed that the noise that gas flaring generates impairs hearing and causes skin burn. According to him, visible effects of gas flaring in Egi Ogba/Egbema/Ndoni LGA of Rivers state causes severe corrosion of corrugated sheets used in building and other metals due to acid rain.

About ninety-five percent of waste gases from the production fields and operation are flared. Gas flaring pollutes the air and it is common practice among companies in Nigeria especially in the Niger-Delta region which is hazardous to the ozone layer of the area and leading to climate change (IPCC, 2007).

The flaring of gas has been practiced in the Niger-Delta for over four decades. This is the major source of air pollution in the area as well untreated waste disposal on the environment. Today, there are about 123 flaring sites in the region making Nigeria one the highest emitter of green house gases in Africa (Uyigue and Agho, 2007).

Some 45.8 billion kilowatts of heat are discharge into the atmosphere of Niger Delta from 1.8 billion cubic feet of gas every day (Aaron, 2006). It is not an exaggeration that gas flaring is environmentally unethical and has contributed significantly to the degradation of the environment in the region. This practice may have altered the vegetation of the area, replacing natural vegetation with stubborn grasses and the presence of these grasses indicates that the soil is no longer fertile for cultivation of crops. A major example could be seen in Opuama and Sekewu communities in the Warri North Local Government Area of Delta State in the region. It is evident that gas flaring has affected the ozone layer of the region leading to climate change that is unhealthy to crops cultivation (IPCC, 2007

Gas flaring results in many health problems, among which are respiratory disorders, headache, cardiac arrests, cancer, eye disorders and death. The poisonous gases usually emitted by incomplete combustion of hydrocarbons like carbon monoxide is a serious asphyxiant, which normally suppresses the supply of oxygen in the environment. The carbon monoxide when inhaled enters into the blood stream and displaces the blood oxygen by combining with blood hemoglobin to form a deadly compound known as oxy-hemoglobin which may choke up cells and cause organ malfunction (Idoniboye-Obu, 1992; Odu, 1989).

2.4 ADVERSE EFFECT OF CRUDE OIL SPILL ON WATER

Dumping of crude oil into waterways have been extensive, often poisoning drinking water and destroying vegetation. These incidents have become common occurrences due to the lack of laws and their enforcement. Between 1970 and 1982, 1581 incidents of oil spillage were documented in Nigeria (Standford, 1991).

From 1982 to 1992, 1,676,000 gallons were splits in 27 separate incidents. The area is subjected to gross flooding and wide coastal erosion. These have greatly affected the farm settlement, thereby rendering the farmers jobless with widespread of poverty and youth restiveness. The area also witnessed very poor infrastructural development. Fisheries depletion is caused by dredging, oil spill, and toxic waste disposal into the rivers. The deforestation, loss of bio-diversity, toxic waste has increased severity of flooding and erosion due to logging canalization, construction of facilities (Wath 1997).

Fresh and marine waters and their sediments, supports a wide spectrum of microbial communities including the phytoplanktons, zooplanktons as well as higher aquatic life forms. Fekumo (2001), Nwankwo and Ifeadi (1988) summarized that the effects of oil-pollution on aquatic life and human health are diverse as they are complex. However, they were able to identify the following effects: Oil is limiting on normal metabolic and physiological functions of fish and oysters and therefore retards their growth and multiplication. The flesh of aquatic organisms are tainted by petroleum products and byproducts; thus rendering such organisms inedible.

The formation of oil film on the water surface limits oxygen exchange, kills surface organisms, contaminates water and increases the content of water soluble materials, which may be toxic to aquatic organisms. Water contaminated with oil is also toxic to humans and livestock.

Crude oil exposure presents a potential hazard to both aquatic terrestrial species (Shore and Douben, 1994). Generally, crude oil reaching the terrestrial and aquatic ecosystems arrives as a consequence of spillage which may result from natural seepages, offshore exploration, leakage from oil wells or from oil tankers, accidents from oil tankers, land based discharges and sabotage (Awobajo, 1981. Wardly and Smith, 1983; Jackson *et al* 1989).

In Nigeria the exposure of crude oil in the aquatic environment is on the increase following the several frequent spillages that have occurred in our coastal waters. Ibiebele (1986) had earlier estimated that an average of 11 – 54 mg/1 of oil is dissolved in water. This deserves attention owing to the possibility of bioaccumulation and bioconcentration of crude oil component in aquatic lives, and the attendant consequences of ingesting such aquatic species. Evidence from other populations abounds on the toxic injuries resulting from ingesting animals exposed to polluted water ways. Apart from this, the existence of aquatic species is threatened by the spillages.

Studies by Imevbore (1980) and Ekekwe (1981) have reported reductions in species densities and diversity in Nigerian environments contaminated by oil from oil spills within the intertidal zones. Within our rural population crude oil is orally ingested for medicinal purposes. It is claimed to be an antidote to poisoning and a cure for various gastrointestinal disturbances The ingestion of crude oil either orally or through polluted marine species represents a pathway for delivery of potential toxicants to the human system.

The effect of oil in aquatic system is perilous. It distorts the beach aesthetics and depletes fisheries potentials. It also impacts on water productivity and human health. Like in terrestrial oil pollution, initial impact of oil on aquatic system manifests in the suffocation of native biotic communities due to the body of the oil covering water surfaces in such a way that primary producers and higher species in the food chain become impacted (Nelson–Smith, 1979).

Akani (1999) contributing on the effects of crude oil pollution of marine environment maintained that oil spillage is one of the most devastating forms of pollution in the marine environment. Several barrels of crude oil are lost into the water. During the process, there is emulsification, weathering and the alkane components evaporates. The alkane and alkynes components are not easily degraded because of their double and triple bond content. The floating oil lead to a mass killing of fish, shrimps, crustaceans, mammals, sea weeds mangrove plants, but also reduced the natural repelling of water.

Ibid (1999) the effect of oil spill on aquatic organisms, mangrove and its community, are so diverse and complex. On the surface of water, oil may limit oxygen exchange, entangle and kill fishes. The degree of biological damage depends mainly on the kind of spilled closeness to shore, configuration of shore, character of bottom and weather at the time of the incident.

2.5 ADVERSE EFFECT OF CRUDE OIL SPILL ON HUMAN

Naanen. (1995) observed that the most conspicuous aspects of life in contemporary Niger Delta are poverty, malnutrition and disease. Although oil from Niger Delta land has provided approximately $30 billion to the economy of Nigeria, the people of the land see little to nothing from their contribution to oil company's pocket book. Nnadozie (1995) observed in his writing of the contributions of oil to the national economy of Nigeria, that "oil is a curse", which means only poverty, hunger, disease and exploitation for those living in oil producing areas. They have no clean water, little electricity, few telephones, abysmal health care, and no jobs for displaced farmers and fisher persons. In addition, they face the effects of unrestrained environmental molestation by government every day.

In the Niger Delta, there were 2,976 oil spills between 1976 and 1991. The number increased to 5,400 from 1990-2005. The areas have had severe problems stemming from oil spillage, including water contamination and loss of many valuable animals and plants. A short-lived World Bank investigation found levels of hydrocarbon pollution in water in Niger Delta more than sixty times US limits (Berkeley, 1996).

Also Ake (1996) found petroleum hydrocarbons in one of the Niger Delta village's water source to be 360 times the levels allowed in the European community, where Shell originates.

In Nigerian Environmental study action Team observed increased discomfort and misery due to fumes, heat and combustion of ages, as well as increased illnesses (NEST, 1991). Owens Wiwa, a physician, has observed higher rates of certain diseases like bronchial asthma, other respiratory diseases, gastroenteritis and cancer among the people in the area as a result of the oil activities (Marah, 1998).

According to Awobajo (2005) Niger Delta communities have suffered damage to farmland and water bodies as a result of oil spillage leading to a decrease in agricultural output and hence the income earning capacity of the people. The area also witnessed an increase in the occurrence of health hazard, air noise pollution and heightened deforestation. A pipeline explosion killed up to 200 people on the outskirts of Lagos, May, 2006 and leaving charred corpses on a sandy bench where locals taping the pipe to steal fuel ignited the blast. In Jesse, the southern state of Delta, a pipeline first killed about 250 people in 2000. Local people are compelled to cope with oil spill after oil spills. A rusting network of pipes and a slow response from oil companies to leaks are blamed. A high-pressure oil pipeline which ruptured at Rukpokwu, took the oil company weeks to extinguish and destroyed much farmland and local forest (BBC News, 2004).

Marine Pollution is one of the most visible consequences of the numerous oil spills and the loss of mangrove trees. The mangrove was once a source of both fuel woods for the indigenous people and a habitat for the area's biodiversity, but is now unable to survive the oil toxicity of its habitat. The oil spills also had an adverse effect on marine life, and have negative consequences on human health for consuming contaminated seafood. Nigeria earns some $10 billions every year from oil but Niger Delta residents remain mired in poverty. Less than 20% of the regions is accessible by good roads, even in the dry season. Hospitals, schools are seriously underfunded. Poor sanitation and pollution means that access to safe drinking water is a major problem facing local communities. In close proximity to the uninterrupted flames agricultural life continues. But the oil operations are affecting the traditional livelihoods of communities living in the Delta\ (BBC News, 2004).

In Rumuekpe in River State, cassava, yams and bananas are grown, but the soil is losing its fertility. Local residents are also no longer able to fish because the waterways are polluted. These cause food security problem (lack of fish and yams, bananas etc) and unemployment (BBC, 2004).

Gas flares and global warming problem which is associated with flaring of natural gas from oil fields has become common sight and dominates the skyline in Niger Delta. Gas is a by-product of crude oil production, which needs to be released to product oil. Oil companies chose to burn the gas instead of re injecting the gas into the ground or selling it, which is the most economic option. Families live among the oil fields breaths in methane gas and coping with frequent oil leaks in African largest oil exporter in the world. Oil giant Shell gets 10% of its oil from the Niger Delta and is failing to invest in its infrastructure to prevent pollution (BBC, 2004).

According to Bossert and Bartha (1984) that oil pollution constitutes a major threat to ground waters and contributes to water poisoning and disease outbreak including metal poisoning and skin disease. This observation corresponds to the report of Hutchful (1980) that water becomes undrinkable and unfit for use when it contains crude oil even in very low concentrations. A World Bank study indicates that in sub-Saharan Africa contaminated drinking water and poor sanitation contributes to infectious and parasitic diseases that account for over 62 percent of all deaths (WorldBank, 1992).

Crude oil and its constituents enter the human body through three (3) primary routes.

- Skin absorption.
- Ingestion of food and drink
- Inhalation of oil on dust or soot particles.

Francis et a1 (1980) observed that the imminent hazard of the consumption of crude oil polluted food, water and fish is the spread of epidemics. Therefore, communities without any alternative source of water supply are forced to use water from wells, rivers and streams which are polluted sources with crude oil on their activities. They use water from the polluted sources for drinking, bathing and washing. This of course would have disastrous effects on their health. This risk could be significantly increased through added skin and inhalation exposure.

Ultoli (2001) asserted that contaminants in air have been implicated in the rising incidence of asthma, bronchitis and emphysema, a serious and debilitating disease of the Lung sacs. Thus, the dimension of the dangers threatening the existence of the oil producing communities in Nigeria is real. Death normally occurs as a result of drinking polluted water, ingestion of polluted fish and crop plants as well as his outbreak of epidemic diseases including abnormalities in blood counts, arthritis, conjunctivitis, cholera, dysentery and other symptoms (Ikporukpo, 1985).

The dangers of transferred effect of oil spill from aquatic creatures life forms to human beings should give Nigerians some concern particularly at this time when many Nigerians depend on frozen fish as their source of protein. Several studies have focused on residents exposed to major coastal oil spills from tankers (Campbell, 1993, Palinkas et al, 1993 and Lyons et al, 1999). However, there are few epidemiological studies concerning persons who live in communities that are near oil fields and who are exposed to acute and or long term contamination (Ikein, 1990).

Abya-yaha (1993), in the Ecuadorian Amazon conducted a descriptive study in its communities. The study suggested that, compared to communities free from oil Exploitation communities in oil producing areas had elevated morbidity rates, with a higher occurrence of abortion, dermatitis, skin mycosis, and malnutrition, as well as higher mortality rates. The diseases and its consequences represent a major obstacle and challenge to economic growth and stability of a workforce. In many countries, it is recognized that crude oil epidemics now threatens profits, productivity and human welfare advances achieved over several decades (Nabila et a1 (2001).

According to Loevinsohn (2003), agriculture and rural development dynamics represent a critical element to which insufficient attention has so far been paid. Rarely is farming mechanized in developing countries. Communities depend on availability of local labour for their survival. Household food security in rural areas is therefore particularly vulnerable to the effects of oil exploitation especially with respect to the supply of labour. Studies done in Ecuadorian Amazon and other countries have shown that oil exploitation will have adverse effects on agriculture, including loss of labour supply and remittance income (Lori et al, 1999). The loss of a few workers at the crucial periods of planting and harvesting can significantly reduce the size of the harvest. A loss of agricultural labour is likely to cause farmers to switch to less labour-intensive crops.

Kwaramba (1997) noted that the adverse effects of oil exploitation on agriculture and rural development are manifested primarily as loss of labour supply of on and off-farm income and of assets. These can contribute to reduced productivity, yield and agricultural output. FAO (2000) observed that the combined loss of labour, income and assets as a result of oil exploitation is likely to increase food, nutrition and livelihood insecurity, and deepen poverty and undermine the resilience and reversibility of household coping mechanisms among some households in the long term.

2.6 OIL SPILLAGE AND ITS INCIDENTS

Since the discovery of oil in Nigeria in the 1950s, the country has been suffering the negative environmental consequences of oil development. The growth of the country's oil industry, combined with a population explosion and a lack of enforcement of environmental regulations has led to substantial damage to Nigeria's environment, especially in the Niger Delta region.

