IMPACT OF OIL SPILLAGE ON PHYSICOCHEMICAL QUALITY PARAMETERS OF ABONEMA CREEK WATER

BY

ONWUAGBA CHINWE GRACE
REG. NO. 20114863568

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CERTIFICATION

We certify that this work Impact of Oil Spillage on Abonnema Creek in River in Port-Harcourt, Rivers State was carried out by **Onwuagba Chinwe Grace Reg No 20114863568** in partial fulfilment for the award of the degree of Master of science (M.Sc) in Environmental Technology (pollution control option) in the Department of Environmental Technology (Soet) of the Federal University of Technology Owerri (FUTO).

----------------------------------- --------------------------------
Dr. E.E. Nkwocha Date
(Supervisor)

----------------------------------- ---------------------------------
Dr. Oguzie Date
(Head of Department)

----------------------------------- ---------------------------------
Engr. (Prof. R.B. Oyoh) Date
(Dean, Post Graduate School)

---------------------------------- ---------------------------------
Prof. E.I. Udoessien
External Examiner Date

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Abstract

The current study investigated the impact of oil spillage on Physicochemical Quality parameters of Abonema creek water. Water sample was collected with a container from 3 different locations which included the control site. The samples were subjected to standard physicochemical analysis. Among other parameters analysed, conductivity(µs/cm^2) (22000 – 29600), TDS (mg/L) (15400 – 20720), total petroleum hydrocarbon (mg/L) (0.001-1246.6) SO_4^{-2}(mg/L) (350 – 510),Cl^- (mg/L) (6900-8900), Pb^{2+}(0.014 – 0.266), and alkalinity (mg/L) (65 – 75), where all above recommended WHO standard. This implies that the river is polluted by the discharge of effluent from petroleum exploration activities. Water sample from the affected site was more higher than that of the control. Companies should not wait until a spill is out of hand before a cleanup intervention; timely cleanup exercise should be encouraged.

KEYWORDS: Mangroove swamp, Biodiversity, Paraffin, Hydro-carbon, Exploration, Hazards**.**

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Oil spillage is the release of liquid petroleum hydrocarbon into the environment especially marine area due to human and or natural activities. It is a form of pollution. The term is usually applied to marine oil spill where oil is released into the ocean or coastal water. Spills may also occur on land.

Sources of oil spill can be traced to tankers operations, terminal operations, jetty operations, depot operations, off shore platforms, drilling rigs, wells and flow stations, refinery operations and pipeline transport. Commercial oil production started in Nigeria in the year 1956 and since then, the Niger Delta have become the sink for environmental consequences of oil and gas activities. Today Nigerian per day oil production capacity is leading other African nations and is the sixth in the world (NNPC, 2013). Invariably it will enjoy same position or worst of oil spill experiences.

Although, natural seeps can cause oil spill but most pronounced is anthropogenic sources which arises from production facilities in areas like deep sea which offers less favourable environment for operation.

Equipment failure is a major cause of oil spillage. In the Niger Delta sabotage, bunkering activities and illegal refining of crude oil is contributing in no small way to oil spillage.

Transport and storage facilities through leakages, breakdown, overflow and insufficient operators is gradually becoming a major source of worry as spill from this sources are now more frequent.

Indiscriminate discharge of oil effluent is a common cause of spillage in the Niger Delta.

Oyem (2001) pointed out other causes of oil spillage in Nigeria which appear remote or less immediate to include among other things, low technical capacity, weak law and almost zero enforcement of the extant laws, the nonchalant attitude of multinational operations in matters concerning Nigeria environmental protection, low indigenous human capacity in the field of oil spill prevention , timely detection and management.

In Abonnema like in most Niger Delta communities, activities like oil transportation, loading and off loading of oil materials, bunkering, illegal refining, drilling operation, flow station operation, terminal/depot operation and oil contaminated effluent discharge as well as pipeline vandalism have lead to the release of millions of barrels of liquid petroleum hydrocarbon into the rivers, creeks, water channels and land.

The 1954 convention for the prevention of pollution of the sea by oil, defined oil as meaning, crude oil, fuel oil, heavy diesel oil and lubrication oil.

Crude oil are complex mixture of hydrocarbon of varying molecular weight and structure comprising three main chemical groups; parafines, naphtenes and aromatics. They range from simple highly volatile substance to complex wastes and asphaltic compounds. Nigeria crude oil is classified as high quality, low sulphur and light. It has major element as carbon 85%, hydrogen 14%, then sulphur (H_2S, SO_2, S) 1 – 3% while Nitrogen, Oxygen, Metals (Nickel, Iron, Vanadium, Cadmium, Arsenic, Copper, Lead and Mineral Salts are the minor constituents.

Water pollution, being the addition of organic or inorganic substance that may affect the physical, chemical and biological properties of water, renders it unfit for a particular use (Singh, *et al*, 2007). The river and creeks are continuous renewable resource and a valuable store of potential energy and a real repository of wide variety of flora and fauna. This important ecosystem component, records a shift in its physico-chemical and biological properties leading to a degradation in the water quality.

The creek water quality and sediment parameters include.

Physical – Temperature, colour, Taste, Odour, turbidity, Electrical conductivity, total dissolved solids, total suspended solids.

Chemical – pH, hardness, acidity alkalinity, dissolved oxygen, BOD, COD, TOC, VOC, chloride, magnesium and calcium.

Nutrient – Nitrates, Phosphates, Organic Nitrogen, Nitrites, Ammonia, synthetic detergent.

Trace Metals- Arsenic, lead, manganese, mercury, iron, copper, cadmium, Chromium, Nickel, vanadium.

Biological – Bacteria, Algae, pathogenic and indicator organism. (Deborah, 1992).

Once oil is spilt on water, series of physical and chemical changes known as weathering will begin to occur the change can take the process of evaporation, spreading, oxidation and photo oxidation, Emulsification biodegradation, sinking, dissolution and dispersion.

These processes tend to treat oil spills but the volume of spill is usually over bearing for the natural process the big challenge of oil spill management is that despite the problem of protecting in shore water like the Abonnema creek, cleaning up contaminated shorelines and oily debris have been generally neglected. Most government have remained largely contented to leave such problem to local administrations that individually lack the required equipment, material and more importantly the trained and experienced supervisors to plan and control an effective cleanup operation (Commission of the European Communities, 1980). The international intervention in Ogoni land clean up is a welcome development. Wish it will go round the entire Niger Delta and Abonnema inclusive.

Whenever there is oil spillage ,the cost of the impact are much felt in the environment so it is better prevented than allowed to occur. Consider the cost of cleanup activities, ecosystem preservation, legal settlement of affected people associated with oil spillage. Ekekwe (1981) studied the impact of spillage on aquatic flora. When spillage occurs on land like the Ejamah-Ebuubu oil spill near Eleme in Rivers State, it was observed that the soil fertility are very much impacted making it unfit for farming while in surface waters the fishes are affected leading to loss of fishing. In Abonnema oil spillage resulted in thick layers of crude oil polluting the water in the centre stretch of the river and creeks, various communities are affected.

This study will be looking at the impact of oil spillage on the Creek water and Sediment of Abonnema with respect to its physico chemical properties.

1.2 Statement of the Problem

Abonnema Creek is an off short channel of the Abonnema River. In the course of river transport sedimentary materials and aquatic organisms are carried in the form of dissolved load, suspended load and bed load which are deposited at the creek bed. Considering the fact that the Creek receives water at about one week interval, the sediment is usually rich in crustaceans like lobster, crabs, shrimps, crayfish and water fleas, the people hunt these resources before the water returns. When oil spillage occurs the once rich creek will become a receiver of oil spill and dead organisms with the creek sediment becoming the sink for these products of pollution (Igbo 2000). Today who is talking about hunting crustaceans and other aquatic animals in the Creek, they are all gone with layers of oil materials forming the sediment bed.

The Abonnema Creek is suspected to have being impacted by oil spillage which can be appreciated from the destruction of the recreational potentials of the Creek. The community used to be a fishing area, the net total loss of fish, crustaceans and other aquatic animals is worrisome and sometimes the few caught are tainted and suspected to be contaminated with toxic materials. Eutrophication is on the increase while some essential Creek flora are disappearing, people have abandoned fishing grounds and traditional pre-occupation in chase of white and blue color jobs which are rather elusive resulting to increase in unrest and crime rates. Unique birds of the creeks are dying and some emigrating.

Loss of drinking water and water for other uses is now common; the situation of so much water but none to drink is the case in Abonnema. The town is witnessing a serious impairment of human health, forced population migration, loss of aesthetics, loss of fishing culture, food insecurity, embitterment of affected communities and insecurity of lives and properties. Who says we are not sitting on a gun powder, our wealth, our environment our plight what a sorry situation.

This study has identified the problem of oil pollution in Abonnema Creek resulting from oil spillage and tends to assess the physico chemical parameters of Abonnema Creek water with a view of finding out the extent of contamination by oil spill to enable the researcher proffer possible solutions.

1.3 Aim and Objectives of the Study

The aim of this research is to study the impact of oil spillage on Abonnema Creek.

In order to achieve the aim the study will be anchored on the following objectives.

a) To determine the level of total petroleum hydrocarbon in the sample

b) To assess the level of heavy metals in the sample

c) To ascertain physical properties of the sample

d) To determine the other chemical characteristics of the sample

e) To establish the impact of oil spill on the water quantity

f) To compare the result with existing standard

g) To determine which among the sample locations has the highest impact of oil spill on the water quantity.

1.4 Scope of the Study

This study will focus on the Abonnema creek, analysis will be on physic-chemical parameters including temperature, pH, conductivity, TSS, TDS, COD, BOD, Total Petroleum Hydrocarbon, Sulphate, Chloride, Lead, Phosphate, Iron, Alkalinity, Odour, Colour and Taste only. It will also emphasize on established water and sediment quality standards like DPR & NESREA.

Sampling and laboratory analysis would conform to the APHA guidelines while statistical analysis involving range, mean, standard deviation and bar charts only would be used. Impact will be deduced from the result of the analysis and literature. The time span would be six months.

1.5 Research Questions.

The research will attempt to find answers to the following questions.

1. What are the concentration level of pollutants in Abonnema Creek water?
2. Is the water in Abonnema Creek portable or not?
3. Did the laboratory results fall within the limits of established standards or were there exceedances?
4. Are there impacts traceable to the Abonnema creek water
5. Which among the sample locations has the highest impact of oil spill on the water quantity?

1.6 Research Hypothesis Question:

In order to determine which among the various sample location has the highest impact of oil spill on the water quality, the research question 5 has to be addressed by a research hypothesis question. Thus we have the null hypothesis (H_0) and the alternative hypothesis (H_1) as stated below:

H_0: There are no significant differences among the sample locations regarding the impact of oil spill on the water quantity.

H_1: There are significant differences among the sample locations regarding the impact of oil spill on the water quantity.

1.7 Significance of the Study

This study will;

a) be a tool for policy making as it affects oil and gas related activities in Abonnema.
b) it will check the excess oil of operators in the area.
c) it will aid the prevention and stoppage of bunkering and illegal refining in the area.
d) it will enhance clean up, recovery and remediation of the study area.
e) the study will also enlighten and educate the stakeholders on the state of their immediate environment.
f) it will serve as a source of information for future research.
g) It will help prevent deterioration of fresh water quantity

CHAPTER TWO

2.0 REVIEW OF LITERATURE

2.1 OIL AND GAS EXPLORATION IN NIGERIA

The Nigerian Bilumencorporation whose activities terminated with the outbreak of First World War in 1914.

In 1937 Shell 'D' Arch which metamorphosed into shell BP in 1956 and now shell petroleum development company (SPDC) was granted license covering the entire nation. Their activities was disrupted by the second world war, the company later resumed exploratory activities in 1947, which lead to the spudding of the first well in IHUO Eastern Nigerian in 1951, after this well many unsuccessful wells were drilled until in January 1956, when the first commercial oil well was discovered in Oloibiri in the present day Bayelsa.

The Niger Delta consist of diverse ecosystems, mangrove swamps, fresh water swamps, rain forest and it is the largest wetland in Africa but due to oil pollution the area is now characterized by contaminated streams and rivers, forest destruction and biodiversity loss. In general the area is an ecological wasteland (Onuoha, 2008).

