ADVERSE EFFECTS OF THE IMPACT OF OIL AND GAS ON ENVIRONMENTAL EXPLOITATION

BY

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FACULTY OF ENGINEERING

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BENIN CITY

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A THESIS SUBMITTED TO THE DEPARTMENT OF PETROLEUM ENGINEERING, IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF BACHELOR OF ENGINEERING (B.ENG) IN PETROLEUM ENGINEERING OF THE UNIVERSITY OF BENIN

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CERTIFICATION

This is to certify that this project work was carried out by **AFIYAGBA PEREDISABOFA SONYA** with matriculation number **ENG1805518** of the Department of Petroleum Engineering, Faculty of Engineering, University of Benin, Benin City in partial fulfillment for the award of the Degree, Bachelor of Engineering (B.ENG).

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DEDICATION

I dedicate this project work to GOD ALMIGHTY for His grace, abundant love, protection, guidance and strength accorded to me throughout my academic programme

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I would like to express my sincere appreciation to God Almighty for his guidance and support from the start to the end of my schools' programme. I wish to express my sincere appreciation to the efforts of my parents MR AND MRS AFIYAGBA and my siblings; MIYENKA, PERE, PREYE AND JOSHUA for their unending support.

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ABSTRACT

This paper assessed the impact of the oil and gas exploitation of the xyz in the Niger Delta region. The Niger Delta region is best known as a region that sustains much oil exploration and exploitation by the agent of western economic power. The Niger Delta region basin is considered as the mainstay of the Nigeria economy for its significantly high level of the oil reserves. The revenue and incomes generated by the petroleum industry have contributed to the well-being of Nigeria. There have been cases of oil spillage reported leaving the people completely impoverished with no meaningful alternative source of livelihood.

.This study was designed to investigate the impact of crude oil exploitation in producing communities by accessing the extent to which it has led to environmental degradation such as heavy metal exposure. This investigation was done by carrying out a comparative study on the producing and non-oil producing communities. To achieve this objective the soil, plant and produced water[effluent] were collected from the oil and non-oil producing communities and analyzed using atomic absorption spectrometry for copper, iron, cadmium, lead, zinc, and magnesium respectively and comparing with WHO standard. The result showed a significant relationship between oil exploitation and environmental degradation in the community. In view of these finding remediation method must be adopted to safeguard the communities. The data will be useful for future monitoring of heavy metal exposure in the communities.

CHAPTER ONE

1.1 Background of the Study

The oil and gas industry over the years has brought tremendous growth to the Nigeria economy accounting for the sustainable development of the nation. It has also accounted for the increase in the Gross Domestic Product of the nation, the revenue of the government and most importantly, foreign exchange. This multi-billion dollar industry is global, with exploration and production activities conducted all over the globe.

However, production of crude oil in producing communities is not without disadvantages as various host communities has lost economic activities such as fishing, palm wine tapping etc. Production activities in Rivers State caused a detrimental effect to the ecosystem of the region impacting on the livelihood of the residents (Apata, 2010). Before oil was discovered and produced in Oloibiri, in Bayelsa State, it was reported that the plant and animal life was solely responsible for the sustainability of the region and the livelihood of the people resulting in an equilibrium balance in the ecosystem (Omorede, 2014).

Despite the revenue generated from production activities, host communities are in an increasing level of threat due to production activities which has caused a deteriorating effect to the land for agriculture and the water for fishing activities thereby increasing the poverty level in the community. This often leads to unrest, characterized by host communities resorting to arms and violence causing socio-economic unrests.

1.2 Aim of the Study

The aim of this study is to evaluate the effects of petroleum exploration and production activities in Oredo local government with a view to finding its impact on the environment(Oredo flow station; A subsidiary to NNPC).

1.3 Objectives of the Study

- Access the extent to which extraction has led to the environmental degradation in Oredo local government carrying out GPS coordinate on the selected area within the Oredo local government
- Carry out a study on plant,soil, water and produced water in oil producing communities (Oredo communities).
- Carry out a study on plant,soil,water and produced water in non-oil producing communities. (University of benin)
- Carry out a comparative study of heavy metal analysis both in plant,soil ,water and produced water of the producing and the non-producing communities.
- Provide recommendations towards finding enduring mitigation measures against the effects of petroleum exploration in Oredo land.

1.4 Statement of the Problem

Production of crude oil in host communities is not without its disadvantages because deteriorating land and water habitat has been for a long time an aftermath of the oil and gas industry. This could be due to recklessness of the multinational company or vandalization by indigenes in the host community. This environmental degradation is a pertinent issue between host communities, oil producing states, multinationals and even the government (Antoniette, 2019).

This work aims at addressing the impact of oil production on the flora and fauna habitats in the host communities, and how it has affected the socio-economic growth of indigenes in the community. It purpose is to understand the reasons for negligence on the part of oil companies and find solutions that can prevent further degradation of the environment in host communities, especially in oredo community

1.5 Scope of Work

This project will focus on the impact of oil production activities, (upstream sector of the oil and gas industry only) on the socio-economic life of indigenes in the oredo community in benin city .This is achieved by collecting samples from the host community flora and fauna ecosystem and analyzing them to investigate the impact of oil production on the ecosystem while comparing the results with non-oil producing communities within the same geographical enclave. Solutions will be presented later, to curb environmental degradation of host communities.

1.6 Study area

Fig 1: Map of Nigeria showing the studied areas (not to scale)

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

Many works has been done to bring to the public the harmful impact oil and gas exploration and production has on the socio-economic development of host communities. Various issues relating to unrest between host communities and the government has been addressed in various research publications with an aim to finding amicable solutions that will further safeguard the host communities from the deteriorating effect of oil spillage.

2.2 Impact on the Environment

Various research has been done to study the causes, effects, and the proposed solutions to environmental degradation of crude oil caused by oil production. Most of these works are centered on the damaging effect of crude oil on host communities in the Niger Delta region which includes the following Niger Delta states namely (Edo, Delta, Abia, Akwa Ibom, Cross River, Bayelsa, Rivers, Imo and Ondo).

2.3 Land Pollution

Oil production has caused detrimental effects to farming activities in the Niger Delta area. This region due to the rich vegetation it possesses, encourages the indigenes to part take in farming activities to improve their livelihood. Nigeria (Niger Delta region) is said to be the third palm oil producer in the world (Kadafa, 2012). This is however cut short, as oil spillage has brought disastrous effects on the land and growth of planted crops.

(Oyinkepreye et al., 2020) investigated the sustained impact of oil production in the Niger Delta region. His article discussed the impact of crude oil spills on farmlands and rivers and even makes recommendations on the proposed combative measures to reduce it to the lowest ebb. Marais et al. (2014) in their work concluded that bunkery and pipeline vandalization caused by host community residents has consequently damaged the environment.

(Oyinkepreye et al., 2020) in their investigation developed a questionnaire to ascertain the impacts of oil spillage on the community. The questionnaire is divided into two sections, the demographic section which relates to the age, occupation, and sex of the respondents to the questionnaire and the environmental section, which addresses the impact of crude oil production on their environment. A similar work was done by (Allen and Seaman, 2007: DeWees et al., 2020) who assessed the impact of oil spill by developing questionnaires that addresses six questions relating to environmental impact of crude oil spills.

The following questions were captured in the questionnaire.

S1- The activities of the non-standard refiners have affected my community farm lands?

S2- The activities of the non-standard refiners have affected the level of farm yields?

S3- The activities of the non-standard refiners have affected my community fishing areas?

S4- The activities of the non-standard refiners have led to reduction of fishing yields?

S5-The major source of water supply is usually polluted by crude oil waste from non-standard refineries?

S6– I am concerned about the method of disposal of refined waste by the non-standard crude oil refiners?

The questionnaire was distributed to the community chiefs, fishermen, farmers, youths, traders, government's employees, and residents of the host community. Their results showed that the activities of production of crude oil affected their farmlands while as much as 64% concluded that crude oil spills have affected their crop yield. It was also reported that over 94% of the population consequently agreed that the activities of crude oil production affected fishing and reduced their catches. They also reported that their major source of clean drinking water was affected by disposal of crude oil wastes. This was agreed by about 93% of respondents.

Their work showed the negative impacts of crude oil activities on fishing and farming areas damaging the ecosystem and destroying ecosystems.

Akpokodje and Salau (2015) adopted a production function termed Ramon Lopez Cobbs to empirically evaluate the relationship that exists between agricultural productivity and oil pollution in the Niger Delta area. The result of this work shows that agricultural activity and crop yields is strongly affected by crude oil spills and loss of forest, all this leading to an inhibition of the economic growth and sustainability of the community.

Ahmadu and Egbodion, 2013a in their work conducted experimental study to investigate the effect of oil production on cassava farming in some communities that produce oil and control communities (those that do not produce oil). The oil producing communities are Otor-Udu, Olomoro and Uzere. They concluded, after collecting samples and conducting experiments that oil spill on land affected cassava production by resulting in poor yield, stunted growth, increased soil toxicity, rotten cassava tubers, a reduction in the fertility of the soil and poor productivity (Ibaba and Olumati, 2009: Odjuvwuederhie, 2006)They compared the results with the non-producing oil communities and concluded that oil companies should do a better job in protecting host communities.

2.4 Water Pollution

Fentiman, 1996 discussed the impact of oil production and its associated activities on the fishing community of some rural villages in the Niger Delta area. The work was centered on the Oloma fishing community on the Eastern Niger Delta area of Bonny Island, River state.

Before the discovery of oil in Bonny Island, the island had lost its significance until oil was discovered. The island revived once again. The establishment of oil terminal resulted in infrastructural development and a revival in the educational system in Bonny town. The generated revenue contributed to the construction of new buildings such as post office, police divisional office, banks, public library for education purposes, police station, even hospitals were built.

However, despite these new infrastructural developments, there have been unrecorded detrimental effects of these ongoing oil production activities which are often neglected by oil companies and operators if they have the right amount to throw around for the right people.

Shell started dredging the creek filling it up with oil pipelines resulting in eroded landscapes. Houses were more susceptible to erosion once shell had started dredging the landscapes. The residents concluded that in their rivers, there are no more fish due to oil spills in the rivers affecting the natural ecological food chain that existed in the river body.

2.5 Livelihood Impacts of Oil activities

The impact of oil and gas exploration activities has brought detrimental effect on livelihood in host communities. Farming and fishing has been grinded to a halt due to exploration activities in host communities, hence impacting negatively on the livelihood of the residents.

According to Akosua, 2010 citizens of host communities in the surrounding regions of Escravos concluded that exploration activities done by chevron has resulted in the destruction of their lands and the pollution of their water, making crops like cassava, Okro and pepper destroyed and impacting on the livelihood of the citizens in the area. This has halted economic activities in these areas which has caused a ripple effect in the livelihood of the community.

The construction of oil field in Gbaraun area has led to various disastrous effects on natural land and water bodies such as lakes, swamps, creeks which was an economic sustainability for women in that community due to the availability of fishes, shrimps, periwinkles and lobsters (Dadiowei, 2003). However, with the production of crude oil from these communities, oil companies have not been careful enough to protect the host communities and its livelihood.

Akosua, 2010 stated that most of the high paying jobs in the oil and gas industry go to expatriates and those from communities far from host communities neglecting the youths who are well educated in the host communities. These multinationals resorts to engaging the activities of the residents of the host community only when menial jobs are to be done . Thereby neglecting the intellectual of the host communities.(Bloomfield, 2008). This is quite unacceptable, and its ripple effect devastating.

2.5.1 Impact on health

The most important problem associated with production activities on host communities is the degradation of the health of residents. .

According to a UNEP technical report, 2009 oil production poses health risks to residents in the communities especially in developing communities.

A report made by a US delegation in 1999 reported that communities in Niger Delta area of Nigeria recorded extreme cases of diseases likely associated with oil and gas production. Some of these diseases are skin rashes, tumors, respiratory diseases, cancers, malnourishments and so much more. These associated health challenges have prompted further research into oil activities and its impact on the health of residents.

(Akosua, 2010) stated that in countries like Ecuador, cancerous growths were observed in the population of under 10 years old due to their exposure to crude oil production areas. This results in ill-health across the population.

Various explosions occurring during pipeline vandalization, or crude oil production has often resulted to injuries, and worse death of the population.

According to US delegation to Niger Delta 1999 report, it was recorded that an explosion that occurred in the Niger Delta area, in the village of Jesse resulted in the death of over 700 people in the community, once again highlighting the danger of oil activities if nor properly managed. These explosions can be attributed to pipelines vandalization, or leaking pipelines caused by an attempt to steal crude oil (Akosua, 2010).

It is quite pertinent to realize that in such host communities, residents who are more susceptible to the use of herbal medications gotten from plants and roots are also endangered by crude oil exploration and production. These plants and roots are affected by crude oil spills and the chemicals contained in it, causing them to be diseased and therefore impacting on the health of residents who tends to use them for medicinal purposes.

