



POLITECNICO DI TORINO

Department of Environment, Land and Infrastructure Engineering
Master of Science in Petroleum Engineering

**SUSTAINABLE EXPLORATION OF OIL AND GAS: A COMPARATIVE
STUDY OF THE UNITED KINGDOM AND NIGERIA**

Supervisor(s):

Prof. Blengini Giovanni Andrea
Prof. Deborah Shields

BATOK EMBANGLIAN EDDY CHRISTOPHER

S230635

MARCH 2018

Thesis submitted in compliance with the requirements for the Master
of Science degree

TABLE OF CONTENTS

ABSTRACT	Page 1
CHAPTER 1	Page 2
1.1 Introduction	Page 2
1.2 General Literature Review & Background information	Page 5
1.3 Overview of Economics, Environmental impacts and Sustainability	Page 7
1.4 The Theories of Weak and Strong Sustainability	Page 9
1.5 The Role of Oil and Gas Industry Process in Sustainable Development	Page 11
1.6 Upstream and Downstream Reaction to Sustainability	Page 12
1.7 Environmental Realities of Oil and Gas	Page 13
1.8 Controlling externalities of Oil and Gas Exploration Development	Page 15
1.9 Environmental drawbacks of Oil and Gas Exploration Development	Page 16
1.91 Health and Safety issues during exploration of Oil and Gas	Page 16

CHAPTER 2	Page 17
Exploration of Oil and Gas in the United Kingdom	
2.0 Oil Exploration & Exploitation	Page 17
2.1 Oil Spillage in the United Kingdom	Page 20
2.2 Impacts of Oil Pollution in the United Kingdom	Page 21
2.3 Environmental legislation of Oil Exploration in the United Kingdom	Page 22
2.4 Gas Exploration, Production and Flaring in the United Kingdom	Page 23
CHAPTER 3	Page 27
Exploration of Oil and Gas in Nigeria	
3.0 Introduction to Nigeria Oil and Gas Industry	Page 27
3.1 Case Study: Niger Delta Region	Page 28
3.2 Environmental Challenges, Socio-Economic Problems and Human Health Risk Linked to Petroleum Exploration in Nigeria	Page 30
3.3 Negative Socio-Economic Impact of Oil Exploration	Page 35
3.4 Losses from Gas Flaring Activities	Page 39

CHAPTER 4	Page 40
Discussion	
4.0 Rationale for Comparing the Exploration System of Nigeria and the United Kingdom	Page 40
4.1 Quantitative analysis of data from the United Kingdom and Nigeria	Page 40
4.2 Taxing Externalities	Page 46
4.3 How to Approach the Issue of the Niger Delta Region and Steps to Follow to Resolve this Problem	Page 47
4.4 What Nigeria and Other Developing Countries Could Emulate from the United Kingdom	Page 48
4.5 Framework for Sustainable Development	Page 49
CHAPTER 5	Page 50
Conclusion, Recommendation and Further Work	
5.1 Conclusion	Page 50
5.2 Recommendation	Page 51
5.3 Suggestions for Further Studies	Page 51
REFERENCES	Page 52

TABLES

Table 1 OPEC Crude Production	Page 4
Table 2 Environmental drawbacks of upstream and downstream activities	Page 14
Table 3 Pollutant released during gas flaring and their adverse effect	Page 26
Table 4 Oil production data	Page 40
Table 5 Price elasticity Nigeria	Page 41
Table 6 Price elasticity United Kingdom	Page 41
Table 7 health conditions from gas flaring activities	Page 43
Table 8: health conditions from water contamination by oil spillage	Page 44

FIGURES

Fig 1 Sustainable development goals	Page 3
Fig 2 Timeline of events related to sustainable development	Page 4
Fig 3 OPEC share of worldwide reserves	Page 7
Fig 4 A model of weak vs strong sustainability	Page 10

Fig 5 The Oil and Gas Industry Process	Page 11
Fig 6 United Kingdom total primary energy consumption	Page 17
Fig 7 North Sea Oil and Gas Fields	Page 18
Fig 8 Oil production in the United Kingdom (1975-2012)	Page 19
Fig 9 Norway vs United Kingdom Crude Oil production (1970-2015)	Page 19
Fig 10 Norway vs United Kingdom gas production (1970-2015)	Page 23
Fig 11 Map Showing the ‘Zero Routine Flaring by 2030’	Page 25
Fig 12 United Kingdom carbon dioxide emission compared to targets	Page 26
Fig 13 Map of Nigeria highlighting the states of Niger Delta region	Page 28
Fig 14 Oil production vs consumption in Nigeria (1980-2012)	Page 29
Fig 15 Top Flaring Countries (2013-2016)	Page 32
Fig 16 Global gas flaring and Oil production (1990-2016)	Page 33
Fig 17 Flaring intensity from top 30 gas flaring nations	Page 33
Fig 18 Gas Flaring activities in Niger Delta and pipeline exposed	Page 34
Fig 19 Frequency Incidents from oil spills in Nigeria 2017	Page 36
Fig 20 Vol of Oil spills/month in Nigeria	Page 37

Fig 21 Oil spill in the Niger Delta region	Page 38
Fig 22 Representation of health condition gas flaring Nigeria	Page 43
Fig 23 Representation of health conditions from contamination Of water by Oil spillage, Nigeria	Page 44
Fig 24: Representation of health conditions from oil spillage UK	Page 45
Fig 25: Representation of health conditions from gas flaring UK	Page 46
Fig 26: Framework for achieving sustainable exploration goals	Page 49

ACKNOWLEDGEMENT

Firstly, I want to thank my supervisor Professor Blengini Giovanni Andrea for his availability during my thesis and the insight he gave to me despite his busy schedule. I would not have finished this work without him. I also want to thank Professor Deborah Shields as her work inspired me to do this thesis.

Secondly, I want to thank all those who directly or indirectly stood by me during this past 2 years especially the support I got from my family, the Embanglian's and particularly Embanglian Harold C.

I want to thank my classmates, work colleagues and friends who always stood by me notably Herman Kamuli, Gerald Nwudo, Mariel Takoudoum, Kemjika Emecheta, Linda Youtha, Brenda Amadi, Okoro Faith, Mutwari Steve, Gimo Mano, Sarpong Carl, Elcidio Manjate, Desiré Elouga, Mr. Raphael Soudan and all those whom I did not mention. You all mean a lot to mean and this work was achieved through your encouragements and prayers.

Finally, I thank God for the gift of life, health and knowledge

THIS THESIS IS DEDICATED TO MY SIBLINGS

**EWANDE EMBANGLIAN CLAUDE SANDRA
MBOY EMBANGLIAN GABRIELA
EMBANGLIAN JEROME JUNIOR**

ABSTRACT

Despite advancement in technology and recent discoveries, there is no telling when we are expected to face peak oil and gas but one thing is sure, peak oil and gas expectations have been postponed. The oil and gas industry breeds a wide range of economic benefits such as:

1. Job creation
2. Increase in tax revenue
3. Provision of industrial feedstocks

Even with these benefits linked to oil and gas industry and its activities, there is hostility linked with oil and gas extraction in most parts of the world. This hostility is fuelled by concern about the management of environment, social and economic impacts of these activities and how they are mitigated. There is also concern about the distribution of risk and benefits among industry, indigenous population and the government.

To respond to these problems, the application of sustainable development principles as depicted by the United Nation Sustainable Development goals is recommended in order to partially provide solutions. On September 25th 2015, countries decided to adopt new goals to end poverty, protect the planet and ensure prosperity for all as part of a new sustainable development agenda (United Nation Organisation , 2017). The different goals have specific targets to be achieved by 2030. Best practice codes and indicators of sustainability, together with understanding the contribution of different operations to sustainable development is key.

For the purpose of this study, two countries (the United Kingdom and Nigeria) are showcased, compared and contrasted in their approach to solve this problem. The United Kingdom is observed to be closer in achieving these goals set by the United Nations while Nigeria on the flip side is facing difficulties keeping up with this challenge. Understanding of the gap in the method of approach of the two nations towards sustainable exploration and analyses of the success and failure of their methods gives a general understanding in the approach of developed and developing nations who are petroleum producers, in their quest to achieving sustainable development goals.

Keywords: Sustainable development, Oil exploration, Gas flaring, Oil spillage, externalities, climate change, local population, Niger Delta region

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

Despite the increase in the use of other forms of energy and particularly renewable energy, fossil fuel is still highly used in most parts of the world. This is not surprising, as oil and gas contribute to most of our day-to-day activities. Energy from fossil fuels are assumed to be finite because they are non-renewable. Regular exploration, production and usage of this form of energy is bound to cause depletion in the amount of available reserves.

An improvement in exploration and production methods of fossil fuel and an amelioration in the technologies used has led to the discovery of more energy fields in the recent years thus increasing the reserves. This has led to some countries rich in fossil fuel like Nigeria to focus primarily on this form of energy. Nevertheless, the exploration of fossil fuel has been said to be non-sustainable because it is assumed finite and also its exploration activities do not meet the three pillars of sustainability which are environment, society and economy. The oil and gas sector has proven to breed vulnerability in Nigeria as there have been many cases of crude and natural gas pipeline vandalism, gas flaring and unrest within populations living close to this zone (Osuoka, 2005).

There is no talk about the oil and gas exploration firms in the United Kingdom, Nigeria and the rest of the world in recent years, without highlighting the importance of environmental issues resulting from this activity. The numerous environmental and health challenges resulting and encountered during the exploration of oil and gas go against the goals of the United Nations Development Programme and its sustainable development goals.

The Sustainable Development Goals (SDGs), is a call to protect the planet, eradicate poverty and ensure that all people enjoy prosperity. There are 17 goals in total taking roots from the success of the millennium development goals. (United Nations Development Programme, 2016).

This thesis focuses on Nigeria which is rich in fossil energy resources, yet constantly under energy crisis; a country at the centre of the oil and gas industry, backed up with huge investments and yet which faces major environmental and sustainability challenges. The challenges encountered and the approach used in tackling the former, will be compared and contrasted with those of the United Kingdom from a sustainability perspective. According to the world bank, Nigeria has about 8 billion cubic metres of gas been flared annually, while approximately 75 million Nigerians lack access to electricity (World Bank, Nigeria's Flaring Reduction Target: 2020, 2017).

Fig 1: Sustainable development goals



Source: United Nations website

This is contrary to what has been observed lately in the United Kingdom and other developed countries where gas flaring and oil spillage are strictly considered illegal, (Omorotionmwan, 2005), except in some particular cases.

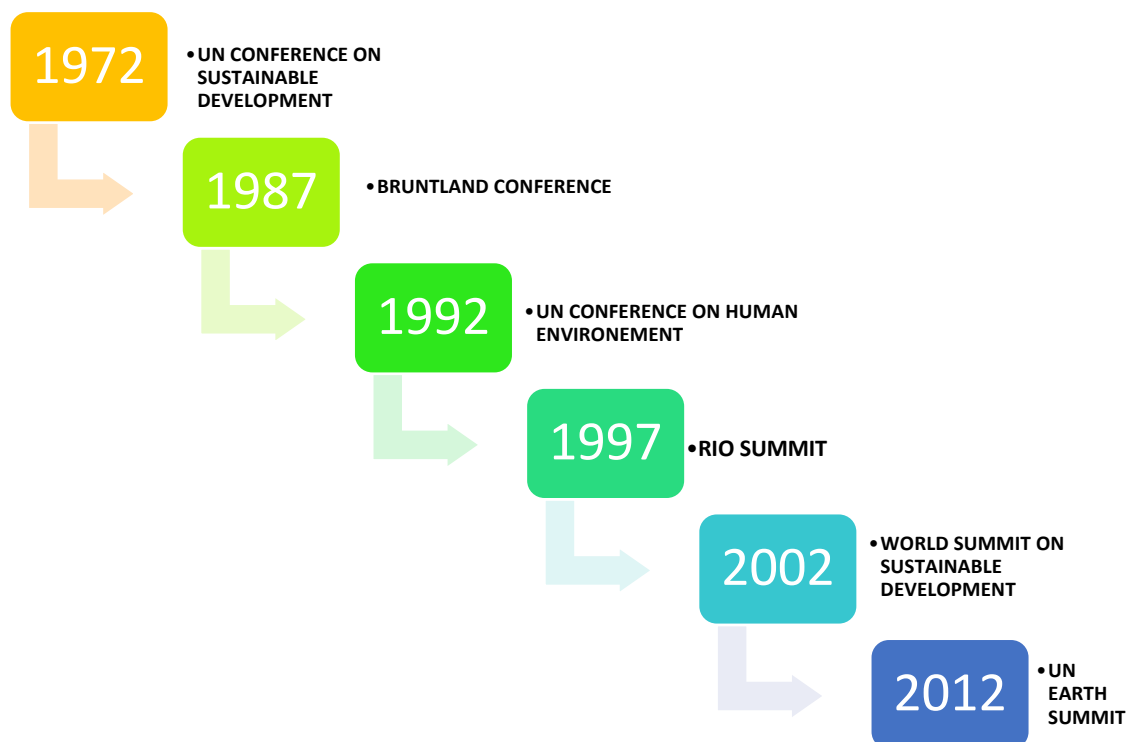
Though Nigeria has shown an improvement in recent years by reducing gas flaring by about 2 billion cubic meters between the year 2012 and 2015 (World Bank, 2017), Nigeria still ranks seventh-largest gas flarer worldwide while the United Kingdom has been seen to drastically reduce its flaring activities over the years and have been able to internalize the externalities caused by the activities of this industry. It is important to compare and contrast the way about of these two countries regarding their oil and gas exploration methods and project the use and impacts of these methods to a near future while capitalizing on its benefits if any and more importantly on negative impacts.

“The oil and gas industry has an important role to play in managing its operations safely and in reducing emissions, discharges and ecological impact while providing energy at a reasonable cost.” (Arscott, 2004)

Table 1: OPEC crude production (Dan Hassey , 2014)

Country	2014Supply (Million Barrel/Day)	Sustainable Production Capacity ((Million Barrel/Day)
Algeria	1.12	1.15
Angola	1.65	1.70
Ecuador	0.53	0.53
Iran	2.78	2.90
Iraq	2.99	3.30
Kuwait	2.78	2.90
Libya	0.50	1.20
Nigeria	1.92	2.25
Qatar	0.72	0.75
Saudi Arabia	9.76	12.40
United Arab Emirates	2.76	2.90
Venezuela	2.44	2.60

Fig 2: TIMELINE OF EVENTS RELATED TO SUSTAINABLE DEVELOPMENT



1.2 GENERAL LITERATURE REVIEW AND BACKGROUND INFORMATION

The need for the study arises from pressures encountered by the oil and gas industry to change their mode of production to one that is more sustainable and less harmful to the environment while emulating the example from countries who are closer to these goals such as the United Kingdom.

The importance of raising awareness regarding environmental issues related to oil exploration firms has become a topic of interest to the world. Crude oil is quoted as being the most important energy source in a global perspective and statistics show that approximately 35% of the world's primary energy consumption is supplied by oil and 21% by natural gas (International Energy Agency, 2006).

Crude oil and natural gas are raw materials of the petroleum industry and every modern society today directly or indirectly depends on oil and gas. Therefore, it is safe to say that oil and gas are vital for the day-to-day functioning of our society.

The different oil companies present today originated from different countries, each with a different history of acquisition, merging and sometimes transformation. These companies often share different point of views on sustainability issues which is as a result of the way they came about, though they have a common fundamental business goal.

The oil and gas industry has always been a very dynamic industry marked by evolutionary stages and changes overtime. This is still the case today as it is now faced with mass production as a response to market demands. This mass production in recent years and in the years to come is gradually changing to sustainable production which is the headline of the twenty-first century.

Nigeria which started its oil exploitation activities over 50 years ago, is the most populous country within the Organisation of Petroleum Exporting Countries (OPEC) and in Africa with a population of around 186 million inhabitants. It is located on Africa's western coast on the Gulf of Guinea (Organization of the Petroleum Exporting Countries, 2018). Nigeria covers an area of around 924,000 square kilometres and has Abuja as its.

The OPEC ranks Nigeria as the country with the 8th largest proven reserves. Nigeria is also the seventh largest producing country in the world in terms of oil and gas and the largest producer in Africa. These characteristics are enough to understand why mention of Nigeria when talking about oil and gas cannot be oblivious. Oil revenue is also the main source of Nigeria's annual foreign exchange earnings and as of 2017 contributes to about 95% of the country's annual revenue.