When there is an oil spill on water, spreading immediately takes place. The gaseous and liquid components evaporate. Some get dissolved in water and even oxidize, and yet some undergo bacterial changes and eventually sink to the bottom by gravitational action. The soil is then contaminated with a gross effect upon the terrestrial life. As the evaporation of the volatile lower molecular weight components affect aerial life, so the dissolution of the less volatile components with the resulting emulsified water, affects aquatic life (Akpofure et al, 2000).

Oil spill incidents have occurred in various parts and at different times along our coast. Some major spills in the coastal zone are the GOCON's Escravos spill in 1978 of about 300,000 barrels, SPDC's Forcados Terminal tank failure in 1978 of about 580,000 barrels and Texaco Funiwa-5 blow out in 1980 of about 400,000 barrels. Other oil spill incidents are those of the Abudu pipe line in 1982 of about 18,818 barrels, The Jesse Fire Incident which claimed about a thousand lives and the Idoho Oil Spill of January 1998, of about 40,000 barrels. The most publicised of all oil spills in Nigeria occurred on January 17 1980 when a total of 37.0 million litres of crude oil got spilled into the environment. This spill occurred as a result of a blow out at Funiwa 5 offshore station. Nigeria's largest spill was an offshore well-blow out in January 1980 when an estimated 200,000 barrels of oil (8.4million US gallons) spilled into the Atlantic Ocean from an oil industry facility and that damaged 340 hectares of mangrove (Nwilo and Badejo, 2005).

Oil spills in the Niger Delta have been a regular occurrence, and the resultant degradation of the surrounding environment has caused significant tension between the people living in the region and the multinational oil companies operating there. It is only in the past decade that environmental groups, the Federal Government, and the foreign oil companies operating in the Niger Delta began to take steps to mitigate the impacts. Large areas of the mangrove ecosystem have also been destroyed. The mangrove forest was in the past a major source of wood for the indigenous people. In some places it is no longer in a healthy state to sustain this use (Nwilo &Badejo 2005).

Oil spillage has occurred primarily in the main oil bearing state of Niger Delta region of Nigeria, mainly in Rivers State Bayelsa, Ogoni and Delta State etc. Between 1991 and 1994, 1.232 spill incidents were reported by the oil companies operating in Rivers State. Also within this period 57,061 barrels of crude oil were discharged into the environment through spill. Worldwide from 1987-1995, there were 4,100 major oil spills of 10,000 gallons or more (Ektim and Weleh, 1997)

Oil that is spilled in and not recovered will have an impact on the local environment, spreading over a wide area and affecting both terrestrial and marine resources, inappropriate clean up actions can make the situation worse. The development of the region has led to the degradation of some sites reducing their value and use. In the past, spills have also necessitated the complete resettlement of some communities. Loss of agricultural land, for example, translates into loss of livelihood for farmers while the psychological and social problems associated with displacements include loss of ancestral homes, familiar surroundings, religious and other cultural artifacts (NDES, 1997)

Mbata (1982) posited that oil spillage in the Niger Delta area had gone a long way to reduce the natural understanding that is expected to exit between the oil producing companies and the members of the host community from where the oil is located.

Gberebu (1978) complained that the remains of an oil spillage on the seas and water of the Niger Delta is the presence of weeds which make navigation difficult and such weeds he said consumes the oxygen present in the water, thereby making for the existence of aquatic lives.

Ikubiesika (1998) observed that oil when spilled into an environment undergoes some changes, both to the natural influence inherent within a given environment. These influences may be those of physical and chemical processes, grouped together as a biotic influence, responsible for the biotic fate of oil within the environment. Or they may be those of biological processes, also grouped as biotic influence for the biotic fate of oil in the environment.

According to Efeduwa (1998), oil spillage can occur due to the malfunctioning of valves at the wellhead. This can result from equipment failure in which a small quantity of crude oil is spilled in the process.

Olusoga (1997) oil spills and contribution from routine operations are yet another sources of oil pollution include massive single spillage resulting from a spill or overflowing storage tank, over turned transport vehicle or fractured pipeline, smaller but repetitive, losses which often arises from careless handing at small factories and similar installations or the surreptitious dumping of waste oil.

Oil spills has adversely affected the market structure and conduct of food crops and fisheries in the Niger Delta region, as the area tends to depend to the other parts of the country for the short fall. The marketing performances of the agricultural products are very low, as a result of low production level caused by infertile soil, acidic nature of the farmland, oil spills and gas flares (NDDC, 2003).

According to Etim (2003) a spillage from a pipeline owned by shell petroleum Development Company (SPDC) IN Karama community of Okorda/Zarama Local Government Area of Bayelsa State in june 2003 caused enormous economic and environmental damage and hardship to the area. The spillage was not properly cleaned and the indigenes were not evacuated by the oil company. Community leaders in the area alleged that SPDC awarded the contract for cleaning the spillage to accompany that did not do an effective job, thereby resulting in fire and destructive of the ecosystem.

Nazigha (1998) made it clear that oil the streams in Niger Delta are no longer safe because of the spread of crude oil spill which resulted from pollution. He contends that these streams have their water surface occupied by patches of crude oil thereby rendering the water very useless for both man and aquatic lives.

2.7 STANDARD FOR DRINKING WATER QUALITY

The establishment of this drinking water quality standard will ensure the safety of drinking water supplies and the protection of public health. Poor quality of water is responsible for the spread of deadly diseases such a cholera, dysentery, typhoid and poliomyelitis. Every year in Nigeria, thousands of cholera cases are reported, causing many human fatalities. In addition, the data of the Federal Ministry of Health show that diarrhea is the most prevalent disease among the population after malaria. Diarrhea is also responsible for 16 % of under-five children deaths.

'The danger that unsafe drinking water poses to health is enormous', underlined the Hon. Minster of Health, Prof. Eyitayo Lambo. 'Today's event marks another landmark in our collective drive to provide safe and good quality potable water to our people. While every effort to ensure access to potable water needs to be sustained, it is equally important to ensure that the water meets the minimum international standard for safety and quality.'

A rapid assessment of drinking water quality, conducted in Nigeria in 2002-2004 and supported by FEPA and WHO, noted the lack of an acceptable Drinking Water Quality Standard in Nigeria, which would guarantee the quality of water supplied to people. In 2005, the National Council on Water Resources (NCWR) recognized the need to urgently establish such Standard.

The new Nigerian Standard for Drinking Water Quality abides by the World Health Organization guidelines. The document sets physical, chemical, and microbiological parameters and maximum allowable limits for disinfectants in drinking water. It also includes normative references or laws guiding drinking water quality, definition of terminologies, institutional roles and responsibilities, monitoring, data management and compliance criteria.

The enforcement of the standard will help improve the quality of drinking water in Nigeria supplied by water service providers and will contribute to reduce the number of persons affected by water-related diseases. It is expected that it will also speed up the process of upgrading non-protected water systems and improving the management of all drinking water systems in the country.

table 2.1: world health organization (1971 and 1984) informational standard for drinking water (3rd end) WHO gevena

PARAMETER	**STANDARD PERMISSIBLE**	**EXCESS**
pH	7 – 8.5	9.2
TDS	500 mg/l	1500mg/l
DO	5.0mg/l	10mg/l
BOD_5	6.0mg/l	10mg/l
CONDUCTIVITY	1250µs/cm^3	3000µs/cm^3
NITRATE	10mg/l	10mg/l
IRON	0.3mg/l	1.0mg/l
LEAD	0.05mg/l	>1mg/l

Source: Ayoade (1988)

Table 2.2: FEPA interim standard for aquatic life water quality (1991)

PARAMETES	PROPOSED STANDARD
pH	6.0 – 9.0
Temperature	20 – 33^{0}C
Nitrate	NS
NS = No standard	

Source: Michael et al, 1998.

Table 2.3:chemical substance affecting potability of water (after WHO 1985)

Substance	Maximum acceptable	Maximum allowable
Total solid]	500mg/l	1500mg/l
Colour	5 units	50 units
Turbidity	5 units	25 units
Odour	Unobjectionable	Unobjectionable
Iron Fe	0.3mg/l	1.0mg/l
Zinc Zn	5.0mg/l	15mg/l
Lead Pb	-	0.05mg/l
pH range	7.0 – 8.5	6.5 – 9.2

Nitrate NO_3	50mg/l	100mg/l
Sulphate SO_4^{2-}	200mg/l	400mg/l
Hardness $CaCO_3$	-	120mg/l
Taste	Unobjectionable	Unobjectionable
Conductivity	1250µs/cm^3	3000µs/cm^3

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 RESEARCH DESIGN

This has to do with the practical considerations given to the problems to provide adequate information and solutions. This is a design or plan of study applied in the collection, interpretation and analysis of data collected during the study period.

In this study, the parameters in the variation needed a lot of experiments to be absolutely sure of the concentration level of oil pollutants in the Abuloma River. In order to determine this, three specific location points at 100 meters interval were mapped out for samples collecting points and each of the samples collected was tested for the presence of specified parameters.

3.2 TYPES OF DATA

The study has to do with data collection and processing; therefore the required data were collected and analyzed for the study.

3.2.1 PRIMARY DATA

In this study, the primary data were obtained through:.

- Direct observations, interviews and ethnographic research.
- The water samples were collected at different three samples points' location.
- The permissible limit was obtained from anal concept laboratory unit as issued to them by FEPA.
- Data collection techniques.
- All the statistical data obtained were performed with the help of laboratory attendants

3.2.2 SECONDARY DATA

In this study, a lot of information and data were obtained from secondary sources, which include those culled (extracted) from publications from oil exploration and exploitation industries. Other materials were obtained from local and international journals, magazines, newspapers, textbooks, seminars, papers, library, laboratory reports, workshop handouts, and scientific dictionary.

3.3 DESCRIPTION OF STUDY AREA

The study was carried out at Abuloma River in Port Harcourt, Rivers State. Abuloma is a town situated spatially at latitude 4^{o} 07 and 4^{o} 25 and longitude 7^{o} 03 and 7^{o} 6 and it is about 6kilometers long.

Vegetation in this area is characteristically mangrove, with the dominant types being red mangrove (Rhizophora racemoss), white mangrove (Avicenna racemosa) and black mangrove (lagunculana racemoss). The area also inhabited by other plants and animals.

The climate of the area was basically that of equatorial tropical rainfall of the year except for the months of December, January and February which comprised the dry season. The annual rainfall in the area was about 2,404.2mm (Gobo, 1988). Annual mean air temperature was 29.7^{o} c with the highest mean temperature at 31.3^{o}c (in August), and the lowest monthly mean temperature at 24^{o} c (in January). The surface seawater temperature values ranged between 25.9^{o} c and 30.6^{o} c, and the salinity of the seawater ranged between 8% and 20%.

The economic activities in the area are mainly fishing, trading, and transportation. The area is characterized by sedimentary rock formation, comprising of tertiary and quaternary (recent) marine or continental deposits, extensive petroleum deposits mask the underlying geological structure. The soil prevalent in the area could be classified as coarse, loamy, highly weathered, and a good drainage system exist. The soils are not water logged. The soil is moderately acidic with low soluble salts contents.

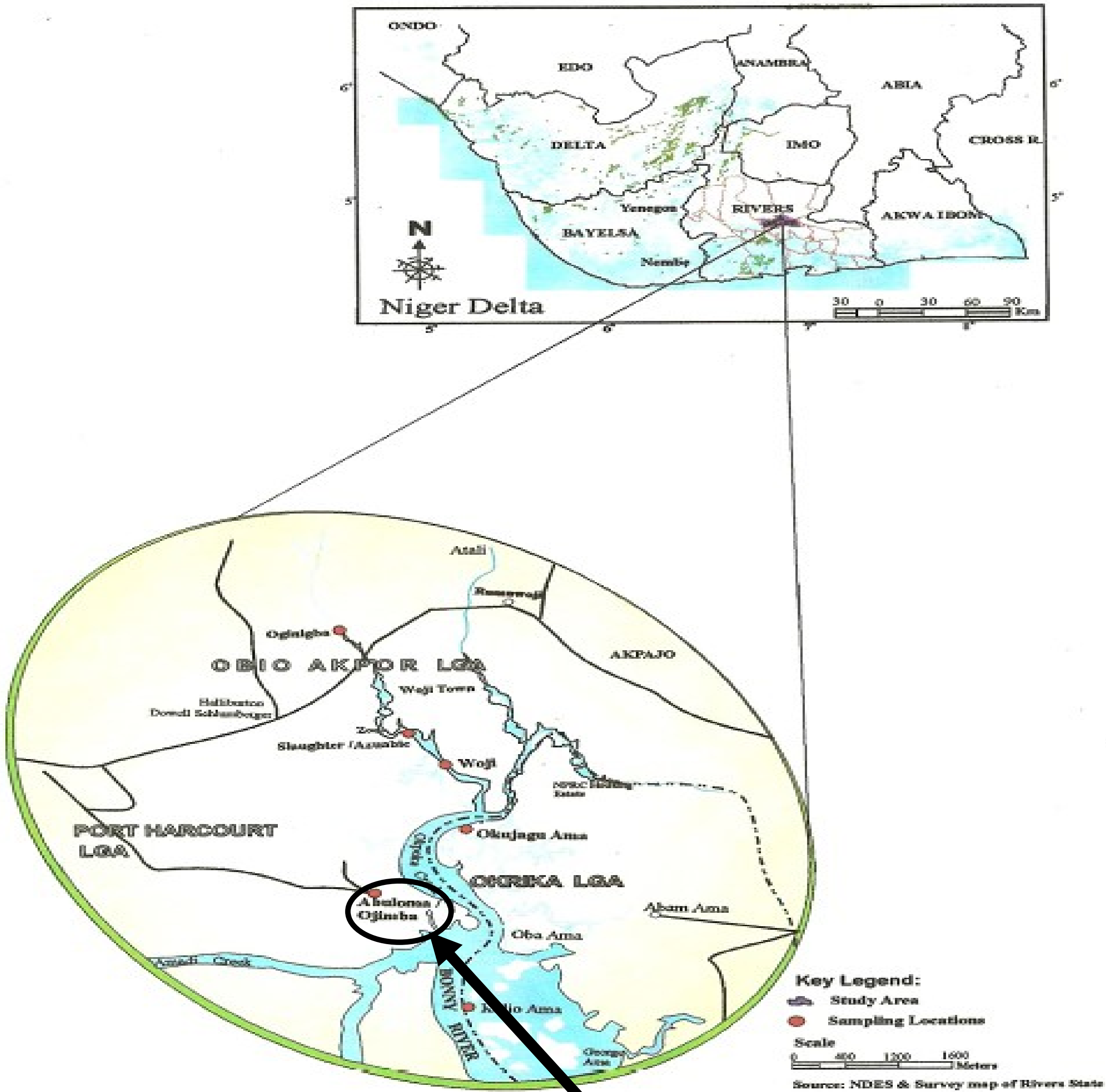

Fig 3.1: Map of Study Area

(ABULOMA, RIVER STATE)

3.4 DATA COLLECTION METHOD

Sampling is very important in this type of research which involved the collection of surface water to be investigated. This implies that:

Careful documentation during sampling is required so that all relevant information on the nature of the sample are clearly recorded on site at the time of sampling. This is necessary because variations in sampling procedures can have a marked effect on the results of analysis.