Nigeria today has over 1,481 oil wells, 159 oil fields, more than 700 kilometer of pipelines and 275 flow station operated by more than 600 barrel per day production capacity in 1956 Nigeria now produced from its onshore, coastal, offshore and deep water 2.5 million barrels per day of crude oil making her first in Africa and sixth in the world crude oil are complex mixture of hydro-carbon of varying molecular weight and structure comprising paraffin, naphteries and aromatics. They are sometime found mixed up with gas.

Studies have shown that the quantity of oil spilled over 50 years was at least 9 – 13 million barrels, which is equivalent to 50 Exxon Valdez spills (FME *et al*, 2006)

The post 100 years can be referred to as the oil age as crude oil dominated the energy sector, its major application is in transportations, power, industry and domestic heating (Essien 1998).

2.2 Oil spillage in Nigeria Niger Delta

Nigeria is now faced with increasing environmental problems and unless laws guiding environment are properly implemented more serious problem will continue to arise.

Oil exploration activities have caused pollution hazard from accidental oil spillage or pipeline vandalization. Quite often, these hazards reach disaster proportions as interested in 1999, Jesse Delta state oil pipe burst causing fire disaster that consumed about 1000 people in addition to large scale destruction. In 2003 similar disaster occurred in Isiukwuato, Abia State (Umoh, 2004).

The mobile oil spillage of 1998 resulted to a loss of about 40, 000 barrel of crude oil and it affected the marine eco-system of Akwa ibom. Some substance that are toxic aquatic fauna and flora were released and they are chronically lethal in concentration of a few part per million (ppm) and lethal in concentration of a few part per billion. The polluting substance pollute the water bodies by depressing phytoplankton photosynthesis, respiration and growth, kill or cause developmental abnormalities in zooplankton and the young age of many aquatic organisms, it kills shell fish, fun fish and crustaceans by its smoldering action and also ingested oil may interfere with fish nutrition (Oditte, 1999).

In shallow in shore sites and creeks contamination may persist for years and also surface organism are killed by oil on the surface of water, which limit gaseous exchange and entangle the organism. The result of spillage as reported by environmental right association (ERA) lead to the formation of thick layers of crude oil in the centre stretch of River and creeks of Abonnema.

The spilt affected severely aquatic organism like snails, crabs, lobsters, prawn, crayfish and fishes which use to be the major source of income of the people (Nov 8 1999). Defoliation and death of Rhizophoraracemosa occur 2-3 months after the spill in creeks.

The damage was due to smoldering of the pneumatyophores of mangroves.

In August 1983, Oshika village in Rivers State witnessed a spill of 5,000 barrels of oil from Ebocha-Brass (Ogada-Brass 24) pipeline which flooded the lake and swamp forest, the area has previously experienced an oil spill of smaller quantity; 500 barrels in September 1979 with mortality in crabs, fish and shrimps (Gabriel, 2004).

2.3 Causes of oil Spillage

Crude oil spillages occur daily in Nigeria from drilling and production operation, pipeline, manifolds hoses, oil tanker, oil terminal and depots.

DPR statistics between 1976-1996 showed that about 4836 spill incident occurred spilling over 2.44million barrel of oil into the environment through oil well blow out, erosion of pipeline, malfunctions of equipment and sabotage. In 1980 the largest spill in the country was the funwa Offshore blow not which spill about 400,000 barrel of crude oil into Atlantic ocean from a Texaco facility and destroyed 340 hectares of mangroves. Ekakpere community in Ugheli South

Local Government of Delta state experienced leakage from pipeline which resulted to over 3000 women taking to the street against the poor management of oil spill by SPDC.

At Abonnema in Akuku Toru LGA of Rivers state a spill occurred as a result of shell rusty pressure pipeline. The Abonnema spillage spread to Idama, Kola and Elem Kelabani creeks, it also spread to Abuloma, Eleme, Sagama, old Bakama and Ifoku in Asari Toru L.G.A. The Mobil oil spill in Akwa Ibom of 1998 occurred due to corrosion and failure on pipeline conveying crude oil from Idoho production platform to Quaiboe terminal. The spill spread to as far as Lagos coat (National Concord, May 6, 1996) SPDC reported an oil spill of about 1500 barrels from a 24 Inch pissing manifold at Chanonic creek in Warri, Delta State. The Punch, December 31, 1999) this spill was due to Sabotage from the communities. Sabotage was by far the most serious cause of oil spillage in SPDC operation in 1997, it went further to say that almost all oil spills from SPDC facilities were due to 80% sabotage, the most common methods used are sawing or drilling holes in pipelines and flow lines.

(SPDC, 1997) other causes of spillage could be discharge from tankers, effluent from refineries bunkering and illegal refinery operation.

J-Wardley *et al* (1983) from 2007 to 2011 SPDC reported that sabotage Oil theft and illegal refining were causing huge environmental damage in the Niger Delta.

2.4. Rivers/Creeks and Pollution

The river is a continuous renewable resources, a valuable store of potential energy and a real reposting of wide variety of plants and animal if there is addition of organic or inorganic substance which may affect the physico-chemical and biological properties of water rendering it unfit for a particular use the water is sad to be polluted (Pandey *et al*, 2007) the parameter associated with water quality are temperature plf, colour, turbiodity taste, Odour, electrical conductivity, Dissolve Oxygen, free COS, BOD, COD, total dissolved solids, oil adgreeseflorides phosphate, Ammonia, Nitrogen, Nitrates phenols, the pollutant are characterized by Toxicity, persistence, tendency to sorbs compactly to dispersed solubility, validity.

2.5 Characteristics of Water

The chemical formula for water is H_8O as widely recognized at low temperature. Water behaves as if molecular form was H^8O_3 or H_8O_4 held together by hydrogen bridges. Density of water increase from 0^{OC} – 4^0C and decrease after-words as temperature rises. Water boils at 100^0C and freezes at 0^0C it has high dielectric constant, low conductivity and its polar structure make it capable of dissolving a lot of substances. All natural water contain varying amount of other material in concentration ranging from minute traces at the Ngil level of trace organizes in rain water to around 35,000 Mg/L in sea water.

River and creek water is characterized as possessing the following Temperature, colour turbidity, odour, total suspended solid, total dissolved solid (TDS) pH, alkalinity Acidity hardness, dissolved oxygen, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Organic Carbon (TOC), Volatile Organic Carbon (VOC), Ammonia, Nitrogen, Nitrite, phosphate, Chloride, synthetic detergent (Surfactant), micro-organisms pathogens and radioactivity.

The suitability of water for intended use is dependent on the water quality parameters which involves the assessment of properties like-physical, chemical nutrient, trace, metals, biological and radioactive characteristics.

Some of the instrument for water quality assessment include Atomic Absorption spectroscopy (AAS) flaire photometry, Inductively coupled plasma spectroscopy, vv, visible, Infrared spectroscopy (sawperetal2003).

Quality issue are raised in River wat, er and are associated with change in physical characteristics, faccal contamination, organic matter, River Eutropuhication, Salinisation, acidification, trace element, Nitrate Pollution, Organic micro-pollution and changes in River hydrology.

2.6 Impact of crude oil spill in water

Release of crude oil into water ways have become popular with oil exploitation often poisoning drinking water and destroying vegetation: Between 1970 and 1982, 1581 incident of oil spillage were documented in Nigeria from 1982 to 1992, 1976000 gallons were spilt in 27 separate incidence. The area is subjected to gross flood and wide coastal erosion which greatly affected farming and fishing settlement thereby rendering the people jobless. Fisheries depletion, deforestation, loss of bio-diversity and logging of canalization are experienced in oil producing communities.

Fresh and marine water and their sediment, support a wide range of microbial communities including the phytoplanktons, zooplanktons as well as higher aquatic life forms (Fekumo, 2001). The effect of oil pollution on aquatic life and human health are diverse as they are complex.

However, they were able to identity the following effect.

Oil is cementing on normal metabolic and physiological functions of fish and oysters and therefore retards their growth and multiplication. The flesh of aquatic organism are tainted by petroleum product and by product thus rendering such organism in-edible.

The formation of oil film on the water surface limit oxygen exchange, kill surface organism, contaminate, water and increase the content of water soluble material. This may be toxic to aquatic organism. Water contaminate with oil is also toxic to human and livestocks. Crude oil exposure presents a potential hazard to both aquatic and terrestrial species.

In Nigeria exposure of crude oil in the aquatic environment is on the increase following the several spillage that have occurred in the costal water. Costal water had earlier estimated that an average of 11 – 54mg/l of oil is dissolved in water. This deserves attention owing to the possibility of bioaccumulation and bio-concentration of crude oil component in aquatic live and the attendant consequences of ingesting such aquatic species. Audience from other population abounds on the toxic injuries resulting from ingesting animal exposed to polluted water. The existence of aquatic specie is also threatened by spillage.

Studies have reported reduction in species densities and diversity in Nigerian environment contaminated by oil from oil spill within the inter-tidal zones.

The effect of oil in aquatic system is perilous. It distorts the beach/costal aesthetic, depletes fisheries potential, impacts on water productivity and human health. Initial impact of oil contamination result in the suffixation of natural biotic communities due to oil covering water surface in such a way that primary producers and higher species in the food chain become impacted (Nelson-Smith, 1979).

The effect of crude oil pollution of marine environment maintained that oil spillage is one of the most devastating form of pollution in the marine environment several barrels of spillage there is emulsification, weathering and the alkane component evaporates.

The Alkene and alkynes double and triple bonds the floating oil leads to a mass killing of fish, shrimps, crustaceans mammals, birds, sea weeds, mongering plant and reduces natural repelling of water.

2.7 Effects of Oil Spill On Human

Naanen (1995) observed that the most conspicuous aspect of life in contemporary Niger Delta are poverty, ambulation and diseases. Although oil from Niger Delta sustains the Nigeria economy but the people see more of corruption, fund diversion, mismanagement and non-challenge than development. Naanen (1995) in his contribution said that oil is a cause of the Niger Delta and Nigeria,probles of poverty, poor infrastructure, and exploitation of resident, no clean water, abysmal health care no job for displaced farmers, fisher and youths.

In the Niger Delta, there were 2, 976 oil spill between 1976 and 1991, the number increased to 5,400 from 1990 to 2005. The area have had several problems stemming from oil spillage including water contamination and loss of many valuable species, a world bank investigation found level of hydrocarbon pollution in Niger Delta.

Ake (1996) found petroleum hydrocarbon in one of the Niger Delta villages water source to be 360 times the level allowed in the European community where shell originate.

Owens wiwa, a physician has observed higher rate of certain disease like bronchial asthma. Other respiratory diseases, gastroenteritis, cancer and chronic headache among the people in the area as a result of oil activity.

Niger Delta communities have suffered damage to farmland and water bodies as a result of spillage leading to a decrease in agricultural input and lowering the earning capacity of the people. The people have also suffered from death arising from poisoning.

Communities in Niger Delta grow cassava, yam, banana, and so on, but the soil is no longer fertile. Local residents are no longer able to fish because the water ways are polluted. These cause food scarcity problems and unemployment.

According to Bossert and Bartha (1984) oil pollution constitute a great threat to ground water and contribute to water poisoning and diseases out break 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 low concentrations.

A world bank study indicate that in sub-Saharan Africa, contaminated drinking water and poor signification contributes to infection and parasitic disease that account for over 621 of all deaths. (World Bank, 1992)

Crude oil and its constituents enters the human body through skin absorption legation, food and drink, inhalation of fumes, particles and gases observed that the imminent hazard of the consumption of crude oil polluted food, water and fish is the spread of epidemics.

It was observed that the combined loss of labour income and assets as a result of oil exploration is likely to increase food, nutrition, and livelihood insecurity and deepen poverty and undermine the residence and river suitability of house hold coping mechanism among some house hold in long term.

2.8 Incident of Oil Spillage in Nigeria

When oil spills on water, spreading immediately takes place the gaseous and liquid component evaporate, some get dissolved in water and even oxidize, some undergo biodegradation and eventually sink to the bottom by gravitational action.

Plate 2.1. Effect of oil spill on aquatic organism

Plate 2.2. Oil spill site in Abonnema Creek in River State

Plate 2.3. Abonnema Creek in Rivers State

CHAPTER THREE:

3.0 MATERIALS AND METHODS

3.1 The Study Area

3.1.2 Location and site

The study was carried out at Abonnema river that passes through Port–Harcourt Rivers State. Abonnema town is situated between Latitude 4^0 07^1 and $4^0.25^1$N and longitude 7^0 03^1E and 7^0 06^1E of the green which meridian. The site of the town is characterized by relatively low elevation and flat topography which enhances natural run off.