Nigeria's oil deposits are naturally located in the Niger Delta region and there is huge literature and reports written on Nigerian oil industry and operations in the Niger Delta

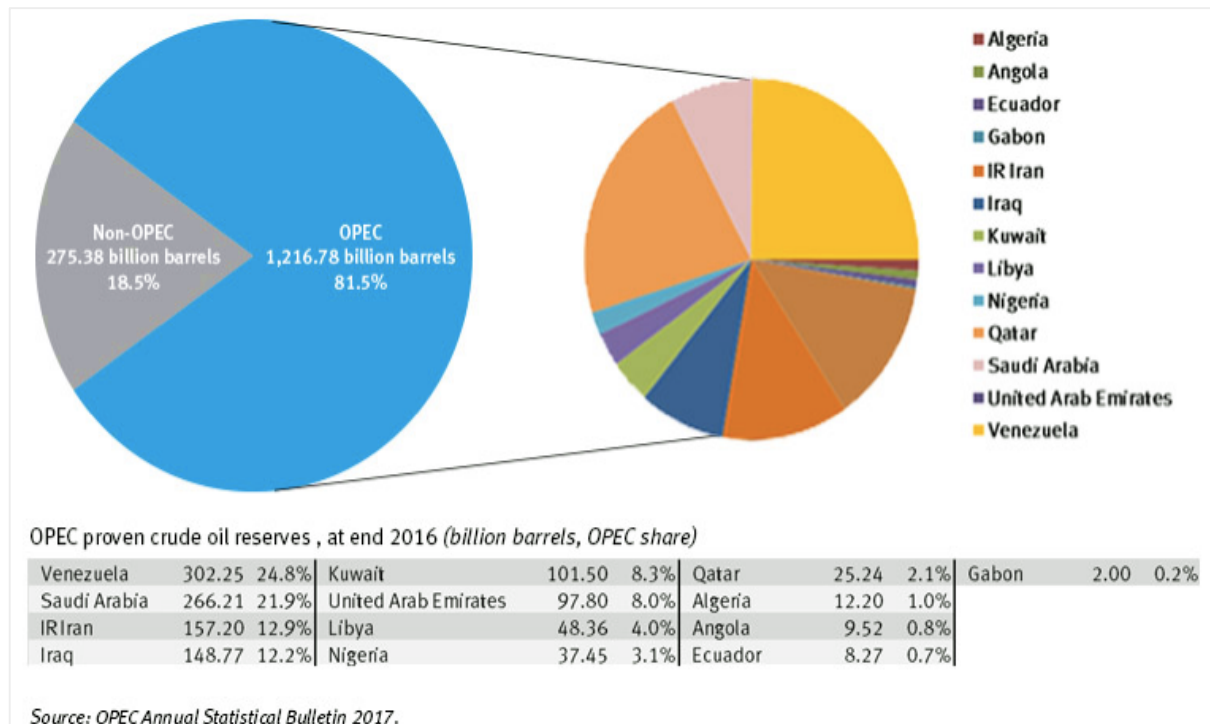
region. This is as a result of its importance to the global economy. Some of the literature published will serve as reference to in this thesis as they are centred around environmental and social rights which are essential to sustainability and sustainable development.

Oil exploration in the United Kingdom goes back to the early nineteenth century as its first oil exploration took place in 1918 (Smith, Norman J., 1978). The United Kingdom continental shelf has most of the country's oil reserves, (Energy Information Administration, 2012). The UK oil sector currently supplies approximately 60% of UK energy demand.

In the year, 2008, the UK was ranked as the 14th largest oil and gas producer worldwide (10th largest gas producer and 19th largest oil producer (Wikipedia, n.d.). In that same year, the act of parliament of the United Kingdom came up with the decision that the UK should reduce its carbon dioxide (CO₂) emission to at least 35% (below 1990 levels) in 2020 and 80% in 2050, (National Archives, 2008). The North Sea oil reserves were discovered in the early 1970s and the UK holds many activities there. Five countries predominantly take part in the oil and gas production activities in the North Sea and they are Denmark, Netherlands, Norway, Germany and the United Kingdom, (Oil and Gas Economic report, 2008)

The exploration of oil and gas goes through a life cycle broken into a series of steps namely exploration, appraisal, development, production and abandonment. There are various actors involved during these phases and it is important for these actors to collectively agree and work together to achieve the sustainable exploitation of these fossil fuel resources.

Fig 3: OPEC SHARE OF WORLD WIDE RESERVES



1.3 OVERVIEW OF ECONOMICS, ENVIRONMENTAL IMPACTS AND SUSTAINABILITY

The oil and gas industry is universal with activities conducted all over the globe from Venezuela to Australia, from Alaska to Norway and in every type of habitats such as deserts, Arctic region, mangroves, tropical rainforest and offshore. This shows that human beings will still heavily depend on oil and gas for a foreseeable future. World primary energy consumption as far as 1994 stood at nearly 8000 million tonnes of oil equivalents, which was representative of 63 per cent of the world energy supply.

The exploitation and exploration of oil and gas reserves though proven to be very lucrative and essential has come at a price in the past years and sometimes the bill has been heavy. This is due to the numerous ecological side effects caused such as fire accidents, oil spills, pollution of both water and air and heavy social impacts especially of operations particularly in remote communities. The oil and gas industry is now more than ever confronted to provide answers to these challenges which are now obvious to everyone. The 'Earth Summit', a conference held by the United Nations on Environment Development in June 1992 aimed at raising awareness on the relationship between environment and how it affects socio-economic growth.

Neither the demand nor consumption of energy from fossil fuel is on a decline hence given that alternative energy technologies, such as nuclear and renewables, will be unable to fully meet society's needs in the short to medium terms, there is natural concern about depletion of hydrocarbon resources (Deborah J. Shields, 2016)). This therefore brings about the question of sustainability as many peak dates have been predicted in the past with the most popular one been the Hubbert peak theory. Hubbert peak oil theory stresses on the fact that the world oil supply has already peaked or is likely to peak soon (Brian Towler, 2014) .

Though this statement now seems premature with improved technology and the rise of oil production in response to the world economy, it should not be forgotten that unlike other forms of renewable energy oil reserves are finite and hence the importance of sustainability for the oil and gas industry.

When the topic of sustainability is raised in the oil and gas industry, a series of doubt expressed by questions are usually asked. Some of which are:

- Is it possible to talk about sustainability and sustainable development when referring to non-renewable extraction?
- How can we internalize the externalities of oil and gas extraction which is important for sustainable development?
- How do we measure the contribution of oil and gas extraction to sustainable development?

Hence making the future a priority instead of putting at stake the well-being of future generations should be our goal when referring to sustainable development. Achieving these goals demand an understanding of sustainability and some concepts often associated to it such as those of weak and strong sustainability. It is also important to understand why oil and gas are important as forms of energy and their disadvantages

Some of the characteristics of crude oil as a form of energy are:

Advantages

- Oil has a high heating value
- Oil is available in liquid form hence easy to use and transport
- Oil is more abundant than other sources of energy

Disadvantages

- Burning oil leads to carbon emission
- Drilling activities represent a danger for the environment and the ecosystem
- Oil transportation can often result to spills which is a threat to the environment and causes ecological damages
- Fossil fuel like oil require billions of years to be formed.

Some characteristics of natural gas as a form of energy are:

Advantages

- Gas has a high heating value
- Contains about 70 per cent less carbon dioxide than other form of fossil fuels
- It burns clean compared to oil and coal

1.4 THE THEORIES OF WEAK AND STRONG SUSTAINABILITY

Sustainability adoption is a modern way that may solve current environmental crisis and that may ensure that production does not degrade resources beyond point of renewal (**WCED, 1987**). There are many ways to look at sustainability with reference to the oil and gas industry but before that, a definition must be assumed.

The common used definition of sustainable development is: *meeting the needs of the present without compromising the ability of future generations to meet their own needs*, thus emphasizing on the long-lasting debate of how to ensure intergenerational equity and has also been the topic of discussion on sustainability of energy by the International Energy Agency (INTERNATIONAL ENERGY AGENCY , 2002).

The above definition of sustainability takes into account the fact that the five types of capital must be taken into account to satisfy human needs which are human capital, financial capital, natural capital, social capital and man-made capital.

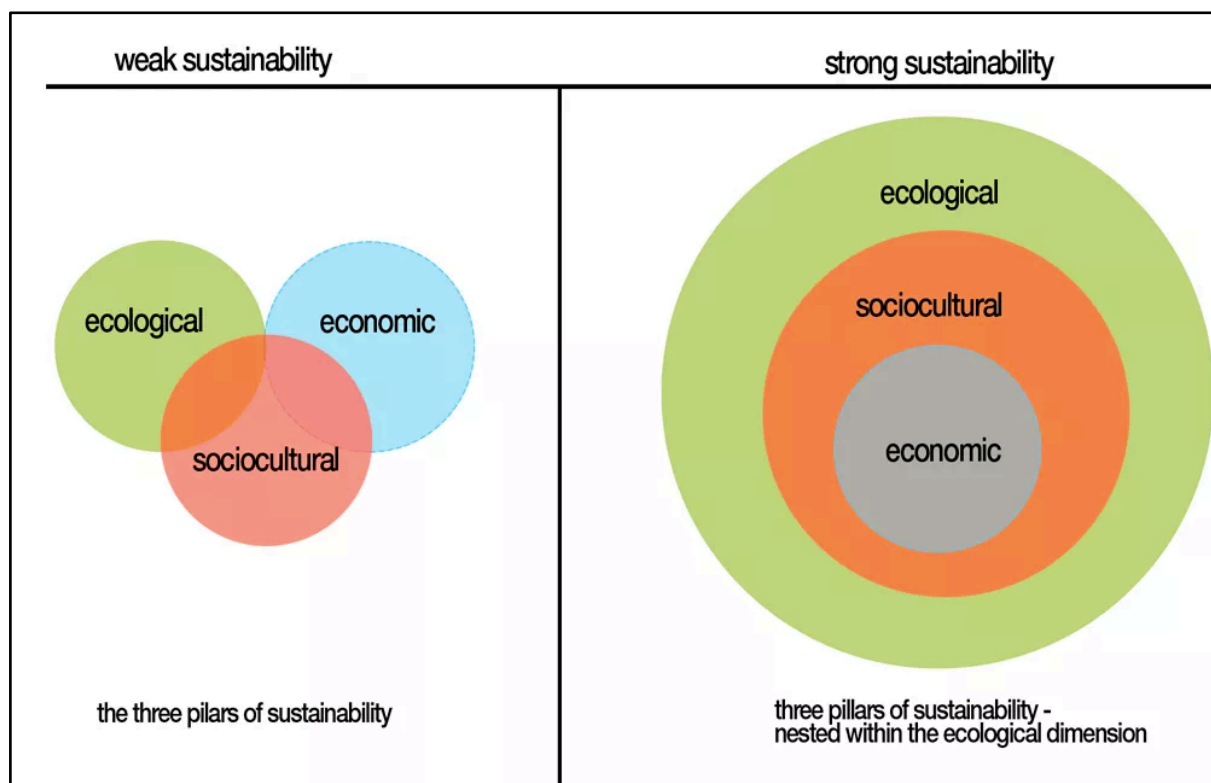
Also, within the former definitions two diverse concepts are defined which are strong and weak sustainability (Neumayer,2003). The former, weak sustainability depicts that the future generation may not essentially need the same types of capital and assumes that it is enough to keep the total stock of capital hence permitting substitution of the different types. The alternative, being strong sustainability brings a more rigid concept in suggesting that all types of capital must be available as one because they cannot be substituted for one another. With this put into perspective, it is clear that oil and gas extraction, just as is the case of the extraction of any non- renewable resource cannot be tagged sustainable if we go by the definition of strong sustainability (**Kronenberg, 2012**). It is unsustainable as once a resource is exploited it is made unavailable for the future generation.

On the flip side, following the thesis of weak sustainability, it would be possible to take advantage of the benefits from resource exploitation of the later to generate other forms of capital that would serve as a substitute for the resource exploited and hence keep the chain of sustainability alive for future development. Following the thesis of weak sustainability, logic, depleting oil and gas reserves should be offset by investing in other forms of capital for future generations. The concept of weak sustainability however does not help in determining the limit at which the level of trade-offs between the different types of capital is permitted and should this be the case, what happens if technological advancement slows down and cannot compensate opportunities for

substitution. Should the pace of technological advancement eventually slow down, are we going to agree with the thesis of strong sustainability?

The world bank has a bank of genuine data reflecting that gross national savings are reduced by depletion of energy resources such as oil and gas resources, depletion of minerals and damages to the environment as a result of the former's exploitation activities such as carbon dioxide emission and other forms of pollution. Should we borrow the world bank solution, to bring about weak sustainability, the depletion hence exploration of oil and gas should be directly proportional to an increase in savings of a nation rich in oil and gas resources. As surprising as it may be, the World Bank data shows an inverse relationship as many resource rich countries are observed to have negative genuine saving rates which goes to approve the findings in the area of research tagged as resource curse, (Eric Neumayer, 2009). It is not uncommon to see nations that suffer from resource curse as it is an easy trap for a nation to fall into if one is not careful as it is the case of many third world countries including Nigeria.

Fig 4: A MODEL OF WEAK VERSUS STRONG SUSTAINABILITY



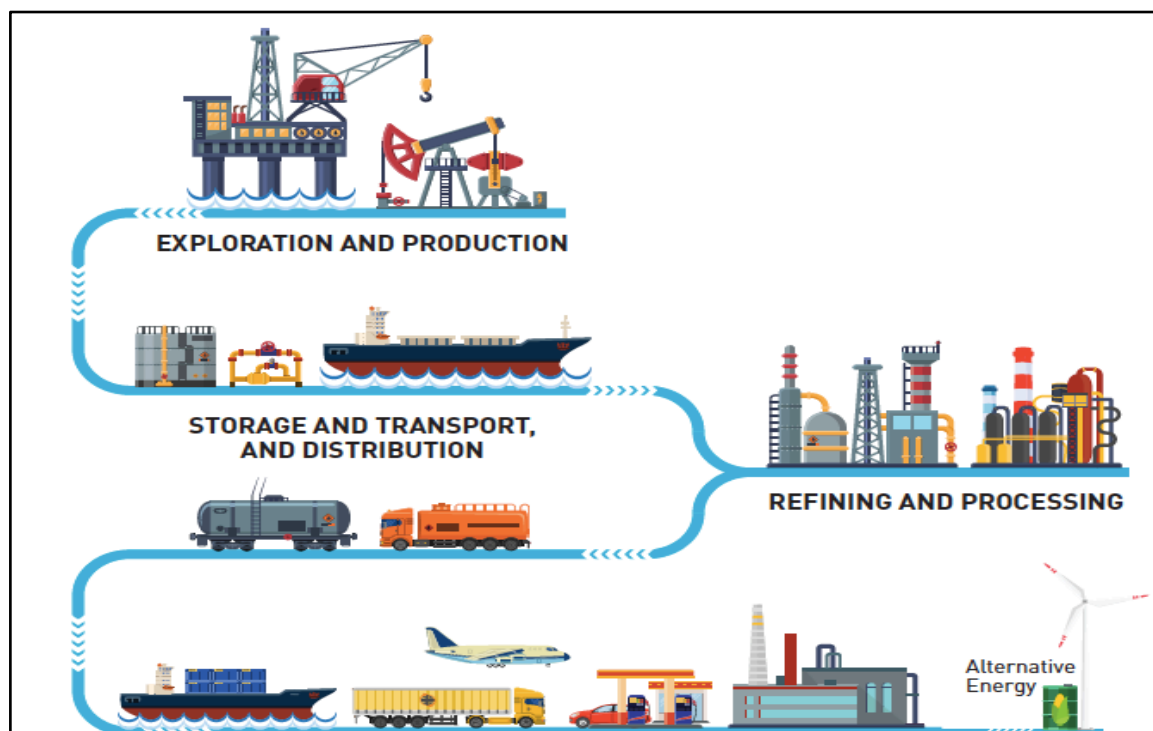
Source: www.ethz.ch

1.5 THE ROLE OF OIL AND GAS INDUSTRY PROCESS IN SUSTAINABLE DEVELOPMENT

The oil and gas industry activities are divided into two main sectors which are the upstream sector and the downstream sector. As mentioned before, the topic of sustainability and sustainable development is now at the heart of the oil and gas industry priority list. To understand why its importance is growing day by day, it will be important to recall the following facts:

- 57% of the world's total fuel consumption originates from the oil and gas industry. In recent years more, renewable fuel has been consumed but hydrocarbons have been projected to still be the most dominant source of energy in 2035 and the years to come.
- 96.3 million barrels of oil per day was produced on average in the year 2016. This is equivalent to about 2 litres for every individual on earth every day.
- Natural gas is forecasted to overcome coal as the second largest fuel source by the year 2035.
- \$700 billion dollars is expected to be invested yearly by the Upstream sector alone until 2040 to meet global energy demand. If we have to add additional investments such as refining and transports, the industry would be expected to invest an amount of \$22.8 trillion for the next 25years.

Fig 5: The Oil and Gas industry process



Source: Richterra Project management

The points enumerated above and the figures attached to them points convey one clear message, which is the fact that oil and gas industry activities are only going to be on the rise in the years to come. This is good news especially to those in the sector as it goes against the assumptions of a ‘dying industry’. On the flipside, an increase of oil and gas activities in both the upstream and downstream sector could be translated to an environment more exposed to pollution and polluting activities, more oil spills and a faster depletion of what could be left of our reserves for the future generations. As a result of this, it is our duty to elaborate ways to mitigate these scenarios by raising awareness in the oil and gas industry and designing possible ways to remediate to this issue which could heavily lower the chances of a possible sustainable industry.

1.6 UPSTREAM AND DOWNSTREAM REACTIONS TO SUSTAINABILITY

By now it is no news that a greater percentage of world’s energy is obtained through burning fossil fuel. Producing energy from fossil fuel and large-scale energy consumption by manufacturing companies calls for concern as it fuels environmental problems. Another call for concern are the damages caused by carbon dioxide emission to the atmosphere. Studies have shown that the level of CO₂ has drastically increased and could contribute to about 70% of global warming. Another issue at hand is the problem of water management which could be a major problem in this century (Grossman,2004).