UNEP, 2009 reported of medical plants been destroyed due to the crude oil spills caused by leaking pipelines.

Please note, however that in such community’s women who are pregnant are affected due to their use of polluted water and diseased plants all of which affects their childbearing and birthing process. (Akosua, 2010) stated that pregnant women close to oil producing areas and communities are prone to give birth to children that are very likely to be defected.

2.5.2 Impact on resettlements

The impact of crude oil exploration and production has resulted in forced resettlements of residents of host communities jeopardizing their homes and livelihood. According to an (April 3rd edition of the Sudan Tribune, 2009) it was reported that to allow for crude oil production to take place in south central part of Sudan, residents have been evacuated and forced to resettle in alien environments. One can easily imagine what this would have done to these residents, as their ancestral homes and their means of livelihoods and business have been taken away from them, and only faced with the prospect of starting life over again. Most of these residents were cash crops farmers and food crops and would have to abandon them to a new environment to begin life from start.

2.5.3 Impact on politics in the Country

The discovery and exploration of oil has the potential to and, in most cases, have negatively affected the political system of developing nations. Western political censorship of governments is sometimes uncritical of badly governed but oil-rich developing nations. Gumede (2008) argues that the West is selective in their pressure for African countries to democratize by ignoring countries that are rich in oil such as Chad and Equatorial Guinea.

Indeed, Ross (2001a) has argued that oil and mineral production is linked to authoritarian rule. Likewise, Boonstra et al (2008), note that there is an intricate relationship between energy production and democracy such that international pressure for bad regimes in oil-rich nations to reform is increasingly weakened as Western countries seek to access the scarce resources in more competitive global markets. In Nigeria, Bloomfield (2008) opines that just as oil has polluted the environment of the Niger Delta, so has it polluted the politics of Nigeria. Likewise, Boonstra et al (2008) argue that the rise of oil revenues in Azerbaijan is associated with the decline in democratic gains.

The news of oil discovery has also threatened the stability of some governments in the developing world. For instance, in Equatorial Guinea, the news of the discovery of oil in commercial quantities resulted in an attempted coup d'état. Gary (2009) also argues that oil revenue tends to negatively affect democratic gains and further advised that for Ghana to avoid this, the right institutions and transparent policies ought to be in place before commercial production begins.

2.6 Oil and its links to corruption

According to a World Bank (2006) document, huge spending and contract allocation associated with the oil business can engender corruption in countries. For Palley (2006), in addition to scoring low on the Human Development Index, countries which depend on oil revenues exhibit higher levels of corruption as the resources are often misappropriated by corrupt leaders and officials. In, Nigeria for example, the oil business offered the opportunity for corrupt politicians to enrich themselves at the expense of the people (Bloomfield 2006). Supporting Bloomfield (2006), Boonstra et al (2008) also stated that corruption in Azerbaijan has increased as oil revenue has increased.

Similarly, Frynas et al (2003) argue that the key beneficiaries of the oil exploration efforts in Sao Tome/Principe (STP) happen to be the owners of ERHC /Chrome, including Emeka Offor, the owner of the latter company who was one of the biggest financial backers of the PDP, government in power in Nigeria at the time. The deal between this consortium and the STP state, the authors argue, has no precedent in the history of the African oil industry since the end of colonialism. In this deal, which the consortium in question won without competitive bidding, a consortium with only $1.5 million in cash and $30 million in market capitalization could find a partner with $50 million to buy an oil concession for which they did not have to pay a signature bonus. In addition, they had future rights to benefits that otherwise should accrue to Petro-states such as future petroleum taxation.

2.7 Oil and its socio-cultural impacts

One of the important effects of oil exploration on communities near oil reserves is its impact on cultural practices. A good case in point are the ways in which commercial sex work can increase with potentially more disastrous consequences in such communities. As noted in the previous section, oil exploration leads to a decline in farming/fishing as viable economic ventures thus increasing the propensity for women to choose commercial sex work for income generating purposes.

In addition, the influx of foreign oil workers who are often paid large sums of money as expatriates makes the profession of commercial sex work potentially more lucrative in such communities.

2.8 The Niger Delta pre and post oil socio-economic life

Before the discovery of crude oil in the Niger delta area, the communities and residents have been solely dependent upon the natural resources in the nation and occupations such as agriculture, forestry, mining, and fishing. However even before the 19^{th} century, this region has benefitted a lot from agriculture, due to the fertile soil they have and the presence of surplus rainfall, all of which supports agricultural activities in the region. Upon the discovery of crude oil in the region, attention shifted dramatically from all these activities to exploration and drilling of crude oil and natural gas due to its profitability and its exportation potential. We shall now consider the socio-economic life of the residents in this region before and after the discovery of crude oil and natural gas, in this way we can explain how the activities of these multinationals has affected the drilling of crude oil and natural gas in the region and corresponding impact on the community.

2.8.1 Pre-oil Niger Delta socio-economic life

Before oil was discovered in the Niger Delta region the residents of the nine states had peculiar environmental, social and an economic life which was enough to support them, to support their families and even the nation at large. The region was famous for the presence and the abundance of various animals and plants for consumption. Some of them are snails, fishes, crocodiles and shrimps, among others. The aquatic environment was clean and serene.

In the Niger Delta region, the natural water bodies were safe and clean enough for human consumption without any need for treatment. This safe and clean water meant, the residents of the community earn a living by selling water commercially for various uses such as drinking, washing, bathing and other activities without the fear of contracting diseases such as cholera, typhoid etc. (Alens, 2014). Please note however that these residents could easily move from one community to another in canoes without fear of being stuck in in polluted water.

Economically the Niger delta region contributed to the income of the nation at large through agriculture even before crude oil was discovered (Okumagba, 2011). The major contributors to the income of the federal government through agriculture were fishing and farming. Some of these agriculture products are rubber, palm oil, cotton etc. Fishing and wildlife reserves were some of the contributors to the income of the government. However, upon the discovery of oil these lands have now been converted to crude oil exploration fields thereby preventing these residents from engaging in such activities and rendering such lands uninhabitable due to crude oil spills.

The main foreign exchange in the country during the period of 1558 to 1855 was palm oil which had contributed to over 75% of the GDP of the nation due to exportation (Otonye and Gowon, 2012). This means that for over 280 years, oil palm had contributed not only to the GDP of the nation but also to the economic life and sustainability of the residents in the region. The economic life of the residents was improved due to their extraction of the palm oil in the fruit and the sale of the palm fruit itself. The extracted oil was used for cooking, making candles, used as pomade and for other medicinal products. This extracted oil was also used as a form of exchange in some other communities for commodities such as gunpowder salts and other goods and services. Note, however that's palm oil is a requirement for various marriage ceremonies and was also used to pay dowries.

The residents also engaged in farming of other cash crops such as cocoa, coffee maize, sugar cane yams plantains coconuts and rice. This made all these crops available for consumption and trading all year round in entire country. It is important to recognize the vast land vegetation in the Niger delta area. The thick vegetation characterized by heavy rainfall supported the growth of these crops in addition to their very fertile soil. The profits made by residents due to the sale of this crops encouraged almost everyone to go into farming. According to Olukoju, 2009 both the old and the young had jobs to do with regards farming.

In terms of fishing, the residents had clean water and unrestricted fishing areas to go for fishing. The rivers boasted different types of fishes, encouraging both young and old to go for fishing. Because deforestation did not exist and trees we're not felled, the residents could make canoes and boats, weave baskets and use the canoes as a form of transporting people from one point of the river to another point in the river. The land and the natural waterbodies provided means of transportation and generated incomes and revenues for their community and the country at large paving the way for occupations like farming, fishing, hunting and canoe riding to be very popular among residents in the community.

According to Ibeanu, 2000 the Niger Delta area is known to contain various species of plant and animal life making the region biodiverse.

2.8.2 Post Oil Niger-delta Socio economic Life

The discovery of crude oil has changed the socio-economic life of the entire nation, especially the Niger delta region. The country's economy which was initially agriculturally based has shifted dramatically too crude oil based we're about 90% of the nation's GDP coming from crude oil alone we shall review some of the changes that has occurred in the Niger Delta region due to the discovery and the exploration both crude oil and natural gas. we shall consider these changes under sub-headings.

2.8.2.1 Occupation of the residents

Before the discovery of crude oil and natural gas in the Niger Delta region the major occupation of the residents in these communities we're mainly fishing and agriculture and other occupations such as weaving, hunting, and trading. However, with discovery of crude oil and natural gas attention has shifted from this occupation to exploration and production of crude oil. The result is a reduction in the production and output of crops such as cassava, maize, rice, and oil palm.

Decline in the production of food and cash crops began in the early 90s due to the distortion that existed in the labor market. land and waterbodies contamination due to production activities of multinational oil companies affected farming and fishing in Niger Delta communities. This slow production of food and cash crops and low production in fishing occurred due to oil spills on the lands and in the water. Please note however that when oil spills in the water it creates an oil film that prevents sunlight from reaching the bed of the river. As we all know the food chain that exists in the river starts from plants. Plants need sunlight to produce their food in the process known as photosynthesis and because sunlight does not reach the bed of the river, plants will not be able to produce their food. Animals such as fish however depends on plants for their survival especially smaller fishes who feeds on such plants for sustainability. Larger fishes that depend on smaller fishes for survival begins to feed on themselves or die because smaller fish are no longer available to feed on due to the scarcity of plants in the river. Now, because no larger fishes exist in the river, residents in the community that depends on these fishes for feeding and for trading will no longer be able to get them, thus distorting their source of livelihood.

Indigenes of the Niger Delta communities began to find agriculture unattractive because of their deteriorating lands and water bodies and because the government began paying farmers low prices for their products (Amnesty international, 2009). As a result of this, lots of the indigenes in the community began to seek for alternative source of income and livelihood by trading other goods or even seeking employment in multinational oil companies that come to explore and drill for crude oil in their community. A lot of them decided to shut down their businesses and instead invest in crude oil and natural gas businesses as an alternative source of livelihood. One of these businesses that suffered from this diversification is the cottage industries. A lot of people became unemployed because of this shift from agriculture to natural gas investment (Ofoche, 2012).

The federal government enacted certain laws such as the petroleum act of 1969 which made a lot of landowners in such communities lose their lands to the federal government without compensation. The reason for this unimaginable act on the part of the federal government was because such compensations were made for only cash crop owners and not food crop owners whose lands were affected by crude oil activities. As a result of this landowners who used their lands for cash crops were compensated if those lands contain crude oil while those who used their lands to farm food crops for consumption and trading were not compensated if their land eventually contained crude oil. This resulted in the spread of poverty in such communities as a lot of these residents could no longer afford to feed themselves and their families and afford basic social amenities.

To alleviate this problem multinational oil companies that drill in such communities tried to employ residents or indigenes of these communities. However, because they cannot employ every single youth or adult in the community these companies contributed in other ways by organizing training and other entrepreneurial programs in order to boost the employability of the youths and the adults in the community. Another advantage of having these oil companies in this community is the development of other business ventures in such communities such as hotels, restaurants, television houses, firms, among others. However, these business ventures are capital intensive and can only be afforded by the rich.

2.8.2.2 Education of the indigenes

The educational life of residents in these communities are appalling. The educational infrastructure is in very poor condition because the school buildings are deteriorating. Children must walk long distances to go to the nearest school (jike, 2004). The reason for this deteriorating school buildings is because the federal government provides inadequate fundings for school renovations and new school buildings. This can be attributed to corruption existing within the federal government. Even in such schools, the absence of qualified teachers, ICT materials makes learning difficult. As a result of this many children drop out from schools from time to time and instead prefer to make quick money rather than go to school increasing the rate of crimes in the society. Please note also that parents who want to send their children to schools do not have the resources to do so because of the increasing rate of school fees and study materials of some schools that are privately owned in such communities jeopardizing the educational system in that region.

It is imperative to know that oil companies in collaboration with NDDC have provided scholarship for indigenes in such regions. But this is not enough as only a handful of students can be awarded scholarships. An example of such scholarships is the Koko scholarship awarded by total Nigeria PLC in 2017. The chart below represents the educational level of 120 households investigated in the Niger Delta region during a study on Nigeria poverty environment linkages in the natural resource sector by World Bank Africa environment and social development units.