There are three sampling points; two of these points are in an area, distance of 100meters apart while the other one is outside the areas i.e. the control point, the reasons for the above space points were:

1) Accessibility of sampling points
2) Distance from discharge point i.e. spills
3) Direction of flow of the water body.

These samples were collected in a clean dry 1 litre wide mouthed transparent glass bottles with Teflon covers. The sample bottles were properly labeled indicating sample name and date of collection.

3.4.1 Sampling Location

Water samples were taken from three difference locations designed A, B and C. in the oil spill area of Abuloma River. Sample location 'A' was taken from upstream known as control point. There was no industrial activities' going on here. Sample location B was taken from the mid-point were bunkering activities was going on and it was about 100meters from sample location A. Sample C was taken from the downstream where industrial activities was going on. The sample location C was at about 100meters from the sample B.

3.4.2 Sampling Method

It is essential that sampling method enables a representative sample of the water to be obtained, avoids contamination of the sample when it is being collected and avoids contamination or changes in composition during transport to the laboratory. It is important that all sampler are fully trained in all aspects of sampling methods and that have demonstrated competence before] they are allowed to take samples unsupervised.

It is good practice to keep a record of sampler's training periodically, the type of sample to be collected will depend on the way in which the standard is applied. Typically standards are applied as absolute maxima in which case a "spot" or "grab" sample is required. However, if a standard is applied as an average, particularly over a short time, it may be appropriate to take a composite sample of the water supplied during that time.

The sample container should be made of a suitable material that it is appropriate for the parameters being sought and which does not lead substances into the water sample. Often suitable plastic bottle are satisfactory, but for some parameters it may be necessary to use glass bottle. The samples container must be clean and the cleansing process appropriate for the parameters being sought.

When collecting the sample from the sampling point, great care needs to be taken to avoid contamination entering the sample either from the sampler's body or the environment. The sample has to be transported to the laboratory in clean conditions.

3.4.3 Sampling Preservation

All the samples were properly labeled with white masking tape and named to avoid samples mix-up with other people's samples in the laboratory. Preservation method of samples interferes with some of the test. Immediate analysis is ideal. Storage at low temperatures ($4^{o}c$) is the best way to preserve most samples until the next day. Chemical preservatives are to be used only when they are shown not to interfere with the examinations being made. When used, they should be added to the sample bottle initially, so that all portions of the composite are preserved as soon as collected. No single method of preservation is entirely satisfactory and the preservative should be chosen with due regard to the determinations that are to be made.

3.5 SAMPLE TREATMENT

Water samples for metal analysis were filled before analysis and were followed by acid digestion before analysis.

3.6 ANALYSIS OF PHYSICO-CHEMICAL PARAMETERS

3.6.1 pH Analysis

pH meter was used to determine the pH of the water sample. The probe of the pH meter which is made up of a glass electrode in association with a colonel electrode was standardized with calibration buffer solution: Borax buffer, potassium hydrogen phthalate and neutral solution in a breaker which gave pH of 4.0 and 7.0 respectively. After calibration, rinsed with de-ionized water, poured in 50ml of the sample into a beaker and standardized probe immersed in it to get the pH value. All samples were adjusted to a temperature of 25^0c before pH measurements. These were done for the various water samples to get their respective pH value.

3.6.2 Temperature

A 0-100^0c mercury thermometer was used for all temperature measurements. The thermometer was put in the sample and enough time was allowed for equilibration. All temperature measurements were down at the time of sampling.

3.6.3 Conductivity

Conductivity measurements were carried out using the conductivity meter at sample temperature of $25^{o}c^{.}$ Result were reported in microsiemens per centimeter us/cm.

3.6.4 Odour And Taste

Visual analysis was used to determined the odour and taste of the water samples

3.6.5 Colour

The colour of samples is determined using a Nesslerise and comparing them with standard disc NSA. Colour values are read directly in Hazen units on the platinum cobalt scale.

3.6.6 Total Dissolved Solid (TDS)

Filtered samples are evaporated and dried in weighed dishes at $105^{0}c$ to constant weight for at least 30mins. The increase in weight over the empty dish represents the total dissolved solid content. 100ml of the samples are used and the evaporating dishes were left to cool in desiccators before the weighing was done. The results are expressed in milligrams per liter (mg/l) of sample.

3.6.7 Total Suspended Solid (TSS)

100ml of samples were filtered through a glass fiber filter disc and transferred to previously ignited and weighed evaporating dishes. The samples were evaporated to dryness in an oven, as in the case of total dissolved solid and further dried at 105^{o}c for two hours in the oven. They were cooled in desiccators and weighed. The difference between the weights obtained gave the valve of the total suspended solid content for the sample. The result was expressed in milligram suspended solid per liter of sample.

3.6.8 Chemical Oxygen Demand (COD)

Method: Colourimetric titration method using the ER-1 COD meter.

Principle: A certain quantity of potassium permanganate ($KMn0_4$) was added to sample water and heated with sulphuric acid; the residual $KM0_4$ which did not react with the organic matter in the sample water was made to react with ferrous ion (Fe^{2+}) by electron reduction of ferrous ion Fe^{3+}. An indicator electrode detected the end point of the reaction. At the end point, the constant current electrolysis ceased and the residual $KM0_4$ was given and directly indicated on the display for COD value.

Procedure: 50ml of distilled water was boiled for 5 minutes in a 100ml beaker. The COD meter electrode was immersed into the boiled water directly from the heater for 5 minutes.

Blank: 20ml distilled water in a 100ml beaker, 1ml solver, 2ml $KM0_4$ (0.8gl) and 20ml $FeNH_4$ (SO_2). $12H_20$ solution was added. The mixture was made up to 50ml and boiled for 5minutes, then read using the COD meter probe.

The COD meter was adjusted to 0.00 using a blank 20ml $AGN0_3$, 2ml $KM0_4$ and 20ml $FeNH_4$ $(S0)_2$. $12H_20$ were added and the volume made up to 50ml with distilled water. The solution was then boiled for 5 minutes and the COD meter probe was immersed into the hot solution and read at the end point (were the green light showed). Results were given in ppm.

3.6.9 Biochemical Oxygen Demand (BOD)

Method: US mean Dilution.

Principle: Sample was diluted to different degrees using dilution water prepared for seeding. The diluted solutions were incubated for five days in darkness in a harmostatically controlled enclosure (20^{o}c). The quantity of oxygen consumed was then measured as the difference in dissolved oxygen before and after incubation.

Procedure: 5l of distilled water in a 5l beakers, small concentrations were added to provide Mg, Fe, Na, Ca, K, NH4 etc. ion 50ml of treated water (biodisc) was also added. The water in the beaker was placed in a thermostat water bath at 20^{o}c and aerated for about I hour with compressed air. This aerated water was used as seeding water for diluting the samples. Using the COD value, the range of dilution of 10, 20, and 40times were prepared by taking appropriate sample volumes and diluting with the seeding water in a 500ml volumetric flask. For examples, for the 10times dilution, 50ml sample was made up to 500ml for 40times dilution; 12.5ml sample was made up to 500ml.

Procedure: Two BOD_5 special bottles were filled with each of the undiluted samples. Two BOD_5 bottles were filled with the seeded water alone as blank. All samples were diluted according to their COD content, such that for each sample there were about 4 dilutions in duplicates. The volumes of the bottles as marked on item were noted. One set of the diluted samples were incubated at 20^{oc} in the dark for five days while the dissolved oxygen content of the duplicate was analyzed immediately. To each of the diluted samples, 1ml $MnS0_4$ and H_2S0_4 were added and the precipitates dissolved (solution then turned yellow). The solution was shaken and transferred into a 250ml Erlenmeyer flask and filtered with 0.4N $Na_2S_20_3$ solution to light yellow colour.

DO = $\frac{\text{Vol. of Liter x Dil. Factor x 200}}{\text{Vol. of bottle 2.0}}$

The DO of the incubated set of samples and blank as determined after five days.

BOD = DO sample – Do blank – DO x Dilution

Initial final final factor.

3.6.10 Total Petroleum Hydrocarbon (TPH)

Extraction: 2gm of samples were weighed into a clean extraction container. 10ml of extraction solvent (dichloromethane) was added into the sample and mixed thoroughly and allowed to settle. The mixtures were carefully filtered into clean solvent rinsed extraction bottle, using filter paper filled into Buchner funnel. The extracts were concentrated to 2ml and then transferred for clean up/ separation.

Clean up/Separation: 1cm of moderately packed glass wool was placed at the bottom of 10mm ID x 250mm long chromatographic column. Slurry of 2g activated silica in 10ml methylene chloride was prepared and placed into the chromatographic column. To the top of the column was added 0.5cm of sodium sulphate. The calcium was rinsed with additional 10ml of methylene chloride. The column was allowed to flow through the column at a rate of about 2 minutes until the liquid in the column was just about the sulphate layer. Immediately 1ml of the extracted sample was transfer into the column. The extraction bottle was rinsed with 1ml of dichloromethane and added to the column as well. The stop cork of the column was opened and the relevant was collected with a 10ml graduated cylinder.

Gas chloromatographic Analysis: The concentrated aliphatic fractions were transferred into labeled glass vial with Teflon rubber crimp caps for GC analysis. 1ul of the concentration sample was injected by means of hypodermic syringe through a rubber septum into the column. Separation occurs as the vapour constituent partition between the gas and liquid phases. The sample was automatically deleted as it emerges from the column (at a constant flow rate) by the FID detector whose response is dependent upon the composition of the vapour.

3.6.11 Sulphate

The sulfave IV method was used. The stored program number 680 was entered with wavelength 450nm. Two sample cells containing 10ml of de-ionized water (the blank) and water sample respectively were filled. One sulfaver (IV) reagent powder pillows Was added to the sample cell containing the water sample to tasted (prepared sample) it was swirled to mixed and left for 3minutes react period. The first sample cell (the blank) was use for zeroing after which the second sample cell (prepared sample) was placed to get the value of sulphate in the water sample.

3.6.12 Chloride

The titration method was used and the reagents used was silver nitrate and potassium chromate 250ml of the sample was pipette into an Erlenmeyer flask 2 or 3 drops of potassium chromatic was added and swirled. While still stirring, it was titrated with standard silver nitrate to the first permanent red tinge of silver chromate. The end point was reached when the reddish tinge persist. The chloride concentration is expressed in mg/l of water.

$$CC\ (mg/l) = \frac{\text{Vol. of AgNo3 x 1000}}{\text{Vol. of Sample.}}$$

3.6.13 Lead

Spectrophotometric methods are used for the metals using the spectrum Lab -22pc.

Reagent - Dethizone

Wavelength – 520nm.

3.6.14 Phosphate

Method: UV Spectrophotometer.

Procedure: 50ml of sample was transferred to a 50ml volumetric flask. 25ml ammonium metalanadate solution was added and 5 minutes allowed for colour development. Using a 20mm curvette, the absorbance was read at 400mm. the concentration in mg/l was obtained from the calibration curve.

3.6.15 Iron

The stored program number (265) was entered, and then the wavelength was rotated and dialed until a small display showed 510nm. A cell riser for 10ml sample cell was inserted and a two sample cell with 10ml of sample filled the content of one ferrover iron reagent powder pillow was added to the sample cell (the blank) swirled to dissolve. The shift timer was pressed for a 3 minutes reaction period. When the timer beeped the displayed showed in ug/l Fe proph. Another sample cell with 10ml of sample was filled which the blank. The blank was with 10ml, then placed into the cell holder and the light shield closed for zeroing within thirty minutes after the times has beeped, the prepared was placed into the cell holder. The light shield was closed and the read knob was pressed which displaced the value of the Iron content in the different water samples.

3.6.16 Alkalinity

A titrimetry method was used to determine the alkalinity of the water samples and the reagents used was sulphuric acid, methyl orange indicator and phenolphthalein. 100ml of sample were placed in a conical flask over a white surface. Two or three drops of phenolphthalein indicator were added until the sample turns pinks, and then titrate with standard acid until the pink colour is just discharged.