There have been some studies and research that depicts the fact that 30 to 80 % of these environmental impacts are rooted in the design stage (Clark,2007). With this information, it is becoming a necessity to pay more attention to design stage intervention processes as it is the most effective method in the battle against environmental impact. This understanding pushed companies into searching and understanding ways of converting waste from one company and making it useful in another company.

When talking of sustainability issues faced by the upstream sector in the oil and gas industry, we look at issues that have to do with the life cycle of the products, energy use and ecological footprints. One of the issue is that of greenhouse gas (GHG) emissions. Internal measures are therefore taken to reduce GHG by adopting changes in the production process promotes by technological development. Internal measures appear to be the most common method currently used companies (Pinkse, Kolk and Pinkse, 2007). Other sectors that need to be reviewed are environmental laws and regulations, natural resources conservation, carbon dioxide (CO₂) emission, renewable resources. On the other hand, downstream is associated with responsibilities such as burning the refined products, refining petroleum products in refineries and disposing phases of product.

1.7 ENVIRONMENTAL IMPLICATIONS OF OIL AND GAS EXPLORATION

By now it would be obvious that oil and gas exploration in a particular zone would appear as a blessing and in others, the downside of the activities trumps the upsides. Every stage of the exploration and the development activities, involves transportation and infrastructure development and when successful, results to the production of large amount of oil, gas and produced water.

A crew of at least 50 people are involved in a shot-hole seismic, while production and development will require an even greater number of workers among which are attendants to waste control and sewage issues. All these activities lead to diverse environmental impacts which must be addressed and mitigated. The environmental challenges encountered are subdivided into two:

- 1) Effects on the natural environment**
- 2) Effects on the human environment**

Effects on the natural environment: Impacts on the environment are legion. These involves impacts on air quality such as:

- Venting, flaring and gas purging
- Combustion processes such as diesel gas turbines and diesel engines
- Fugitive gas losses
- Acid rain

There are also emissions resulting from oil and gas activities such as carbon dioxide, carbon monoxide, natural gas (methane), nitrogen oxides and if the hydrocarbon contains sulphur, it would be possible to have sulphur dioxide and toxic hydrogen sulphide (toxic).

Hydrologically speaking, we have impacts on surface and ground water which include contaminations originating from produced water, well and drilling fluids, drainage water and domestic wastes. Site excavation and road infills can also affect drainage patterns which will have an effect on the nearby wildlife and vegetation. Accidental oil spills and leaks will also greatly damage other natural resources.

Activities promoting soil compaction and most of the time erosion, can distort the initial shape of the land and reduce the natural scenic view of the environment. Pipelines construction roads, drilling and production sites will greatly affect vegetation and even destroy them in case of contamination from discharges. Wildlife will be affected were habitat is disturbed and this can even lead to the loss of biodiversity.

Effects on the human environment: Activities from oil and gas exploration can lead to a number of socio-economic effects, especially on the local communities and the indigenous people. Activities such as seismic activities, can have a significant impact on the population living in remote regions. Other oil and gas activities can affect land

use activities such as fishing and hunting. The visual impact of oil and gas activities could also deteriorate the tourism values of areas in which they are practiced. Noise brought about by drilling activities and the helicopters may drive away birds and chase other animals that tourist would want to view.

Table 2: Environmental drawbacks of upstream and downstream activities

Activities	Potential associated risks	Environmental, health and safety issues
Exploration operations		
<ul style="list-style-type: none"> • Geological survey • Aerial survey • Seismic survey • Gravimetric and magnetic survey • Exploratory drilling • Appraisal 	<ul style="list-style-type: none"> a. Noise pollution b. Habitat destruction and acoustic emission c. Drilling discharges e.g. drilling fluids (water based and oil based muds) and drill cuttings d. Atmospheric emission e. Accidental spills/ blowout f. Solid waste disposal 	Ecosystem destruction and interference with land use to access onshore sites and marines resource areas; environmental pollution (air, soil and controlled water) and safety problems associated with the use of explosives; land pollution which affects plants and pose human health risks; groundwater contamination and adverse effects on ecological biodiversity.
Development and production		
<ul style="list-style-type: none"> • Development drilling • Processing: separation and treatment • Initial storage 	<ul style="list-style-type: none"> a. Discharges of effluents (solids, liquids and gases) b. Operation discharges c. Atmospheric emission d. Accidental oil spills e. Deck drainage f. Sanitary waste disposal g. Noise pollution h. Transportation problems i. Socio-economic/ cultural issues 	Ecosystem destruction and interference; contamination of soils and sediments with petroleum-derived wastes; atmospheric emissions from fuel combustion and gas flaring/venting; environmental pollution (air, soil and sediments, controlled waters) and groundwater contamination; ecological problems in the host communities, adverse human health risks; safety related risks and interference with socio-cultural systems.
Decommissioning and rehabilitation		
<ul style="list-style-type: none"> • Well plugging • Removal of installations and equipment • Site restoration 	<ul style="list-style-type: none"> a. Physical closure/removal b. Petroleum-contaminated waste disposal c. Leave in situ (partial or total) d. Dumping at sea 	Environmental pollution and human safety; pollution related to onshore and offshore operations; hazard to other human activities such as fishing and navigation; marine pollution, fishing and navigation hazards
Refining of petroleum products		
	<ul style="list-style-type: none"> a. Atmospheric emissions and air pollution b. Discharges of petroleum-derived wastes 	Atmospheric emissions and air pollution; oil spillages; water effluents and production discharges.
Transportation and distribution		
<ul style="list-style-type: none"> • Pipelines • Barges, ships, tankers and FPSOs • Road tankers and trucks 	<ul style="list-style-type: none"> a. Emissions and accidental discharges b. Discharges from transporting vessels e.g. ballast, bilge and cleaning waters 	Air emissions (hydrocarbons from loading racks and oil spills); accidental discharges and operational failures; disposal of sanitary wastes; contamination of soils and sediments.

1.8 CONTROLLING EXTERNALITIES OF OIL AND GAS EXPLORATION AND DEVELOPMENT

A lot of measures have been discussed to minimize the impact of oil and gas exploration activities but the application of this methods will demand careful attention, qualified staff, trained personnel and monitoring.

A project planning is done primarily by drafting an environmental profile done even before having rights to explore a land. This profile reviews the actual environment and social state of the region. This will help in the planning and the control of all exploration activities as well as help the company to get acquainted with the land use pattern and regulations of the region.

After this review, there is need for formal and informal meetings. Formal encounters with the government authorities to discuss on the terms and regulations to operate in that region and informal encounters with the population that will mostly be affected by the exploration activities. Meeting this two bodies is tantamount as the government will not have the same worry and challenges when compared to the population living close the affected region. A third form of encountered should be encouraged which is an encountered with NGOs, legislative representative, media and local businesses.

If all the above criteria are fulfilled, and an exploration concession is granted, there is now need for a preliminary Environmental Impact Assessment (EIA) before any seismic activity should be carried out because they could have irreversible effects. The preliminary EIA will touch trivial issues discussed in the profile and help in gathering site specific information while looking at ways impacts can be mitigated. It is prepared while involving environmental specialists, the local community and the appropriate authorities. The end goal of this EIA is to determine when and if a full Environmental Impact Statement (EIS) is necessary.

It is important to stress on the fact that a full EIS should be prepared and presented whenever activities to be carried out in a region could affect directly or indirectly human and natural environment. In summary, the EIS will provide the go about of each stage and analyse the procedures to be implemented. It will also identify impacts of the projects and when necessary alternative methods that can be used. At the end it would propose the most suitable methods to mitigate the impacts and promote environmental benefits. This EIS will also pay attention to disastrous possibilities such as spills and blowouts and propose the best monitoring programs to avoid these contingencies.

Once the project is operational, routine tests, and environmental checks should be performed regularly to ensure that the exploration activities are carried out while respecting the EIS. This will also help in collecting feedbacks and new information which will help in proposing new methods and solutions.

1.9 ENVIRONMENTAL DRAWBACKS OF OIL AND GAS EXPLORATION ACTIVITIES

It is important to focus on a way to combat against uncompensated effects (negative externalities and unsustainable activities resulting from development programs. This should become a target of global development strategies.

Environmental damage refers to the process of consuming the natural resources at a faster rate than they can be replaced or replenished. Environmental degrading activities like is the case of some oil and gas activities, could affect the biosphere depending on the human activities taking place.

Looking at the short term, environmental degradation will significantly reduce the the living standard, affect the health of the local population, fuel violence and be the catalyst to numerous problems.

On the long- term, environmental degradation promotes a population not able to sustain its human population. Extrapolating this condition on a larger scale (Global scale), this is very dangerous

1.91 HEALTH AND SAFETY ISSUES DURING EXPLORATION OF OIL AND GAS

Activities undertaken in the oil and gas sector are intrinsically hazardous such as working on offshore facilities and transportation to these facilities, working at elevated temperatures and pressures, working beside flammable hydrocarbons. These working conditions have to be looked after and managed across the company's activities.

To improve performance, companies are encouraged to report on the approach used to manage health and safety risk and from there device methods to improve the methods already in place or substituting them with more effective methods. Safety is a key when talking about sustainability.

To ensure that energy development such as oil and gas development activities are carried out under the best environmental and social standards, the mission of equitable origin (EO) published the EO100, (Board of Directors, Equitable Origin Inc, 2015)for onshore conventional oil and gas exploration and identified 6 principles namely:

1. Accountability, Ethics and Corporate governance
2. Social impact, Human rights and Community Development
3. Working conditions and fair labour
4. Local and Indigenous people's right
5. Environment, Biodiversity and Climate Change
6. Project life cycle management

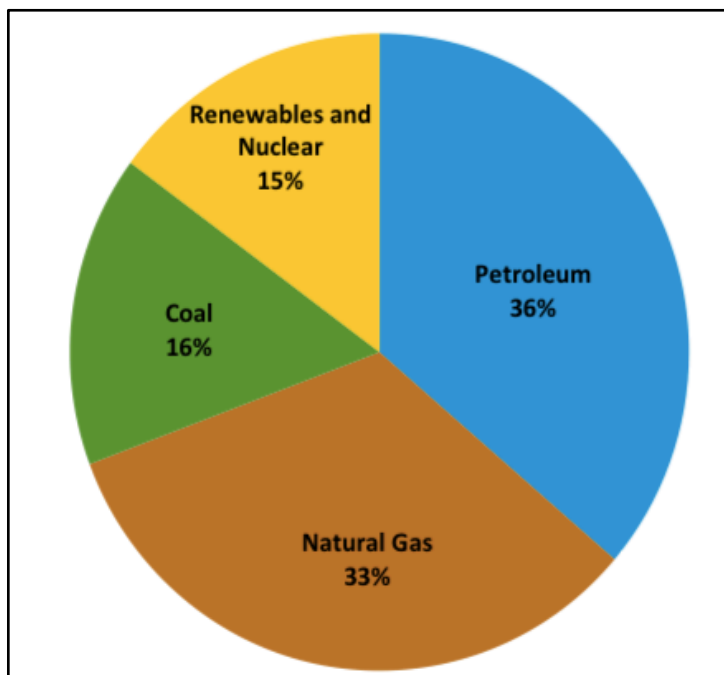
CHAPTER 2: EXPLORATION OF OIL AND GAS IN THE UNITED KINGDOM

The United Kingdom is approximately 243,610 square kilometres in size, which means it is approximately 4 times smaller than Nigeria and has a population of 64 million people which is much less than that of Nigeria. Nevertheless, the United Kingdom is more developed than Nigeria and benefits from better advancement in technology, more qualified human resources and a more organized and productive legislative system. That been said, the United Kingdom has greatly reduced its gas flaring activities and its spillage frequency.

2.0 OIL EXPLORATION AND EXPLOITATION

Activities of oil exploration in the UK goes back to the nineteenth century and most of the country's oil reserves are contained in the continental shelves. The United Kingdom is among the five countries exploring and producing in the North Sea. The United Kingdom produced 1.42 million barrels of oil equivalent per day (BOEPD) in 2014 (wikipedia, 2018). About 98% of this production comes from offshore fields which explains why, the services industry in Aberdeen have been among the elites in developing technology used in hydrocarbon offshore extraction. 39 billion barrels of oil and gas have been produced on the United Kingdom and an estimated 2.5 billion are left (Oil & Gas UK Economic Report 2008), which means the United Kingdom could still be a major player and producer in the oil and gas industry for the years to come.

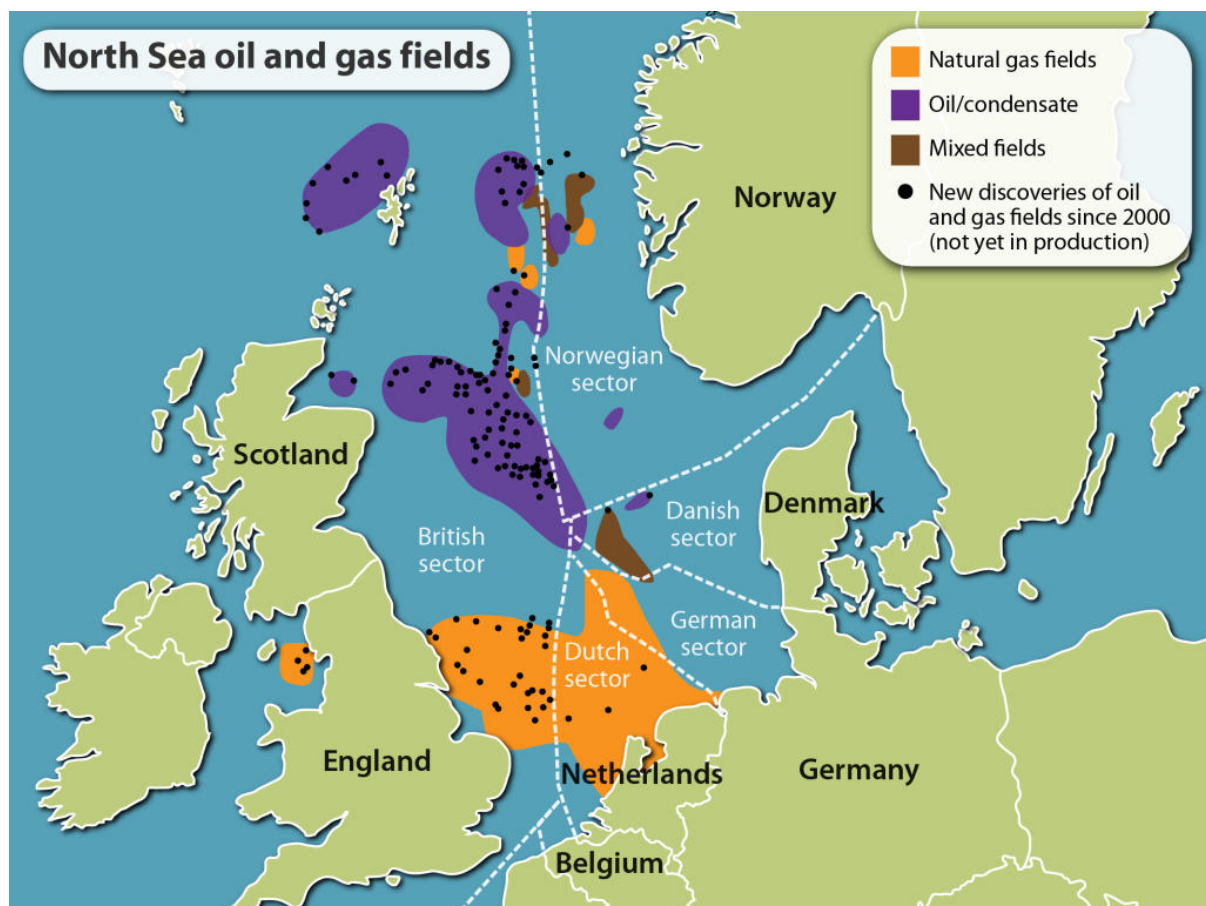
Fig 6: United Kingdom total primary energy consumption



Source: US Energy Information Administration

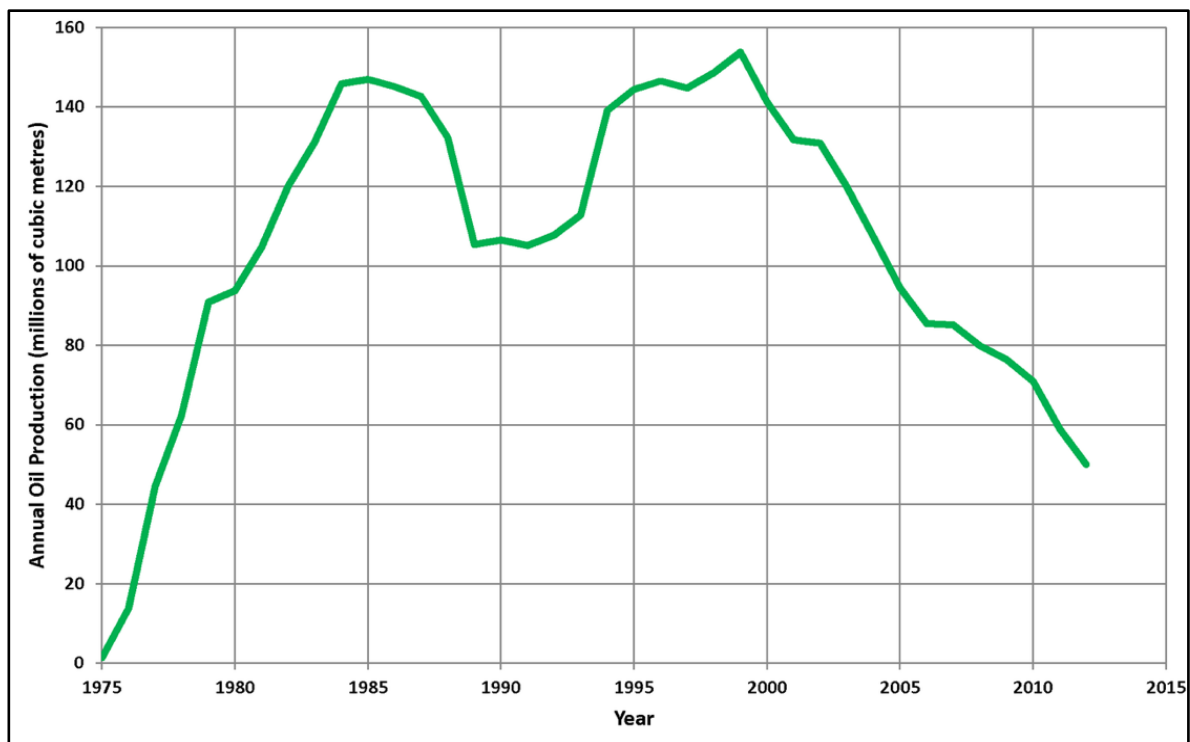
Presently, the UK's crude oil production capacity is the largest in the EU and second in the EEA with Norway being the largest. The UK is also among the 20 top producers of oil worldwide. The production of oil and gas in the UK has been on a decline since 1999 but the year 2015 has seen a rise in production of about 13,4 per cent. The decline rate started to slow down by 2014 and increased in 2015 due to the opening of new fields. The UK presently holds a total of six refineries used to process the UK's oil into petroleum products. In 2014, these refineries produced a total of 60.3 million tonnes of product and in 2015 there was a rise to about 66.6 million tonnes of product. This production is still not up to the refinery capacity of 2008 which was about 20 percent higher than today. This difference in production is due to more refineries being open ten years ago.