Abonnema river is recharged by precipitation and ground water.

3.1.3 Climate and vegetation

The area is located in the humid tropics with characteristic heavy rainfall averaging about 2404mm between April and October during the rainy season. Most part of the area is flooded during this period due to poor drainage system and indiscriminate construction growing in the area.

The dry season starts from November and ends in March characterized by dry and hot wind, with little or no rainfall. The annual mean temperature was 29^0C with the highest recorded mean temperature of 29^oC and the lowest monthly mean 24^0C.

The Vegetation is characteristically mangrove with the dominant type and mangrove (Rhizophers). White mangrove and the black mangrove, the area is rich in tropical plant and animal. The surface sea water temperature values ranged between 25.9^oC and 30.6^oC and the salinity of the river water ranged between 8% and 20%.

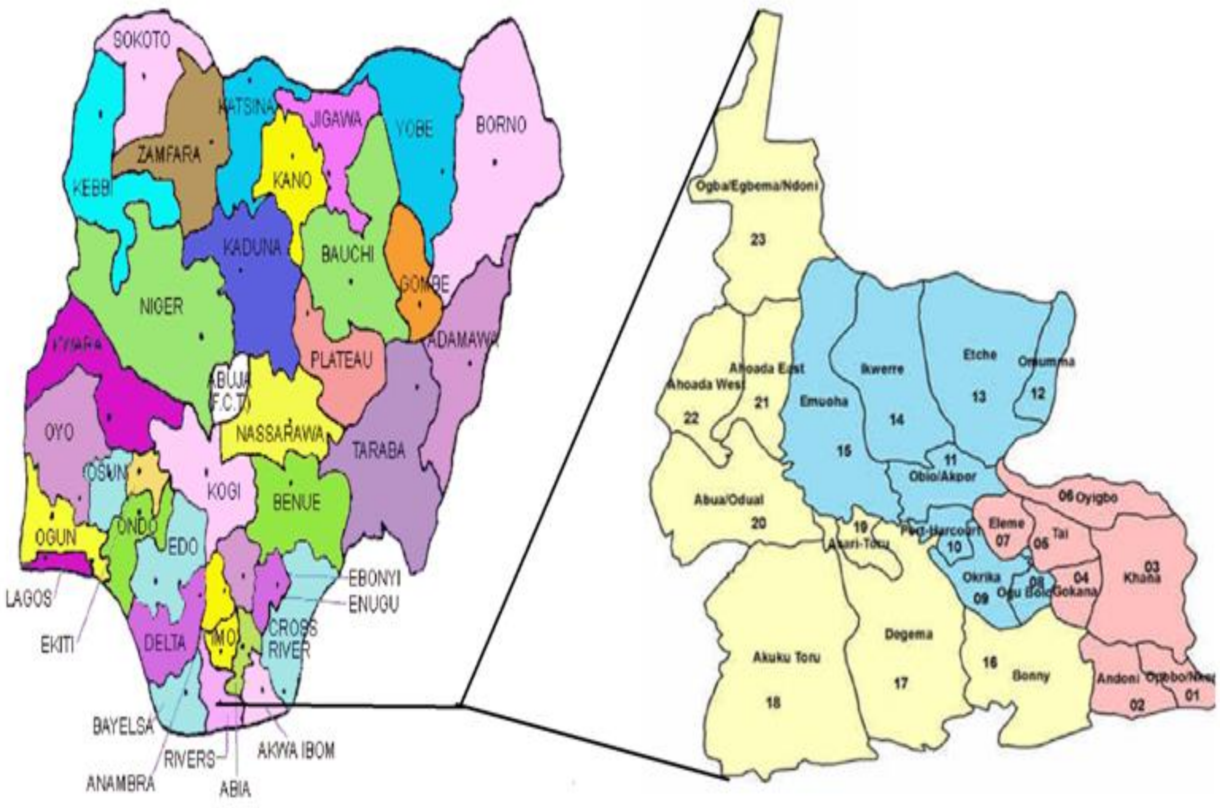

Fig 3.1. Map of Nigeria showing Rivers State

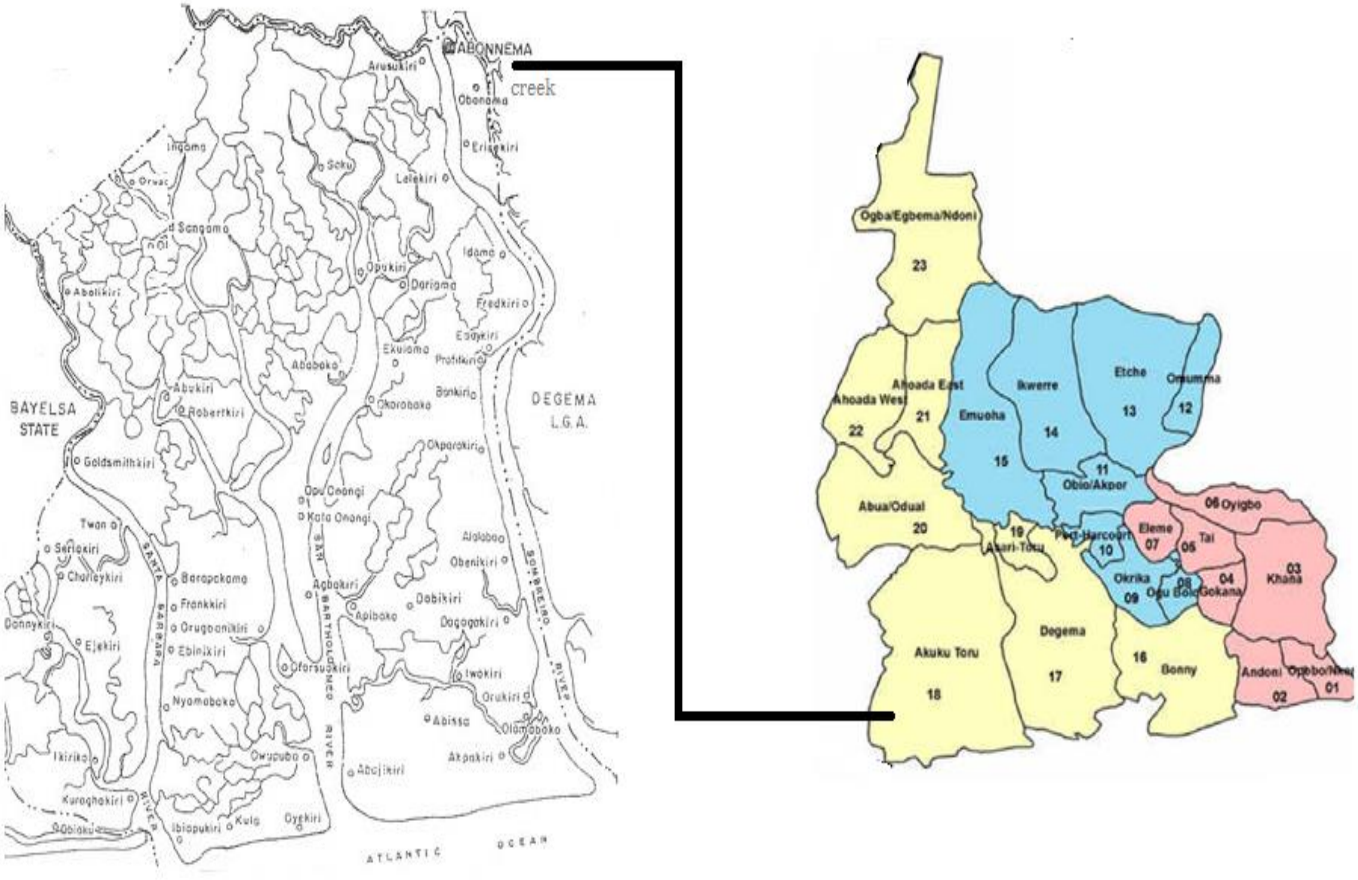

Fig 3.2. Map of Rivers State showing Abonema Creek in Rivers State

3.1.4 Population and Activities

The estimated population of Abonnema town is based on population census data of 2006. The main occupation of the local population are farming, fishing and trading. Farming activities takes place on the dry land ridges within the galloping swampy forest producing cassava, maize, cocoyam and other food crops and vegetables mainly for local consumption.

Fishing is another important economic activity as fish constitutes a major source of protein to local population. The catches are partly retained for consumption and little quantity for sale at local market.

3.1.5 Infrastructural Facilities

Infrastructures are those basic amenities in forms of road, school, health centre, market that are needed to enhance living standard.

3.1.6 Sampling location

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

The sample was collected during the dry season; 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 located within the impacted area at a distance of 100 meters apart while the other one is located outside the areas (i.e the control point). The reasons for the above space points were located

a) accessibility of sampling points

b) distance from discharge points i.e spills

c) direction of flow of the water body.

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

Water samples were taken from different location designed A, B and C. In the oil spill area of Abonnema 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 where bunkering activities were going on and it was about 100 meters from sample location A. Sample C was taken from the downstream where industrial activities were going on. The sample location C was about 100 meters from the sample location B. Three basic conditions were considered during the collection of the sample, namely accessibility of sample points, distance of discharged points and direction of flow of the river.

3.1.7 Sampling Method

The Sample was collected with a sample container and it was completely filled. When collecting the sample from the sampling points, great care was taken to avoid undue contamination and the avoidance of metal-lined cap was taken into consideration. The samples were transported to the laboratory in good conditions.

3.1.8 Sample Preservation

Collected samples were properly labelled with white masking tape and named to avoid a mix-up with other people’s samples in the laboratory. These samples were immediately analyzed on arrival at the laboratory. During transportation they were stored at low temperature.

3.1.9 Sample Treatment

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

3.2 Analysis of Physicochemical Parameters

3.2.1 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 gave pH of 4.0 and 7.0 respectively. After calibration, rinsed with de-ionized water, poured in 50ml of the sample into a breaker and standardized probe immersed in it to get the pH value. All samples were adjusted to a temperature of 25°C before pH measurements. These were done for the various water samples to get their respective pH values.

3.2.2 Temperature

A 0-100°C 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 done at the time of sampling.

3.2.3 Conductivity

Conductivity was measured by the conductivity meter at sample temperature of 25°C Results were reported in microsiemens per centimetre us/cm.

Method: instrumental method (use of hanna conductivity meter)

Apparatus: Beaker, conductivity meter (EC215), cylinders, thermometer, water bath.

Reagents: 0.011g Anhydrous Potassium Chloride, distilled water

Procedure: the standard solutions were placed into three cylinders and the water sample into three other cylinders. These samples were kept for 30mins inside water bath to obtain a constant temperature of 25°C. The conductivity cell probe was rinsed thoroughly by moving it up and down several times in the standard solution and measuring. The resistance in the second and third cylinders. The procedure is repeated with the sample measurement. The record resistance valve is obtained from the standard solution and compared with that of the sample to give the conductivity level.

3.2.4 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.

3.2.5 Total Dissolved Solid (TDS)

Filtered samples are evaporated and dried in weighed dishes at 105°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 were 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/1) of sample.

Method: APHA 209C

Apparatus: Beakers, Hanna TDS meter

Procedure: the TDS meter was switched on and the probe rinsed with distilled water. The probe was then immersed into the water sample and the corresponding reading was recorded in miligrams per liter (mg/l).

3.2.6 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 oven, as in the case of total dissolved solid and further dried at 105°C for two hours in the oven. They were cooled in desiccators and weighed. The difference between the weights obtained gave the value of the total suspended solid content for the sample. The results are expressed in milligrams suspended solid per liter of sample.

3.2.7 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 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 KMO_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 boiled water directly from the heater for 5 minute.

Blank: 20ml distilled water in a 100ml beaker, 1ml solvet, 2ml KMO_4 (0.8gl) and 20ml $FeNH_4$ (SO_2) $12H_2O$ solution was added. The mixture was made up to 50ml and boiled for 5 minutes, then read using the COD meter probe.

The COD meter was adjusted to 0.00 using a blank 20ml $AgNO_3$, 2ml KMO_4 and 20ml $FeNH_4$ $(SO)_2.12H_2O$ 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.