CHAPTER FOUR

ANALYSIS AND DISCUSSION

4.1 INTRODUCTION

This chapter deals with data presentation and analysis and assessment of the impact of the oil spill on water quality of Abuloma River.

the results of water analysis compared to who or fepa standards as shown in table 4.1.

TABLE 4.1: Result of Laboratory analysis of water sample.

s/no	Parameters	SLA	SLB	SLC	WHO (mg/l)	FEPA (Mg/l)
1	Temperature	28.3	27.8	28.4	20 -33^{0}C	-
2	pH	6.62	6.90	6.79	7.0 -8.5	6.5-8.5
3	Conductivity µs/cm^2	22,000	29,600	26,000	1250µs/cm^2	100
4	Total Dissolved Solid (TDS)	15,400	20,720	18,200	500mg/l	250
5	Total Suspended Solid (TSS)	11	21	16	50	50
6	Chemical Oxygen	2.352	4.157	2.627	10	

	Demand (COD) (mg/l)					40
7	Biochemical Oxygen Demand (mg/l)	1.50	2.77	1.65	40	-
8	Total Petroleum Hydrocarbon (mg/l)	<0.001	1,246.6	1,126.0	10	-
9	Sulphate SO_4^{-2} (mg/l)	350	510	400	200mg/l	250
10	Chloride Cl^- (mg/l)	6,900	8,900	8,200	200	600
11	Lead (mg/l)	0.014	0.266	<0.001	0.05	0.05
12	Phosphate (mg/l)	2.2	5.3	2.2	200mg/l	-
13	Iron Fe (mg/l)	<0.001	0.103	<0.01	0.3	0.3
14	Alkalinity (mg/l)	70	65	75	10.0	10-40
15	Odour	Odour less	Offensive	Odourless	Unobjection able	3
16	Colour	Colour less	Slightly Brown	Colourless	0-50	15
17	Taste	Saline	Saline	Saline	Tasteless	-

Source: Field Work, 2010.

KEY 1

SLA	=	Sample Location A
SLB	=	Sample Location B
SLC	=	Sample Location C

WHO = World Health Organization

FEPA = Federal Environmental Protection Agency

4.1 PHYSICO-CHEMICAL EVALUATIONS

4.1 Temperature: The variation in temperature of the river as recorded at the three sampling locations is shown and presented in Fig 4.1

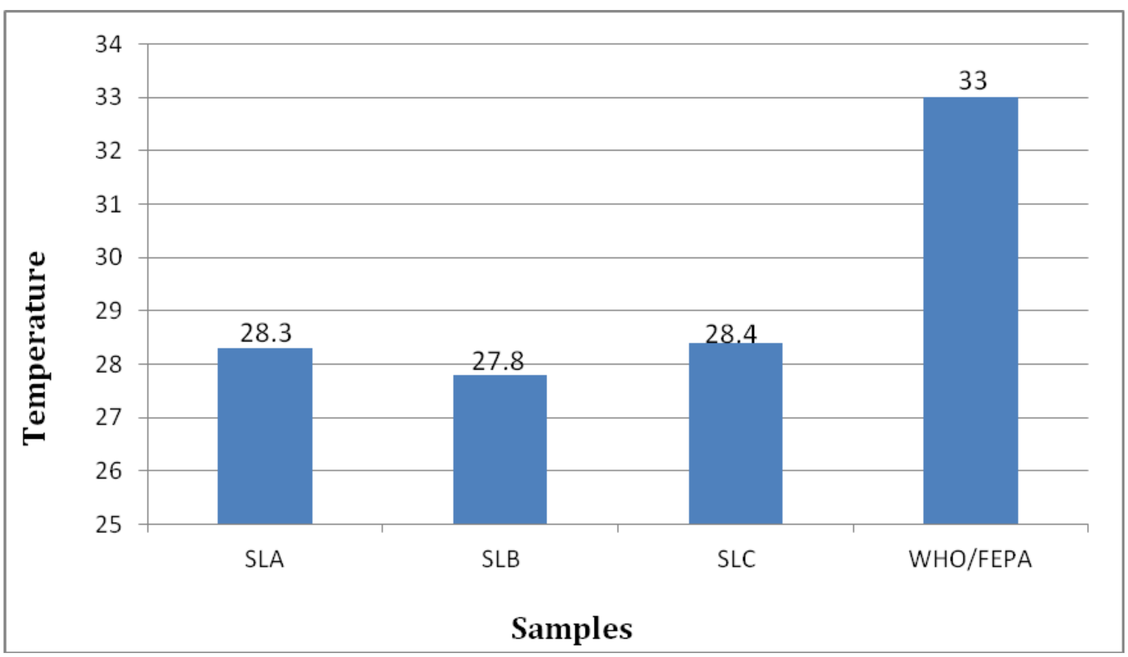

Fig 4.1 Temperature variation of various points

From the chart above, it was observed that the temperature of the river has its lowest value at SLB; the highest at SLC and this slightly decrease at SLA. The temperature of the river ranges between 27.8 – 28.4 and falls within the WHO limit.

4.2 pH (Potential of Hydrogen)

The variation of pH along the river course of the different sample location is represented in fig 4.1.2

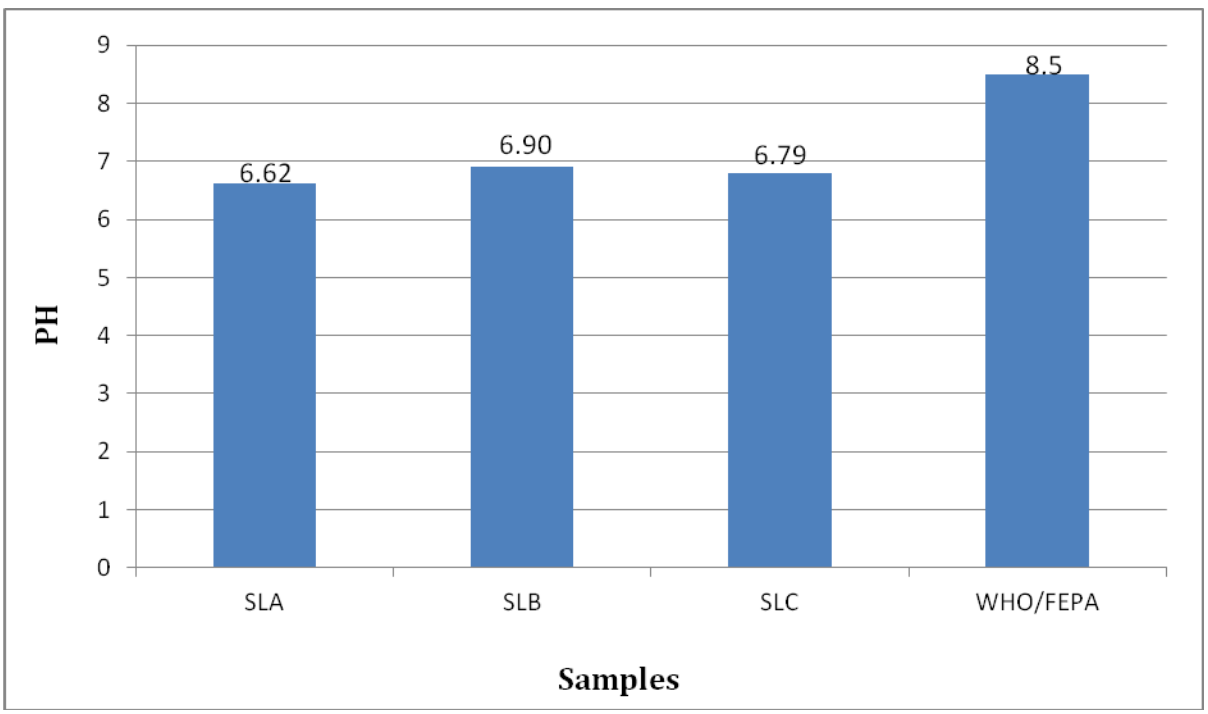

Fig 4.2 pH variation at various sampling points

From the chart, pH has the highest value at SLB while SLA and SLC has the least pH values. The values obtained from the samples fall within the WHO recommended limit of 6.5 – 8.5. The pH ranged between 6.62 – 6.90.

4.3 Conductivity (µs/cm^2)

The conductivity variations recorded at the three sample location are presented in fig 4.3

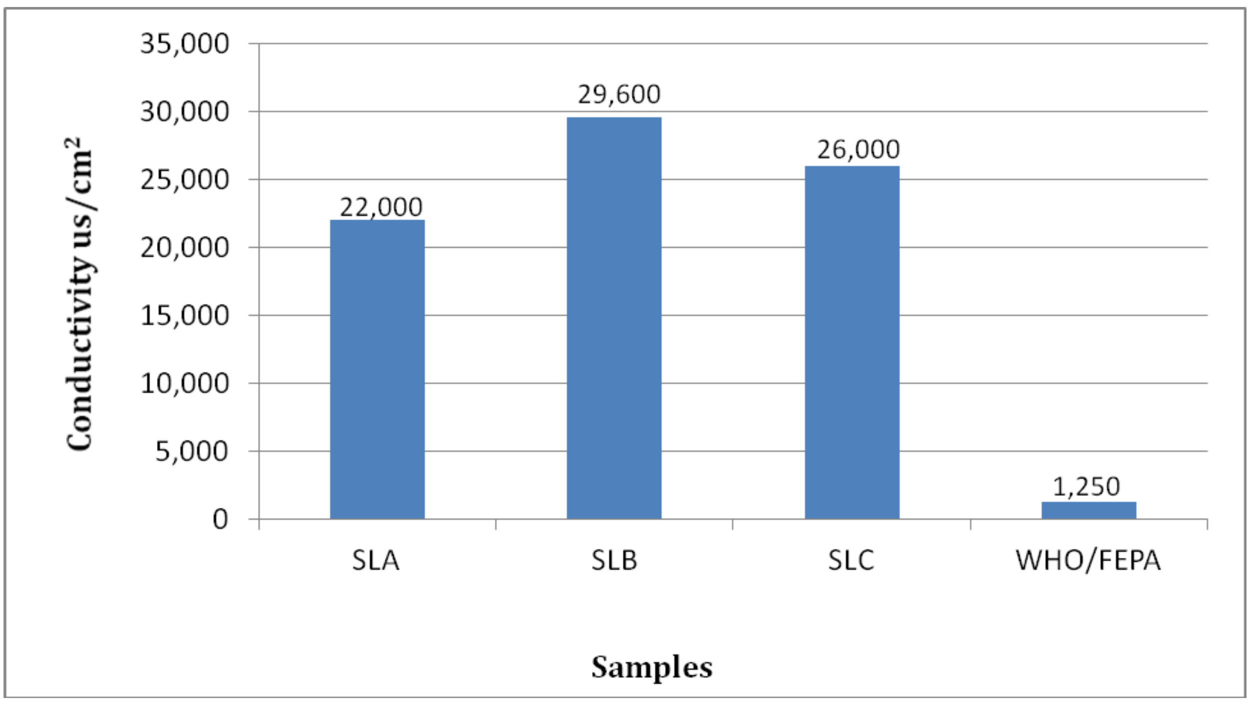

Fig. 4.3 shows conductivity variation of the river

The conductivity range of the river during the time of sampling falls between 22,000 – 29,600. The conductivity increased at SLB, and then decreases from SLC to SLA with WHO of 1250. These indicated that the conductivity of all the three samples exceeded the WHO standard.

4.4 Total Dissolved Solid (TDS) (mg/l)

The amount of total dissolved solid in mg/l at the different sampling location is presented in fig 4.4

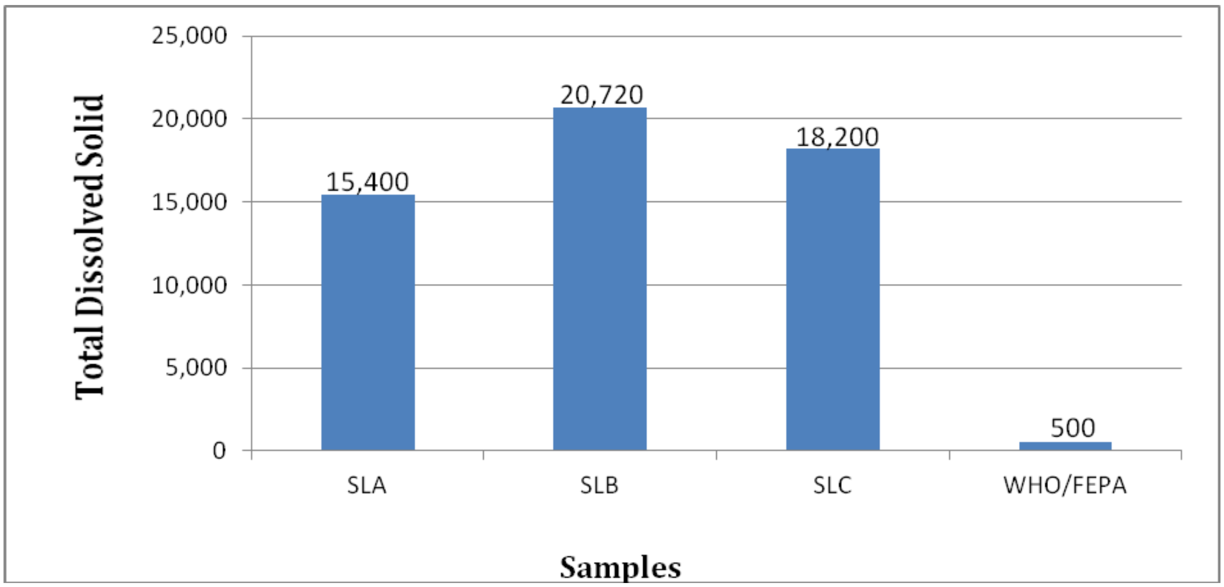

Fig. 4.4 Total Dissolved Solid variation of the river

From fig 4.4, it was observed that the real amount (mg/l) of total dissolved solid in the river varies from 15,400 – 20,720. The river at SLB has the greatest amount of total dissolved solid (TDS) followed by SLC, and SLA has the least, with the WHO of 500. Therefore, the total dissolved solid (TDS) for all the samples exceeded the WHO limit.