Fig 7: North Sea oil and gas fields



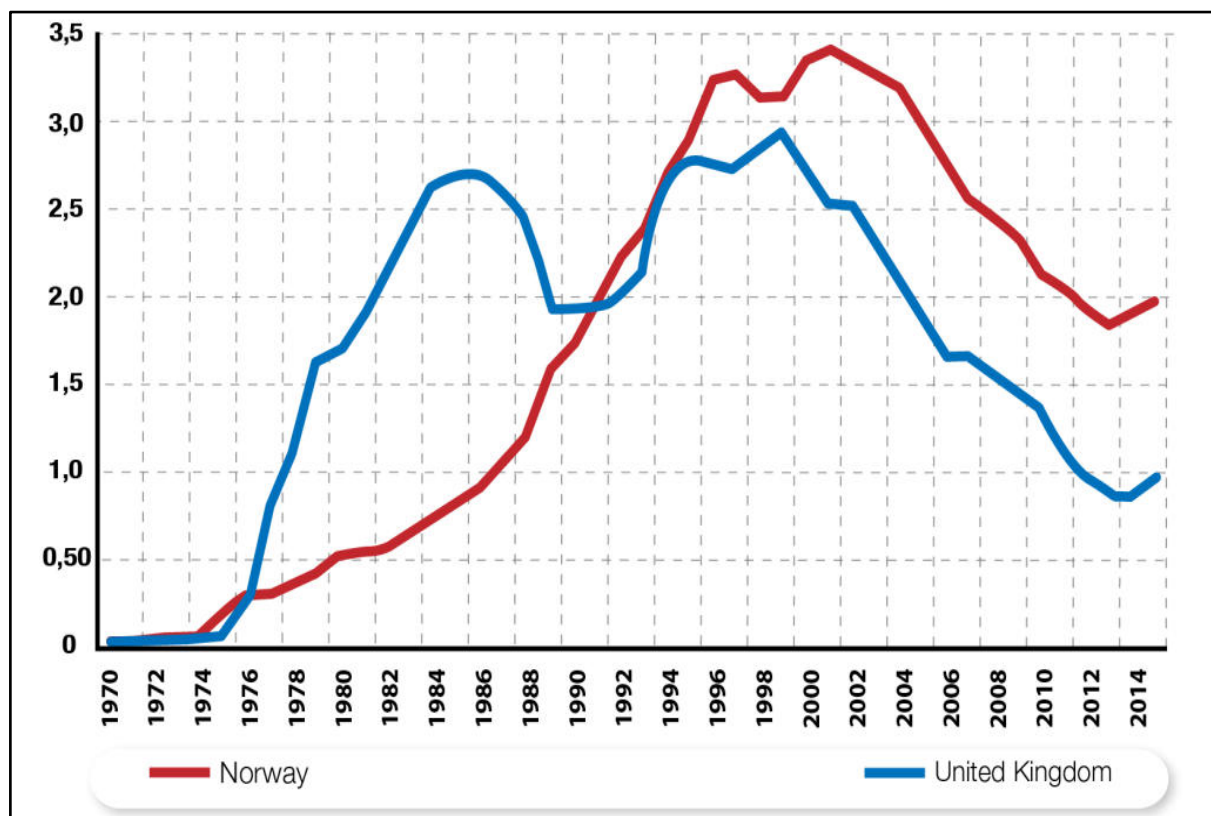
Source: Shell UK

Fig 8: Oil Production in the United Kingdom from 1975 to 2012



Source: US Energy Information Administration

Fig 9: Norway vs UK crude oil production from 1970 to 2015 (million barrels per day)



Source: US Energy Information Administration

As seen above the oil and gas industry in the United Kingdom is very active. This sector has been key in the economic growth of the country and as such calls for more detailed look at how to continue its operation from a sustainable point of view by identifying the factors that would promote sustainable exploration and the ones that could be a barrier to this goal. More importantly the environmental sustainability problems often faced. The issue of environmental sustainability particularly is of major concern among actors in the oil and gas industry worldwide. The negative impacts as a result of activities carried out during the exploration of oil and gas, have been a major toll to the health of people surrounding this region and also to the depreciation of the environment as the level of pollution increases.

The risk of environmental pollution is visible in most oil and gas activities. Gas emissions, solid waste and wastewaters during the drilling, production, refining and transportation processes can expose the zone of interest to about 800 different chemicals released into the atmosphere. There are other environmental effects such as oil spills and accidents, of which a great example in the North Sea is the case of the Piper Alpha disaster which killed about 167 workers in July 6th 1988, acid rain, and water contamination. As a result of this, major oil and gas companies as it is the case of British Petroleum have device goals such as *“No accidents, no harm to the people, no damage to the environment”* –BP HSE Policy

In the past five years, Oil has always been among the UKs top three pollutants which makes sense when considering that one litre of oil is sufficient to contaminate about one million litres of water and the fact that in recent years the United Kingdom has suffered from major oil spill disasters.

2.1 OIL SPILLAGE IN THE UNITED KINGDOM

Oil spill is as a result of liquid petroleum being released into the environment through pipelines or vessels. The UK has suffered from quite a number of such incidents in the past among which the ones commonly known are the Torrey Canyon oil spill which spilled more than 100,000 tonnes of crude oil into the English Channel and the Piper Alpha incident. With this, a lot of pressure from stakeholders, the public, governmental and non- governmental is put to address environmental concern, regarding oil and gas activities. This is because any activity in the oil and gas industry at any given stage is bound to affect the environment in one way or the other.

Hassol (2004) suggested that several factors lead to oil spillage. According to him some of these factors could be an increase in the simultaneous production and exploration. Accordingly, USRC (2004), suggested that an increase in events such as oil spillage could be as a result of greater number of vessels and oil volumes transported as cargo. Another actor, the United states protection agency suggested a cause different from the former two. According to them, the major sources of oil spillage could be blowouts during exploration and even production, releases from some on-line storage tanks, pipelines travelling through water and accidents involving oil transformation vessels. A different thesis is shared by **Anderson and Talley, (1995)**, who believe that the crux of

the matter are the arctic conditions with low visibility, extreme storms and high winds help to promote oil spills by making it difficult to avoid accidents leading to oil spillage.

With the point enlisted above, it is hard not to agree with Keisha Huijter (2004), stating that, most of the oil spillage in the United Kingdom is caused by either mistake in operation or accidents. Since the United Kingdom is a major importer and exporter of crude oil, there are still high possibilities of having an oil spillage in the future should we not find ways to mitigate it.

2.2 IMPACTS OF OIL POLLUTION IN THE UNITED KINGDOM

It has been over thirty years now that the Brundtland report raised awareness to the world's public, by raising the topic of how we use our resources with little or no concern for the environment and the future generation. This report was not taken seriously by the public and led to a further call to a change in attitude during the Earth Summit that was held at Rio de Janeiro. During the summit a comprehensive plan of action on environment and development was elaborated which is now referred to as 'Agenda 21'. Ten years later, there was a world summit on Sustainable development this time held in Johannesburg as a recall to pay more attention on the environment and use of resources in a sustainable way.

If we quote the first principle of thermodynamics otherwise known as the law of conservation of energy, we are reminded that energy can neither be created nor destroyed but instead, energy can only be transferred or changed from one form to another. A practical yet simple example is the conservation and conversion of energy and matter into different form when burning wood. By the same token, the amount of energy taken from the environment for the production of crude oil will be kept and converted to waste.

Among the many complications associated to oil exploration are the challenges we face in the happening of an oil spillage. Sebastián et al (2001) highlighted on the fact that oil extraction involves several environmental pollution processes. Such statements have been the spark to embark on a series of studies to mitigate the environmental impacts of oil spillage on the environment.

It has been found that waste discharge during oil exploration expose the environment to chemicals such as poly aromatic hydrocarbon (PAH), organic acids such as BTEX (Benzene, Toluene, ethylbenzene and xylene), alkyl phenols (AP) and heavy metals all of which have negative effects on human lives, marine lives and wild lives (Khatib and Verbeek 2002).

Similarly, it was reported by the United Nations Conference on Trade and Development that environmental pollution from oil exploration leads to the destruction of life hoods hence penalising the future generation (UNCTAD 2007). The absence of an adequate environmental legislation has been the root of people's exploitation, land destruction and promotion of wastelands.

Today more than ever there is an enormous plea for justice rooting from environmental injustice and as a result, an increase in the amount of legislations. Even with the increasing number of legislations, recent reports acknowledged that there still are intentional oil spillages promoted by oil exploration companies **Carpenter and Macgill (2003, 2005)**.

2.3 ENVIRONMENTAL LEGISLATION OF OIL EXPLORATION IN THE UNITED KINGDOM

The environment has always been a major contributor to human existence. The environment is the source of raw materials which are later transformed into consumer goods with the use of energy helping in their transformation. Since the environment is an essential ingredient for our wellbeing, we can all agree that it would be of everyone's benefit to preserve it. Every country has legislations and regulations that oversee their oil exploration and the United Kingdom is no exception.

The United Kingdom regulation is subdivided into three national governments namely Scotland, Wales and Northern Ireland (**Boyes et al 2003**) and abide by the following laws:

- Offshore Chemical Regulations 2002
- Merchant Shipping (Prevention of Oil Pollution) Regulations 1996
- Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005

The three regulations stated above are just a few from a list of many laws and regulations which are constantly updated to address new environmental concerns especially those caused by the oil and gas industry. They also represent standard codes and guidelines to help government officials to facilitate regulations of oil exploration activities. The fact that more regulations are put in place helps in holding the oil and gas exploration firms more accountable by means of environmental principles such as:

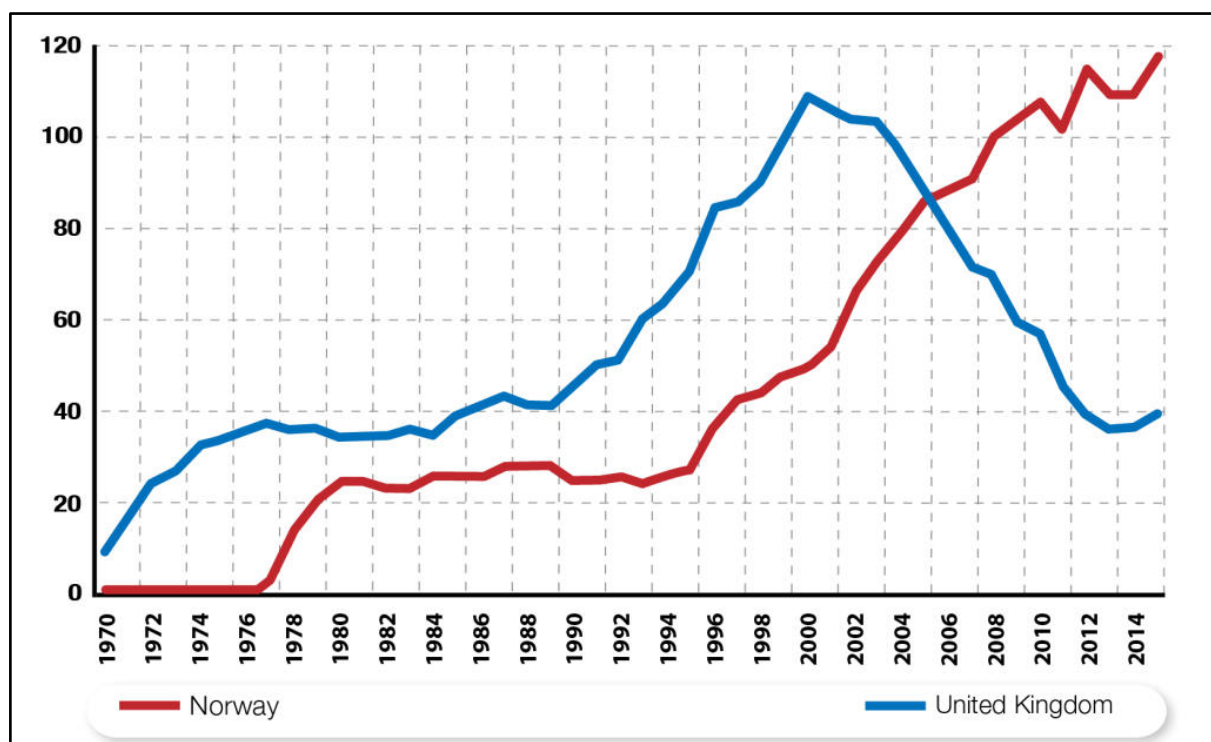
- The polluter pays principle
- The precautionary principle
- The producer responsibility

The United Kingdom is blessed with abounding energy resources and these laws contributes to a more sustainable future and pushes the oil operating firm to internalise their externalities.

2.4 GAS EXPLORATION, PRODUCTION AND FLARING IN THE UNITED KINGDOM

In 2016, the United Kingdom produced up to 41.0 billion cubic metres (bcm) of natural gas which is the equivalent of 1.2 per cent of the world's total natural gas production. This number represents an increase of about 3.3% as compared to 2015. The UK comes second in gas production in Europe and is surpassed only by Norway. At the end of the year 2016, the UK's proven reserves were calculated to be at 0.2 trillion cubic metres. Most of these reserves are located in the North Sea on the United Kingdom continental shelf (UKCS).

Fig 10: Norway vs UK gas production from (1970 - 2015 billion cubic meters)



Source: US Energy Information Administration

In 2004 the UK became a net importer of gas and as of 2016, it imported an amount of 44.6 bcm of natural gas seeing a rise from 2015's 42.1 bcm importation quantity. This transportation is done with the help of interconnector pipelines and through the help of ships to liquefied natural gas receiving terminals in the UK.

Pipeline imports is still important in the energy of the UK today but LNG imports is not to be dismissed as it is increasingly gaining traction. Data show that LNG transport capacity fell to about 20 per cent in 2016 as compared to 2015. There is no commercial production of shale gas in the UK till date. **(International comparative legal guides)**

One major source of energy waste in oil and gas activities is gas flaring associated with oil production. Flaring of gas contributes to climate change and impacts the environment through emission of carbon dioxide, black carbon and other pollutants (**zero routine flaring 2030**). Reports from the world bank estimate that about 150 billion cubic meters of natural gas are either been flared or vented every year. This number is the equivalence of 30 per cent of the gas consumption in the European Union and 25 per cent of the consumption in the United States. The yearly amount flared in Sub-Saharan African alone amounts to 35 billion cubic meters and could suffice at supplying the continent with half its power consumption. In managing to reduce gas flaring, we would not only reduce the amount of CO₂ emission but also, we will increase energy efficiency and increase its access for more people.