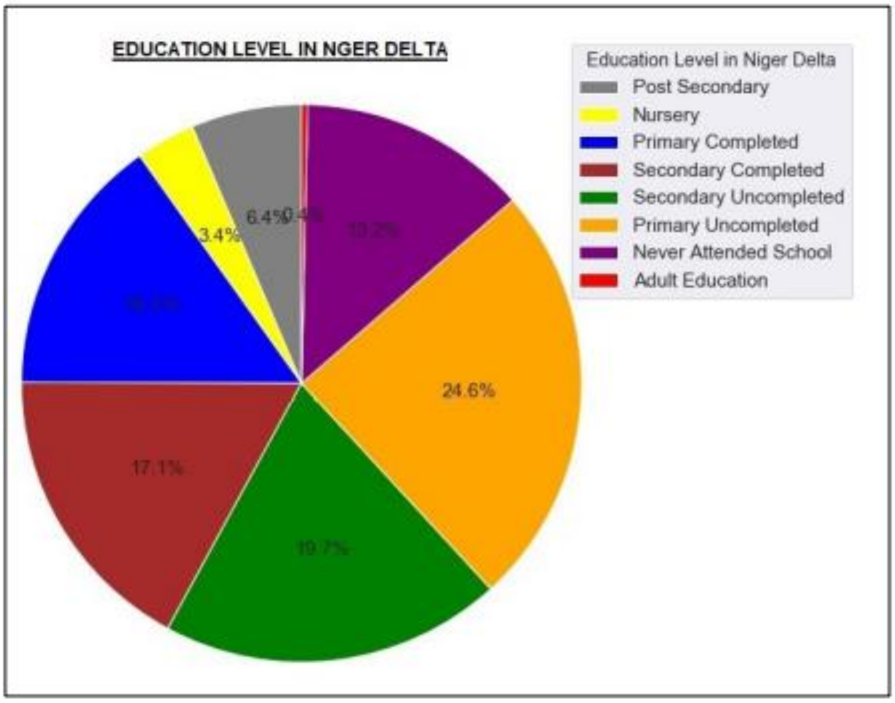


Figure 2.1: Educational level of Indigenes in Niger delta communities (Jike, 2004)

It can be seen from the chart above that a larger percentage of residents in the Niger Delta region did not complete the primary school and the secondary school education due to the appalling nature of educational infrastructures in such communities. These dropouts from secondary and primary schools' resort to making quick money by involving themselves in crimes in the society.

2.8.2.3 Standard of Living

The standard of living of residents in oil producing communities is very much different from residents in non-oil producing communities. The cost of living is very much on the high side because of the existence of oil companies in such communities as compared to communities where extractive activities like gold or copper take place. This is detrimental to the residents in such communities because they can no longer afford basic food and social amenities, a situation that did not exist prior to the existence of oil companies in their communities. Transportation of food stuffs, dishes and other provisions across the river to riverine areas increases the price of goods.

A lot of these residents are not employed by the oil companies and as such can no longer be able to afford such goods and services in their communities (Uyigue and Agho, 2007). With all the development occurring in other communities or villages, oil producing communities still lack basic social amenities and infrastructure such as power water health centers and even access roads forcing people to relocate from their villages.

According to Apata, 2010 from the year 1985 to 2002 the poverty level in the Niger Delta area has dramatically increased to about 55% with Ondo state being the poorest among all the oil producing states. Despite the revenue that is generated from these communities and region, these people live in abject poverty with about 40% of residents in such communities living below the poverty line.

2.8.2.4 Social environment

According to Odoemena, 2011 residents in oil producing communities believe that the federal government and oil companies are not providing them their share of the wealth and the revenue generated from exploitation of crude oil in their region. This has resulted in social and political unrest in such host communities culminating in the destruction of oil facilities, the attack against various petrol businesses in this host communities and even kidnapping of oil company workers, all with the aim of reiterating their desire for a share in the profits coming from the production of crude oil in their community.

Omorede 2014, in their report revealed that a considerable amount of respondents claim that multinational oil companies have refused to pay compensation to the communities once degradation in the farmlands occur due to spills, rendering poor indigenes with absolutely nothing to live on. The table below summarized the response from the indigenes,

Response	Zone A, Warri		Zone B, sapele		Zone C, Isoko	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	32	80	30	75	22	55
No	8	20	10	25	18	45
Total	40	100	40	100	40	100

Table 2.1: Questionnaire on Oil companies renumeration payment (Omorede, 2014)

We can deduce from this study that a larger percentage of the respondents are quite aware that multinational oil and gas companies have not been forthcoming with their promise of paying compensations for the disastrous impacts of their activities on host communities.

Intercommunal conflicts have been on the rise or increase in the region from the 1990s due to the struggle of the ownership of Petroleum Resources such as land or even properties of state government or of oil companies, all of which has contributed to the unrest in the regions.

2.8.2.5 Health issues

This has perhaps been one of the most troubling issues affecting residents in oil producing host communities. Due to the crude oil spills in the rivers in such communities and the contamination of the natural water body present only a very few of the population even have access to safe drinking water hence increasing the prevalence of water borne diseases amongst the population. Because there is basically no availability of health facilities in such communities a lot of these people do not have access to proper health care to take care of these prevailing health conditions and for some of them, they must travel for over 50 miles in order to gain access to proper health care facilities. Illnesses in this region includes fever, respiratory problems, cough and even malaria.

As of 2011, Imo state had the highest number of health facilities with Rivers state having the least number in totality with both private and public sectors combined (UNDP, 2015). It is imperative to note also that there is a higher rate of mortality among children in such communities due to the prevalence of malaria and the absence of proper health care facilities to take care of such challenges.

According to Omorede, 2014 she conducted an interview in an oil producing host community to determine their knowledge of the influence of oil and gas production on their communities and their natural water bodies. Their reports were recorded in tabular format and shows below.

Response	Zone A, Warri		Zone B, Sapele		Zone C, Isoko	
	Frequency	Percentage	Frequency	Percentage	Frequency	percentage
Yes	36	90	35	87.5	35	87.5
No	4	10	5	12.5	5	12.5
Total	40	100	40	100	40	100

Table 2.2 Questionnaire on Effect of oil production (Omorede, 2014)

The results show that about 90% of the population of the indigenes in these communities are fully aware of the impact of oil and gas production on their livelihood and environment. These people were fully aware of the environmental hazards of crude oil and natural gas production and flaring, while only about 10% of them seems to be ignorant or unaware. We can infer from this, that crude oil production has led to oil spills on their waters and land damaging aquatic life and vegetation respectively.

2.9 Environmental impacts of oil and gas exploration and production in Niger delta region

Oil and gas exploration and production in the Niger Delta region has had devastating effect on the environment. This section will attempt to describe the various environmental challenges and impacts oil and gas production in the Niger Delta region and how residents in these communities have struggled to adapt to the ever-changing conditions that these activities has posed to their livelihood and to their source of income.

2.9.1 Impacts on farming

In the Niger Delta region farming is one of the major occupations among the residents in such communities. Most of the crops that were planted by the residents in such communities include cassava, cocoa, oil palm, maize and cashew. However, upon the discovery and the production of crude oil and natural gas attention has shifted from agriculture or farming to oil production activities. According to Ahmadu and Egbodion 2013, in their research they discovered that oil spillage on farmlands in the Niger Delta region had resulted in crop failure, poor yield, stunted crop growth, toxicity and reduction in crop fertility. Most of the oil spillage is as a result of water washing away the crude oil into rivers and farmlands resulting in the degradation of the fertility of the land.

Major oil producing communities in the region has suffered greatly from oil spillage on their lands and in their waters. Oloibiri, for example is a shadow of what it used to be. The community was an agriculturally rich community boasting serene farmlands and beautiful vegetation, all of which has been destroyed because of production of crude oil in the region. Farmlands have been destroyed and fishing activities has been reduced to the lowest ebb, while aquatic life has been totally dilapidated.

Another environmental challenge in the Niger Delta region is gas flaring. Gas flaring occurs when multinational oil companies vent excess gas into the atmosphere. Natural gas contains carbon compounds which upon inhalation by humans in large quantities poses devastating effects to their health. It's can even lead to the loss of lives. According to Dung et al., 2008, crops that are planted close to facilities where gas are flared experiences retardation in the development mainly due to the increase in temperature around such flare sites.

The Table below analyze the effects of oil spillage on the farmlands in the Niger Delta region. The oil spillage we're classified based on the intensity of the oil spill from the highest level to the lowest level, with the heavy oil spill resulting in the destruction of all crops, medium oil spill results in in the destruction of almost all crops and finally the light oil spill results in the destruction of just few crops.

Degree of oil spill	total crop farm affected by the spill in hectares	average farm size affected by the oil spill in hectares
heavy oil spillage, all crops destroyed	272.9	3.37
medium oil spillage, almost all crops destroyed	164.5	2.79
light oil spillage, some crops destroyed	110.69	8.29
Total	548.09	8.25

Table 2.3 Area of crop farms affected by crude oil spillages in varying degrees in Rivers State in 2003, Ojimba,

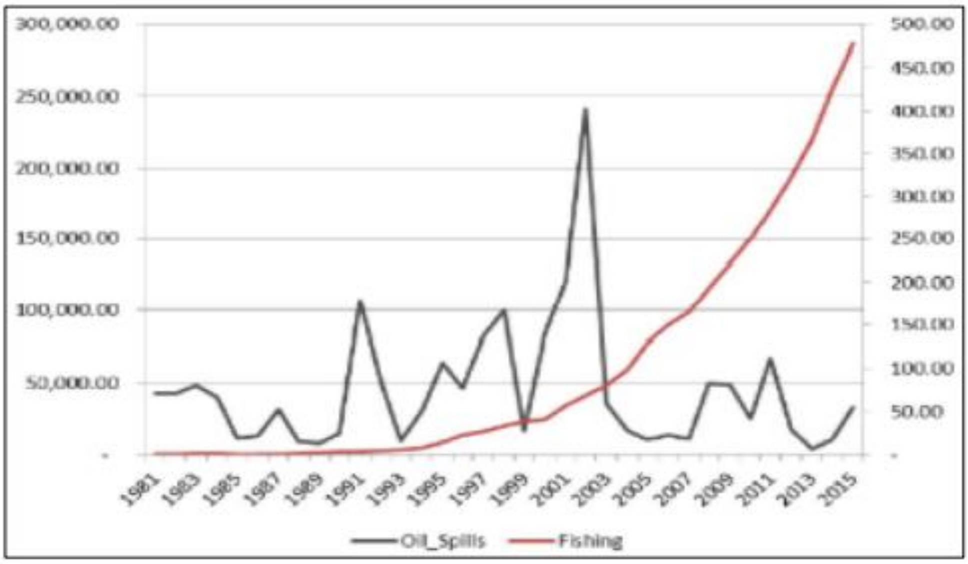
The table above shows the devastating effect of oil spillage in Rivers State as more than half of the farmlands in the state had been destroyed by oil spillage in the year 2003. Medium oil spillage which destroyed majority of crops in farmlands in Rivers State accounted for about 1/3 of the total farmlands in River State destroyed because of oil spillage. This table emphasizes the negligence of oil companies in host communities with regards to protecting the farmlands used by residents for farming and the waterbodies used by residents for fishing.

This oil spillage has made farmers in these communities to reduce the size of their farms and avoid areas that have been affected by the oil spillage, the result of this is a reduction in the size of the land and the fewer crops that will be planted and harvested culminating in the reduction in the profits made by the farmers. This consequently has affected their livelihood preventing most of them from being able to cater for themselves and their families and provide education and health care for their children.

2.9.2 Impacts on fishing

Oil spillage has also contributed to the contamination of natural water bodies in these communities. Some of the oil spills into the natural water bodies and the rivers are caused by vandalization and negligence on the part of the multinational oil company. Once the oil spills find its way into the rivers it contaminates the water body and destroys aquatic life. The oil spills prevent sunlight from reaching the bed of the river preventing plants from producing food through photosynthesis resulting in their deaths, smaller fish that depends on these plans for survival no longer have food to eat hence engage in cannibalism. Larger fishes that depend on smaller fishes for survival have less food to eat and their population begins to dwindle dramatically. However, farmers that depends on fishing for the source of livelihood no longer have fishes in the river and no longer have businesses to run hence resulting in poverty.

The graph we shall consider below represent the impact of oil spills on fish production in Nigeria.



According to the graph, fish production increased as soon as the barrel of crude oil spilled in the community reduces. For example, from the year 2005 to 2015 fishing activities has been

Figure 2.2 Impact of oil spillage on fish production (Kadafa, 2012)

on the rise because the barrels of oil spills in the community was at the lowest ebb. However, between the year 1999 and 2003 which experienced a large spike in the oil spills in the Niger Delta region it was observed that's fishing activities in the region was very low.

In the year 1983 the oil spill resulted in the death of fishes, birds, crabs and some aquatic vegetation. The water bodies were polluted, and the rich mangrove forest was destroyed. This resulted in the reduction of fish production and even the abandonment of majority fishing grounds in Ondo states.