4.5 Total Suspended Solid (TSS) mg/l

The total suspended solid in the river as recorded at the three samples location is as presented in fig. 4.5

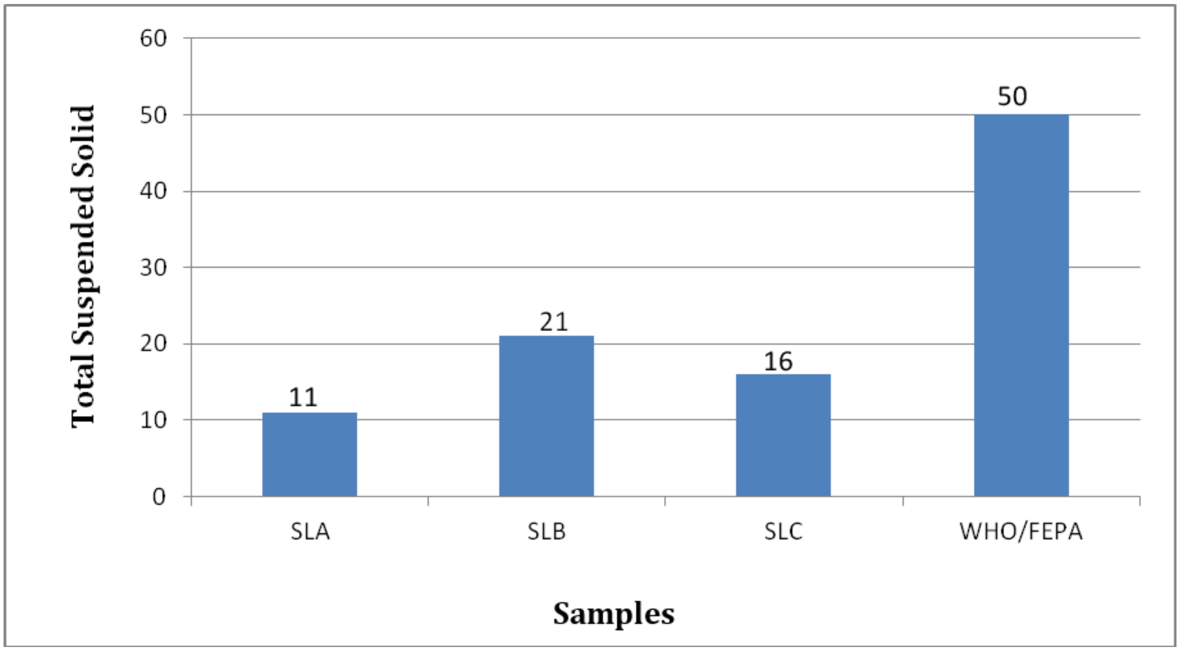

Fig. 4.5 Total Suspended Solid variation at various points

From the chart, the total suspended solid concentration was highest in SLB, followed by SLC, and SLA has the least concentration with WHO of 50, therefore the total suspended solid of all the samples fall within WHO standard.

4.6 Biochemical Oxygen Demand (BOD_5)

The BOD_5 at 20^0C of the rule, from three representative points is given in fig 4.6

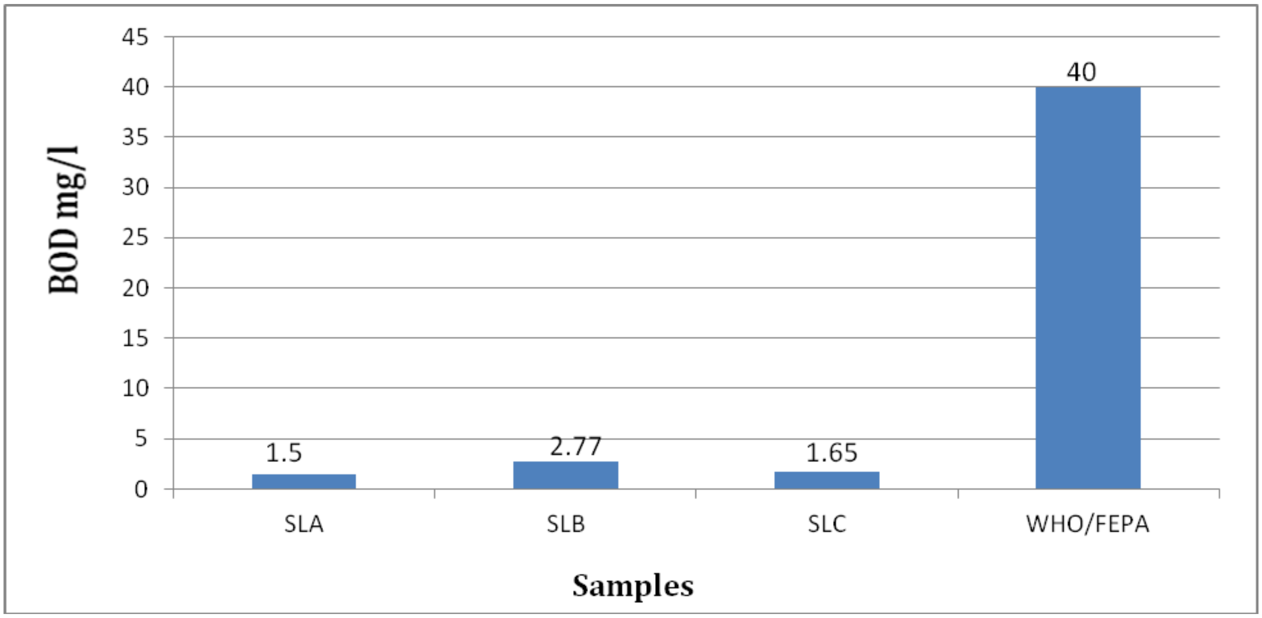

Fig. 4.6 shows BOD_5 concentration of the river

From fig 4.6, SLB has the highest biochemical oxygen demand, followed by SLC and SLA has the lowest BOD concentration. The biochemical oxygen demand of the river at the time of sampling ranges from 1.50 – 2.77 with WHO limit of 40, which indicates that the BOD of all the samples fall below standard.

4.7 Chemical Oxygen Demand (COD)

The chemical oxygen demands of the river as indicated at the three sampling points are presented in fig 4.7.

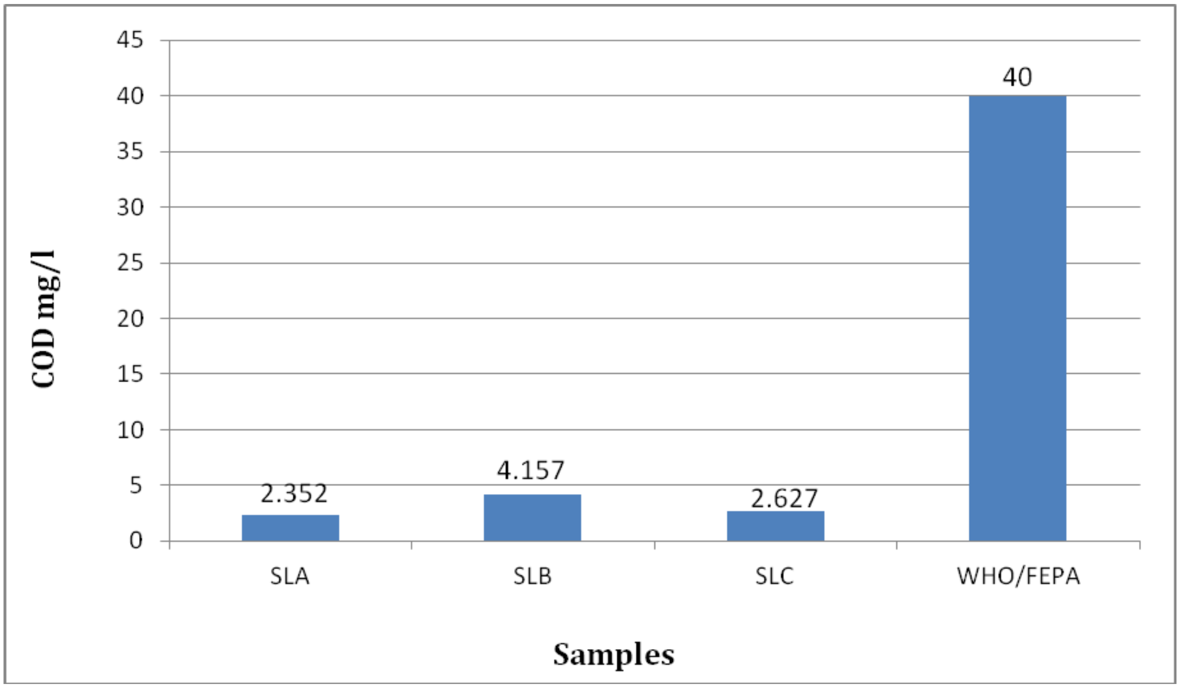

Fig. 4.7 shows COD concentration

From Fig 4.7, SLB has the highest concentration of chemical oxygen demand followed by SLC and SLA has the least recorded. The COD ranges from 2.352 – 4.157 with WHO of 40?. Therefore COD of all the samples falls below WHO standard.

4.8 Total Petroleum Hydrocarbon mg/l

The total hydrocarbon concentration indicated by the three sample location is shown in fig 4.8

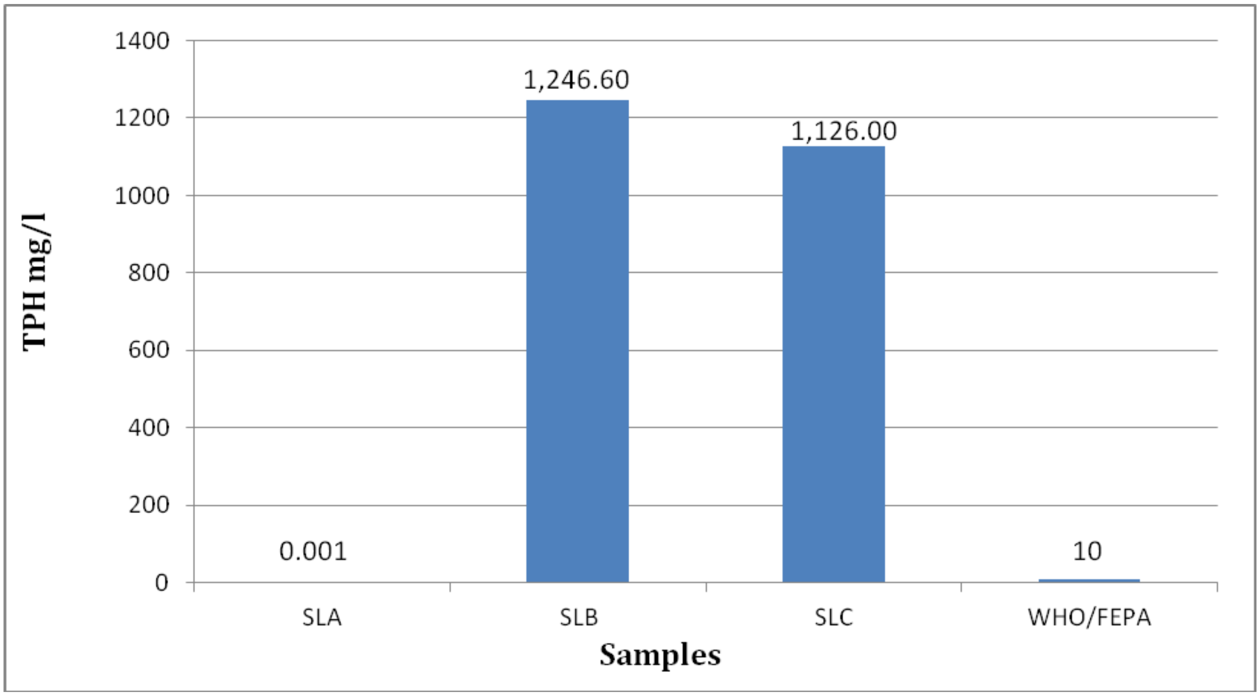

Fig 4.8 Total Petroleum hydrocarbon at various point

From Fig 4.8, it was observed that the total petroleum hydrocarbon concentration of the river decreases down the river with the highest concentration recorded at SLB and SLC then SLA has the least concentration value of TPH. The total petroleum hydrocarbon of the river fall 0.01 to 1,246.6

4.9 Sulphate SO_4^{2-} mg/l

The sulphate concentration of the river as indicated from the samples is shown in fig 4.9.