Various reasons could promote the flaring of gas during oil and gas activities. Some of them are due to:

- Absence of pipeline to transport the gas to the market
- There are no options to liquefy the gas to be transported by ship or road means to the market
- The gas is not injected back into the reservoir for pressure support
- No regulation in place to prevent gas flaring

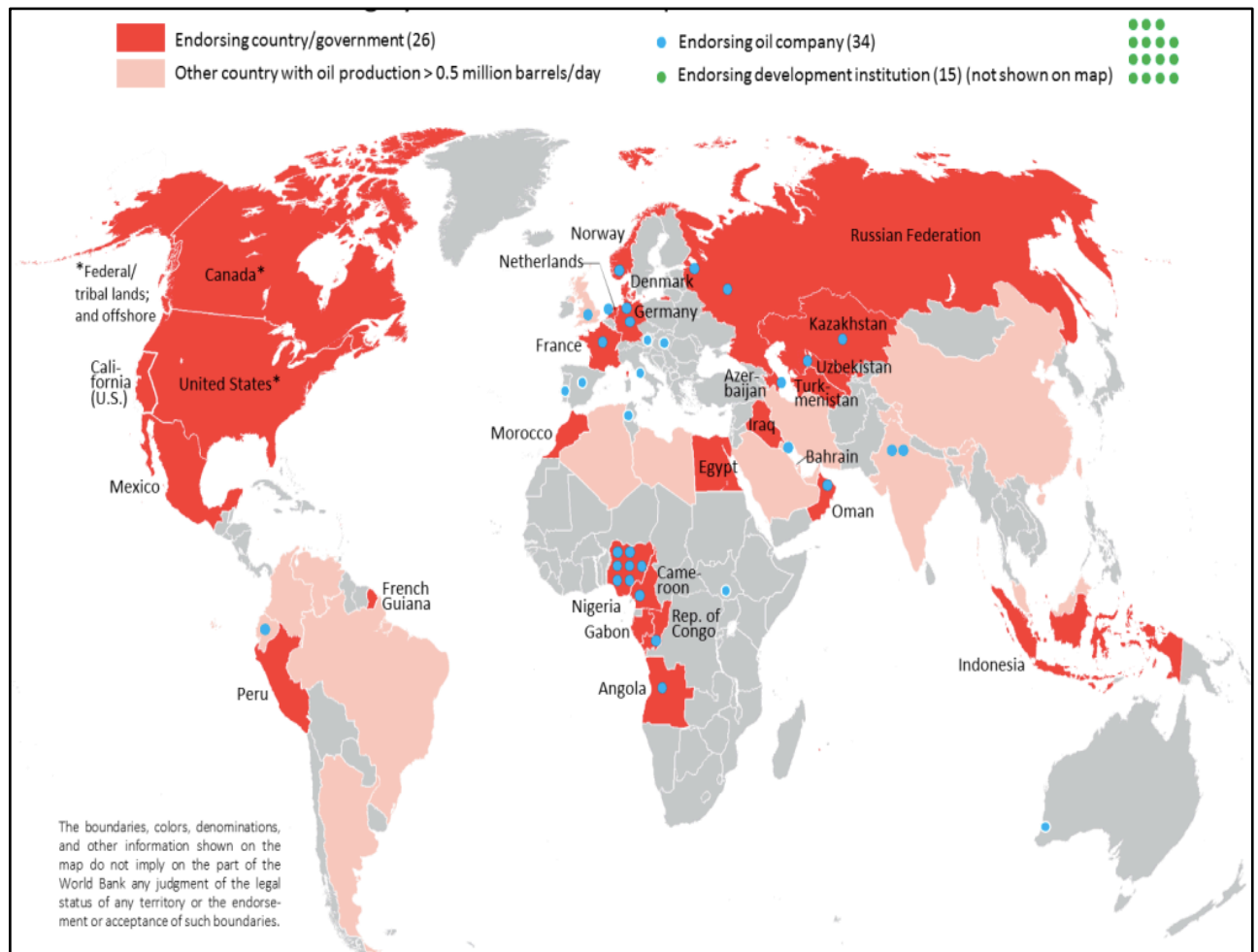
Flaring of this gas pollutes the environment and more importantly wastes a source of clean energy. It is to be noted that venting is not a substitute for flaring. In other to mitigate this flaring, the world bank introduced an initiative by name “Zero Routine Flaring by 2030” which brings together actors in the oil and gas industry such as oil companies, government, and development institutions which recognise a common danger in gas flaring and described it as unsustainable from an environmental and resource management point of view. They all agreed to eliminate the threatening practice by 2030.

Gas plays an important role in the UK and contributes a lot to the energy consumed. Mainly it serves as a source of heat and many industries use natural gas to manufacture products such as fertilizers, paint, plastics, insecticides, detergent and even glue. The list is non-exhaustive. The UK has fought a good fight against flaring and has drastically reduced its flaring activities, this is good news for a country which performed flaring activities at an alarming rate during the industrial revolution. This is a trend common in most developed countries as they understand the value of gas and have the adequate technology advancement.

When it comes to gas flaring. The United Kingdom aims at two major targets.

1. It aims at maximising the economically the recovery of gas flaring
2. The second target which is based on the Kyoto protocol simply aims at reducing greenhouse gases that eventually contribute to global warming

Fig 11: Map showing the “Zero Routine Flaring by 2030”

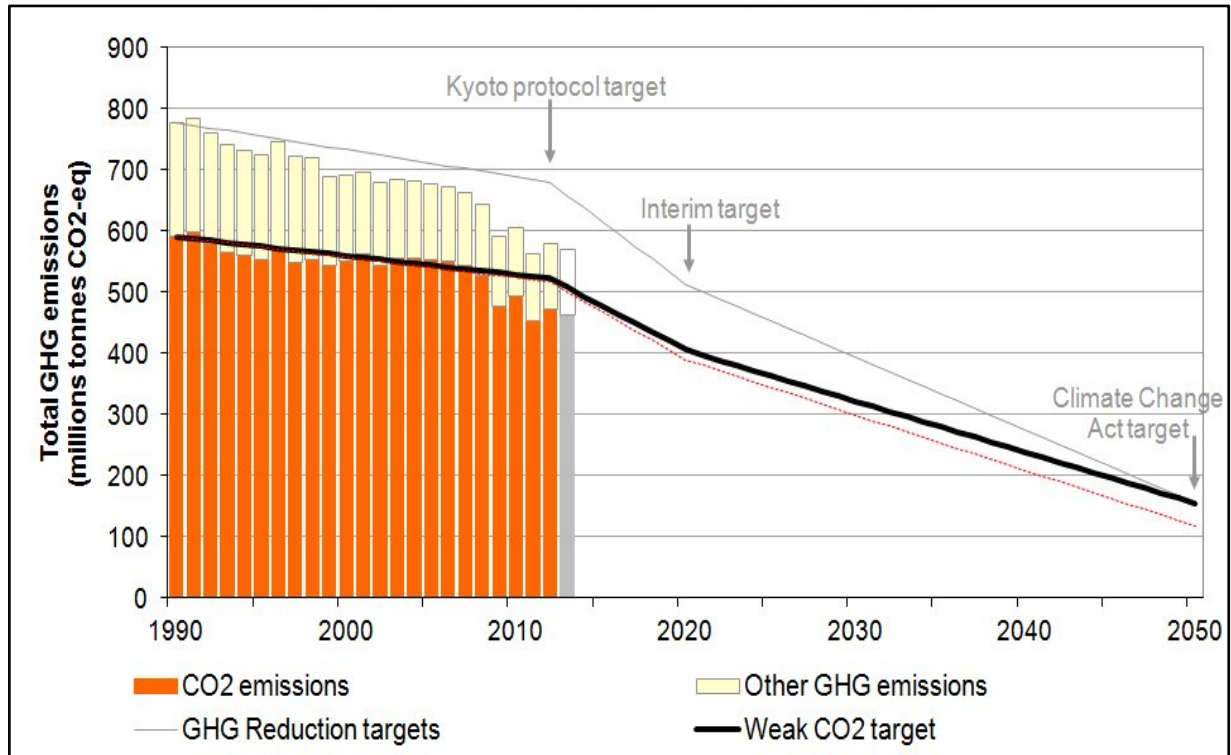


Source: Gas Processing News

The UK has established well defined regulatory measures as an intervention process to combat the gas flaring perpetrators. Two measures were stipulated. Direct regulations and Indirect regulations. Direct regulation takes the form of decrees to prohibit flaring activities and are mostly supported by governmental bodies. Some of these decrees common to the UK are Energy act 1976 and Petroleum act 1998.

Indirect on the flip side, measures promote fiscal measures to promote the reduction of activities susceptible of releasing greenhouse gases to the atmosphere

Fig 12: UK carbon dioxide emissions compared to targets



Source: US Energy Information Administration

Table 3: Pollutant released during gas flaring and their adverse effects.

NAME OF CHEMICAL	Health Effects
Hydrogen Sulphide	In low densities affects the eyes and nose which resulting to insomnia and severe headache
Nitrogen Dioxide	Dangerous for the lungs, and respiratory pipes. Aggravates illnesses like asthma.
Sulphur Dioxide	Dangerous to the respiratory system
Alkanes: Methane, Ethane, Propane	Even when present in low densities will cause swelling, inflammation and itching an in higher densities can cause lung swelling
Alkenes: Ethylene, Propylene	It causes vomiting and body weakness
Aromatics: Benzene, Toluene, Xylene	It is poisonous and carcinogenic, It can also affect the nervous system and promote blood irregularities

CHAPTER 3: EXPLORATION OF OIL AND GAS IN NIGERIA

3.0 INTRODUCTION TO NIGERIA OIL AND GAS INDUSTRY

Nigeria is a west African country and it is the most-populous country in Africa with an estimated population of about 186 million people. Nigeria is one of the most endowed African countries when it comes to natural resources yet continuously ranks among the poorest countries in the world. Nigeria is also a victim of the natural resource curse, as it is usually the case of developing countries after the discovery of an abundant reserve of natural resources. It is neighboured by Cameroon in the east, Niger in the north and the republic of Benin in the west. Nigeria has a land area of about 924 000km².

Oil was discovered in Nigeria in the year 1956 in the Oloibiri oilfield and went on to be the first commercial oil discovery. The petroleum rich country did not escape the eyes of multinationals as there are many multinationals that presently operate there in partnership with the Nigerian National Petroleum Corporation (NNPC).

The petroleum industry in Nigeria has been the largest in the continent closely followed in recent years by Angola. In the year 2000, earnings from oil and gas exports contributed to about 98% of the total earning exports and contributed to about 14% of the country's GDP.

The United States Energy Information Administration estimates Nigerian's proven oil reserve to be in the magnitude of 37.2 billion barrels. On the other hand, natural gas reserves are estimated to be 188 trillion standard cubic feet (scf). These reserves make Nigeria the richest petroleum nation in Africa and tenth in the world. There is a total of 159 oil fields and about 1481 operating wells according to the Department of Petroleum Resources. Nigeria has a maximum crude oil producing capacity of 2.5 million barrels per day

The composition of oil extracted in Nigeria is very close to that of the North Sea. Its petroleum is light, sweet and sulphur free. It's crude oil is branded locally as "Bonny light" and depending on the export terminal it could carry other names such as Qua Ibo, Forcados , Odudu Blend and Escravos blend.

All the above-mentioned facts serve as narratives to why Nigeria always figures on the headlines when making mention of the oil and gas industry especially on the African continent. For the sake of simplicity, this thesis will case study the Niger Delta region to showcase the actual state of oil and gas industry in Nigeria.

Fig 13: Map of Nigeria highlighting the states of the Niger Delta Region



Source: www.thisdaylive.com

3.1 CASE STUDY: THE NIGER DELTA REGION

Based on findings from (CURTIS), we can find a greater portion of the world's oil and gas reserves in tertiary terrigenous fill on passive continental margins. The most significant hydrocarbon of this type is found in Canada Beaufort-Mackenzie Delta, Gulf of Mexico in the U.S and the Niger Delta in Nigeria.

Seismic results show that the Niger Delta petroleum systems consists of Upper Cretaceous, Lower Cretaceous (lacustrine) and Tertiary (deltaic) which is the principal source of oil and gas in this region according to geological findings. The Oloibiri region where oil was first discovered in Nigeria is located in the Niger Delta region.

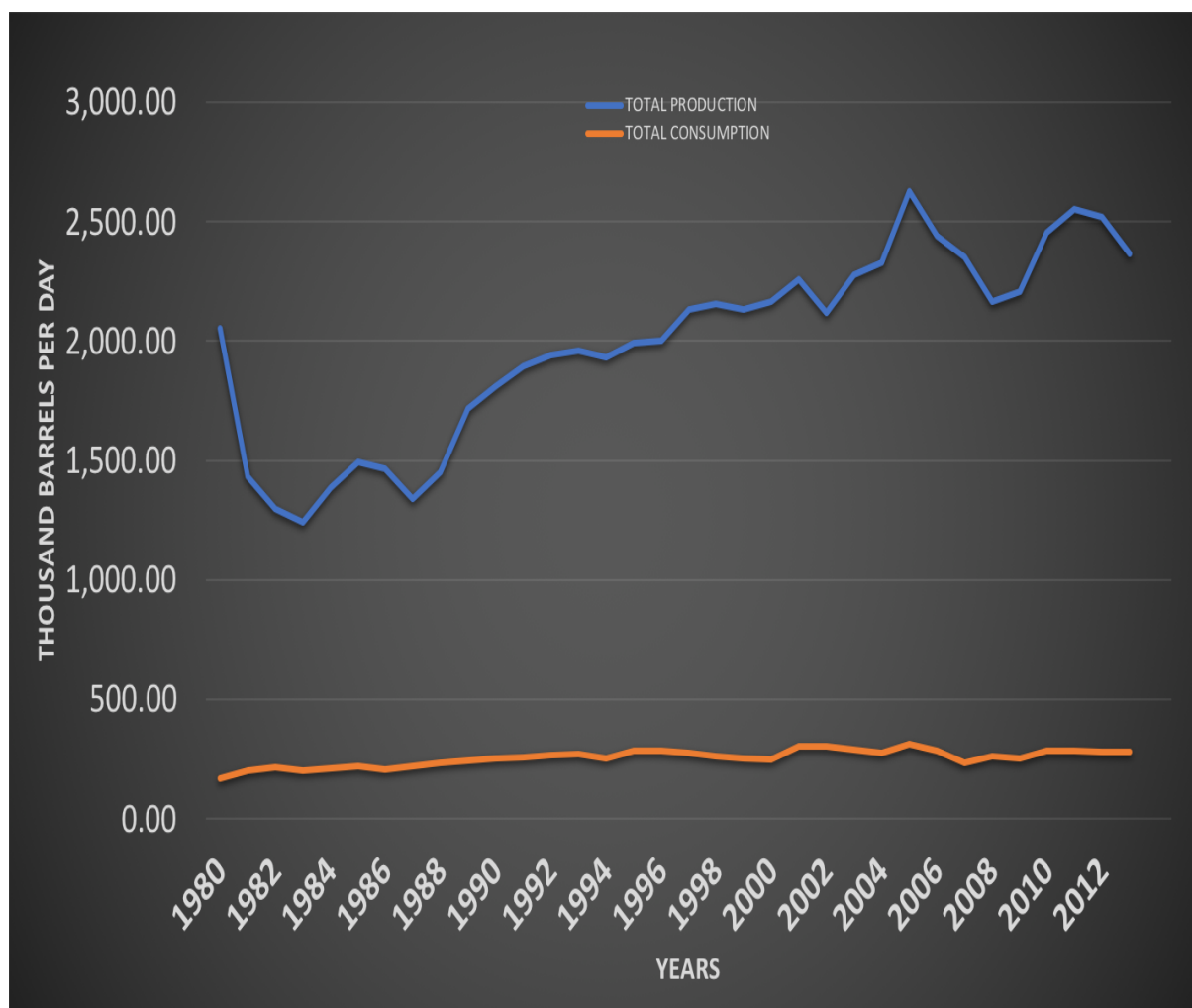
The Niger Delta region has a population of about 31 million people, occupies a total area of 75,000 km² (7.5% of Nigeria's land mass) and is a location of massive oil

deposits where the major oil activities have taken place and continue to take place in Nigeria. 100km away from the Niger Delta region can be found the Agbami oil fields. This fields hold more than one billion barrels and at its full production, produced at a rate of 250,000 barrels a day from a depth of 1,500m.

The Niger Delta region is made up of 9 oil producing states (Abia, Akwa Ibom, Bayelsa, Cross river, Delta, Edo, Ondo, Imo and Rivers). This area has a network of 900 producing oil wells and other facilities linked to petroleum production.

It is good to note that an estimated \$600 billion has been generated from oil exploitationan activities from its inception in 1960 (Goodwin, 2017)

Fig 14: OIL PRODUCTION VS CONSUMPTION IN NIGERIA FROM 1980-2012



Data Source: United States Energy Information Administration

Though there has been a substantial improvement on the economy in Nigeria due the petroleum exploration and production ongoing activities in the Niger Delta region for

the past five decades, the development and continuous operations of this industry has been detrimental to the local population and has had significant impacts on sustainability of the environment and ecosystem in this part of the country. This is because Nigeria seems to suffer from the “oil curse” due to lack of a structured environmental and sustainability awareness system unlike it is the case of developed countries such as the UK.