3.2.8 Biochemical Oxygen Demand (BOD)

Method: US mean Dilution.

Principle: Sample was diluted to different degrees using dilution water prepared for seeding. The dilution solution was incubated for five days in darkness in a harmostatically controlled en enclosure (20^0C). The quantity of oxygen consumed was then measured as the difference in dissolved oxygen before and after incubation

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 sample were diluted according to their COD content. Such that for each sample there were about 4 dilution in duplicates. The volumes of the bottles as marked on item were noted. One set of the diluted sample 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 $MnSO_4$ and H_2SO_4 were added and the precipitates dissolved (solution then turned yellow). The solution was shaken and transferred into a 250ml Erlenmyer flask and filtered with 0.4N $Na_2S_2O_3$ solution to light yellow colour.

$$DO = \frac{\text{Vo1 of Liter x Di1. Factor x 200}}{\text{Vo1. Of bottle 2.0}}$$

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.

3.2.9 Total Petroleum Hydrocarbon (TPH)

Extraction: 2gm of sample were weighted 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 pare filled into Buchner funnel. The extracts were concentrated to 2ml and then transferred for clean up/ separation.

1cm of moderately packed glass wool was placed at the bottom of 10mm ID x 250mm long chromatographic 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 extraction was transfer into the column. The extraction 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 fraction was transferred into labeled glass vial with Teflon rubber crimp caps for GC analysis. Lul 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

3.3 Sulphate

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

3.3.1 Chloride

The titration method was used and the reagents used was silver nitrate and potassium chromate. 250ml of the sample was pipetted into an Erlenmeyer flask 2 or 3 drops of potassium chromate was added and swirled. While still stirring, it was titrated with standard silver nitrate to the first permanent re tinge of silver chromate. The end point was reached when the reddish tinge persist. The chloride concentration is expressed in mg/1 of water.

$$CC\ (mg/1) = \frac{\text{Vol of AgNo3 x 1000}}{\text{Vol. of sample.}}$$

3.3.2 Lead

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

Reagent – Dethizone

Wavelength – 520nm

3.3.3 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/1 was obtained the calibration curve.

3.3.4 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/1 Fe proph. Another sample cell with 10ml of sample was filled which the blank was with 10ml, then placed into the cell holder and light shield closed for zeroing within thirty minutes after the time 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.

3.3.5 Alkalinity

A titrimetry method was used to determine the alkalinity of water sample the reagent used was sulphuric acid, methy1 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.

3.3.6 Method of Data Analysis

This research work involves the application of One-way Analysis of Variance (ANOVA). This statistical tool was considered due to the nature of the study and the data collected.

3.3.7 The One-Way Analysis of Variance (ANOVA)

The one-way analysis of variance (ANOVA) is a generalization of the two sample t-test to $k \geq 2$ groups. Assume that the populations of interest have the following (unknown) population means and standard deviations:

Table 3.1 Mean and Standard deviation of k - population

	population 1	population 2	…	population k
Mean	μ_1	μ_2	⋯	μ_k
Stddev	ó$_1$	ó$_2$	⋯	ó$_k$

A usual interest in ANOVA is whether µ1 = µ2 = ⋯ = µk. If not, then we wish to know which means differ, and by how much. To answer these questions we select samples from each of the k populations, leading to the following data summary:

Table 3.2 Mean and Standard deviation of k - sample

	sample 1	sample 2	…	sample k
Size	n_1	n_2	··	n_k
Mean	$\overline{Y}_1$	$\overline{Y}_2$	⋯	$\overline{Y}_k$
Stddev	s_1	s_2	⋯	s_k

A little more notation is needed for the discussion. Let Y_{ij}denote the jth observation in the ith sample and define the total sample size $n* = n_1 + n_2 + \cdots + n_k$. Finally, let $\overline{\overline{Y}}$ be the average response over all samples (combined), that is

$$\overline{\overline{Y}} = \frac{\sum_{ij} Y_{ij}}{n^*} = \frac{\sum_i n_i \overline{Y}_i}{n^*}$$

Note that $\overline{\overline{Y}}$ is not the average of the sample means, unless the samples sizes ni are equal. An F-statistic is used to test $H_0 : \mu_1 = \mu_2 = \cdots = \mu_k$ against H_1 : not H_0 (that is, at least two means are different). The assumptions needed for the standard ANOVA F-test are analogous to the independent pooled two-sample t-test assumptions: (1) Independent random samples from each population. (2) The population frequency curves are normal. (3) The populations have equal standard deviations, $\sigma 1 = \sigma_2 = \cdots = \sigma_k$.

The F-test is computed from the ANOVA table, which breaks the spread in the combined data set into two components, or Sums of Squares (SS). The Within SS, often called the Residual SS or the Error SS, is the portion of the total spread due to variability within samples: SS(Within) = $(n_1 - 1) s_1^2 + (n_2 - 1)\ s_2^2 + \cdots + (n_k - 1)\ s_k^2 = \sum_{ij} \left(Y_{ij} - \overline{Y}_i\right)^2$. The Between SS, often called the Model SS, measures the spread between the sample meansSS(Between) $= n_1 \left(\overline{Y}_1 - \overline{\overline{Y}}\right)^2 + n_2 \left(\overline{Y}_2 - \overline{\overline{Y}}\right)^2 + \ldots\ n_k \left(\overline{Y}_k - \overline{\overline{Y}}\right)^2 = \sum_i n_i \left(\overline{Y}_i - \overline{\overline{Y}}\right)^2$

weighted by the sample sizes. These two SS add to give SS(Total) = SS(Between) + SS(Within) = $\sum_{i\,j} \left(Y_{i\,j} - \bar{\bar{Y}}\right)^2$

Each SS has its own degrees of freedom (df). The df(Between) is the number of groups minus one, k−1. The df(Within) is the total number of observations minus the number of groups: $(n_1 - 1) + (n_2 - 1) + \cdots + (n_k - 1) = n* - k$. These two df add to give df(Total) = $(k - 1) + (n* - k) = n* - 1$. The Sums of Squares and df are neatly arranged in a table, called the ANOVA table:

Table 3.3 The Mean Square for each source of variation of SS divided by its df

Source	df	SS	MS	F
Between Groups (Model)	dfM = k − 1	SSM $=\sum_i n_i \left(\bar{Y}_i - \bar{Y}\right)^2$	SSM/ dfM	MSM/MSE
Within Groups (Error)	dfE = n∗ − k	SSE $=\sum_i (n_i - 1)\, s_i^2$	SSE/ dfE	
Total	dfT = n∗ − 1	SST $=\sum_{i\,j} \left(Y_{i\,j} - \bar{Y}\right)^2$	SST/dfT	

The Mean Square for each source of variation is the corresponding SS divided by its df. The Mean Squares can be easily interpreted. The MS(Within)

$$\text{MS(Within)} = \frac{(n_1 - 1)\, s_1^2 + (n_2 - 1)\, s_2^2 + ... + (n_k - 1)\, s_k^2}{n^* - k} = s_{pooled}^2$$

is a weighted average of the sample variances. The MS(Within) is known as the pooled estimator of variance, and estimates the assumed common population variance. If all the sample sizes are equal, the MS(Within) is the average sample variance. The MS(Within) is identical to the pooled variance estimator in a two-sample problem when k = 2. The MS(Between)

$$\text{MS(Between)} = \frac{\sum_i n_i \left(\bar{Y}_i - \bar{\bar{Y}}\right)^2}{k - 1}$$

is the variance in the combined data set.

The decision on whether to reject $H_0 : \mu_1 = \mu_2 = \cdots = \mu_k$ is based on the ratio of the MS(Between) and the MS(Within):

$$\text{Fs} = \frac{\text{MS(Between)}}{\text{MS(Within)}}$$

Large values of Fs indicate large variability among the sample means $\bar{Y}_1, \bar{Y}_2, \ldots, \bar{Y}_k$ relative to the spread of the data within samples. That is, large values of Fs suggest that H_0 is false. Formally, for a size α test, reject H_0 if Fs ≥ Fcrit, where Fcrit is the upper-α percentile from an F distribution with numerator degrees of freedom $k-1$ and denominator degrees of freedom $n* - k$ (i.e., the df for the numerators and denominators in the F-ratio). The p-value for the test is the area under the F-probability curve to the right of Fs:

CHAPTER FOUR

4.0 RESULTS

4.1 Physicochemical parameters of water sample

The level of physicochemical parameters measured across the sampling point at the Abonema River creek are shown in Table 4.1. Wide ranges where recorded across the sampling points. Temperature ranges from 27.8-28.4, unit pH from 6.5-8.5, conductivity from 22,00-29,600, unit total dissolve solid from 15,400-20,720 unit and total suspended solid ranges from 11-21 unit.

Biochemical oxygen, Chemical oxygen demand, Total Petroleum Hydrocarbon and sulphate varied from 1.50 – 2.77, 2.352 – 4.157 , 0.01 – 1,246.6 and 350 – 510 respectively.

The level of Chloride ranges from 6,900 – 8900, that of Lead from 65 – 75, phosphate from 2.2 – 5.3 , and ranges from 0.001 – 0.01 respectively.

Table 4.1: Result of laboratory analysis of water sample

S/N	Parameter	SLA	SLB	SLC	WHO	FEPA
1	Temperature (^{o}C)	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) (mols)	15,400	20,720	18,200	500mg/1	251
5	Total Suspended Solid (TSS) (mols)	11	21	16	50	50
6	Chemical Oxygen Demand (COD) (mg/1)	2.352	4.157	2.627	10	40
7	Biochemical Oxygen Demand (mg/1)	1.50	2.77	1.65	40	-
8	Total Petroleum hydrocarbon (mg/1)	<0.001	1,246.6	1,126.0	10	-
9	Sulphate SO$_{4}^{-2}$ (mg/1)	350	510	400	200mg/1	250
10	Chloride C1^{-}(mg/1)	6,900	8,900	8,200	200	600
11	Lead (mg/1)	0.014	0.266	<0.001	0.05	0.05
12	Phosphate (mg/1)	2.2	5.3	2.2	200mg/1	-
13	Iron Fe (mg/1)	<0.001	0.103	<0.01	0.3	0.3
14	Alkalinity (mg/1)	70	65	75	10.0	10-40
15	Odour	Odourless	Offensive	Odourless	Unobjectionable	3
16	Colour	Colourless	Slight Brown	Colourless	0 – 50	15
17	Taste	Saline	Saline	Saline	Tasteless	-

Source: Field, 2010.

Key 1

SLA = Sample Location A

SLB = Sample Location B

SLC = Sample Location C

WHO = World Health Organization

FEPA = Federal Environmental Protection Agency

4.2 PHYSICO-CHEMICAL PARAMETER

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

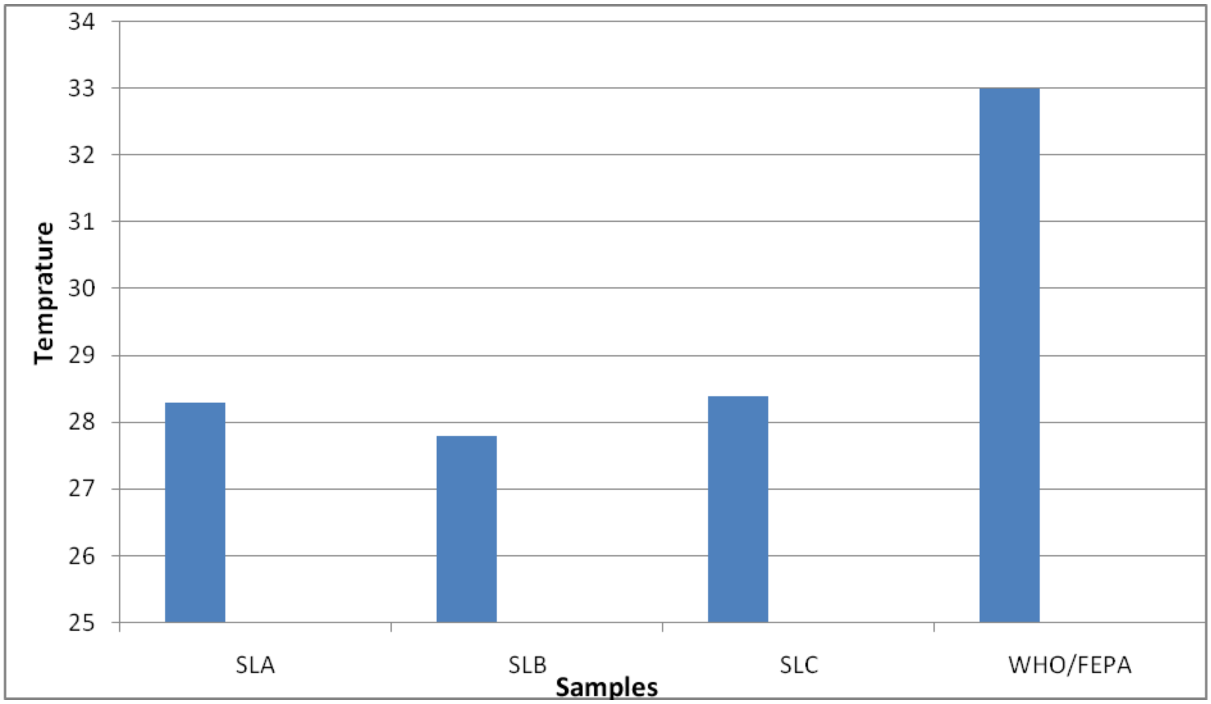

Fig 4.1 Temperature variation of various points

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 river ranges between 27.8 – 28.4 and falls within the WHO limit.