Fishing activities is not only affected by oil spills, seismic activities during exploration of crude oil in the Niger Delta area also affects aquatic life in these regions. Recall that during seismic activity a disturbance it's usually introduced into the formation where crude oil is suspected to be trapped. Disturbance is usually in the form of a dynamite usually left to explode and sound waves picked up either by geophone or the hydrophone placed at strategic points in the formation. As a result of the noise generated during the process of the explosion of the dynamite majority of fish present in river bodies disperse traveling from one point in the river to another point far away from the reach of the residents in the communities that depends on this fish for survival. In most cases the dispersed fishes do not return to their natural habitat due to the disturbance created by exploration activities of crude oil and natural gas. Many rivers' swamps and even creaks have been polluted by oil spillage and other activities leading to the loss for fishing grounds (Kadafa, 2012)

2.10 CASE STUDIES (Contaminated Sand and Water analysis)

- Osuji et al., 2006 investigated Mgbede-20 oil polluted site in the Niger Delta area. Various soil physiochemical properties investigated includes Soil PH, soil electrical conductivity, soil total organic matter, micronutrient level, total hydrocarbon content (THC). The micronutrient recorded includes Mn, Fe, Cu and Zn).

The presence of hydrocarbon in the soil accumulates themselves within the walls of the pores, which results in oxygen deficiency and permeability reduction (Andrade et al., 2004).

Below is a picture of the Mgbede 20 oil producing site, an indication of the damage crude oil spills has on soil and water.

Fig 2.3: Oil spillage in Mgbede-20 oil community (Osuji et al., 2006)

The picture shows how hydrocarbon spills percolates the soil and vegetation. Results from their experimental analysis of the samples shows that soil physiological properties were affected.

The Soil PH, from the surface and subsurface soil samples were investigated, including a control soil. Results show a PH of 5.2 and 5.6 for surface and subsurface soil samples indicating an increased acidic level of the soil, in turn causing the death of vegetation. The control site shows a less acidic soil PH value of 5.8.

Electrical conductivity value of about 71.7 and 107.4, while that of control soil was 70.5 were recorded for the Mgbede 20 oil site. The relative difference observed in the subsurface soil samples with respect to the others could signify the presence of metal ions of high conductivity, which was aggravated by the leaching of the crude oil from the surface soil to subsurface soil (Godson et al., 2010).

Moisture content is the parameter of a soil that affects respiration of the soil, as they provide an environment that encourages the growth of microbial activity. Moisture content recorded at the surface and subsurface levels shows 16.7 and 11.2resp. respectively, with an average value of 13.2 recorded for the control soil. A reduced moisture content of the surface soil is due to a coagulation of sand particles sue to crude oil reducing pores of the soil, thereby affecting porosity and a resistance to penetration and hydrophobicity. Upon all these, the soil begins to develop a repellency to water due to wettability alteration (Sims, 1990).

Total Organic Content (TOC) and Total Organic matter (TOM) are parameters that determine the fertility of the soil. Mean TOC values recorded for both surface and subsurface soil samples are 10.2 and 1.7 while their TOM recorded were 17.6 and 2.9 respectively. An increase in the level of organic matter has implications because it increases carbon dioxide release due to microbial activities, but however reduces oxygen level. This affects microbial activity. This inhibits plant growth mainly because microbial bacterial is insufficient to break down the organic matter to simple ones that can be taken in by the plants.

Micronutrients are required nutrients for plant growth; however, they are only needed in small quantities (Osuji et al., 2006). Analysis from the study stats show that Fe is slightly above the limit acceptable which is 100mg Kg^{-1} while the other micronutrients such as Cu, Zn and Mn were at acceptable limits.

They concluded in their work that oil spillage has adversely affected the physiochemical properties of the soil to varying degrees.

- Osuji and Adesiyan (2005) investigated the alteration to the soil physiological contents due to high pressure crude oil pipeline spill at Isiokpo community, southeastern part of Delta State. They measured experimentally the TOC and TOM contents of the soil. The samples taken were from both surface soil (depth of 0-15cm) and subsurface soils (depth of 15-30cm).

Ogbodo-Isioko pipeline under investigation is in Ikwerre Local Government area of Rivers State southwestern part of Nigeria. The site slopes towards the Western part of the region dropping abruptly into the Ogbodo stream. Field surveys were carried out to investigate the extent of soil pollution. They investigated samples from contaminated soils and control soils. Soil samples were put in a 500ml flask and xylene (200ml) was added to it. The resulting mixture was agitated. The hydrocarbon contents were determined by analyzing UV/VIS spectroscopy at 425nm using a Fisher type II spectrometer. The moisture content was measured by heating of soil sample to about 110^0 for an hour and allowed to cool in a desiccator for another 30minutes. The sample was then weighed to calculate the percentage of mixture. The TOM and TOC contents were obtained by exposing air dried soil sample in a conical flask containing potassium heptaoxochromate (VI), $K_2Cr_2O_7$ of 25ml. Concentrated sulphuric acid was then added rapidly, and the flash agitated until miscibility of the sample and reagents were achieved. The flask is then vertically placed in a cupboard for about 30minutes. Thereafter, 5-10drops of diphenylamine indicator is added and the test probes titrated against $FeSO_4$. The TOC and TOM contents were calculated as follows

$TOC\% = (meq(K_2Cr_2O_7) – (meq(FeSO_4)) \times meq(C) \times f \times$

$TOM\% = 1.724 \times TOC$

The figure below is the section of the Isiokpo pipeline showing crude oil spillage.

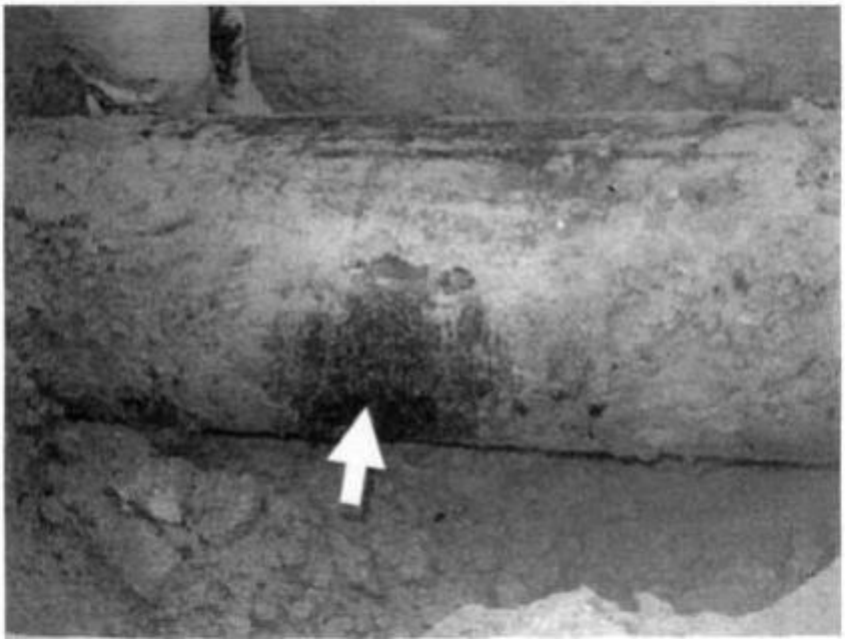


Figure 2.4: Section of Isiokpo Pipeline leakage (Osuji and Adesiyan (2005))

RESULTS from the analysis shows the following.

PH soil level was between 4.7 and 5.4 which is above the acceptable standard for soils indicating an increased toxicity and acidity of the soil. An increase in the acidity of the soil makes some organisms intolerant to the condition of the soil, affecting the nutrients that would be available for plant growth and maintenance. The presence of toxic minerals like Al and Mn salts are prevalent in acidic soils exposing the plants to its toxicity.

Moisture content was rather high due to the nature of the environment bounded by rivers. Due to the low PH of the soil of the polluted area, the presence of high moisture content results in an acidic water or even cause an aggregation of soil resulting in leaching which will affect the TOM and TOC.

The presence of hydrocarbon reduced the oxygen content of the soil

They concluded that the oil spill damaged the flora and the fauna content of the pollution site.

- Osuji and onojake (2004) investigated oil spill sites, precisely Ebocha-8-Oil -spill in the Obiobi and Obrikom area of the Niger Delta. In Nigeria, the Niger Delta, a region of over 70000km2 land mass and 800 oil producing communities, containing flow stations and trunklines is the worst hit of oil spillage. The samples taken were from both surface soil (depth of 0-15cm) and subsurface soils (depth of 15-30cm). They investigated trace heavy metals such as Ni, Cu, V, Cd and Pb using the atomic absorption spectrometry.

Soil samples from the surface and subsurface according to dimension already explained were taken from the pollution sites in polytene bags and labelled properly.

TOC and TOM measurements were done by chromic acid titration method reported in literature. 2.5g of the soil was collected into a beaker and a chemical called sodium dithionite was added. Sodium dithionite is prepared by mixing 88g of sodium citrate, 21.02g of citric in a flask. The beaker was allowed to be vigorously stirred overnight and later filtered. Volumetric titration of the extract and 30% H_2O_2 was done and covered with glass. After the mixture is allowed to cool, the trace metals were then tested for using atomic absorption spectrometry.

Results show high amounts of Ni, Cu and Pd in surface polluted soils ranging from 0.53 to 18mg/kg while 0.26 to 0.39 was recorded for non-polluted soils. The bar chart below illustrates the results. Such higher level of these micronutrients leads to increased absorption by plants and animals leading to toxic reactions in the food chain.

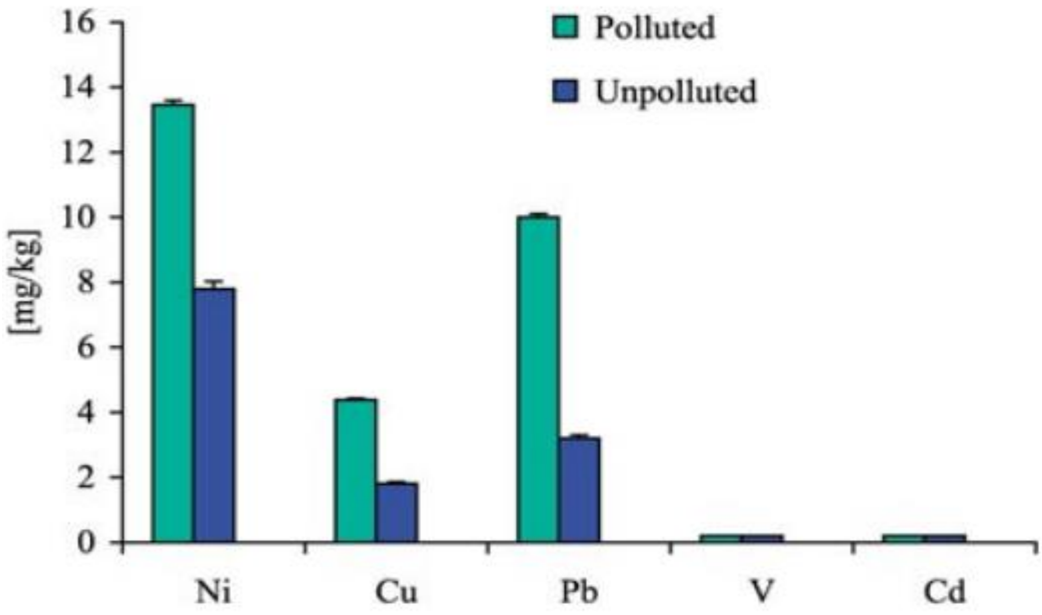


Figure 2.5 Micronutrients analysis of Ebocha-8 oil pollution site (Osuji and onojake (2004)

The bar chart below shows the PH, conductivity, and the moisture content of the contaminated and unpolluted soils in the Ebocha-8 oil spillage site in the Niger Delta Area.

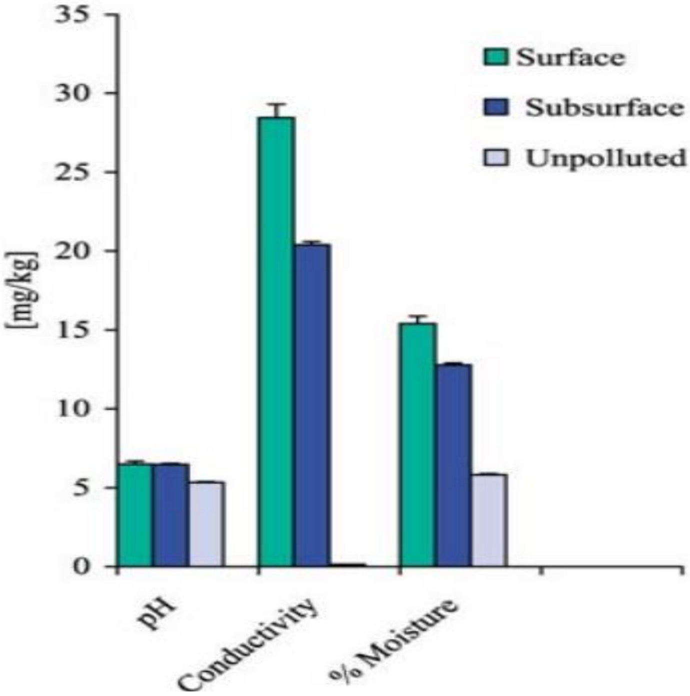


Figure 2.6 Physiochemical analysis of Ebocha-8 oil pollution site (Osuji and onojake (2004))

Flooding of soil when heavy rainfall is available leads to the presence of and mobilization of heavy amounts of these heavy metals (Alexander, 1961). Hence, River's state, characterized by heavy rainfall results in weathering and leaching which ultimately increase the concentration of these heavy metals. They concluded from their analysis that Ebocha-8-oil spills is responsible for higher levels of these heavy metals present in the soil, and aggravated by heavy rainfall through processes like leaching, weathering etc. these higher concentrations of these heavy metals are capable of impairing plant growth and causing accumulation of the metals.