For a nation’s economic development, it is important to have a sense of sustainability both in the short and long term. The petroleum industry in Nigeria has to arm itself with the right weapons to remediate the problems it is facing due to a poor management of this sector. Added to the environmental problems caused by production, the petroleum industry in Nigeria is also exposed to challenges such as oil bunkering and oil theft which really affect the country as Nigeria depends on oil directly or indirectly for up to 80% of its earning.

The exploration and production of oil and gas from the various companies in the Niger Delta region has also had adverse health effects on the surrounding population and has led to environmental contamination. The effects of this operation heavily affected the socio-economic state of Niger Delta and Nigeria as a whole.

3.2: ENVIRONMENTAL CHALLENGES, SOCIO-ECONOMIC PROBLEMS AND HUMAN HEALTH RISK LINKED TO PETROLEUM EXPLORATION IN NIGERIA

As continuously emphasised throughout this work, in all continents all around the globe, environmental pollution is an issue of major concern, because a poor environment negatively affects human survival and to a bigger extent, the survival of the earth itself.

In the Niger Delta Region the threats faced are similar especially in the oil and gas industry where these threats to the ecosystem are experienced mostly during crude oil transportation activities. Nigeria has suffered from a lot of oil spills in the last years and by extension is heavily polluted due to its activities.

Here are some other statistics that could help understand the extent of this challenge or have a more vivid picture of the scale of oil spills and pollution in the Niger Delta region:

- 1.67 million barrels is the amount of oil lost in 12 years (1970-1982) within Nigeria. These losses were the result of an outrageous 1,581 oil spillages
- In a survey made by Shell, between the year 1982 and 1992 revealed that 40% of their total oil spillages were endured in Nigeria while Nigeria contributed only to 15% of Shell’s output.
- 4,835 is the number of times Nigeria experienced oil spills between 1976 and 1996. The rate of occurrence of oil spillage in Nigeria is about 440 per annum

The Niger Delta region in Nigeria has experienced more oil spillages than any part in the rest of Nigeria. Quoting from Ikporukpo, (2000), as much as 98% of crude oil transportation in Nigeria takes place in the Niger Delta region. This is not surprising given the numerous flow stations, oil fields and terminals in which crude oil is flown present in the region. Other interesting even facts to keep into account are:

- The estimated amount of oil spilled into the Niger Delta ecosystem in the last 50 years goes between 9million-13million barrels, so we have an equivalent of 1.5 million tons. To put this into perspectives, this is equal to 50 times the volume of oil spilled in the Exxon Valdez oil spill in Alaska 1989 (Aniefiok pet exp and prod)
- Between 1976 to 1990, 25% of the oil spills within the Niger delta region took place in swamps among which 69% was offshore and relatively 6% was found on dry land
- Ikporukpo, (2000) also noticed the three largest in Nigeria were the Forcados terminal spill (1970) were 570,000 barrels was spilled; Apoi North spill (1980) with a loss of 280,000 barrels; The Idoho spill (1998) in which 40,000 barrels was spilled.
- According to the Ministry of Petroleum Resources in Nigeria, 2,676 spills were recorded. 21 % of these spills was due to corrosion greatly affecting the equipment, 18 % due to sabotage by the local population and 3.8 % due to malfunctioning of the equipment. Though a great number of these oil spills are as a result of sabotage, it should be noted that the sabotage usually happens due to protest or conflicts between the operating companies and the local communities.

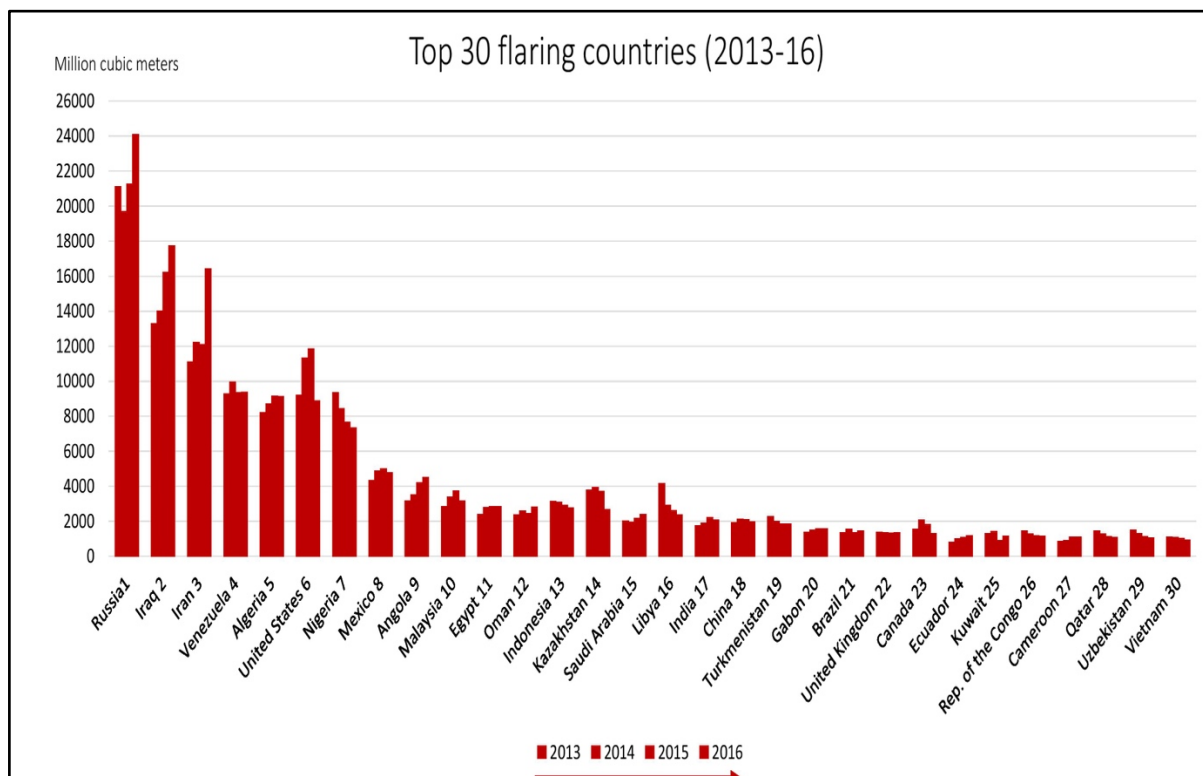
Another cankerworm to the environment which is also a by-product to oil and gas activities in the Niger Delta region is the occurrence of gas flaring activities in this region. Studies from Dokpesi et al (2004) concludes that Nigeria flares a huge amount of gas and is among the highest among the petroleum producing countries. Another study from the world bank (1995) shows that in 1991, while 5% of the world's product was flared, the percentage flared in Nigeria amounted to 76% which means Nigeria's flaring activities was 4 times the OPEC average and even more than 15 times that of the world.

Other sources of pollution and gas flaring in this area comprise of:

- Continuous damage in in areas exposed to large spills like in industrialized zones surrounding refineries and oil terminals
- Waste from drill cuttings and drill mud at the drilling stage. Seismic lines and detonation of explosives during the exploration stages.
- No adequate preparedness in the face of damage control when accidents such as oil spills, fire incidents and explosions occur.

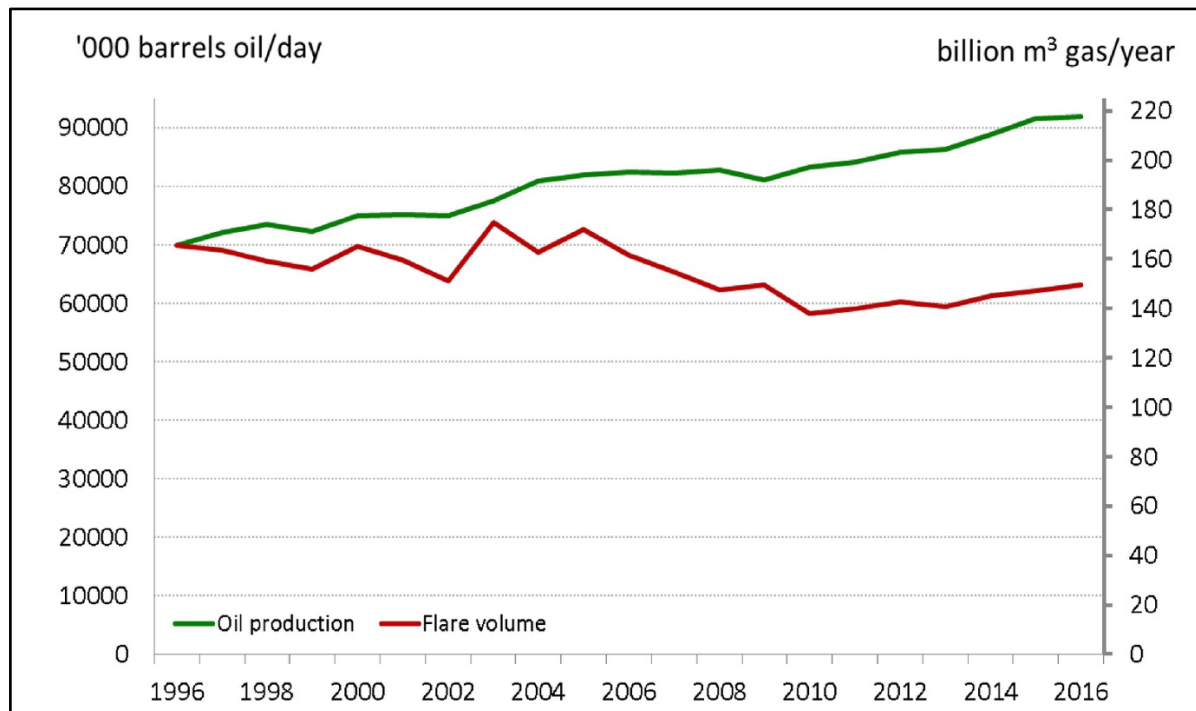
- Unexpected spills of refined petroleum products especially during transportation, storage and utilization of these products.
- Pollution generated from oil tanker traffic due to oil tanker transport and inadequate port facilities especially at the major shipping harbour in Port-Harcourt (Niger Delta)
- Sabotage from the angry local population along the network of oil and gas pipelines which goes across the Niger Delta.

Fig 15: TOP FLARING COUNTRIES FROM 2013-2016, Nigeria 7th, UK 22nd



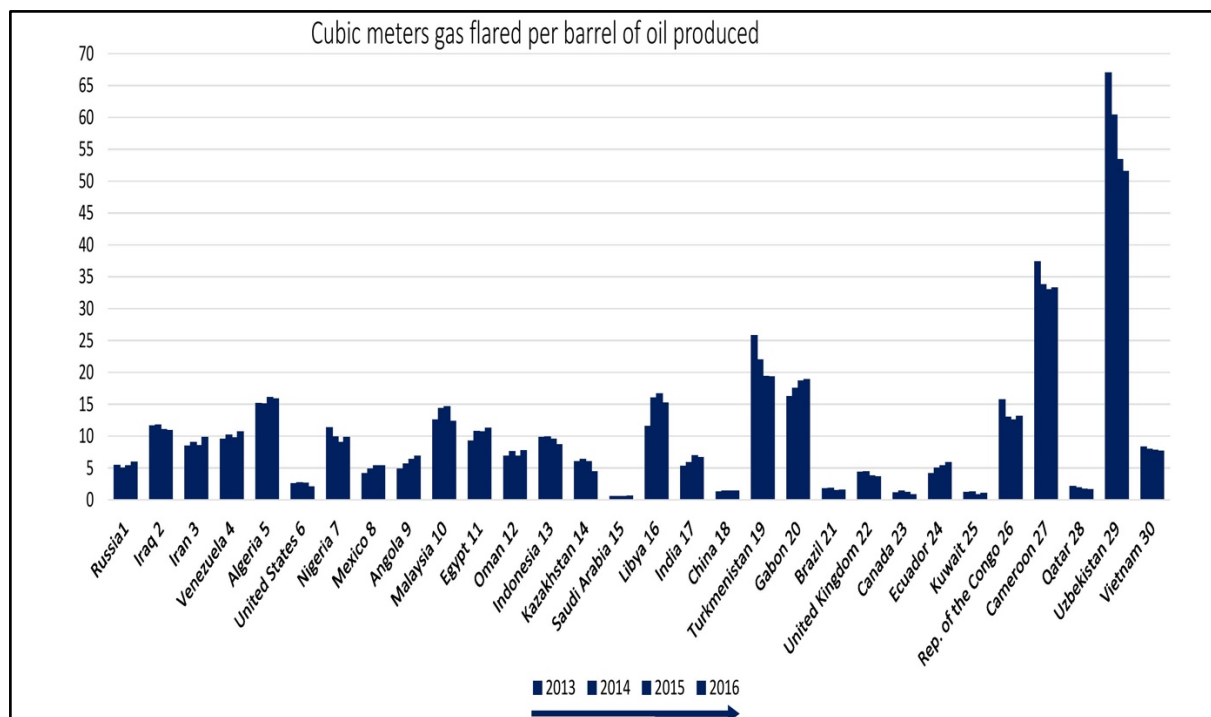
Source: NOAA/GGFR

Fig 16: Global gas flaring and oil production 1996 – 2016



Source: NOAA/GGFR

Fig 17: Flaring intensity from top 30 Gas flaring Nations



Source: NOAA/GGFR

Fig 18: Gas flaring activities in Niger Delta and pipelines exposed



Source: World Bank

3.3: NEGATIVE SOCIO-ECONOMIC IMPACT OF OIL EXPLORATION

“Babies in Nigeria born in areas of oil spills are more likely to die before their first birthday if their mothers reside in an area of oil spills before they are born”

Source: THE GUARDIAN

With the numerous oil and gas activities undergoing in the Niger delta region of Nigeria, it would be easy for someone to assume that these activities will greatly favour the local population and grant them better living conditions and facilities. Nevertheless, the past years have shown this assumption to be totally far from the reality.

The Niger Delta region often referred to as the heart of the Nigeria's economy has known little to no peace. On the contrary, the region has been subjects of conflicts especially with the interest of the federal government on the control of the resources. There has been a lot of complaints from the local population on the pains and harm caused by the excessive exploitation of oil and gas while neglecting the hazardous ecological problems. (UKOHO 2003), qualifies these problems to result from the increased level of oil prospecting activities from the multi-national companies.

When one takes a look at the problem faced by Nigeria in the 21st century in terms of socio-economic, physical impacts and ecological, it is easy to identify oil and gas pollution in aquatic zones, coastal, offshore and ecological sensitive zones to be one of the major challenge. Nwafor, (Nwafor, J. C., 2006), has qualified the local activities of oil and gas companies to be the root of environmental challenges which are intense, visible and cumulative negative impact. Apart from the physical impacts such as water contamination, there is also a rise in the influx of outsiders into oil cities of Warri and Port Harcourt.

Akpofure et al (2000) observed that oil spilled on water bodies spreads much faster and instantaneously. The liquid and gaseous component evaporate, while some of it get dissolved in the water and will sink due to gravitational forces. This will further lead to contamination of the soil and causes damage to terrestrial life. On the flip side, the evaporation of the lower molecular and volatile component causes damage to the aerial life. Aquatic lives are threatened by the component dissolved. So, a spill will leave no one safe.

Another factor observed in the Niger Delta region of Nigeria is the rise of carcinogenic diseases which has been traced to the exposure of the local inhabitants to the radioactive elements of gas flaring. Fagade (1990), insists on the thesis that multiple spillages no matter the extent, will orchestrate undesirable series of events especially negative impacts on the biological, chemical and biological characteristics of water, land and air. These impacts disrupt the economic life of farming, fishing and even navigational activities.