4.2.2 pH (Potential of Hydrogen)

The variation of pH along the river course of the different sample location is represent in fig 4.2

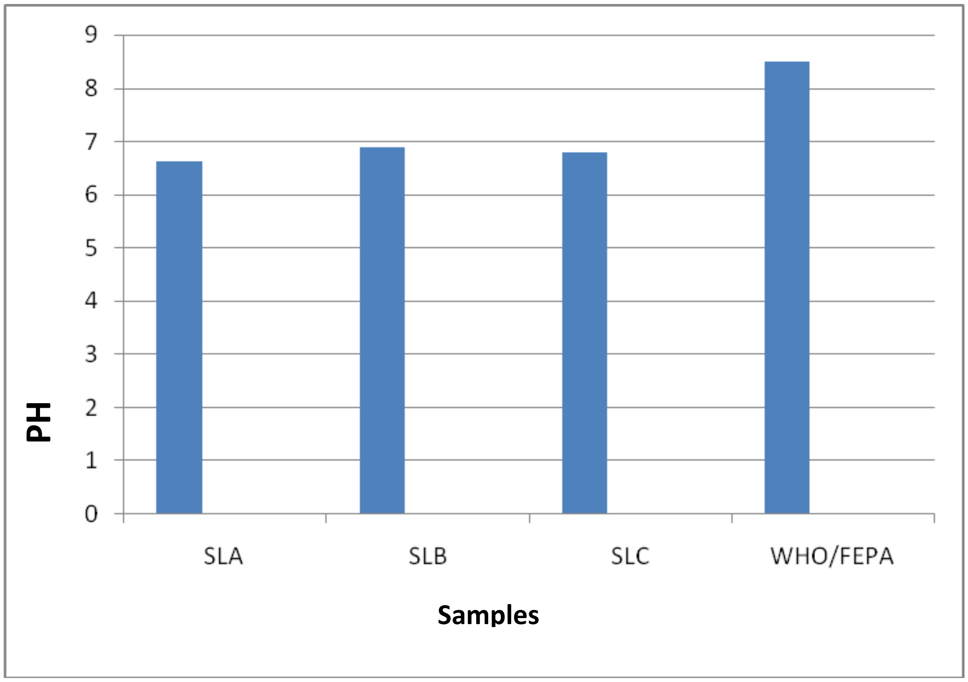

Fig 4.2 pH variation at various sampling points

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

4.2.3 CONDUCTIVITY (µs/cm^2)

The conductivity variations recorded at the three sample location are presented below

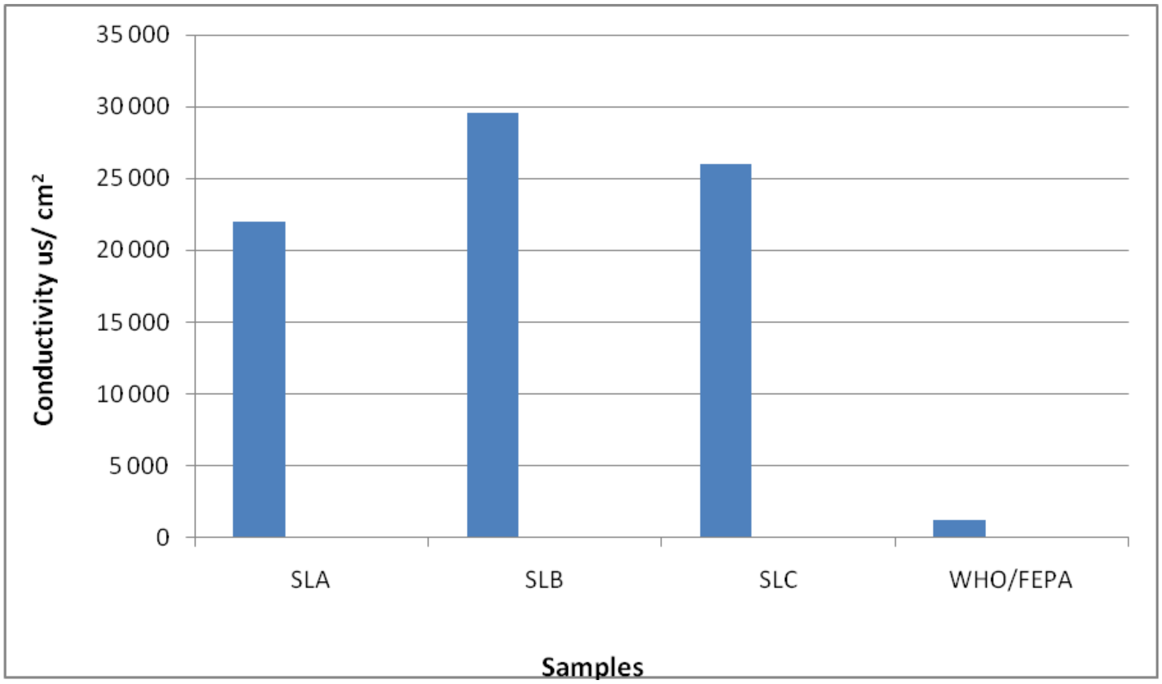

Fig. 4.3 shows conductivity variation of the river

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.

4.2.4 TOTAL DISSOLVED SOLID (TDS) (mg/1)

The amount of total dissolved solid in mg/1 at the different sampling location is presented in Fig 4.4

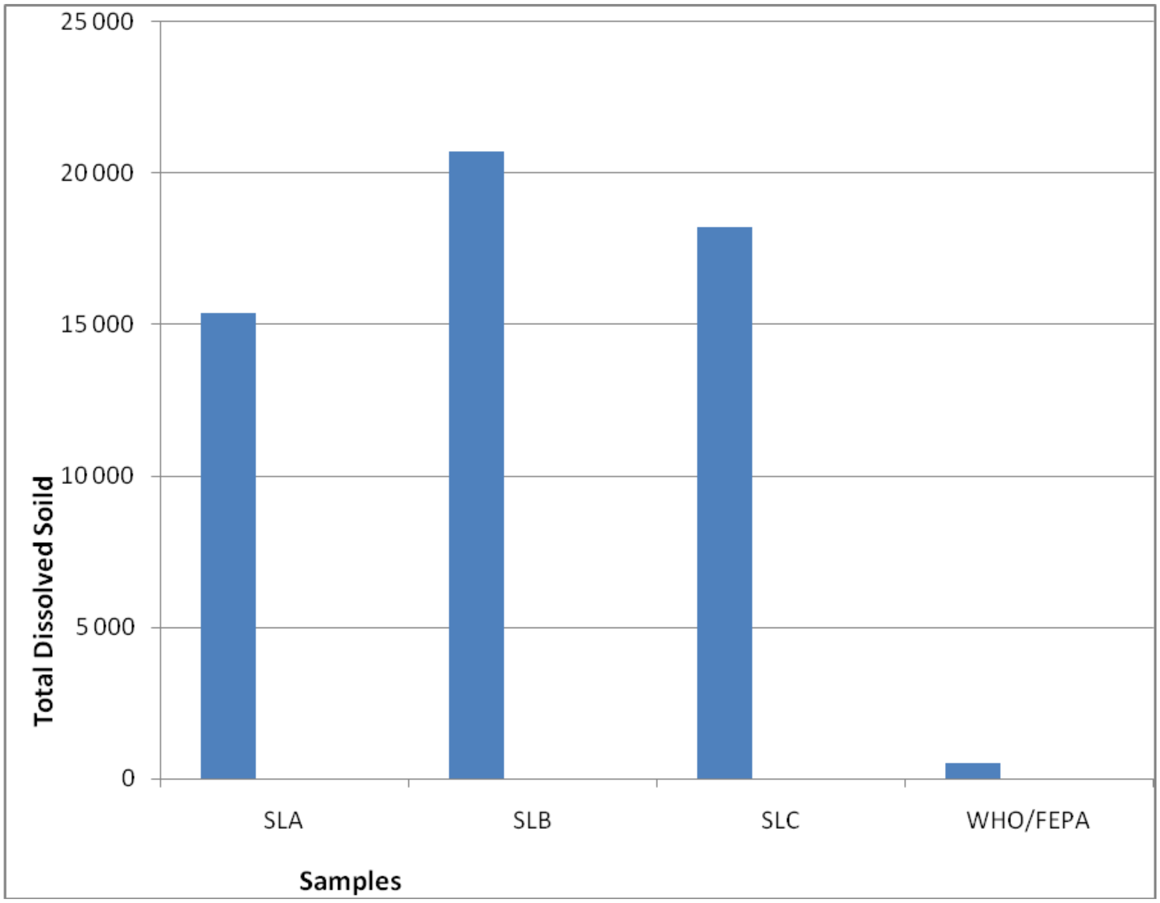

Fig 4.4 Total Dissolved solid variation of the river

From fig 4.4, it was observed that the real amount (mg/1) 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.

4.2.5 TOTAL SUSPENDED SOLID (TSS) mg/1

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

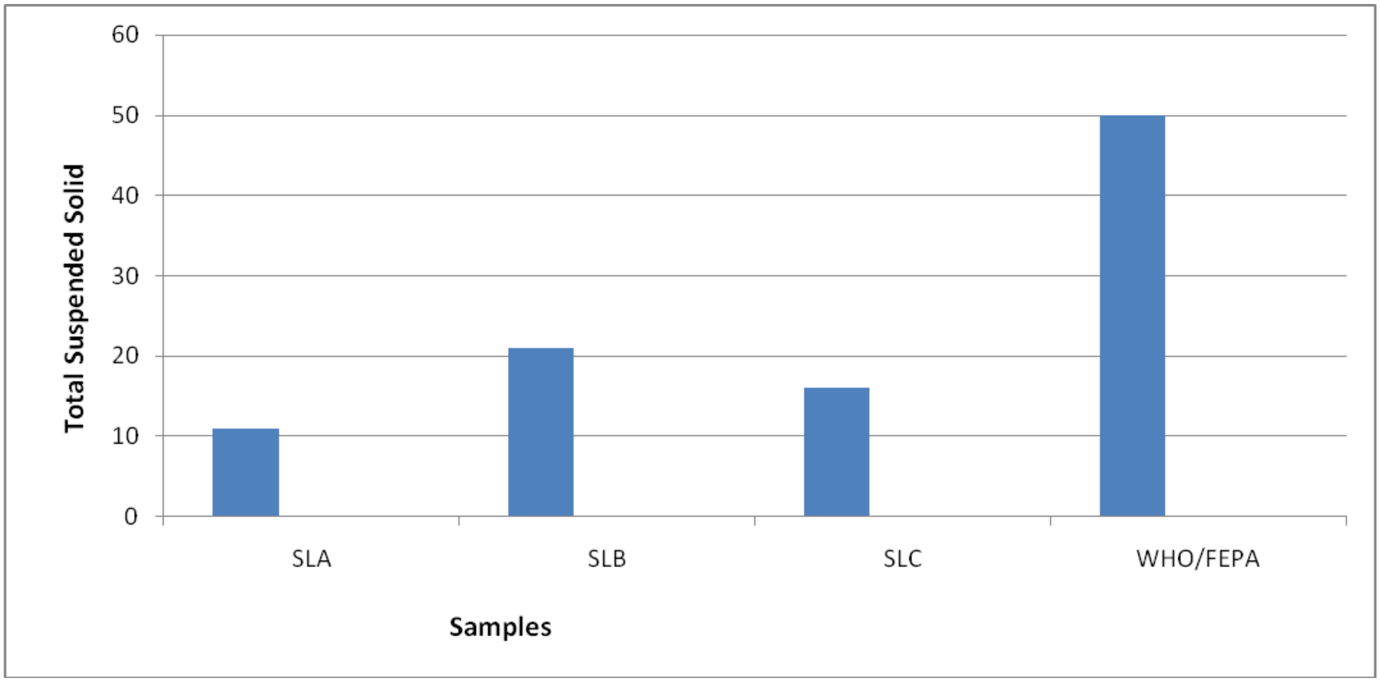

Fig. 4.5 Total Suspended Solid variation at various points

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.