➢ Chinedu and Chukwuemeka (2018) studied oil spillage and heavy metal analysis of polluted oil sites in the Niger delta area from 1976 through to 2014 and its impact on the population. They argued that oil spillage affected communities in the Niger Delta region during the time of investigation deteriorating the environment and destroying crops. Oil spills can occur due to natural disasters like earthquakes or hurricanes (Egbe and Thompson, 2010) in addition to bunkering and pipeline vandalization in the Niger Delta region.

They investigated the effect of oil spill by gathering data published by both government and non-governmental organizations. Other data was gotten from Amnesty international, DPR report, seminar, and conference papers. They conducted the analysis as reported by literature by extrapolating heavy metals data based on the average concentration of crude oil in the region.

They results obtained showed that in the Niger Delta region, from the year 1976 to 2014, there has been a reported case of about 12000 oil spills. This monster amount of oil spillage did not follow a uniform pattern, because of substantial yearly meteoric rise in spillage cases followed by a decline. These results are shown in the diagram below.

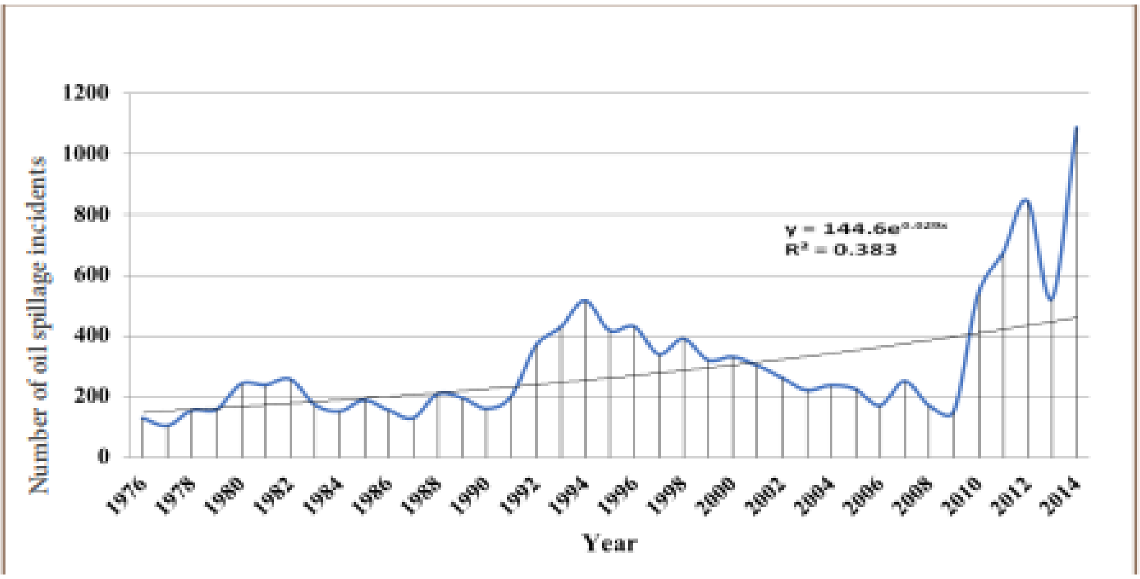


Figure 2.7: Oil spillage in the Niger Delta from 1976 to 2014 (Chinedu and Chukwuemeka (2018))

From the diagram above, it can be interpreted that number of oil spillage cases in the Niger

Delta area increased from 1976 to 1994, where a short decline is consequently replaced by another rising trend to 2014 which recorded the highest cases of oil spillage. 3.1 million barrels of crude oil was estimated to have been spilled during these periods. This is evaluated from the bar chart below.

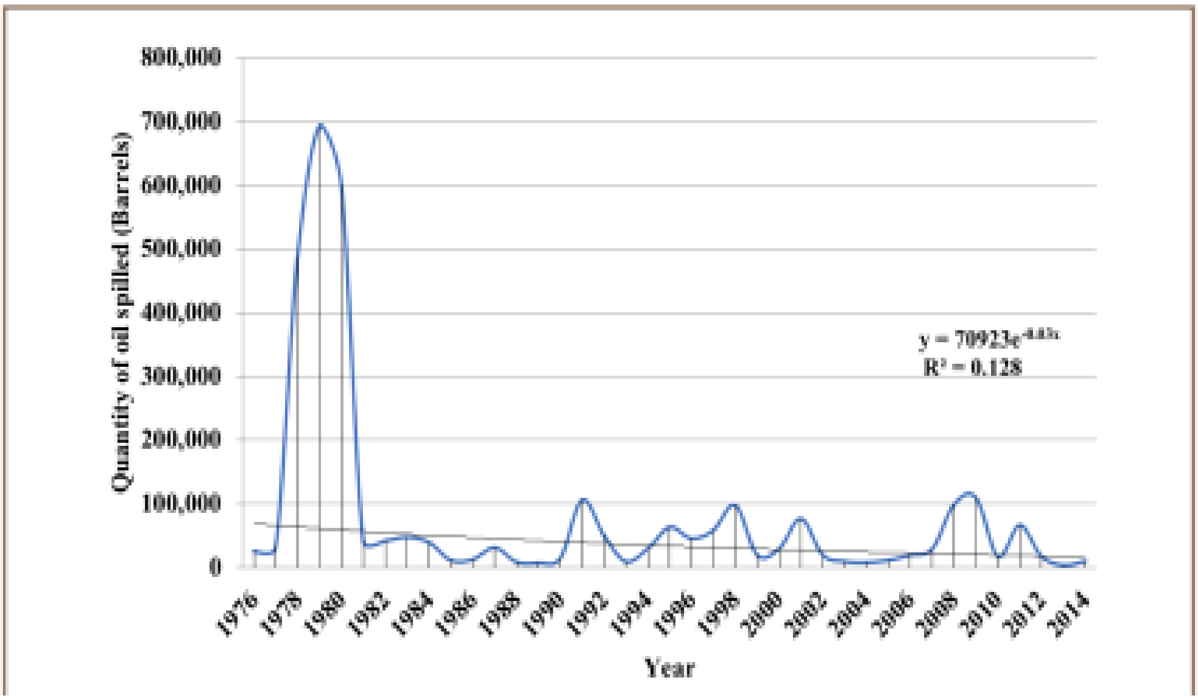


Figure 2.8: Volume of oil spillage in Niger Delta from 1976 to 2014 (Chinedu and Chukwuemeka (2018)

The findings of their research shows that this region experiences crude oil spillage to a very large degree. From the figures above, there has been an increase in this spill rate yearly, showing how ineffective the measure taken by the government and the multinational oil companies have been. These spills occur through various methods such as pipeline vandalization, bunkering, accidents pipe corrosion, mechanical failure, etc. (Achebe et al., 2012 : Suruch, 2011).

Heavy metal analysis shows a high concentration of Mn, Ni and Fe amongst others. These heavy metals are known to have harmful effects to both plants and humans and can cause malaise, headache, cough, nausea, diarrhea, sore throat, sore eyes, and skin rash (Ordinioha, 2010). The diagram below shows the heavy metals concentration in the Niger Delta region from the year 1976 to 2014. They concluded from their study that this heavy concentration of these heavy metals is attributed to crude oil spills.

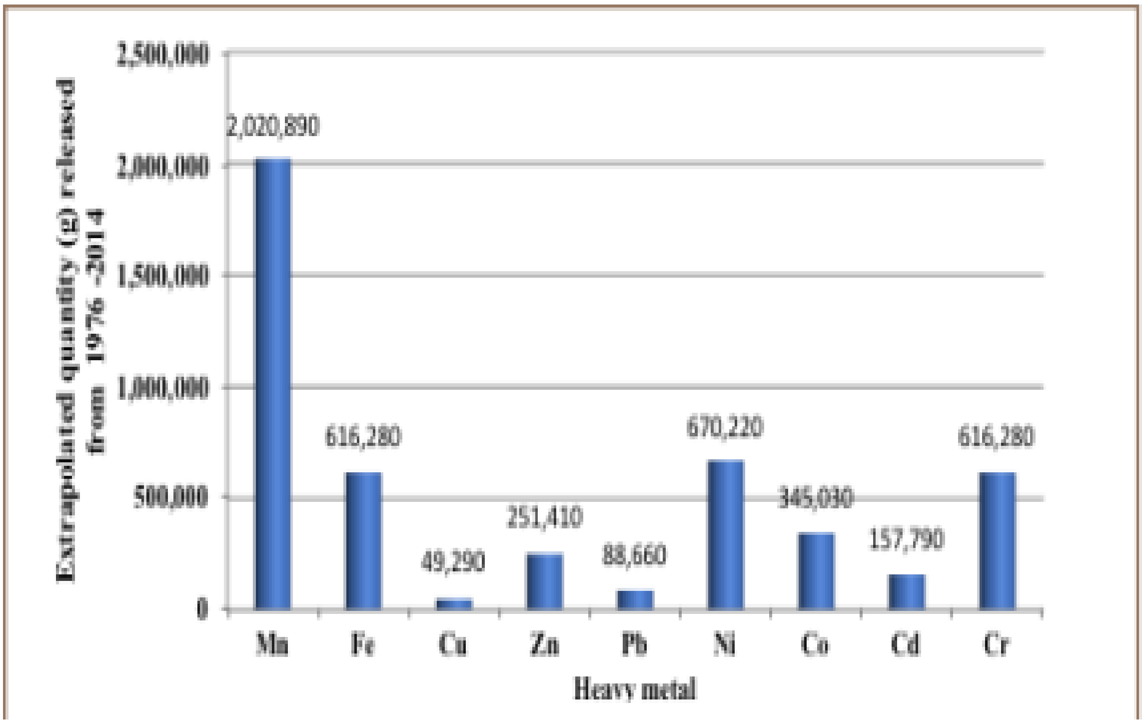


Figure 2.9: Heavy metal concentration in the Niger Delta from 1976 to 2014 (Chinedu and Chukwuemeka (2018)

Other studies from this region shows that heavy metal analysis in rivers in the Niger Delta area shows an increased concentration above the WHO acceptable limits (Owamah, 2013).

They concluded from their study that occupants of the Niger Delta region have been exposed to high toxic levels of heavy metals above WHO acceptable limits hence impacting the environment and causing hazards to both humans and plants. Remediation action should be ameliorated to combat the effects of these oil spills on the communities to return the environment to the state it was before contamination, or at least close to it. Oil companies must ensure their practices does not endanger the environment and the resident of the host communities.

2.11 EQUIPMENT USED FOR EXPERIMENT

- **ATOMIC ABSORPTION SPECTROMETRY(AAS)**

Figure 2.10 The university of Benin central laboratory atomic absorption spectrometer

WHAT IS SPECTROMETRY OF ATOMIC ABSORPTION?

Atomic absorption spectrometry uses a characteristic wavelength of electromagnetic radiation from a light source to detect elements in liquid or solid samples. Individual elements absorb wavelengths in different ways, and their absorbances are measured in comparison to standards. In essence, atomic absorption spectrometry makes use of the various radiation wavelengths absorbed by various atoms.

Analytes are atomized first in AAS to emit and record their characteristic wavelengths. Then, during excitation, electrons in their respective atoms move up one energy level when those atoms absorb a specific amount of energy. This energy corresponds to the element's specific wavelength. Specific elements can be detected depending on the light wavelength and intensity..

The following components are found in all atomic absorption spectroscopy instruments:

- Atomization
- Lamp with hollow cathode
- Monochromator
- Detector
- Recorder

Atomization

Atomization can be accomplished with a flame or a furnace. In atomic absorption spectroscopy, heat energy is used to convert metallic elements into atomic dissociated vapor. The temperature must be carefully monitored during the conversion of atomic vapor. Atoms can be ionized at very high temperatures.

Fuel and oxidant gases are introduced into a mixing chamber before being routed to the burner via baffles. In the AAS instrument, a ribbon flame is produced. The sample is drawn into the mixing chamber through the air.

Lamp with a hollow cathode:

In the AAS instrument, this provides a continuous source of radiation. In atomic absorption spectroscopy, we used a hollow cathode glow discharge lamp to produce sharp emission lines for a specific element. The electrodes in the hollow cathode lamp are cup-shaped and made of a specific element. Because of spurious radiations, the radiation from the hollow cathode lamp should not be continuous.