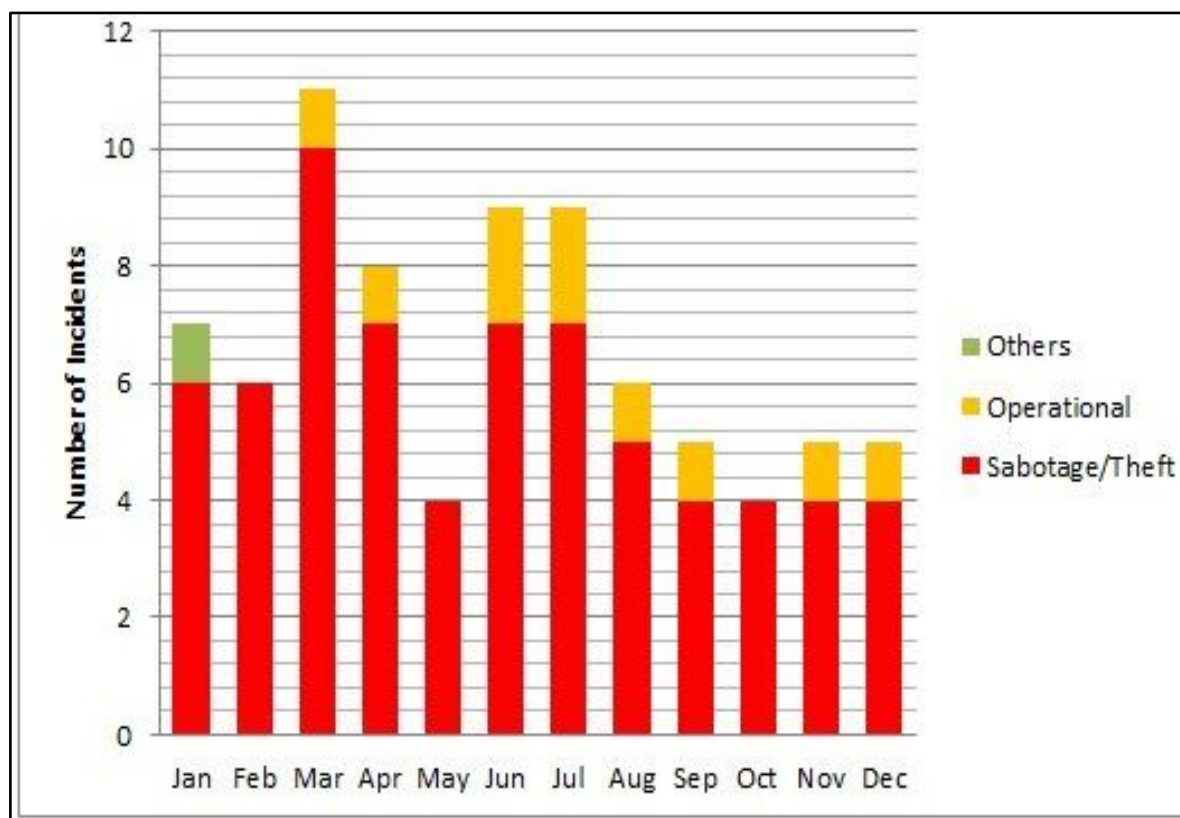
The chemicals contained in the flaring of gas are threats to both the wild life and human lives accompanied by acid rains and the emission of methane (30% component from

the flared gas) with a global warming capacity higher than that of carbon dioxide (about 64times higher).

Aside the loss of land as environmental damage, there is an everlasting damage caused to the flora and fauna. Critics have complained about the quality of crops in the Niger delta region, as their quality has been seen to be depreciating with the increase of oil and gas exploration activities.

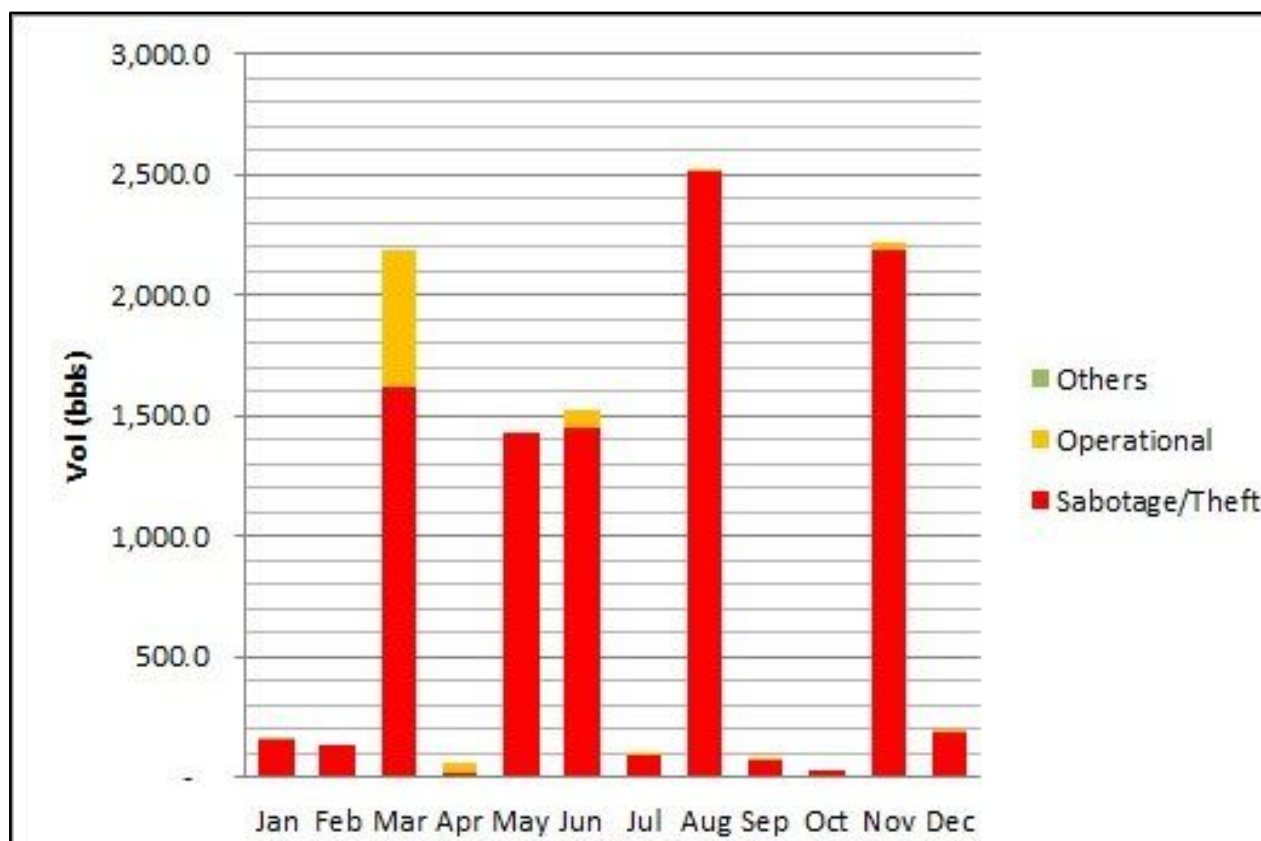
Rural – Urban migration is another downside effect of oil exploration in the Niger Delta region. Due to the activities undergone in this region, the local population are separated from their daily bread activities such as farming of their own land and hence are obliged to relocate to urban areas or sometimes take their destiny at hand by engaging in criminal activities such as sabotage, oil pipelines destruction and even oil theft while selling it illegally.

Fig 19: Frequency of incidents from oil spills in Nigeria for 2017



Source: NOAA/GGFR

Fig 20: Volume of oil spills/month in Nigeria (bbl.)



Source: NOAA/GGFR

Fig 21: Oil Spill in the Niger Delta Region



Source: Vanguard Nigeria

3.4: LOSSES FROM GAS FLARING ACTIVITIES

According to the Nigerian Bureau Statistic (NBC), 1.698 trillion cubic feet of gas was flared between the year 2012 and 2017. Taking an average international price of natural gas to be around \$2.9 per 1000 standard cubic feet. Looking at the volume of gas flared between these year, and the price money of the value for every 1000 standard cubic feet, we can re-evaluate this loss in terms of monetary value and observe that \$4.9 billion was lost in this activity. \$4.9billion is also 20% of Nigeria's 2017 budget.

https://www.youtube.com/watch?time_continue=54&v=3wqXddTljCY

Borrowing a page from the Audit report (2014) of the Nigerian Extractive Industries Transparency Initiative, (NEITI), we find disclosed an imposed penalty of \$3.5 per 1000cf of the gas flared by oil and gas companies, but the later refused to align by such rules. If we are to take into account the date when the law was set, and the quantity of gas flared since then, then Nigeria has lost close to \$15 billion resulting payments of these fines

Between 1983 and 2016, seven deadlines have been set for oil companies to stop flaring, but this has not stopped them from moving on with flaring activities. Instead the deadlines are continuously extended to future dates. Last year the date for secession of this activity (Gas Flaring), was further pushed from (2020 to 2030).

CHAPTER 4: DISCUSSION

4.0 RATIONALE FOR COMPARING THE EXPLORATION SYSTEM OF NIGERIA AND IN THE UNITED KINGDOM

- The relationship between Nigeria and the United Kingdom originates back to the colonial rule of Nigeria by the United Kingdom.
- Both the United Kingdom and Nigeria are major oil producing countries with crude oil having similar characteristics. For example, the UK Brent crude oil has an API of 38 while the Nigeria's Bonny Light has an API of 37. They are both referred as sweet crude oil because of their low sulphur content.
- The UK being the colonial master of Nigeria back in the days, has had a significant economic and political influence.
- Both countries though having different economic and developmental profiles share different approaches and fiscal systems. Nevertheless, they deal with the same multinational companies

4.1 QUANTITATIVE ANALYSIS OF DATA FROM UNITED KINGDOM AND NIGERIA

Table 4: Oil Production Data

ACTIVITIES	NIGERIA	UNITED KINGDOM
OIL RESERVES	37. 2 billion barrels	2.5 billion barrels
AVERAGE OIL PRODUCTION	2.53 million barrels/day	1 million barrels/day

After reviewing data from past literature sources, it is clear that oil spillage in the North Sea and damages to pipelines is dangerous for the wildlife thereby exposing them to petroleum hydrocarbons and causing ingestions of these hydrocarbons. Nevertheless, the negative impacts are fewer compared to those of the Niger Delta environment. This is because all stages of the various activities (exploration, development and production), are subjected to environmental Impact assessment, (The Department of Trade and Industry , 2002) .

END USES OF OIL AND GAS IN THE UK AND NIGERIA

Understanding the end use of hydrocarbons in both the UK and Nigeria is important as it gives us an idea of the trend in use of its products hence the importance of oil and gas. The end-use of hydrocarbons in the UK and Nigeria are almost same as they could be narrowed down to electricity and petroleum products.

In Nigeria the demand of hydrocarbon has always been more than the supply and the demand in gas is expected to rise in 2020 by 246 per cent compared to what it was in 2010. This is because of its use in industries like cement production, fertilizers production and steel manufacturing.

The price of petroleum products depends on a variety of factors such as oil price, transportation cost, refining cost and distribution cost. These prices will fluctuate many times many times in a month and could vary among states.

Table (5 and 6) below shows the population growth in both the UK and Nigeria between 2008 to 2012 and the changes in petrol prices. From this table, the minimum and maximum prices are calculated in terms of percentage price change, while the percentage change in population is translated to the percentage change of quantity demanded. From this data, we use the midpoint formula to get values for the price elasticity of demand

Table 5: Price elasticity Nigeria

NIGERIA			
YEAR	MONTH	FUEL PRICE(N/L)	POPULATION
2008	JUNE 1	75	150000000
2012	JUNE 4	104	168000000

$$\text{Price elasticity of demand Nigeria} = \frac{\left(\frac{168000000 - 150000000}{\frac{168000000 + 150000000}{2}} \right) * 100}{\left(\frac{104 - 75}{\frac{104 + 75}{2}} \right) * 100} = \frac{11.3}{32.4} = \mathbf{0.34}$$

Table 6: Price elasticity UK

UNITED KINGDOM			
YEAR	MONTH	FUEL PRICE(P/L)	POPULATION
2008	JUNE 1	1.04	61000000
2012	JUNE 4	1.40	64000000

$$\text{Price elasticity of demand UK} = \frac{\left(\frac{64000000 - 61000000}{\frac{64000000 + 61000000}{2}} \right) * 100}{\left(\frac{1.40 - 1.04}{\frac{1.40 + 1.04}{2}} \right) * 100} = \frac{4.8}{29.5} = \mathbf{0.162}$$

Both the Nigeria and the UK have values less than 1 hence the hydrocarbon demand in both cases is inelastic, this is also an indicator that at the moment there are not many alternatives to petroleum products, hence petroleum will continue to be explored. The

elasticity in the demand of this product is enough motivation for the multinationals to continue their exploration and extraction activities hence the importance to promote sustainable development in the oil and gas industry.

SOCIO-ECONOMIC POSITIVE AND NEGATIVE IMPACTS IN THE UK

Information from the department of energy and climate change report that the oil and gas industry created more than 265000 jobs and helped to improve the UK supply chain making it more established internationally. Another added value of oil and gas exploration on the socio-economic state of the UK is the taxes paid by multinational oil companies.

On the negative side, oil exploitation activities bring about workers and their families to areas not commonly inhabited, hence causing accelerated urbanization and sometimes introducing health disorder (Wolf et al., 2004). These potential negative impacts are usually addressed by establishing licensing systems.

ENVIRONMENTAL POSITIVE AND NEGATIVE IMPACTS IN THE UK

In the United Kingdom, all stages of exploration, development production and decommissioning life cycle are reviewed with the use of Environmental Impact Assessments (EIAs) while all discharges and emissions are regulated by permits. Some of this legislation include:

- Offshore petroleum production and pipelines (SI 1999/360)
- Offshore petroleum Activities Regulations (SI 2001/1754)
- Offshore chemical regulations (OCR), (SI 2002/1355)

British Petroleum (BP) focuses on three principle which are key to their activities, (British Petroleum , 2002):

1. Promoting a culture focused on safety, compliant operations and reducing risk
2. Developing an operating managing system (OMS) with good conduct expectation
3. Self-checks carried out at all levels of organization

Shell on the other hand focuses on creating a culture of safety and identifies 3 principles for this (Shell, 2004),

1. Protection of the environment
2. No harm to people
3. Align with internal health safety and security laws and regulations

GAS FLARING POSITIVE AND NEGATIVE IMPACTS IN THE UK

The oil companies in the UK flare gas in rare cases which usually is done with respect to the operation process. This is possible as stipulated by, (Isishone, 2004) because of improved technology and knowledge of the economic value of associated gas. There is more recognition in developed country that gas flaring is a significant threat to the environment and greatly contributes to the total CO₂ emission.

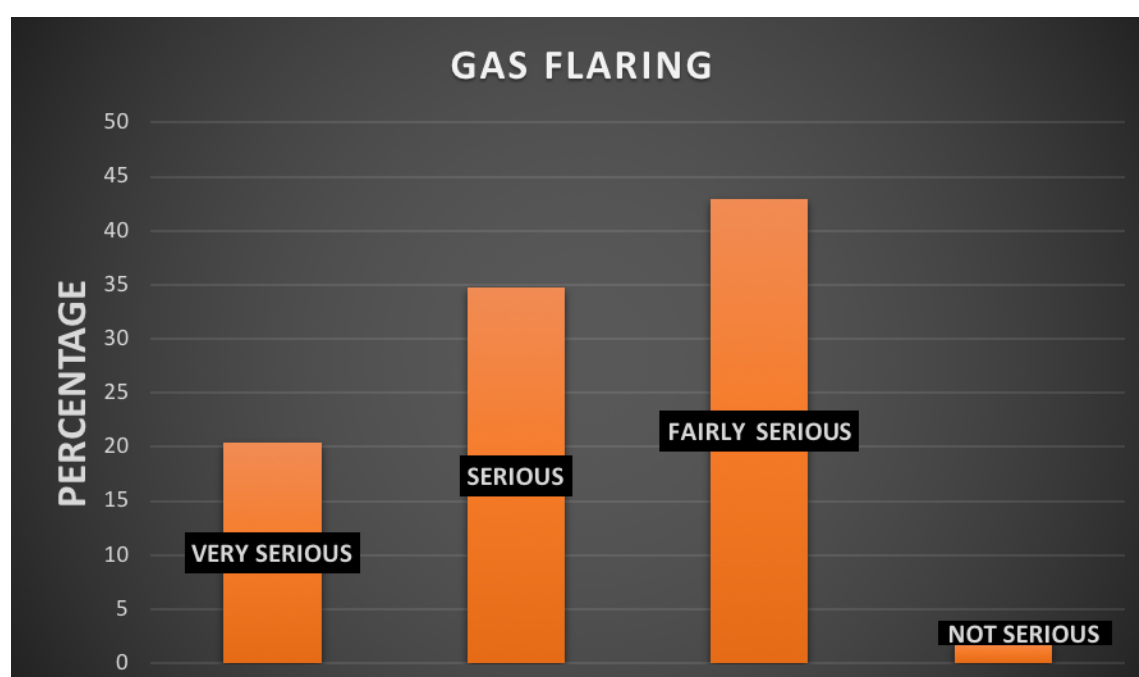
HEALTH IMPLICATION OF OIL AND GAS ACTIVITIES IN NIGERIA

Based on data gotten from a questionnaire sent out to 49 random participants in the Niger Delta, these participants had to fill in questionnaires indicating whether or not they experienced cough, skin illnesses and respiratory diseases during oil and gas related activities. Out of the 49 participants the following Data was collected:

Table 7: health conditions from gas flaring activities

CSORD	Frequency	Percent
Very Serious	10	20.4
Serious	17	34.7
Fairly Serious	21	42.9
Not Serious	1	2
Total	49	100

Fig 22: Representation of health conditions from gas flaring Nigeria



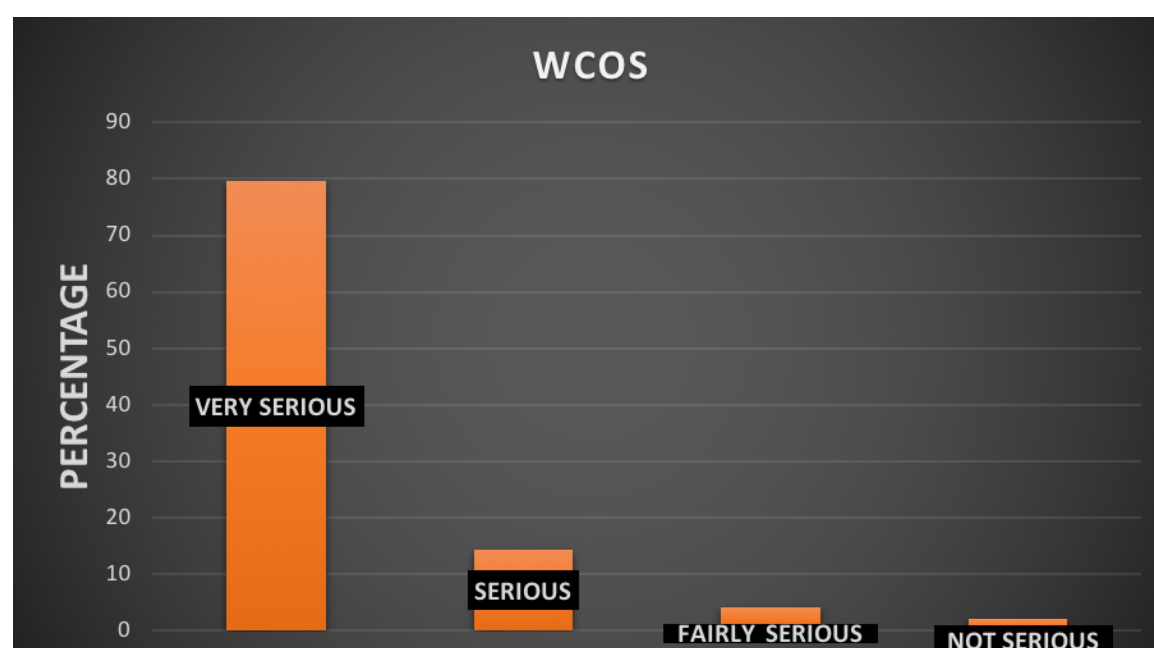
Though the results above reflect large discrepancy, it could be attributed to the fact that the local population is not aware of the intrinsic impacts of these activities or careless to report such acts because they do not have the financial means to receive hospital care. This is dangerous on the long run as there is no clear data on the impact of these activities. This however shows that there is need for attention to be given to this situation and efforts should be put to relocate the local inhabitants or stopping the flaring activities.