4.2.6 BIOCHEMICAL OXYGEN DEMAND (BOD_5)

The BOD_5 at 20°c of the rule, from three representative points is given in Fig 4.6

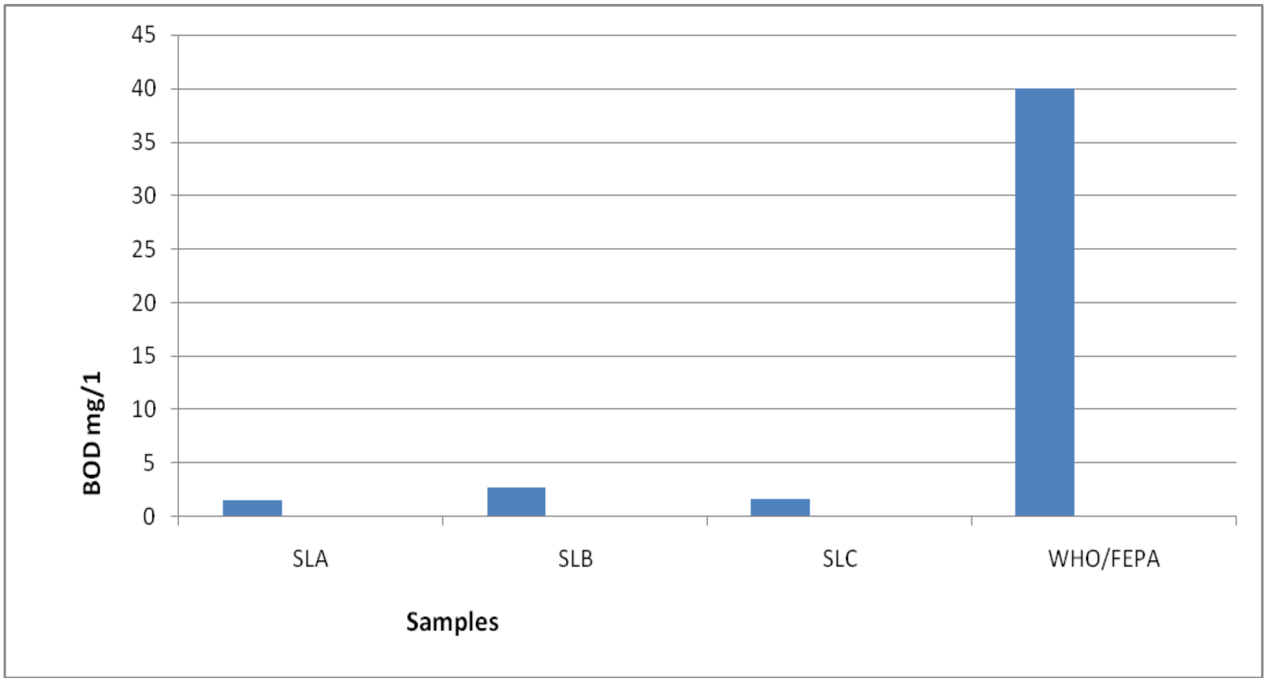

Fig 4.6 shows BOD_5 concentration of the river

From fig 4.6, SLA 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.

4.2.7 Chemical Oxygen Demand (COD)

The chemical oxygen demand of the river as indicated at the three sampling points are presented in Fig 4.7

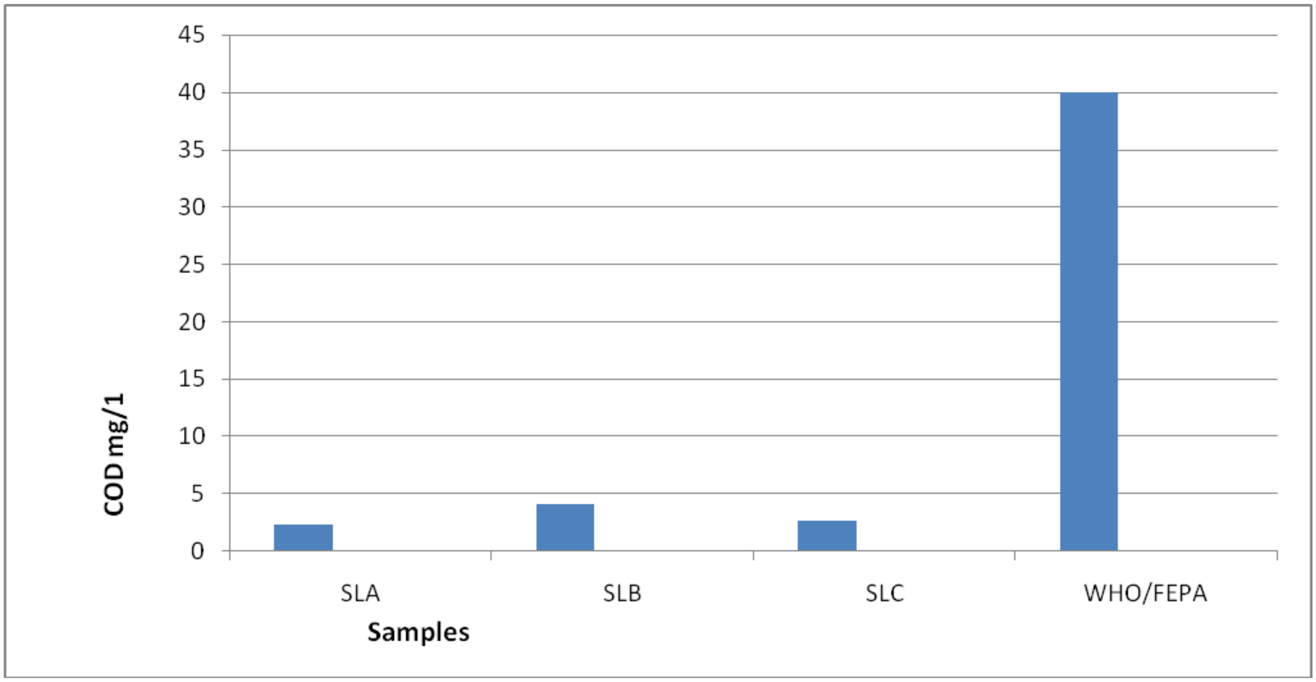

Fig. 4.7 shows COD concentration

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

4.2.8 TOTAL PETROLEUM HYDROCARBON mg/1

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

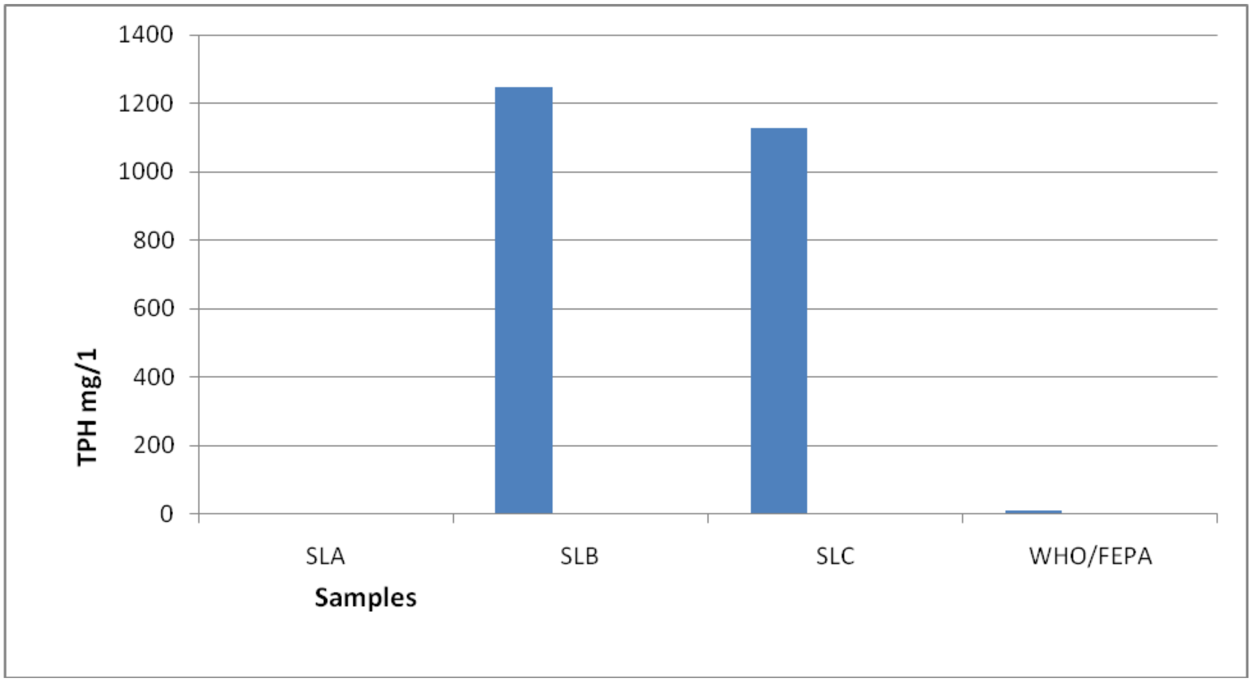

Fig 4.8 Total petroleum hydrocarbon at various point

From Fig 4.8, it was observed that the total petroleum hydrocarbon concentration of the river decreases down the river with 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

4.2.9 Sulphate SO_4^{2-} mg/1

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

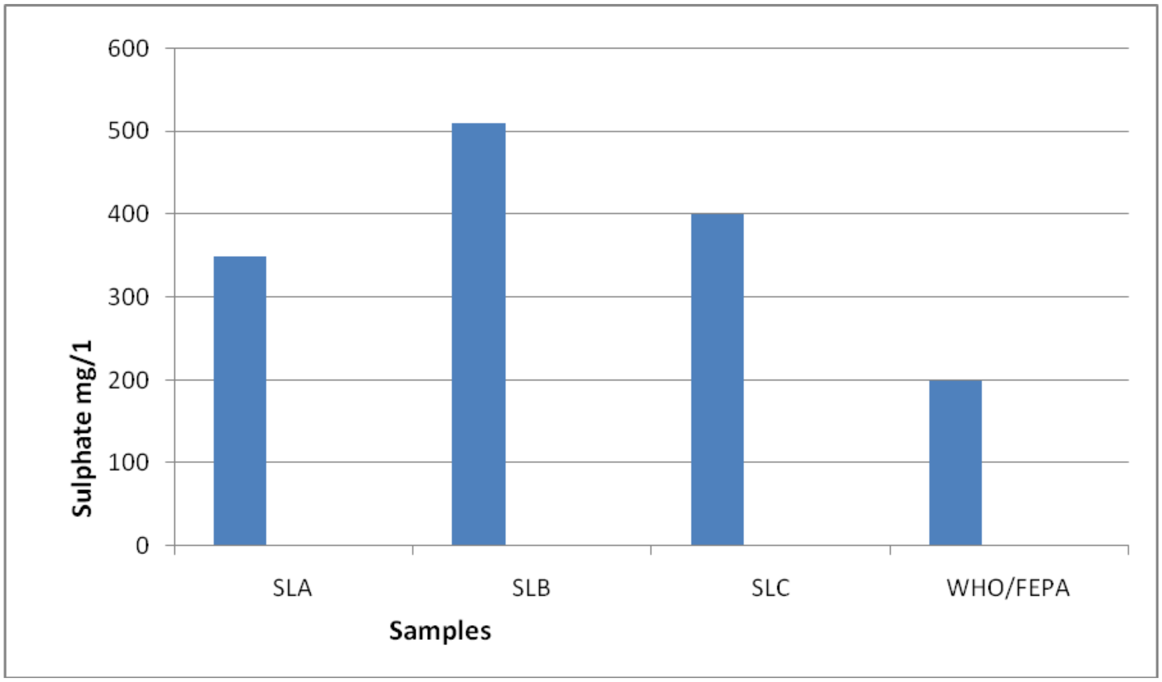

Fig 4.9 show sulphate concentration

The sulphate concentration was highest at SLB, and decreased at SLC and SLA with the WHO of 200mg/1. The sulphate ranges from 350 – 510, which shows that the sulphate for all the three samples exceeded the WHO limit.