Monochromator

A monochromator is an optical device that transmits a narrow band of light or other radiation from a wider range of wavelengths.

Detector

A detector can convert light from a monochromator into a simplified electrical signal.

Recorder

The recorder can receive electrical signals from the detector and convert them into a readable response..

2.Weighing balance

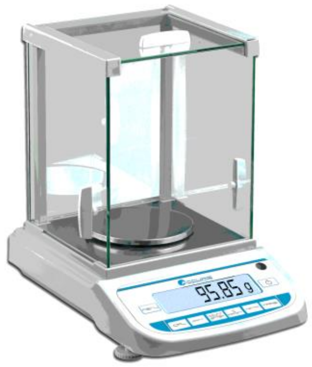


Figure 2.11 A weighing balance

This is a device used to determine the weight or mass of an object; in this work, it was used to weigh the samples for digestion.

3. Bottles of samples

figure 2.12 The samples in labeled sample bottle

This was used to properly identify the various samples to avoid a mixup

4.Filter paper

This was used to separate the samples from the already digested sample's liquid content**.**

5.fume cupboard

Figure 2.13 The university of Benin central laboratory fume cupboard

A fume cabinet, also known as a fume cupboard, fume closet or a fume hood, is an extraction system used for capturing and removing toxic dust, fumes, aerosol and vapours to minimise exposure to a safe level. It is most commonly found in laboratories, where such substances are handled.

Heating mantle : used for producing heat for digestion

Figure 2.14 Heating mantle

Other materials used included a **cronical flask , 100ml volumetric flask, 10ml beaker,filter paper funnels, and a test tube.**

CHAPTER THREE

MATERIALS AND METHOD

The following equipment were used to achieve this work;

- Atomic absorption spectroscopy
- Weighing balance
- fume cupboard
- Oven

The following apparatus was used ;

- Filter paper
- Sample bottles
- 100ml volumetric flask
- Funnel
- 25ml beakers
- 1000ml graduated cylinder
- chemicals and reagents used;
- HCL,HNO3,standards for heavy metal
- Samples used for this work ;
- Water,plant,soil and effluent

3.1 PREPARATION OF APPARATUS AND WORKING AREA

1. Sterilization of Glass wares and other working equipments: Materials which included conical flasks, funnels and test tubes were sterilized in a hot air oven at 160°C for about 1hour.
2. All pipettes and other heat-resistant glassware's were wrapped in Aluminium foil to protect the items from recontamination during handling and storage before sterilization was done at 160°C for 1hr in the hot air oven.
3. Water was used to wash all the equipment's, detergents were used where necessary and 70% ethyl alcohol which is bactericidal was usedto swab the top of the working bench in the laboratory where the inoculations were done.

3.2 SAMPLE PREPARATION

A small amount of each representative soil sample was properly air-dried for two days at room temperature in the laboratory environment, and any unwanted objects were discarded. Each of the air-dried samples was then crushed into fine powder using a mortar and pestle and passed through a sieve with 2 mm steel wired meshes. These were stored in polythene bags until they were digested (Reenwijk, 1995).The plant samples were oven dried and blended to fineness for easy digestion

3.3 SAMPLE DIGESTION

1.0g of sieved soil and plant samples and 1ml of water sample and effluent were accurately weighed with an analytical weighing balance and transferred to a crucible; 100ml of aqua regia in a ratio of 3:1 concentrated HN03 and concentrated HCl was added to the samples.]. The samples were heated on a heating mantle inside a fume cupboard until it appears crystal clear and gives a colorless fume then we can say it has digested meanwhile the acid was added at intervals. The digested soil samples were filtered with a funnel and filter paper into a 100ml volumetric flask and made up to the mark with distilled water after cooling (Oluyemi et al., 2008). The metals were determined using an Atomic Absorption Spectrophotometer (AAS) model AA310N system.

Figure 3:1 The digestion process

3.4 LABORATORY ANALYSIS

Heavy Metals analysis Using Atomic Absorption Spectrophotometer (AAS): Atomic Absorption Spectrophotometer (AAS) Analyst AA310N model used in determining the content of heavy metals in the previously digested water samples. The nitrous oxide, acetylene gas and compressor were fixed and compressor turned on and the liquid trap blown to rid of any liquid trapped (AOAC, 1990). The Extractor and the AAS control were turned on. The slender tube and nebulizer piece were cleaned with purifying wire and opening of the burner cleaned with an arrangement card. The worksheet of the AAS programming on the joined PC was opened and the empty cathode light embedded in the light holder (Haswell, 1991). The light was turned on, beam from cathode adjusted to hit target zone of the arrangement card for ideal light throughput, at that point the machine was touched off. The fine was set in a 10 ml graduated chamber containing deionised water and yearning rate estimated (AOAC, 1990). The analytical blank was prepared, and a series of calibration solutions of known amounts of analyte element (standards) were made. The blank and standards were atomized in turn and their responses measured. A calibration graph was plotted for each of the solutions, after which the sample solutions were atomized and measured. The various metal concentrations from the sample solution were determined from the calibration, based on the absorbance obtained for the unknown sample (Haswell, 1991).

3.5 PREPARING WORKING STANDARD FOR AAS

1ppm-1mg/l

Stock-1000mg/ml=1000ppm=1000mg/l

Preparing 1ppm, 2ppm, 3ppm,4ppm,5ppm

For 5ppm

$$C_1V_1=C_2V_2 \quad (3.1)$$

C=concentration v=volume

(C_1=1000ppm,C_2=5ppm,V_2=200,V_1=?)

V_1= 1ml in 200ml flask

For 4ppm

(C_1=5ppm,C_2=4ppm,V_2=50ml,V_1=??)

V_1=40ml

For 3ppm

(C_1=5ppm,C_2=3ppm,V_2=50ml,V_1=?)

V_1=30ml

For 2ppm

V_1=20ml

For 1ppm

V_1=10ml

CHAPTER FOUR

4.1 RESULTS AND DISCUSSION

Permissible limit for drinking water, soil, plant and effluent quality according to world health organization was compared in this review.

Table 1: WHO permissible limit of heavy metal concentrations for normal drinking water (WHO, 2008)

S/N	HEAVY METAL	WHO PERMISSIBLE LIMIT (mg/L)
1	COPPER	2
2	ZINC	5
3	MAGNESSIUM	50
4	IRON	1.0
5	CADMIUM	0.01
6	CHROMIUM	0.05
7	LEAD	0.05

Table 2: WHO permissible limit of heavy metal concentrations for plant(2008) in mg/l

S/N	HEAVY METAL	WHO PERMISSIBLE LIMIT (mg/L)
1	COPPER	10
2	ZINC	0.6
3	MAGNESSIUM	50
4	IRON	20
5	CADMIUM	0.02
6	CHROMIUM	1.30
7	LEAD	2

Table 3: WHO permissible limit of heavy metal concentrations for soil

S/N	**HEAVY METALS**	**WHO PERMISSIBLE LIMIT(mg/L)**
1	COPPER	36
2	ZINC	50
3	MAGNESSIUM	<100
4	IRON	40.7
5	CADIUM	0.8
6	CHROMIUM	100
7	LEAD	85

Table 4: WHO permissible limit of heavy metal concentrations of effluents(WHO 2008)

S/N	**HEAVY METAL**	**WHO PERMISSIBLE LIMIT (mg/L)**
1	COPPER	1.5
2	ZINC	15
3	MAGNESSIUM	
4	IRON	20
5	CADMIUM	0.003
6	CHROMIUM	0.05
7	LEAD	0.01

Table 5: Result of heavy metal concentration analysis in milligram per litre done on P1 which is the plant sample collected from the Oredo flow station and P2 which is the plant sample collected from the University of Benin

Metal	CU (mg/L)	FE (mg/L)	PB (mg/L)	ZN (mg/L)	CD (mg/L)	CR (mg/L)	MG (mg/L)
P1	0.005 0.008	0.043 0.051	0.000 0.001	0.018 0.011	N.D N. D	0.010 0.010	2.66 2.64
P2	0.025 0.020	0.333 0.288	0.047 0.045	0.300 0.256	0.035 0.036	0.020 0.030	0.46 0.44

Table 6: Mean values for the double heavy metal analysis done on plant samples in milligram per liter from the Oredo flow station and the University of Benin

Metal	CU (Mg/L)	FE (Mg/L)	PB (Mg/L)	ZN (Mg/L)	CD (Mg/L)	CR (Mg/L)	MG (Mg/L)
P1	0.0065	0.047	0.0005	0.015	N.D N. D	0.01	2.65
P2	0.0225	0.311	0.046	0.285	0.036	0.025	0.45

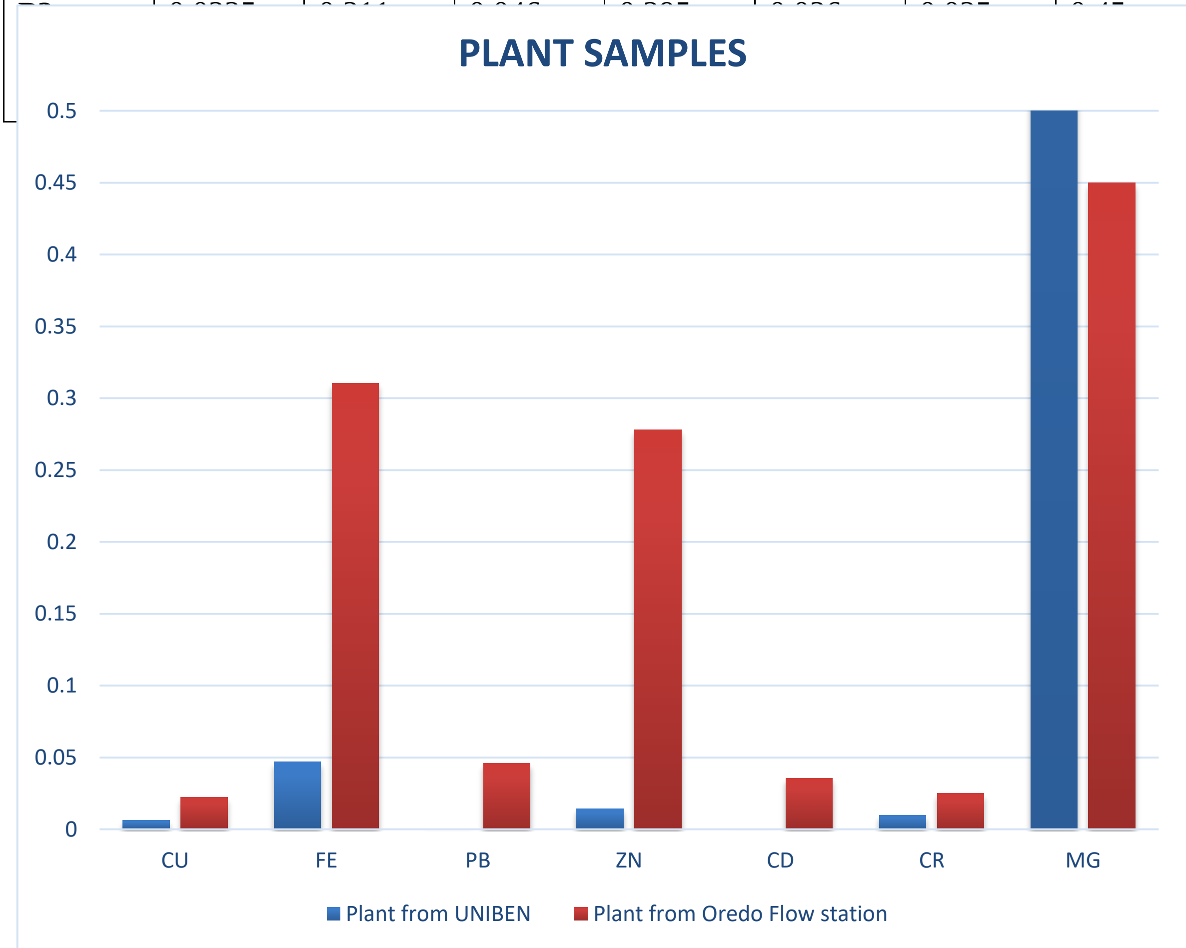


Figure 4.1: A graph representation of the mean value of plant sample from Oredo flow station and the University of Benin

Table 7: Result of heavy metal concentration double analysis in milligram per litre done on W1 which is the water sample collected from the Oredo flow station and W2 which is the water sample collected from the University of Benin

Metal	CU (mg/L)	FE (mg/L)	PB (mg/L)	ZN (mg/L)	CD (mg/L)	CR (mg/L)	MG (mg/L)
W1	0.002 0.003	0.004 0.002	0.001 0.003	N.D 0.001	0.001 N.D	N.D N.D	0.410 0.310
W2	0.029 0.030	0.020 0.018	0.043 0.041	0.062 0.056	0.027 0.021	0.030 0.030	0.280 0.410