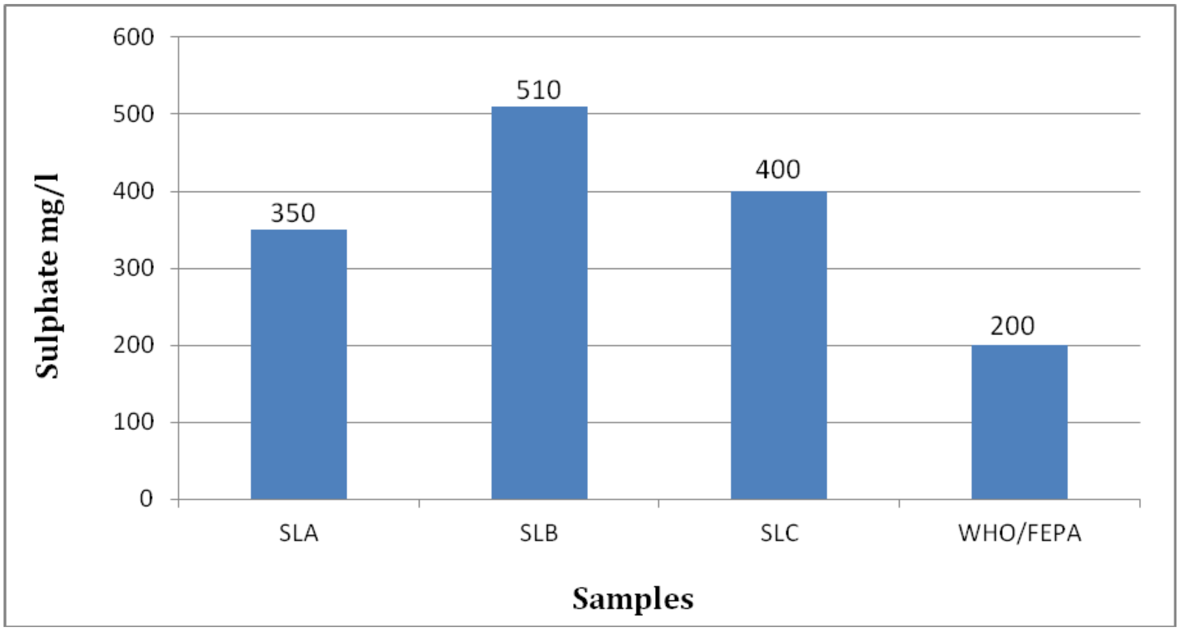

Fig. 4.9 shown sulphate concentration

The sulphate concentration was highest at SLB, and decreased at SLC and SLA with the WHO of 200mg/l. The sulphate ranges from 350 – 510, which shows that the sulphate for all the three samples exceeded the WHO limit.

4.10 Chloride Cl^- mg/l

The concentration of chloride recorded at the three sample locations are presented in Fig .4.10

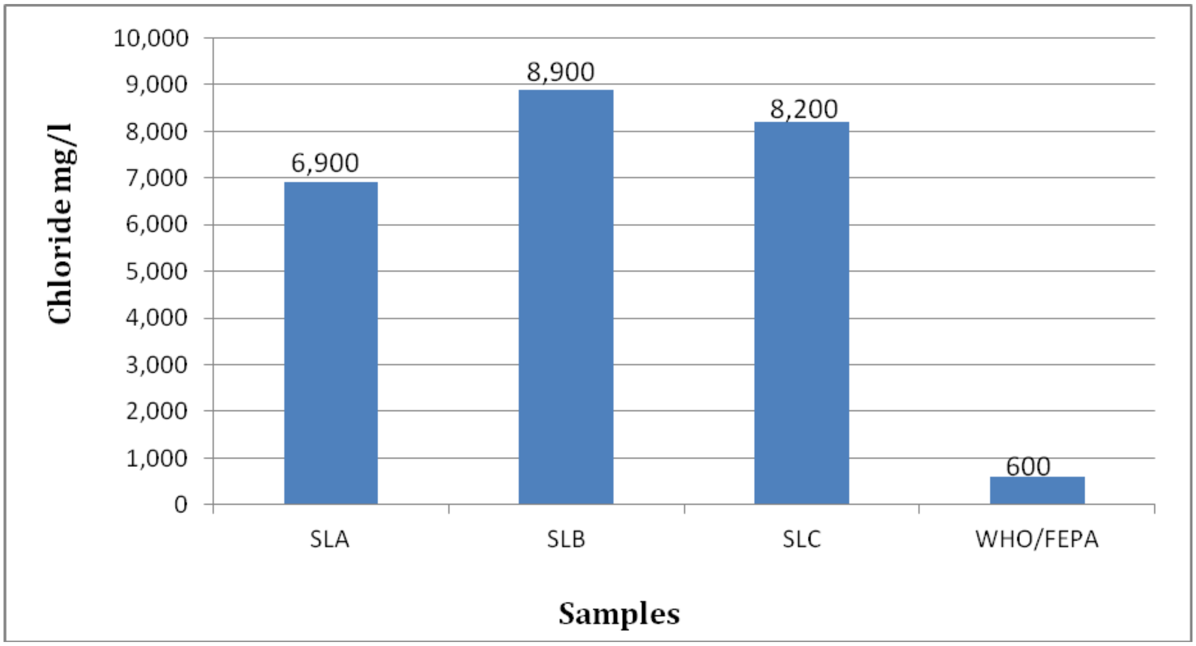

Fig 4.10 Chloride concentration at various points

From the chart, it was observed that SLB has the highest chloride concentration, followed by SLC, and then SLA has the least recorded. The chloride concentration of the river at the time of sampling ranges from 6,900 – 8,900 with FEPA of 600mg/l. This implies that the chloride concentration for all the three samples exceeded the FEPA limit.

4.11 Lead mg/l

The concentration of lead recorded at the three sample location is presented in fig 4.11.

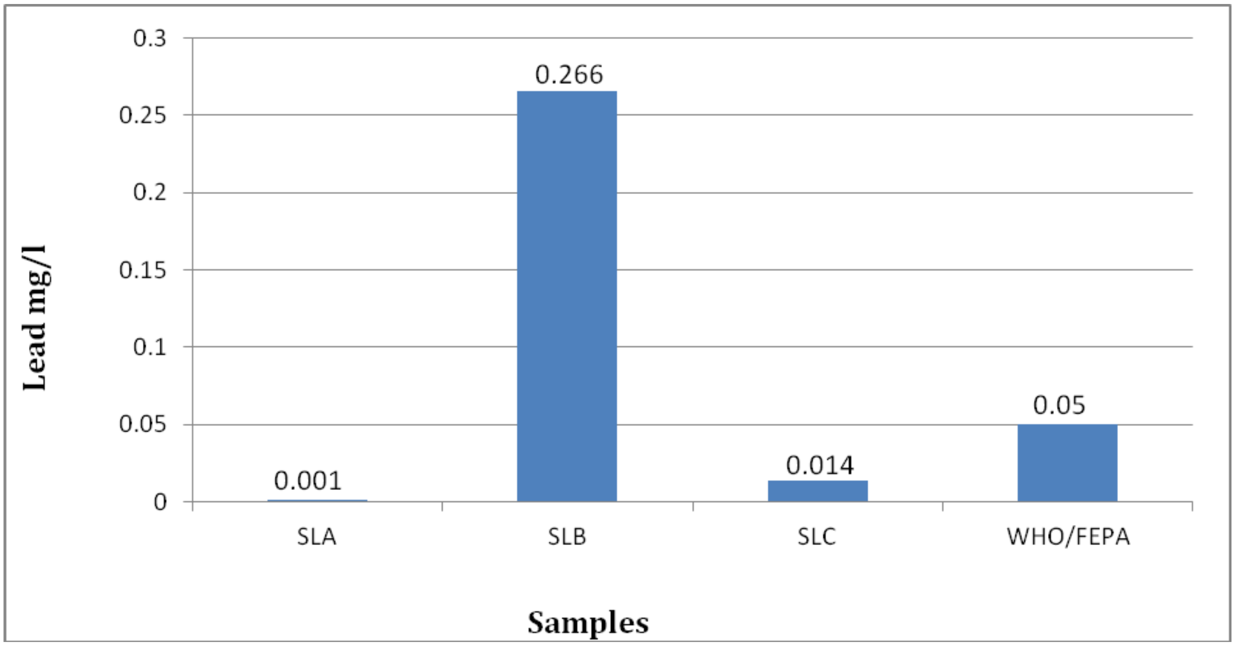

Fig. 4.11 shows concentration of lead in the river

The lead concentration was highest at SLB and increased at SLA and then decreased at SLC. The range of river during the time of sampling is between 0.001 - 0.26 with FEPA of 0.005. Therefore lead concentration for all the three samples exceeded the FEPA standard.

4.12 Phosphate mg/l

The phosphate concentration of the river as indicated from the sample location is shown in Fig. 4.12.

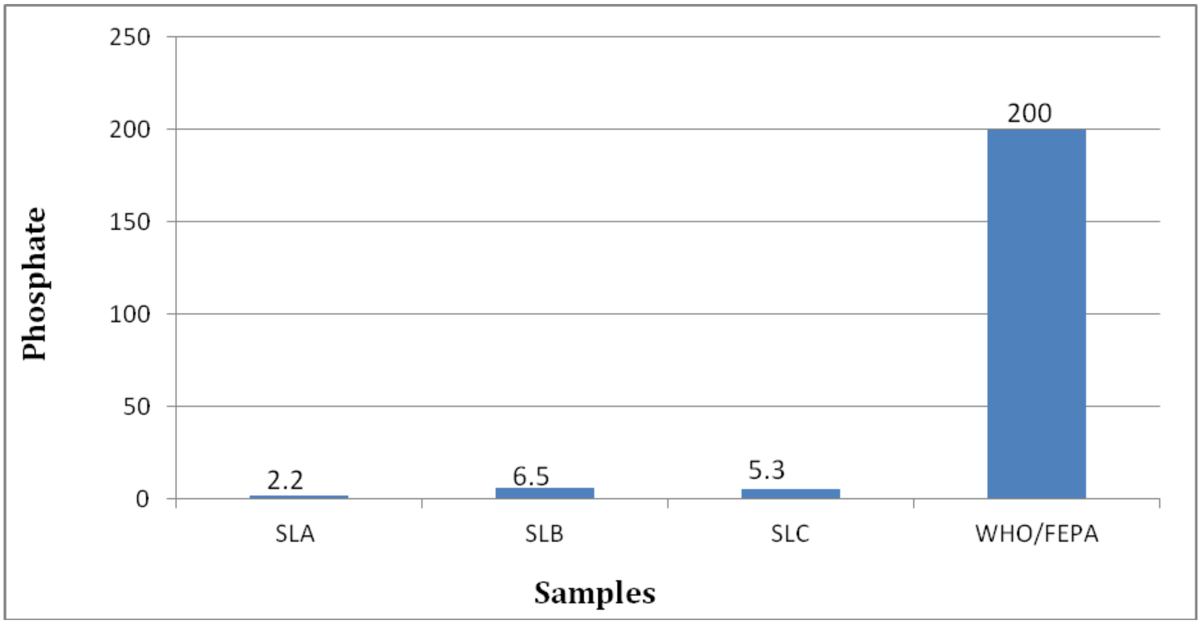

Fig. 4.12 show phosphate concentration

The phosphate concentration was highest in SLB, and has the least value at SLA. The phosphate ranges from 2.2 – 6.5 which indicated that all the samples fall below WHO limit.

4.13 Iron mg/l

The iron concentration as recorded at the three sample location is given in Fig 4.13.

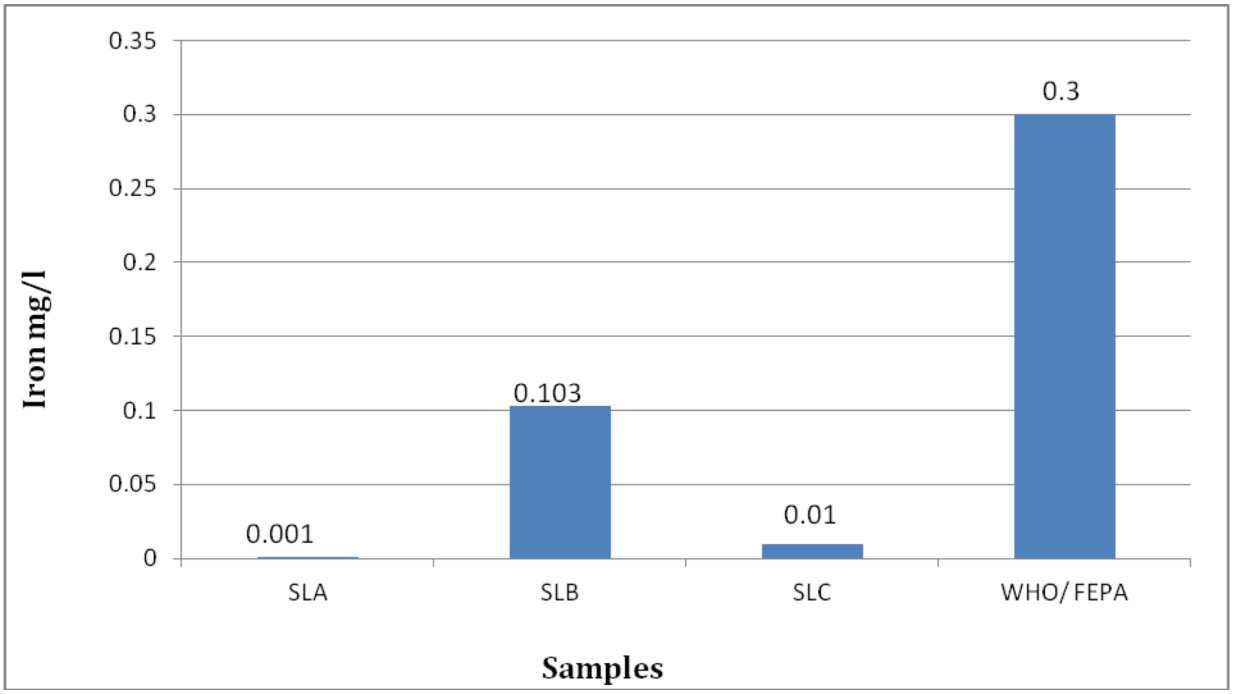

Fig. 4.13 Iron concentration variation of the river

The iron concentration was highest at SLB, lowest at SLA and SLC The iron of the river ranges from 0.001-0.103 and falls within the WHO limit.