4.3 CHLORIDE CI$^-$ mg/1

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

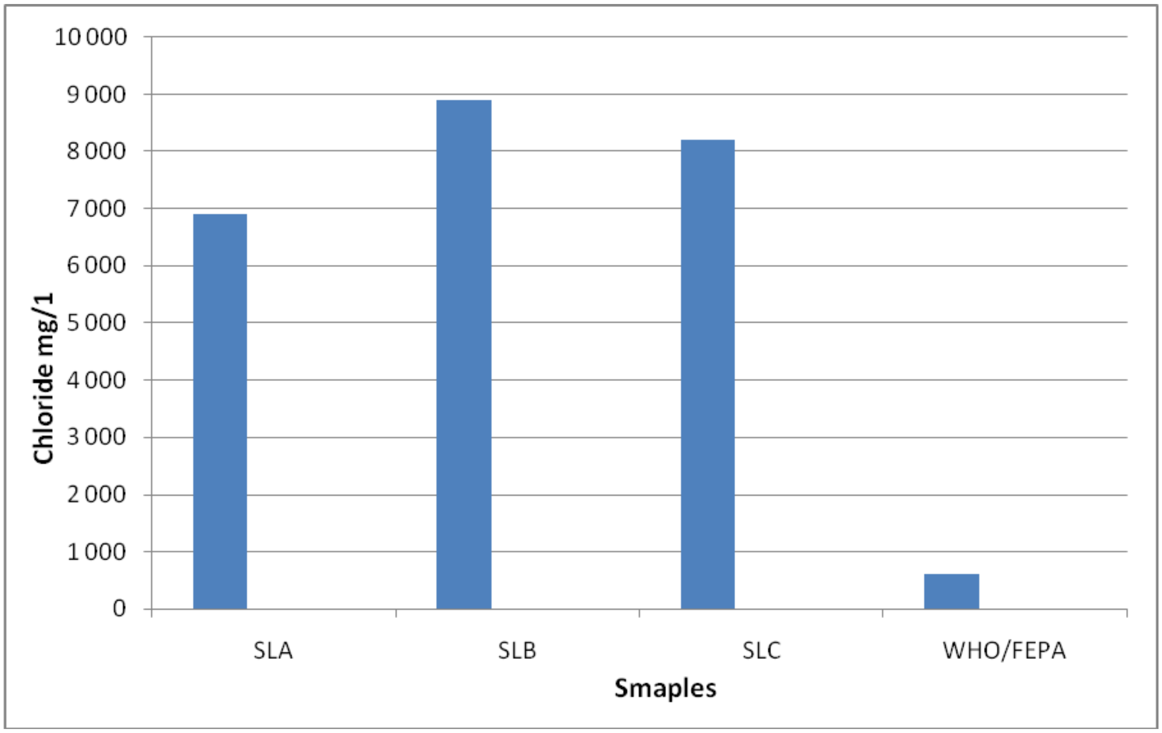

Fig 4.10 Chloride Concetration

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 river at the time of sampling ranges from 6,900 – 8,900 with FEPA of 600mg/1. This implies that the chloride concentration for all the three samples exceeded the FEPA limit.

4.3.1 LEAD mg/1

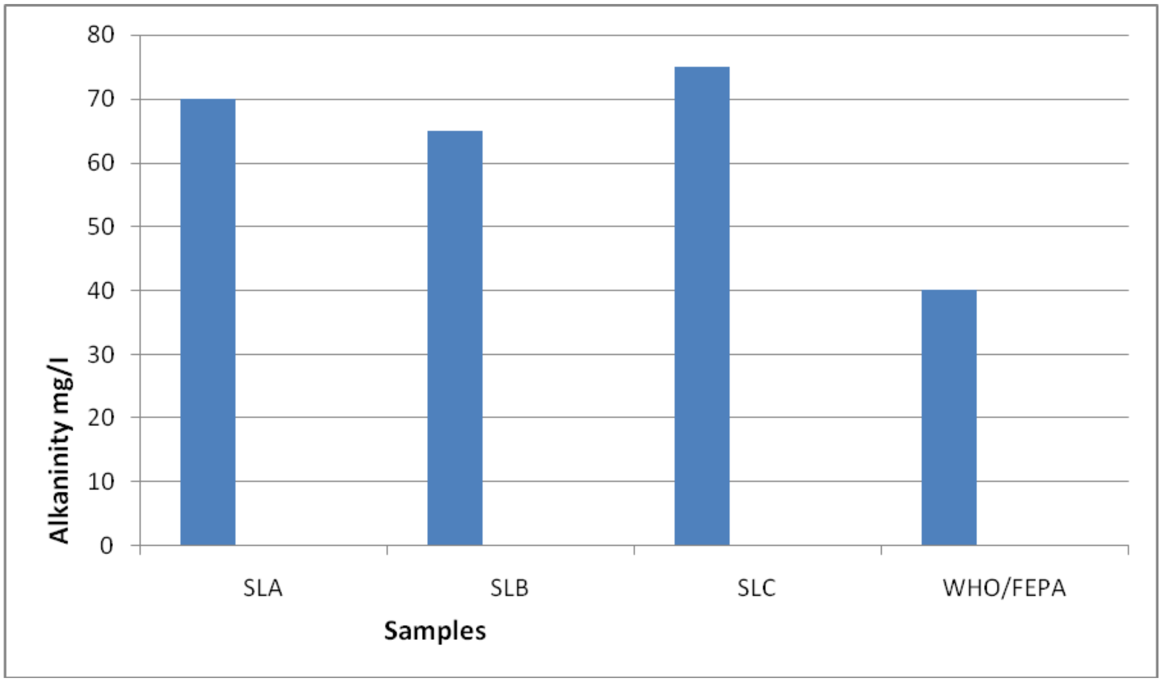

Fig 4.11 Concentration of lead at the three samples location

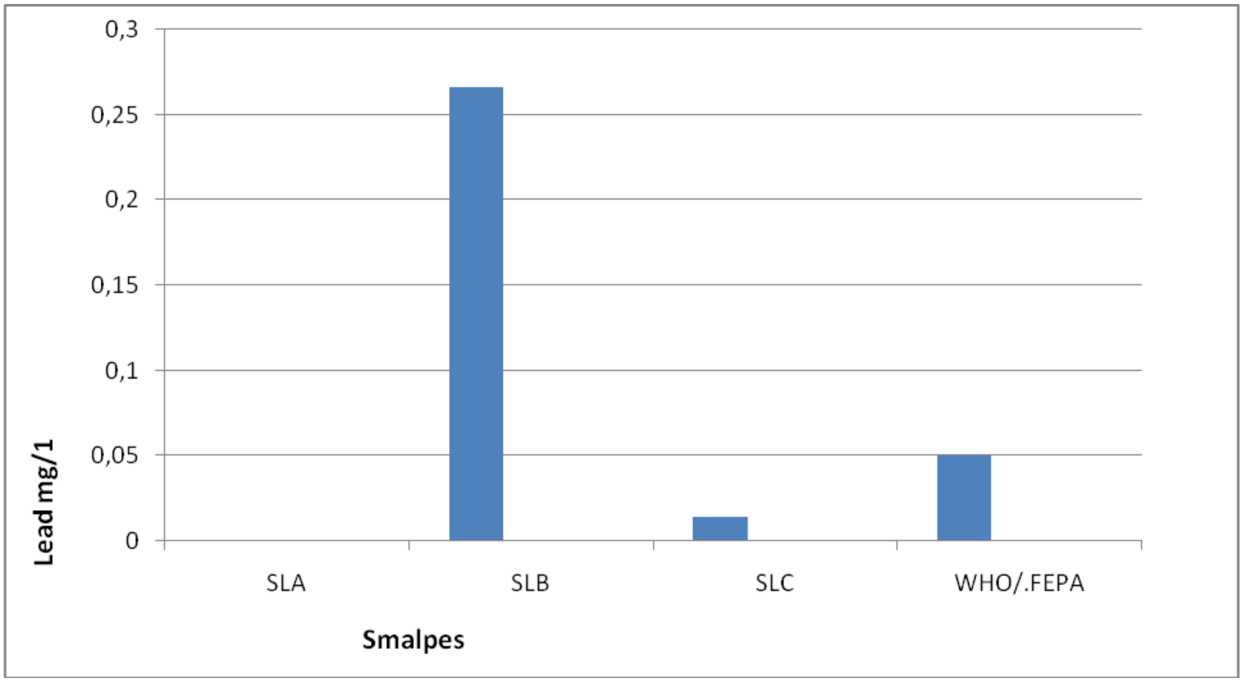

Fig 4.12 Shows concentration of lead in the River

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.

4.3.2 PHOSPHATE mg/I

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

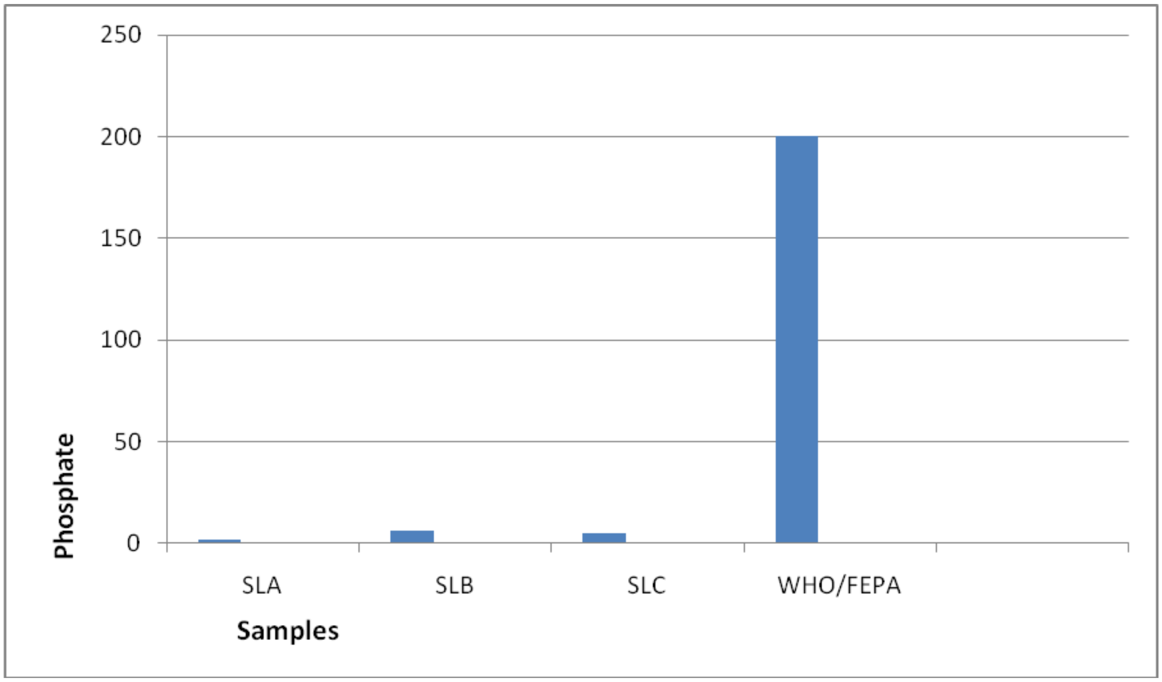

Fig 4.13 Show Phosphate concentration

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

4.3.3 IRON mg/I

The iron concentration as recorded at the three samples location is given in fig 4.13.