Table 8: Mean values for the double heavy metal analysis done on water samples from the Oredo flow station and the University of Benin

Metal	CU (mg/L)	FE (mg/L)	PB (mg/L)	ZN (mg/L)	CD (mg/L)	CR (mg/L)	MG (mg/L)
W1	0.0025	0.003	0.002	N.D 0.001	0.001 N.D	N.D N.D	0.36
W2	0.029	0.019	0.042	0.059	0.024	0.03	0.69

Figure 4.2: A graph representation of the mean value of water sample from Oredo flow station and the University of Benin

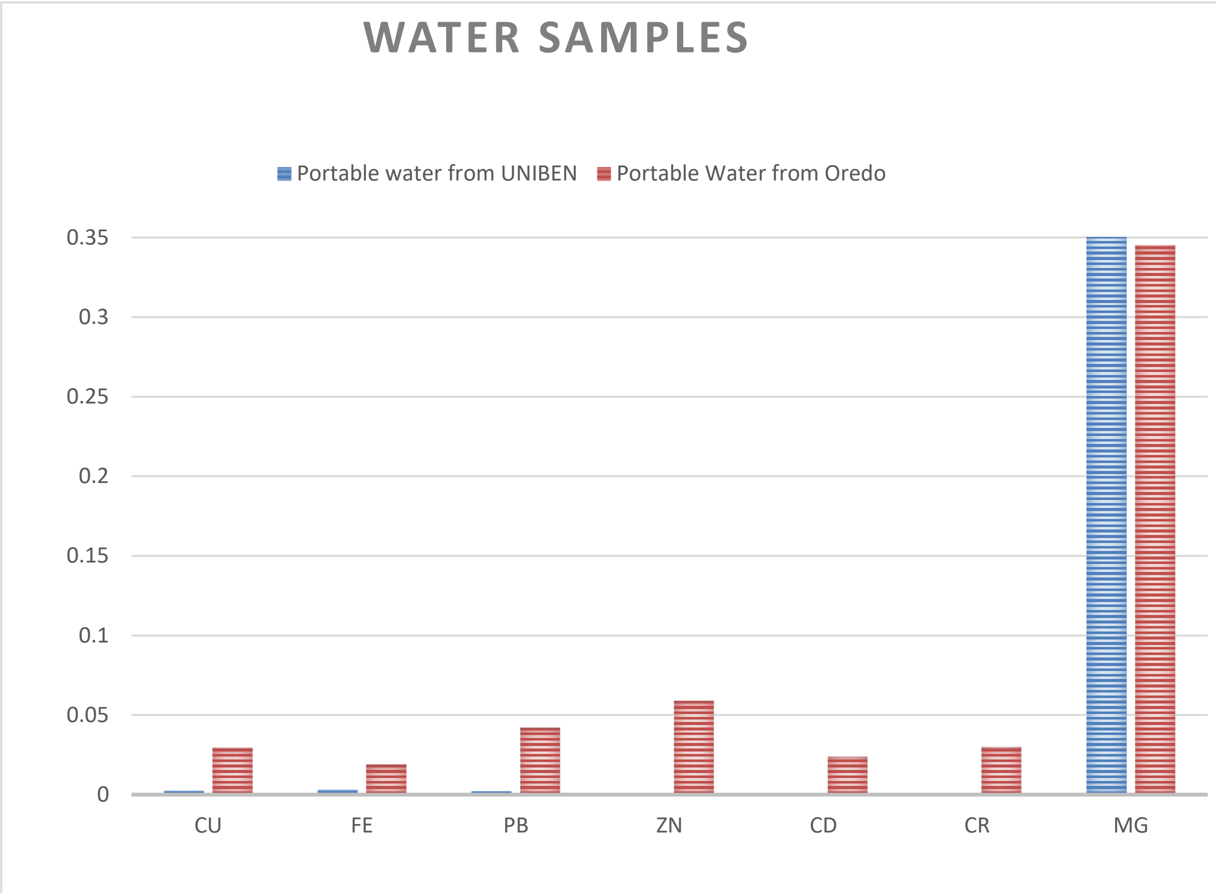


Table 9: Result of heavy metal concentration double analysis in milligram per litre of S1 which is the soil sample collected from the Oredo flow station and S2 which is the soil sample collected from the University of Benin

Metal	CU (mg/L)	FE (mg/L)	PB (mg/L)	ZN (mg/L)	CD (mg/L)	CR (mg/L)	MG (mg/L)
S1	0.005 0.006	0.014 0.008	0.008 0.006	0.003 0.004	N.D N.D	N.D 0.010	0.580 0.630
S2	0.080 0.050	0.792 0.765	0.034 0.037	0.055 0.063	0.041 0.040	0.020 0.030	2.00 1.04

Table 10: Mean values for the double heavy metal analysis of soil samples from the Oredo flow station and the University of Benin

Metal	CU (mg/L)	FE (mg/L)	PB (mg/L)	ZN (mg/L)	CD (mg/L)	CR (mg/L)	MG (mg/L)
S1	0.006	0.011	0.007	0.004	ND	0.010	0.605

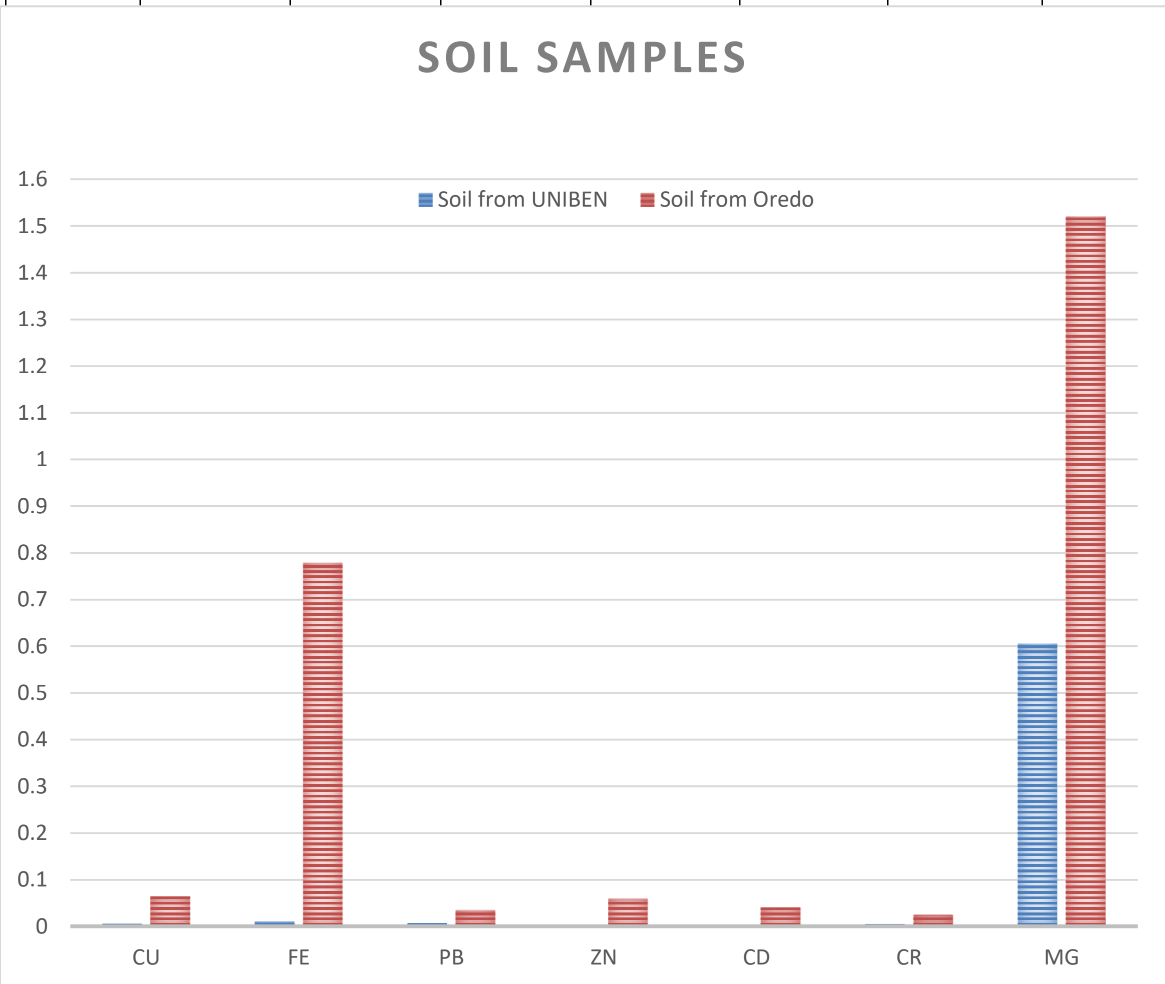


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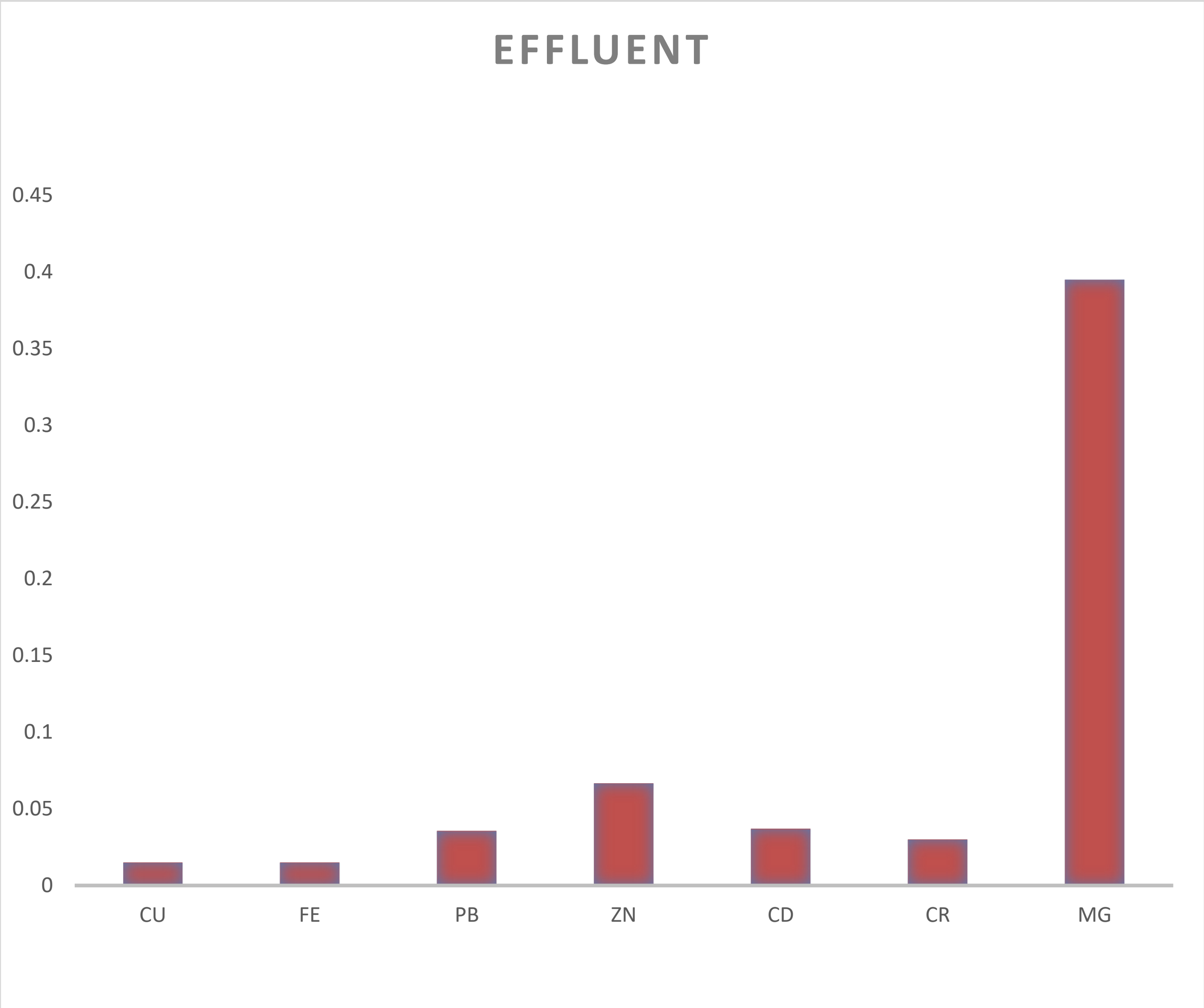
Table 11: Result of heavy metal concentration double analysis of E1 which is the effluent sample collected from the Oredo flow station

Metal	CU (mg/L)	FE (mg/L)	PB (mg/L)	ZN (mg/L)	CD (mg/L)	CR (mg/L)	MG (mg/L)
E1	0.014 0.016	0.015 0.015	0.036 0.035	0.068 0.765	0.038 0.036	0.030 0.030	0.39 0.40