4.14 Alkalinity mg/l

The alkalinity values of the river as indicated at the three sampling points are presented in 4.14.

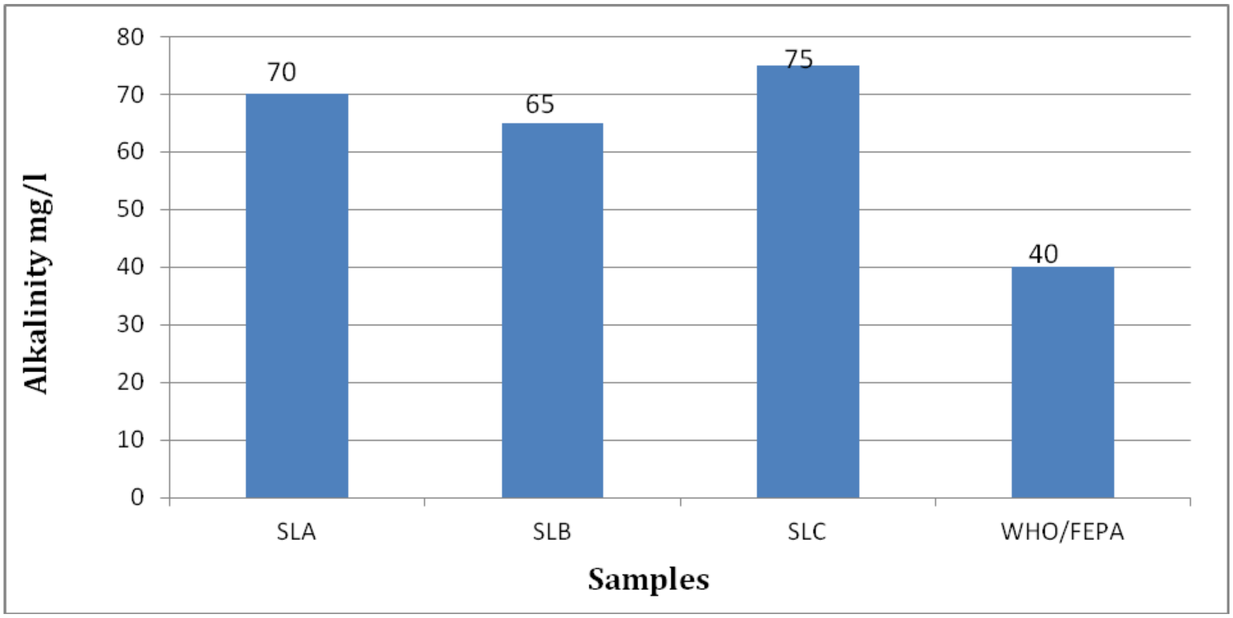

Fig. 4.14 show Alkalinity concentration variation of the river

The alkalinity concentration in the river was found to increase from SLA to SLC and was observed to fall markedly at SLB. The alkalinity of the river ranges between 65-70 and falls within WHO limit.

4.2 DISCUSSION OF RESULTS

Temperature is the most important factor that affects the chemical, biochemical and biological characteristic of life in water. It measures the degree of hotness or coldness of a body or system. It is a very important parameter in monitoring aquatic pollution because it controls the extent of metabolic processes of animal and chemical reactions. The observed temperature values obtained from all the samples fall within the acceptable limit for aquatic life. The analysis from the standard of FEPA (1991) for aquatic life is 20^oc - 30^oc .This indicates that the temperature of the water can support aquatic life.

The pH of any water system is an important physico-chemical parameter. It is the negative logarithm of hydrogen ions concentration and usually determines the acidity or alkalinity of a water system. pH regulates the chemical and biological state of water. Again toxicity of most compounds in water is affected by the degree of dissociation of weak acids and bases brought about by changes in pH. The analysis from the standard of FEPA for aquatic life is 6.0-9.0; this indicates that the pH of the water for all the samples can support aquatic life because it falls within the standard stipulated. The pH value for all the samples shows that the water is slightly acidic thus fall within the allowable limit of WHO standard in chemical affecting portability.

However, in terms of pH, the water can be accepted for both domestic and industrial uses. The sources of the pH of the value may be due to run-off and atmospheric deposition in the form of acid rain.

The conductivity values of 29,600; 26,000; and 22,000us/cm^2 show that the river has a very high conductivity value when compared with WHO standard of 1250us/cm^2 for drinking water. However, this implies that a high conductivity of the river will bring about low resistivety of the biota (flora and fauna) of the river and its quality. Conductivity depends on the quantity and quality of dissolved salts present. In the water high conductivity results in low concentration of metals in aquatic environment. The conductivity agrees quite well with the pH of the water which is close to neutral and also to be TDSmg/l. Therefore conductivity for all the samples shows that the water exceeded the WHO standard.

Water with high dissolved solid concentration gives an unobjectionable taste and may affect ecosystem and domestic and agricultural usefulness (FEPA 1991). The Total Dissolved Solid concentration of river is greatly affected by pH as indicated from the result. Increase in pH brought about an increase in Total Dissolved Solid concentration. The analysis shows the total Dissolved Solid exceeded the WHO permissible limit of 500mg/l, thus thee water is not safe for domestic uses.

Biological Oxygen Demand (BOD) measurement is an approximant measure of the amount of biochemical dependable organic matters present in the water sample. It declined by the amount of oxygen required for the aerobic micro-organism present in the sample to oxidize the organic matter to a stable inorganic form. The Biological Oxygen Demand is measure by standard laboratory procedure which measure the amount of oxygen consumed after incubating at $20^{o}c$ for 5days (BOD). The value of BOD is considerably low as indicated from the analysis. According to Champman (1992) npolluted has a BOD of about 2mg/l or less the BOD range of the river was found to be 1.50-2.77 which is below the WHO standard (40mg/l). The value of BOD of the river can be attributed to increased input of domestic effluent, industrial effluent and run-off from several waste dumps from market and slaughter. Despite the fact that the BOD fall below the acceptable limit, the river is good for consumption.

Sulphate $S0_4^{2-}$ widely distributed in nature and may be present in underground water in concentration (milligrams per liter). It is the major anions present in natural water. Sulphate gives undesirable taste to water and in the presence of calcium. It could cause diarrhea as well as render water hard. According to the analysis, the concentration ranges from 350-510. The result of sulphate obtained in this study were higher than the FEPA (1991) and WHO (1991) recommended limit of 200mg/l for drinking water. The high concentration of sulphate also account for the hardness of the water. Since the concentration of sulphate in all the water from the samples (SLA, SLB, & SLC) appear to pose pollution threats, the water is therefore not good for human consumption as well as industrial and domestic uses.

The result of chloride obtained in this study were very high than the WHO (1991) recommended limited of 0-200mg/l of Cl^-in drinking water. The high concentration of chloride in water under study is an indication of pollution in the water. Thus the water is not good for drinking (domestic) purposes.

The Iron content in this river fall within limited compared with the WHO standard. The value for SLA is 0.001, SLB <0.103 and SLC <0.01 which fall within the WHO standard (0.05) for drinking water. In this respect, the water recommended for domestic purpose and also very good for consumption.

Phosphate is an essential nutrient for living organisms and exists in water bodies as both dissolve and particulate species. It is generally, the limiting nutrient for algae growth and therefore controls the primary productivity of water body. From the analysis, the concentrations of phosphate range from 2.2-6.5mg/l with WHO value of 200mg/l which is below acceptable limit. Phosphate is rarely found in low concentration in fresh water as it is actively being taken up by plants. Low concentration of phosphate in the can indicates that the water poses no health risk.

Total Petroleum Hydrocarbon: A term used to describe a broad family of several hundred chemical compounds that originally come from crude oil. In this sense, TPH is really a mixture of chemicals. They are hydrocarbons. The amount of TPH found in sample is useful as a general indicator of petroleum contamination at that site. However, this TPH measurement or number tells us little about how the particular petroleum hydrocarbons in the sample may affect people, animals and plant. TPH is release to the environment through accidents, as release from industries or as by-products from commercial or private uses. The TPH content in this water is really high at SLB and SLC and their values are 1,246.6 & 1,126.0 which exceeded the WHO standard for drinking water. The TPH content for SLA is <0.001 which fall within the acceptable limit. The high concentration indicates that the water is highly polluted and can pose health risk, cannot be good for human consumption. Also the water cannot support aquatic life because of its high concentration, it can be irritating to the skin, eye and it is very toxic to aquatic life.

Alkalinity analysis shows that concentration of alkalinity ranges from 65 – 75 with WHO of 100 which indicates that the alkalinity of all the samples falls within FEPA standard. In this respect, the water recommended for domestic and agricultural uses.

Lead can be found in drinking water where it comes from different sources. The most significant of these sources is lead silver and pipe in water distribution system, particularly when contaminated by corrosive water. Since the toxic effects of lead depend on total exposure, environmental assessment must take into account all these sources. The analysis shows the range concentration of lead to be 0.01 – 0.266mg/l. The SLA and SLC fall within the FEPA permissible limit of (0.05) the water is recommended for domestic and agricultural purposes, while SLB is quite high and exceeds both the acceptable and allowable limit of FEPA standard. Because of its high toxic nature, it can affect the neuromuscular system, decreasing muscles line in the wrist and feet. Lead can interfere with the synthesis of the oxygen carrying compel hemoglobin, therefore causing anemia source of lead include atmosphere deposition of lead input from leaded petrol used in automobiles.

CHAPTER FIVE

SUMMARY FINDING, CONCLUSION AND RECOMMENDATIONS

5.0 SUMMARY FINDINGS

From the analysis of physico chemical test conducted on Abuloma River, the following findings were observed.

- The electrical conductivity value was higher than WHO standard which indicates that the river has a high resistivety quality.
- The Total Dissolved Solid was exceptionally high and exceeded the WHO permissible and allowable limits.
- The Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) Concentration values all fall within the WHO standard.
- After test on Sulphate and Chloride, the recorded values were higher than FEPA/WHO standard, thus its presence in the water can pose pollution threat and not fit for human consumption.
- The pH value obtained is slightly acidic.

- Total Petroleum Hydrocarbon (TPH) was very high in Sample Locations B & C and all exceeded the WHO permissible and allowable limits. Its presence in the water pose threat to aquatic life and thus not good for domestic purposes.
- The Phosphate concentration was lower than WHO/FEPA standard, thus its presence in the water does not have any adverse effect on flora and fauna.
- Iron, Lead and Temperature fall within the FEPA standard. Its presence in the water shows that the water can support aquatic life and thus recommended for domestic purposes.
- The Odour and colour in sample Location A shows that the water exceeded WHO limit. Also the taste of the water is highly salty.

5.2 CONCLUSIONS

Pollution occasioned by oil spills has been rife in the Niger Delta especially in Rivers State, the centre of oil exploration and exploitation in Nigeria. The pollution has been acclaimed to have negative impact and consequences on water quality. Oil spillage decimates aquatic life (flora and fauna) destabilizing the entire aquatic ecosystem.

Based on the physic-chemical analysis carried out on the water samples, it can then be inferred that the water in Abuloma has been heavily polluted. Most of the physico-chemical parameters tested exceeded the recommended limits of WHO standard. Also the trace metals at some of the locations exceeded the recommended limits thereby posing a threat to the water body and life of the aquatic dwellings. The Total Petroleum Hydrocarbon (TPH) was very high as compared with the standard, and the reason could be attributed to the drilling and bunkering activities in the area.

People of oil producing area example Abuloma people used as case study suffer untold hardship as a result of oil pollution of their water. Their economic base is negatively impacted upon. The impact of oil spillage on water quality are far reaching and enormous and have not been viewed kindly by the communities hence the continued youth restiveness.

Government should enact laws to check illegal bunkering and disposal of oil waste into water bodies and companies engaged in drilling activities. There should be adequate protection of the environment by ensuring strict adherence to safe rules of exploration and exploitation of oil resources to minimized spillage and disposal of oil waste.

Companies should plans to take necessary actions on spills immediately it occurs to still maintain relevance among their host communities and to ensure hutch-free operations.

In all, the companies should be able be fulfill their social responsibility among them.

5.3 RECOMMENDATIONS

From the observation, the following recommendations are made, with the believe that these contribution may help the government and companies draw up measures for pollution abatement on River adjoining oil production facilities.

Legislation: Oil companies should honour government legislation and rules essential for healthy operations. They should also maintain operation ethics as obtained in other countries.

- **Environmental Monitoring Plan:** The environmental monitoring should be a part of oil companies' operational plan. This will ensure control and check on the areas of operation and equipment used.
- **Maintenance:** There should be efficient and routine maintenance of equipment and personal discipline especially in handling of equipment.
- **Compensation:** Though no amount of money paid as compensation to individuals and communities affected by oil spill could be enough to restore the damage caused, it will however attempt to alleviate the sufferings of the people.
- **Cleaning up:** companies should not wait unit a spill is out of hard before a clean up intervention. Timely clean up exercise should be encouraged.

- **Soci al Responsibility:** companies should take up their social responsibilities to their host communities with high sense of seriousness, especially in the area of :
  1. Community development
  2. Skill Empowerment or Capacity building.
- **Enlightenment Campaign:** Enlightenment campaigns should be carried out in the communities on the dangers of vandalization of pipelines and necessary safety measures required.
- The Companies involved in polluting the river either through oil spillage/effluent discharge and oil dump at the river side should ensure adequate treatment with best available technology BAT to reduce the pollutants to permissible limit before discharging.
- The problems of oil spill can be minimized if the oil companies should be more environmental conscious and follow strictly the provision of the law and standards set by regulatory bodies or agencies. They should also have regular monitoring of oil production activities and facilities and adequate compensation to the host affected communities.
- Report immediately any case of oil spillage to appropriate office for companies to prevent the spillage of these effluents into aquatic bodies, land and farmlands etc.