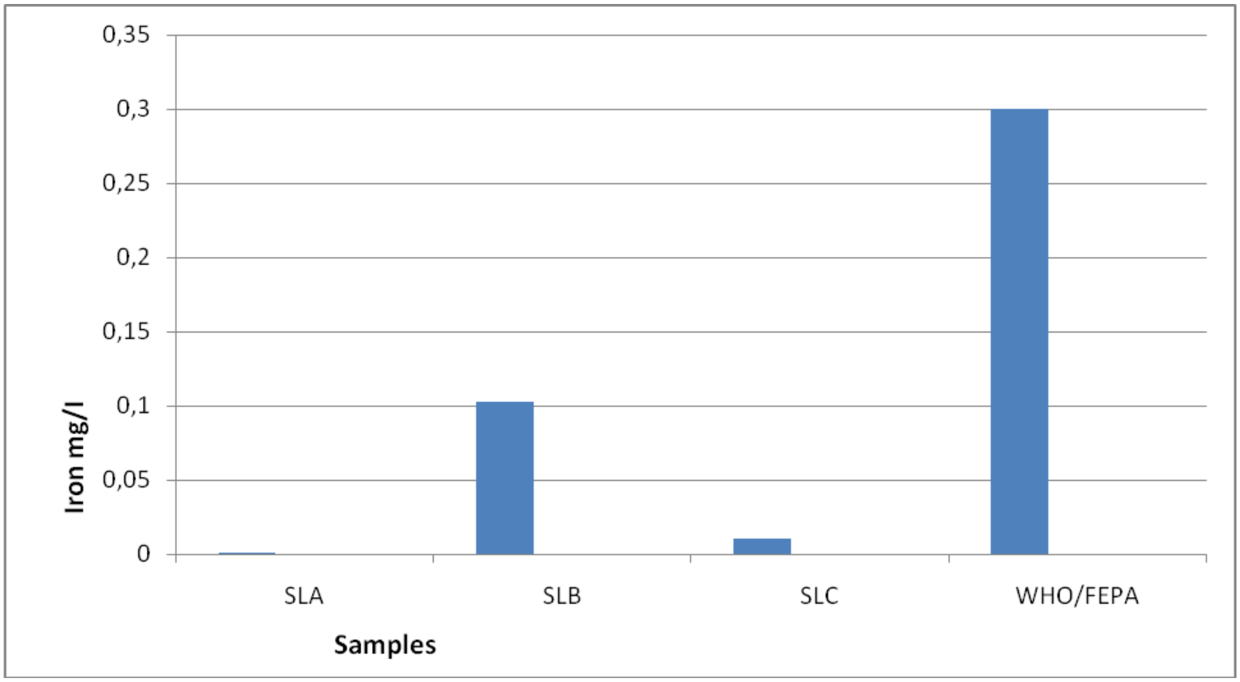

Fig 4.14 Iron concentration variation of the River

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

4.3.4 ALKALINITY mg/I

The alkalinity vales of the river as indicated at the three sampling point are presented in fig 5.4.

In Fig 5.4, it shows Alkalinity concentration variation of 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 60–70 unit, and falls within WHO limit.

4.3.5 Sample locations that have the highest impact of oil spill on the water quantity

Table 4.2: The ANOVA Table

<table>
<tr><td colspan="6">Dependent Variable: variable variable</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Source</td><td>DF</td><td>Sum of Squares</td><td>Mean Square</td><td>F Value</td><td>Pr> F</td></tr>
<tr><td>Model</td><td>3</td><td>5053907</td><td>1684636</td><td>0.03</td><td>0.9933</td></tr>
<tr><td>Error</td><td>58</td><td>3364954695</td><td>58016460</td><td></td><td></td></tr>
<tr><td>Corrected Total</td><td>61</td><td>3370008602</td><td></td><td></td><td></td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>R-Square</td><td colspan="2">CoeffVar</td><td>Root MSE</td><td colspan="2">variable Mean</td></tr>
<tr><td>0.001500</td><td colspan="2">229.1117</td><td>7616.854</td><td colspan="2">3324.515</td></tr>
</table>

The p-value for the F-test is 0.9933 (p-value calculated), which is not less than the usual test tolerance levels (such as, 0.05 or 0.01), thus the test is insignificant. Therefore, the null hypothesis would not be rejected. The data suggest that the population mean among various sample locations do not differ across the parametric measurements regarding the impact of oil spill on the water quantity in some way. Furthermore, since the null hypothesis is not rejected we conclude that there is insufficient evidence to claim differences among population means of the different parametric measurements taken on samples of different locations regarding the impact of oil spill on the water quantity.

CHAPTER FIVE

5.0 DISCUSSION, SUMMARY AND CONCLUSION

5.1 DISCUSSION

Temperature

The temperatures at the different sampling points were all within WHO limit. This implies that the effluents did not significantly alter the temperature and there was no terminal pollution.

pH

The PH values, though showed slight variation but they are also within the recommended WHO limit.

Conductivity

Conductivity value at the different sampling points were quiet above WHO standard (1250 µS/cm) . The discharge point value was higher than other points. This might be due to the impact of the effluent from oil petroleum exploration.

TDS

The TDS values were quiet beyond the established standard of 500 mg/L. though all other sampling points were high, the discharged points were higher followed by the downstream point. At the discharge point, the high value might be due to effect from petroleum exploration. Effluent, while at the downstream, the river might be recovering from the effluent discharge.

TSS

The discharge point showed highest level of TSS, indicating that effluent discharge from the oil exploration might has influenced increased levels of TSS at the discharge point. The TSS level were quite below WHO standard. High TSS values in fresh water system reduces dissolved oxygen (DO) levels and might prevent light penetration to photosynthetic aquatic organism at the bentic region.

BOD$_5$

The biochemical oxygen demand at the different point of the creek showed similar dynamism as observed in other parameter. The highest levels recorded at the discharged point indicated impact of effluent from oil exploration and with possible high concentration of organic compounds.

BOD$_5$ is one of the most important parameters used to monitor the quality of water regarding organic matter present in both suspended and dissolved form. High BOD level in aquatic system have been known to support high heterotrophic microbial population. The BOD level were quite below WHO standard and this implied that the creek was not heavily polluted by organic matter.

COD

The COD levels showed similar trends with that of the BOD. The highest COD level recorded at discharge point might be due to oil spillage and effluent discharge from oil exploration which might increase COD load of fresh water system (Sial *et al* 2006) . High COD level is responsible fordepletion of oxygen levels in rivers. The COD level was below WHO standard.

Sulphate

Sulphate levels recorded at the different points of the creek were quite above recommended standard. This might imply possible contribution from other sources rather than oil effluent discharge point was highest, indicating more contribution from effluent discharge from oil exploration

Chloride

Values of Chloride recorded at the different sampling point were all above WHO standard. This indicated that the creek naturally has high level of chloride. Though the value at discharge point was higher than others it indicated additional addition of chloride from effluent discharged into the creek.

Phosphate

Phosphate level was quite below standard. This implied negligible influence on the phosphate level of the creek from oil exploration activities

Lead(Pb)

The lead values at the discharge point was higher than other points and was quite beyond WHO standard. High level of lead might be due to effluent from oil oxploration activities

Iron(Fe)

The levels of ion recorded were quite below WHO standard. This implied that effluent discharge from oil exploration and activities did not alter the quality of the creek

Alkalinity

The alkalinity level were quite above WHO recommended standard. The implied that the river was naturally highly alkaline. This report is quite contrary to the pH values recorded.

5.2 SUMMARY

In the Abonnema River the electrical conductivity was higher than WHO standard, likewise the total dissolved solid was exceptionally high. The Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) values all was within the WHO standard. After test ran on sulphate and Chloride, the recorded values were higher than FEPA/WHO standards and its presence in the water can pose pollution threat. The phosphate concentration was minimal, thus its presence in the water does not have any adverse effect on flora and fauna. Iron, lead, and temperature was within the regulatory standards and its presence in the water shows that the water can support aquatic life. The pH was slightly acidic

5.3 CONCLUSION

There were very high level of Total Petroleum Hydrocarbon (TPHC) recorded at discharged point and downstream. Activities of oil vandalization, bunkering activities and effluent discharged from oil exploration might be responsible for the high value of TPH recorded. This could lead to possible depletion of aquatic life. The values recorded were quite above WHO standard implying possible danger to water quality and aquatic health.

The total petroleum hydrocarbon was in sample location B and C and it all exceeded the WHO permissible and allowance limit. Its presence in the water posses threat to the aquatic life and thus not good for domestic purposes.

Pollution occasioned by oil spills has been rife in the Niger Delta especially in Rivers State, the centre of oil exploration 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 pysico chemical analysis carried out on the water samples, it can then be inferred that the water in Abonnema has been heavily polluted. Most of the physic-chemical parameters tested, including trace metals exceeded the recommended limits of WHO standard.

The people of oil producing area like the Abonnema people are used as case study and the economy base is negatively impacted upon. The impact of oil spillage on water are far reaching and enormous and it has not been viewed kindly by the communities hence the continued youth restiveness.

5.4 RECCOMENDATIONS

The following are recommended with the believes that these contributions may help the government and company draw up measures for pollution abatement on the River adjourning oil production facilities

1. **Environment Monitoring Plan :** The environmental monitoring should be part of oil companies operational plan. This would ensure control and check on the areas of operation and equipment used.

2. **Legislation :** Oil companies should honour government legislation and rules essential for healthy operations. They should also maintain operation ethics as obtained in their countries
3. **Maintenance :** They should efficient and routine maintenance of equipment and personal discipline especially in handling of equipments.
4. **Compensation :** Thou no amount of money paid as compensation to individuals and communities effected by oil could be enough to restore the damage caused, it will however attempt to alleviate the suffering of the people.
5. **Cleaning Up:** Companies should not wait until a spill is out of hand before a cleanup intervention. Timely cleanup exercise should be encouraged.
6. **Enlightenment Campaign :** Enlightenment campaigns should be carried out on the communities on the dangers of vandalization of pipelines.
7. **Prompt Action:** Report immediately any case of oil spillage to the appropriate for companies to prevent the spillage of these effluents into aquatic bodies, lands and farmlands
8. **Audit:** The government should 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/N	Parameters	SLB	SLC	SLA	WHO (mg/1)	FEPA (mg/1)
1	Temperature	27.	28.4	28.3	20-33^{0}C	6.5
2	pH	6.90	6.79	6.62	7.0-8.5	8.5
3	Conductivity us/cm^2	29,600	26,000	22,000	1250$_{us}$/m^2	100
4	Total dissolved solid (TSS)	20,720	18,200	15,400	500mg/1	250
5	Total suspended solid (TSS)	21	16	11	50	50
6	Chemical oxygen demand (COD) (mg/1)	4.157	2.627	2.352	10	40
7	Biochemical oxygen demand (mg/1)	2.77	1.65	1.50	40	-
8	Total petroleum hydrocarbon (mg/1)	1,246.6	<1.246.6	<0.001	10	-
9	Sulphate SO_4	510	400	350	200mg/1	250
10	Chloride C1-(mg/1)	8,900	8,200	6,900	200	600
11	Lead (mg/1)	0.266	<0.001	0.014	0.05	0.05
12	Phosphate (mg/g)	6.5	5.3	2.2	200mg/1	-
13	Iron Fe (mg/1)	0.103	<0.01	<0.001	0.3	0.3s
14	Alkalinity (mg/1)	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

PARAMETER	STANDARD LIMITS PERMISSIBLE	EXCESS
pH	7-8.5	9.2
TDS	500mg/1	1500mg/1
DO	5.0mg/1	10mg/1
BODs	6.0mg/1	10mg/1
Conductivity	1250mg/1	300us/cm^3
Lead	0.05mg/1	>1mg/1
Nitrate	10mg/1	10mg/1
Iron	0.3mg/1	1.0mg/1
Phosphate	1.0mg/1	5.0mg/1

APPENDIX 3

FEPA INTERM STANDARD FOR AQUATIC LIFE WATER

PARAMETERS	PROPOSED STANDARD
pH	6.0-90
Temperature	20-33^{0}C
Nitrate	NS
TPH	10mg/1

NS=N0 standard

Source: Michael et al, (1998).

CHEMICAL SUBSTANCE AFFECTING POTABLE WATER (W.H.O 1990)

Substance	Maximum acceptance	Maximum allowance
Total solid	500mg/1	1500mg/1
Colour	5 units	50 units
Turbidity	5 units	25 units
Odour	Unobjectionable	Unobjectionable