Table 12: Mean value of the double heavy metal analysis of effluents sample(mg/L)

Metal	CU (mg/L)	FE (mg/L)	PB (mg/L)	ZN (mg/L)	CD (mg/L)	CR (mg/L)	MG (mg/L)
E	2.03	0.03	0.035	0.416	0.037	0.03	0.39

Figure 4.4: A graph representation of the mean value of effluent sample from oredo flow station



4.2 DISCUSSION

Present study was carried out in order to check the heavy metal contamination of water,soil and plants of the oredo flow station in comparison to the university of benin.As pollution is dangerous to the environment cause it poses threats to our health so therefore there is need to access the quality cause it is an important issue related to human and environment. For this purpose ,A total of 4 samples(effluent,water,plant and soil)were collected each from the NPDC oredo flow station and the university of Benin which were subjected to heavy metal analysis . The maximum allowable levels (MAPs) for all heavy metal concentrations in drinking water as established by the World Health Organization (WHO) were included in table 1. According to the WHO, this table's values for each of the heavy metals listed were provided (2003, 2005 and 2008)universal standards. The concentrations of WHO maximum permitted limits for all metals recommended for regular drinking water are as follows: zinc(Zn); 5mg/L (WHO, 2003);copper(Cu);2mg/L Iron (Fe); 0.3 mg/L (WHO, 2003);

Cadmium (Cd): 0.003 mg/L (WHO, 2011); Chromium(Cr) 0.05 (WHO, 2003)Lead (Pb); 0.05 (WHO, 2003); magnesium(Mg): 50mg/L. These standards were established by the WHO to assess the quality of various water sources and to determine whether they are safe to drink, to determine the level of heavy metal toxicity in various sources of water, and to assess the level of heavy metals in effluents ,plants and soil. The WHO criterion for plants' heavy metal content is outlined in Table 2 for quick reference. . The WHO criteria for soil heavy metal content is also shown in Table 3.The WHO criteria for effluent heavy metal content is also shown in Table 4. Table 5 lists the results of our atomic absorption spectrometry analysis for plants. Table 7 list the result of our atomic absorption spectrometry analysis for water .Table 9 list the result of the atomic absorption spectrometry for soil .Table 11 list the result of the atomic absorption spectrometry in effluent .

4.2.1 COPPER LEVEL

The permissible limit of copper for plants is 10mg/L recommended by WHO. The plant concentration of copper from the oredo flow station is 0.0225mg/l and that from university of Benin is 0.0065mg/l as seen in table 5 above which was below the permissible limit,The maximum permissible limit for Cu in water is 2 mg/l. The values of cu in water samples collected from the oredo flow station was 0.029mg/l and that of university of Benin was 0.0025mg/l as seen in the table 7 above .In the collected water samples from the oredo flow station concentration of copper was recorded below the permissible limit set by WHO. Concentration value of copper in soil samples from the oredo flow station is 0.065mg/l and that of university of benin is 0.006mg/l as seen in the table 9 above . In all the collected soil samples concentration of copper was recorded below the permissible limit set by WHO which is 36mg/L.The values of cu in effluent samples collected from the oredo flow station was 2.0mg/l as seen in the table 12 above .In the collected effluent samples from the oredo flow station concentration of copper was recorded above the permissible limit set by WHO which is 1.5mg/l.copper in concentrations below or even higher than its standard of 2mg/l in water can pose threat to the human health such as nausea,abdominal pain,diarrhea this is in agreement with previous work done by pizzaro *et al*.,(1999). contamination of drinking water with high level of copper may lead to chronic anemia(Asma Iqbal *et al* 2011)more effect of deficiency of copper include fatigue and weakness,weak and brittle bone,sensitivity to cold and vision loss

4.2.2 IRON LEVEL

The permissible limit of iron for plants is 20mg/kg recommended by WHO. The plant concentration of iron from the oredo flow station is 0.311mg/l and that from university of Benin is 0.047mg/l as seen in the table 5 above which was below the permissible limit,The maximum permissible limit for fe in water is 1.0mg/l. The values of fe in water samples collected from the oredo flow station was 0.019mg/l and that of university of Benin was 0.003mg/l as seen in the table 7 above .In the collected water samples from the oredo flow station concentration of fe was recorded below the permissible limit set by WHO. Concentration value of iron in soil samples from the oredo flow station is0.779mg/l and that of university of benin is 0.011mg/l as seen in the table 9above . In all the collected soil samples concentration of iron was recorded below the permissible limit set by WHO which is

40.70mg/kg. The values of iron in effluent samples collected from the oredo flow station was 0.03mg/l as seen in the table 12 above .In the collected effluent samples from the oredo flow station concentration of iron was recorded below the permissible limit set by WHO which is 1.0mg/l. iron deficiency anemia is a common type of anemia,a condition in which blood lacks adequate healthy red blood cells. Red blood cells carry oxygen to the body's tissues.Without enough iron, your body can't produce enough of a substance in red blood cells that enables them to carry oxygen (hemoglobin). As a result, iron deficiency anemia may leave you tired and short of breath.

4.2.3 LEAD LEVEL

The permissible limit of lead for plants is 2mg/L recommended by WHO. The plant concentration of lead from the oredo flow station is 0.046 and that from university of benin is 0.0005 as seen in the table 5 above which was below the permissible limit,The maximum permissible limit for pb in water is 0.05 mg/l. The values of pb in water samples collected from the oredo flow station was 0.042mg/l and that of university of benin was 0.002mg/l as seen in the table 7 above .In the collected water samples from the oredo flow station concentration of pb was recorded below the permissible limit set by WHO. Concentration value of pb in soil samples from the oredo flow station is 0.006mg/l and that of university of benin is 0.0065mg/l as seen in the table 9 above. In all the collected soil samples concentration of pb was recorded below the permissible limit set by WHO which is 36mg/kg. The values of lead in effluent samples collected from the oredo flow station was 0.03mg/l as seen in the table 12 above .In the collected effluent samples from the oredo flow station concentration of lead was recorded below the permissible limit set by WHO which is 0.05mg/l.lead poisoning also known as plumbism and saturism is a type of metal poisoning caused by lead in the body

4.2.4 ZINC LEVEL

The permissible limit of zinc for plants is 0.6mg/L recommended by WHO. The plant concentration of zinc from the oredo flow station is 0.295mg/l and that from university of benin is 0.015mg/l as seen in the table 5 above which was below the permissible limit,The maximum permissible limit for zn in water is 5 mg/l. The values of zn in water samples collected from the oredo flow station was 0.059mg/l and that of university of benin was 0.001mg/l as seen in the table 7 above .In the collected water samples from the oredo flow station concentration of pb was recorded below the permissible limit set by WHO. Concentration value of pb in soil samples from the oredo flow station is 0.036mg/l and that of university of benin is 0.007mg/las seen in the table 9. In all the collected soil samples concentration of pb was recorded below the permissible limit set by WHO which is 85mg/kg. The values of zinc in effluent samples collected from the oredo flow station was 0.416mg/l as seen in the table 12 above .In the collected effluent samples from the oredo flow station concentration of copper was recorded below the permissible limit set by WHO which is 15mg/l.Low zinc in drinking water is associated with the risk of developing type 1 diabetes during childhood.(samuelsson et al 2011) acrodermatitis enteropatica is a disorder caused as a result of deficiency of zinc and this causes hair loss ,impaired immunity.impaired growth,elemental zinc of 1-3mg is given orally once a day for the remission of this.

4.2.5 CADIUM LEVEL

The permissible limit of cadium for plants is 0.02mg/L recommended by WHO. The plant concentration of cadium from the oredo flow station is 0.036mg/l and that from university of benin was not detected as seen in the table 5 above therefore that of oredo flow station was above the permissible limit,The maximum permissible limit for cd in water is 0.003 mg/l. The values of cd in water samples collected from the oredo flow station was 0.024mg/l and that of university of benin was 0.001 mg/l as seen in the table 7 above.In the collected water samples from the oredo flow station concentration of cd just in oredo communities was recorded above the permissible limit set by WHO,while that of the university of benin was recorded below.. Concentration value of cd in soil samples from the oredo flow station is 0.041 mg/l and that of university of benin was not detected as seen in the table 9 above. In all the collected soil samples, concentration of cd was recorded below the permissible limit set by WHO which is 0.8mg/l. The values of cadium in effluent samples collected from the oredo flow station was 0.037mg/l as seen in the table 12 above .In the collected effluent samples from the oredo flow station concentration of cadium was recorded above the permissible limit set by WHO which is 0.003mg/l. Breathing high levels of cadmium damages people's lungs and can cause death. Exposure to low levels of cadmium in air, food, water, and particularly in tobacco smoke over time may build up cadmium in the kidneys and cause kidney disease and fragile bones. Cadmium is considered a cancer-causing agent.Cadmium toxicity may cause renal dysfunction with both tubular and glomerular damage with resultant proteinuria.

4.2.6 CHROMIUM LEVEL

The permissible limit of Chromium for plants is 1.30mg/L recommended by WHO. The plant concentration of chromium from the oredo flow station is 0.025mg/l and that from university of benin is 0.01mg/l as seen in the table 5 above which was below the permissible limit,The maximum permissible limit for Cr in water is 0.1 mg/l. The values of Cr in water samples collected from the oredo flow station was 0.03mg/l and that of university of benin was not detected as seen in the table 7 above .In the collected water samples from the oredo flow station concentration of chromium was recorded below the permissible limit set by WHO. Concentration value of chromium in soil samples from the oredo flow station is 0.025mg/l and that of university of benin is 0.010mg/l as seen in the table 9 above . In all the collected soil samples concentration of chromium was recorded below the permissible limit set by WHO which is 100mg/L.The values of chromium in effluent samples collected from the oredo flow station was 0.03mg/l as seen in the table 12 above .In the collected effluent samples from the oredo flow station concentration of copper was recorded the same as the permissible limit set by WHO which is 0.03mg/l.

Low chromium levels can increase blood sugar, triglycerides (a type of fat in the blood), cholesterol levels, and increase the risk for a number of conditions, such as diabetes and heart disease. A higher risk of stomach tumours have been reported in studies where humans and animals have been exposed to high levels of hexavalent chromium in drinking water over a long time, however, research is inconclusive

4.2.7 MAGNESSIUM LEVEL

The permissible limit of magnessium for plants is 50mg/L recommended by WHO. The plant concentration of magnessium from the oredo flow station is 0.45mg/l and that from university of benin was 2.65mg/l as seen in the table 5 above . concentration of mg in the plant samples was recorded below the permissible limit,The maximum permissible limit for mg in water is 50 mg/l. The values of mg in water samples collected from the oredo flow station was 0.69mg/l and that of university of benin was 0.36 mg/l as seen in the table 7 above. Concentration of mg was recorded below the permissible limit set by WHO.. Concentration value of mg in soil samples from the oredo flow station is 1.52 mg/l and that of university of benin was 0.605 as seen in the table 9 above. In all the collected soil samples, concentration of mg was recorded below the permissible limit set by WHO which is <100.The values of mg in effluent samples collected from the oredo flow station was 0.39mg/l as seen in the table 12 above.Low magnesium levels are associated with endothelial dysfunction, increased vascular reactions, and decreased insulin sensitivity. Low magnesium status has been implicated in hypertension, coronary heart disease.(WHO2009).

CHAPTER FIVE

5.1 CONCLUSION

The major goal of this research work was to access the concentration of some toxic heavy metals present in te soil, plant water and effluent as a result of oil and gas exploitation activities and the following conclusions were gotten.:

1. This study determined the level of heavy metals(Zn ,Fe, Cd, Cr, Cu,Mg) the main goal was to access the concentration of these toxic heavy metals .These metals both in their higher levels and lower levels is detrimental to the human health and the environment cause in their lower value with time their concentration increases cause they are non biodegradable and persist in the environment for a long time.
2. A total of 8 samples were collected from a contaminated area labeled xyzflow station and uncontaminated area labeled the University of Benin.
3. The concentration of heavy metal in the samples were determined using atomic absorption spectrometry and the values were compared with the WHO standard to check for toxicity.Figure 4.1-4.4 shows the high difference in the concentration of the samples compared to the WHO whether lower or higher

5.2 RECOMMENDATION

Environmental degradation problem has been here for several years and should not be sustained to the next generation to handle effort to solve them should be taken more seriously. It is the responsibility of the government to protect vulnerable group of the society Environmental protection laws and policies should be carried out with utmost sense of responsibility.

The capacity of the monitoring Agencies should be enhanced to effectively carry out regular suvelliances of the activities of participants in oil industry so as to sanction those found wanting if environmental issues are to be mitigated Government and oil producig industry should fast track the cleaning up of polluted areas due to oil spillage and four month later to begin clean up operation which are set on fire causing tuture damage like the case of Oriya in Bayelsa state in 2005, should be avoided.

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