- Government should also audit oil companies from time to time to minimize pollution of the environment.

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APPENDIX 1

RESULT OF LABORATORY ANALYSIS OF WATER SAMPLE.

s/no	Parameters	SLB	SLC	SLA	WHO (mg/l)	FEPA (Mg/l)
1	Temperature	27.8	28.4	28.3	20 -33^{0}C	-
2	pH	6.90	6.79	6.62	7.0 -8.5	6.5-8.5
3	Conductivity µs/cm^2	29,600	26,000	22,000	1250µs/cm^2	100
4	Total Dissolved Solid (TDS)	20,720	18,200	15,400	500mg/l	250
5	Total Suspended Solid (TSS)	21	16	11	50	50
6	Chemical Oxygen Demand (COD) (mg/l)	4.157	2.627	2.352	10	40
7	Biochemical Oxygen Demand (mg/l)	2.77	1.65	1.50	40	-
8	Total Petroleum Hydrocarbon (mg/l)	1,246.6	<1.246.6	<0.001	10	-
9	Sulphate SO_4^{-2} (mg/l)	510	400	350	200mg/l	250
10	Chloride Cl^- (mg/l)	8,900	8,200	6,900	200	600
11	Lead (mg/l)	0.266	<0.001	0.014	0.05	0.05
12	Phosphate (mg/l)	6.5	5.3	2.2	200mg/l	-
13	Iron Fe (mg/l)	0.103	<0.01	<0.001	0.3	0.3
14	Alkalinity (mg/l)	65	75	70	10.0	10-40
15	Odour	Offensive	Odourless	Odourless	Unobjectionable	3
16	Colour	Slightly brown	Colourless	Colourless	0-50	15
17	Taste	Saline	Saline	Saline	Tasteless	-

Source: Field Work, 2010.

APPENDIX 2

WORLD HEALTH ORGANIZATION (1971 – 1999) INTERNATIONAL STANDARD FOR DRINKING WATER

Parameters	**Standard Permissible Limits**	**Excess**
pH	7 – 8.5	9.2
TDS	500mg/l	1500mg/l
DO	5.0mg/l	10mg/l
BOD_5	6.0mg/l	10mg/l
Conductivity	1250mg/l	300µs/cm^3
Lead	0.05mg/l	>1mg/l
Nitrate	10mg/l	10mg/l
Iron	0.3mg/l	1.0mg/l
Phosphate	1.0mg/l	5.0mg/l

APPENDIX 3

FEPA INTERIM STANDARD FOR AQUATIC LIFE WATER QUALITY (1991)

PARAMETERS	PROPOSED STANDARD
pH	6.0 – 9.0
Temperature	20 – 33^{0}C
Nitrate	NS
TPH	10mg/l

NS = No standard,

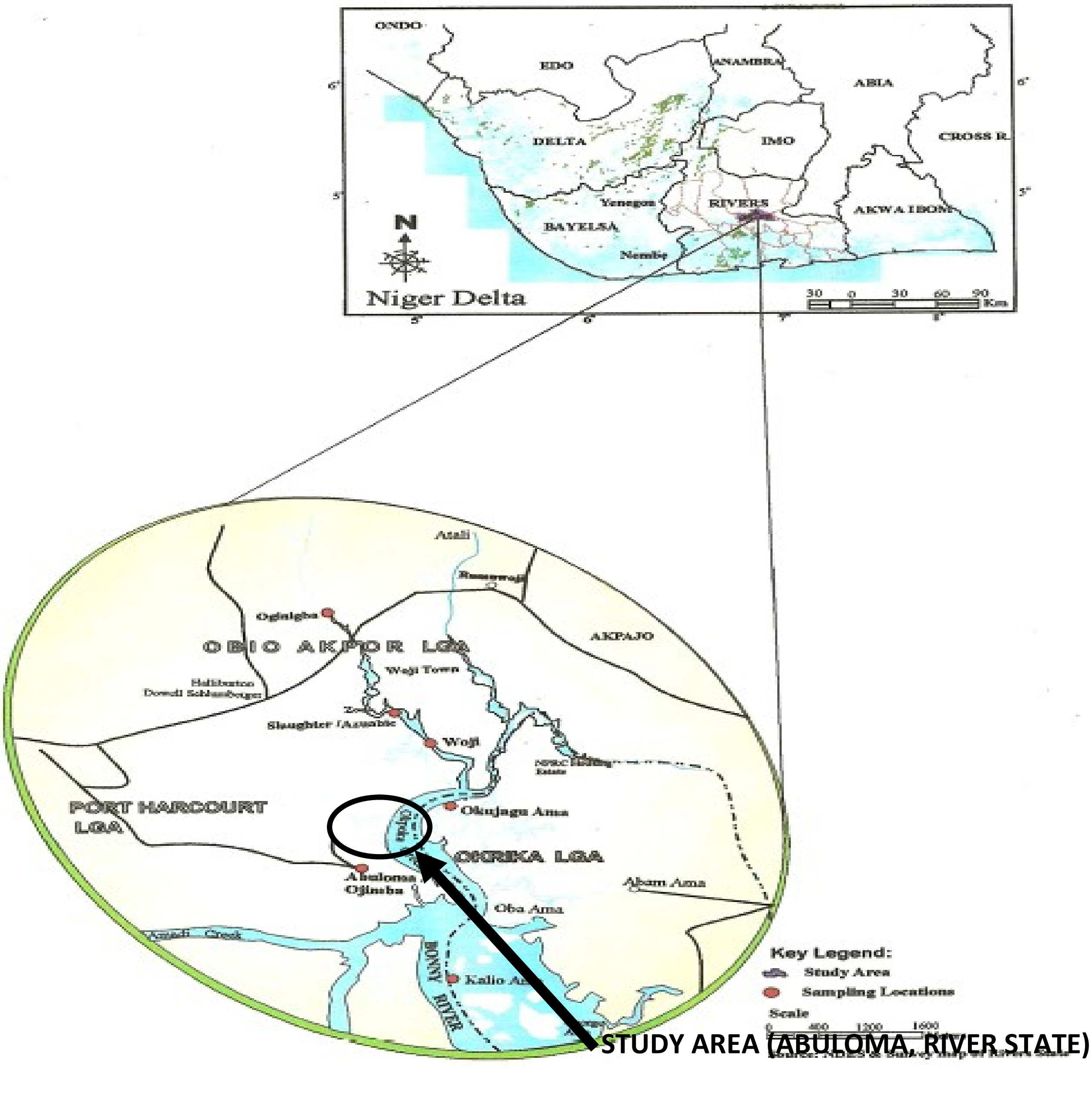
Source: Michael et al, (1998)

CHEMICAL SUBSTANCE AFFECTING POTABILITY OF WATER (W.H.O, 1990)

Substance	Maximum acceptable	Maximum allowable
Total solid]	500mg/l	1500mg/l
Colour	5 units	50 units
Turbidity	5 units	25 units
Odour	Unobjectionable	Unobjectionable
Iron Fe	0.3mg/l	1.0mg/l
Zinc Zn	5.0mg/l	15mg/l
Lead Pb	-	0.05mg/l
pH range	7.0 – 8.5	6.5 – 9.2
Nitrate NO_3	50mg/l	100mg/l
Sulphate SO_4^{2-}	200mg/l	400mg/l
Hardness $CaCO_3$	-	120mg/l
Taste	Unobjectionable	Unobjectionable

Conductivity	1250µs/cm^3	3000µs/cm^3

APPENDIX
4

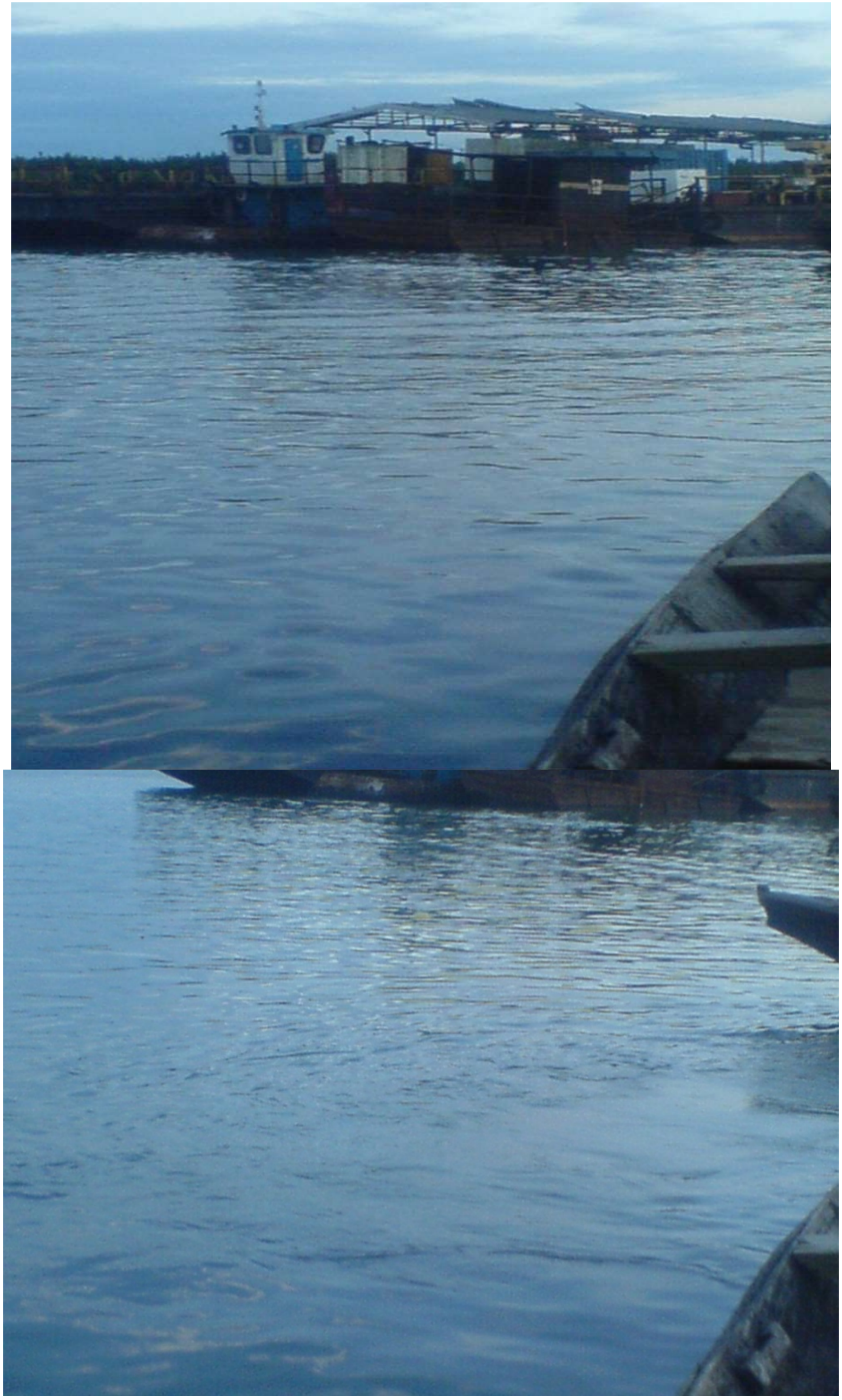


MAP OF STUDY AREA

PLATE 1

BUNKERING ACTIVITIES THAT ARE GOING ON AT ABULOMA RIVER THAT RESULT TO THE POLLUTION OF THE RIVER

PLATE 2

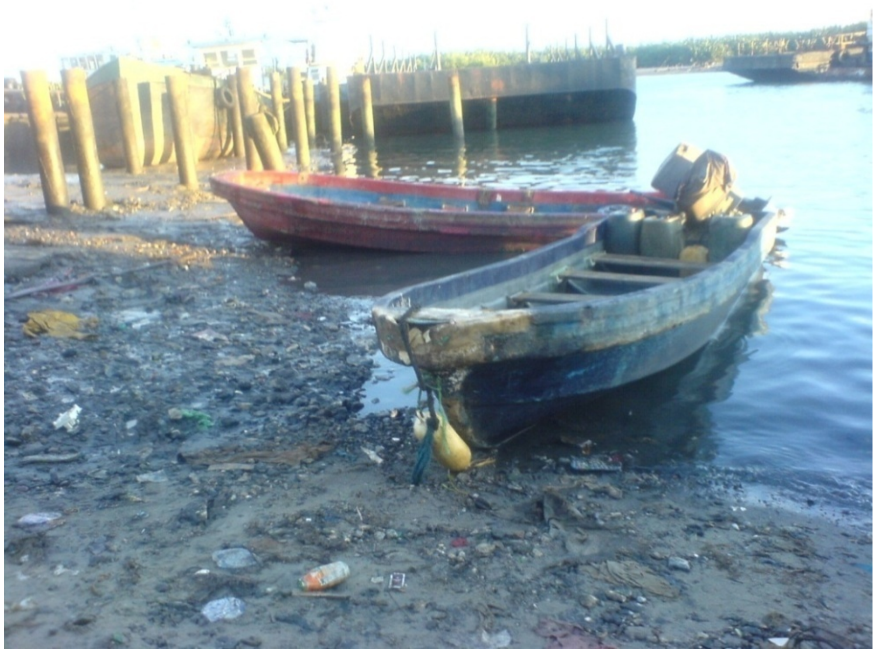


POLLUTED RIVER

PLATE 3

INDUSTRIAL ACTIVITIES THAT ARE GOING ON AT ABULOMA RIVER THAT RESULT TO THE POLLUTION OF THE RIVER.

PLATE 4



TRANSPORTATION ACTIVITIES THAT ARE GOING ON AT ABULOMA RIVER THAT RESULT TO THE POLLUTION OF THE RIVER.