The same questionnaire was filled to have an idea of how much the local population was affected by water pollution as a result of oil spillage (WPOS), in the same Niger Delta region and whether or not they felt disturbed by the situation in the area and it was found that about 79.9 % of them were disturbed by this situation which they found very dangerous.

Table 8: health conditions from water contamination by oil spillage Nigeria

WPOS	Frequency	Percent
Very Serious	39	79.6
Serious	7	14.3
Fairly Serious	2	4.1
Not Serious	1	2.0
Total	49	100

Fig 23: Representation of health conditions from contamination of water by oil spillage



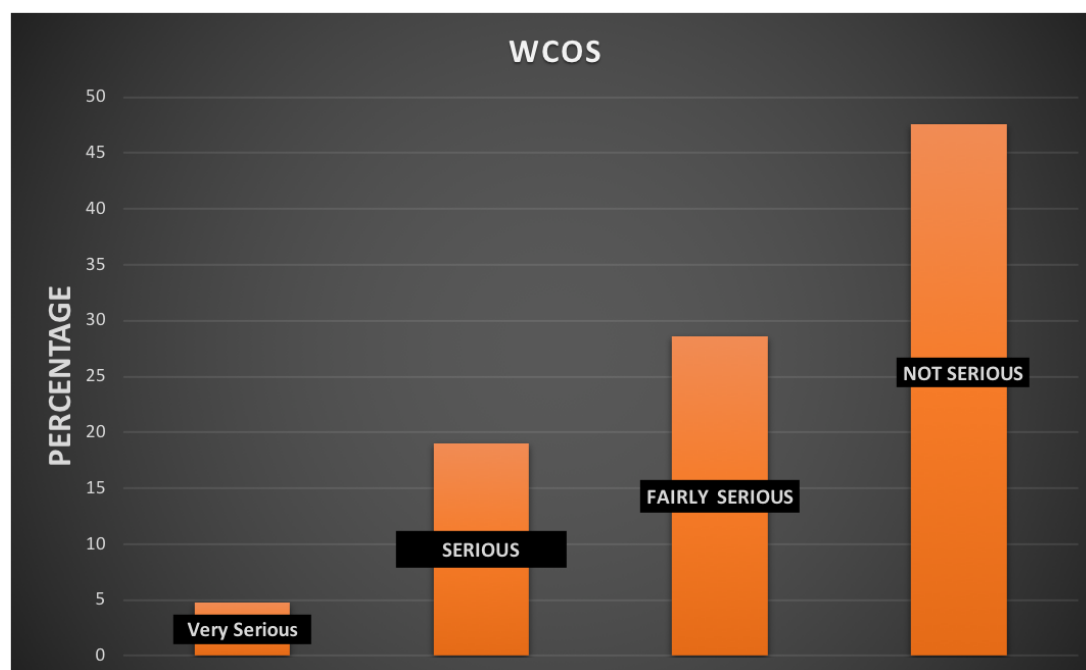
The UN and some environmental experts have identified oil spillage to be the primary variable causing negative impact on the communities' resident of the Niger Delta region. The impact of these oil spillages is very devastating, for example the local fishers have to travel to far distances to fish which is very dangerous, (Chux Ibekwe, 2014). Farming has now be destroyed in many communities of the Niger Delta region, fishing activities become scares while most of the aquatic life is destroyed, (Dickson Ekpe, 2014).

HEALTH IMPLICATION OF OIL AND GAS ACTIVITIES IN THE UK

The same survey was carried out with 15 people in the United Kingdom residing in an area close to oil and gas exploration activities. Though the number of participants were less than in Nigeria the results can't be neglected.

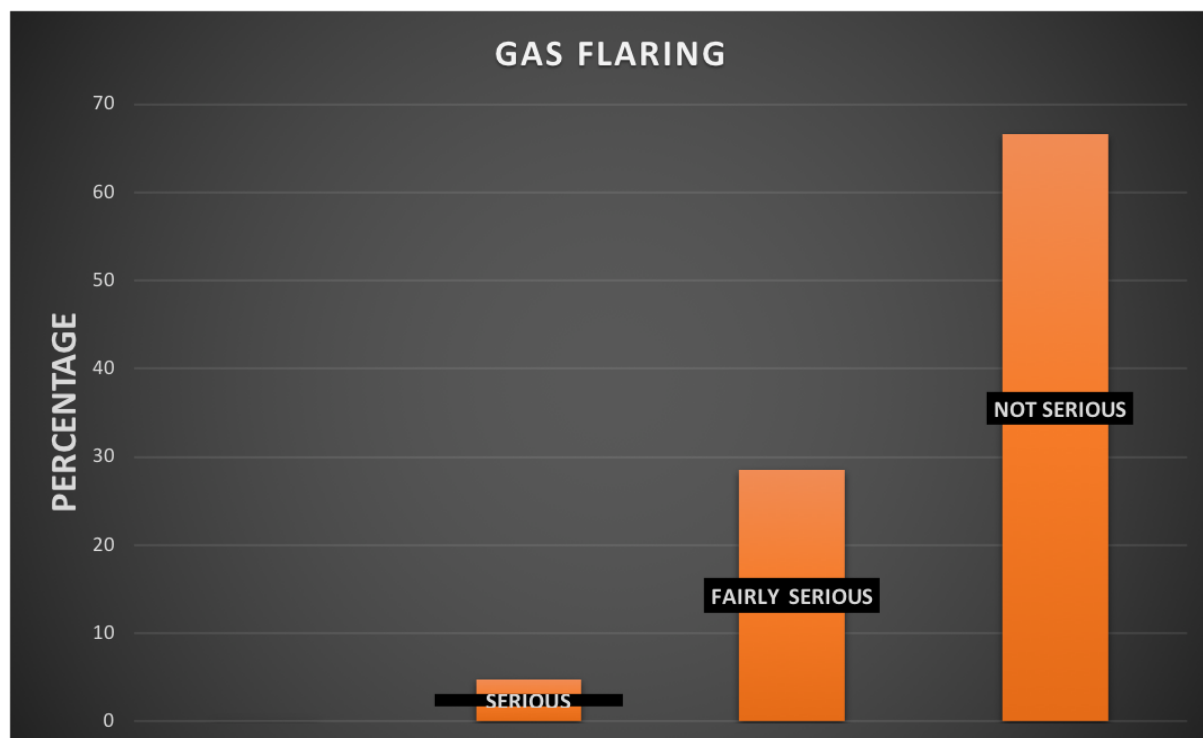
WPOR	Frequency	Percent
Very Serious	1	4.7
Serious	4	19.0
Fairly Serious	6	28.5
Not Serious	10	47.6
Total	21	100

Fig 24: Representation of water contamination from oil spillage UK



GAS FLARING	Frequency	Percent
Very Serious	0	0
Serious	1	4.8
Fairly Serious	6	28.6
Not Serious	14	66.7
Total	21	100

Fig 25: Representation of health conditions from gas flaring UK



4.2 TAXING EXTERNALITIES

A simplistic approach for accounting for environmental externalities induced by the exploration of oil and gas especially linked to global climate change has commonly been to introduce carbon tax. Carbon tax can help in raising the price of the fossil fuel hence encouraging its limited use by the end user. The tax could then be given to the consumers for their selected use. Most European nations like the United Kingdom have adopted such type of carbon taxes.

4.3 HOW TO APPROACH THE ISSUE OF THE NIGER DELTA REGION AND STEPS TO FOLLOW TO RESOLVE THIS PROBLEM.

The Niger delta region is without doubt the hub of oil and gas exploration activities in Nigeria. As stated and described before, it contributes at a high percentage to the economic sector in Nigeria. Should we look only from this point of view, we deprive ourselves from looking at the major downside of the methods adopted by these exploration activities which lead to pollution and environmental problems, hence affecting the sustainable exploration of the later. Besides, can we justify that exploration activities in this zone is a major contributor of the economy and sustainability if on the flip side it is also the cause of major environmental problems? The effect of poor methods in oil and gas exploration activities usually leads to series of negative successive events.

Unlike the United Kingdom which has shown very positive results in the terms of the sustainability of their production, the Niger Delta region continues to be associated with flaring and spills. On the short run it might not be obvious to notice the harm to the environment but to put things into perspective, flaring reduces the available oxygen as fire needs oxygen as fuel. This intake of oxygen reduces the available oxygen and increases the release of carbon dioxide. The release of carbon dioxide will be a catalyst to acid rain and hence reduce the flora and fauna. Whatever harms the flora and fauna reduces the fishing and hunting activities hence reduces the food accessibility to the local population.

The problems of the sustainability of oil and gas exploration are legion. Figure 17 shows some of the local inhabitants sitting on an exposed pipeline hence no follow up or adequate supervision. Flaring activities also destroy natural capital. To solve a problem, we have to identify the source of the problem. This is the same for every problem in life and this law is the same in sustainability of oil and gas exploration activities. After looking at both the condition of the Niger Delta region and comparing it to that of the United Kingdom, the following observations are made:

- There is not enough technology transfer in the Niger delta region. An increase in the technology transfer will encourage a more competent personnel and sustainable environment.
- The lack of environmental professional is a call for concern as the local population is seen living in areas surrounded by pipelines.
- The local population can't always be delocalized but they can be sensitized on the effects and harms that will result from sabotaging pipelines.
- More infrastructures such as hospitals, schools, attraction parks should be built by the multinationals to benefit the local population and hence ease the tension between multinationals and the local population. This will help in reducing the sabotage and destruction of pipelines
- More locals should be recruited to work for the multinational in order to promote equity.

- The local rights of the local population have to be revised, promoted and adopted.

4.4 WHAT NIGERIA AND OTHER DEVELOPING COUNTRIES COULD EMULATE FROM THE UNITED KINGDOM

Exploration of oil and gas activities will never come free, as it will always have a cost on the environment hence it is important to study, understand and adopt a system that will reduce the impact of this activities on the local population. The United Kingdom has been able to do well in this sector as they have greatly reduced gas flaring and also observed a drop in the spills. The tools for the success of this activity in the United Kingdom could be emulated in Nigeria. For this, the following must be looked into:

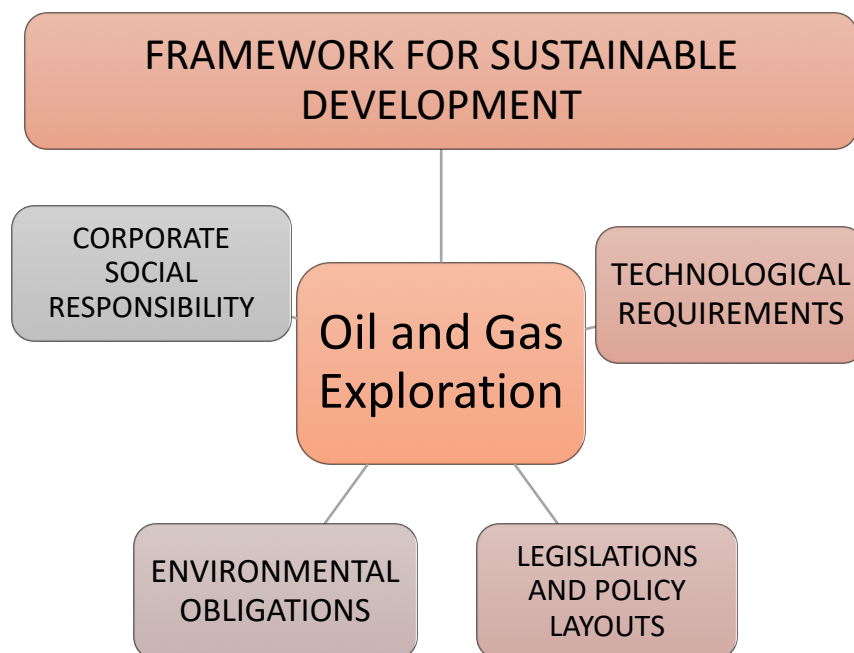
1. In Nigeria the environment ministry and health ministry do not have an organised staff, are usually understaffed and not qualified. The strengthening of these bodies and government agencies advocating for regulations protecting the interest of the public and local population just as is the case of the United Kingdom would be of great help to address the citizen on the impacts of oil and gas exploration activities and hence reduce possible future conflicts.
2. Nigeria should be strict and firm when dealing with Gas flaring. This has been a topic of conversation for a long time but almost little to nothing has been done regarding this sector. The government has shown will to prohibit these activities, but a will that is usually followed up by inaction. This is usually because the government is scared about multinationals not investing should the rules be very stiff hence affecting government revenue. This fear however is not proven given that in the United Kingdom and in Norway such laws have been beneficial to both the host nation and the multinationals operating in those regions.
3. There should be promotion and development of associated gas reinjection and associated gas infrastructure. This investment will initially prove costly but on the long run will prove more economically viable than gas flaring. This has been the case in the Drogue field which had no gas transport facilities when oil production started, and associated gas was re-injected in the water reservoirs in order to be disposed. Today the associated gas is transported by pipelines to feed the local market and is of great economic value
4. Developing countries like Nigeria should have the understanding that crude oil activities and gas flaring are simultaneous, which means one will lead to the other. Hence to avoid such, facilities should be developed together from the very beginning.

4.5 FRAMEWORK FOR SUSTAINABLE EXPLORATION OF OIL AND GAS IN UK AND NIGERIA

In this chapter, a proposed framework to guide multinationals, the government and the local population in oil and gas exploration zones is proposed. The practicality of a framework will be to:

- Have a clear definition of the concepts required to achieve sustainable exploration and sustainable goals hence making adequate preparations and measurements.
- A framework will facilitate idea collection
- The use of a framework will be a guideline to properly layout the results of previous work and research and hence facilitate transfer of knowledge
- It helps in holding everyone accountable and conscious of the part to be fulfilled

Fig 26: Framework for achieving sustainable exploration goals



CHAPTER 5: CONCLUSION, RECOMMENDATION AND FURTHER WORK

This chapter discusses the conclusion and proposes recommendation for the future in order to enrich the area of research. The aim of this research was to

- Analyse the impact of sustainability of oil and gas exploration in the United Kingdom and that of the Niger Delta region of Nigeria while highlighting ways in which the Niger Delta can emulate the example of the UK
- To review literature and provide the reader with evidence and information of the effects and danger caused by gas flaring and oil spillage while highlighting the extent to which it affects the economy
- To look at the technology growth and best practice of the oil and gas sector in the UK and compare it with that of Nigeria
- To examine the existing legislation and institutions in relation with oil and gas exploration in the UK and Nigeria
- To understand the level of destruction on natural capital and the local population especially those of Nigeria
- To discuss on the internalization of externalities by multinationals.
- To propose step-by-step solutions that can be used to enhance the activities of oil and gas exploration in the UK and particularly in the UK
- To validate finding from literature reviews and data on the sustainable exploration of oil and gas from Nigeria and the UK

5.1 CONCLUSION

The thesis had two case studies. Analysing these case studies proved that the oil and gas sector and activities in Nigeria is different from that in the UK.

The findings also suggest that the lack of technological advancement, good management, corruption and legislation are strong factors to the environmental impact during the exploration of oil and gas activities in Nigeria especially regarding gas flaring. The thesis highlights on the importance of a balance between economic growth and sustainability especially in the case of environmental sustainability

Strategic methods and the savoir-faire which can be adopted in Nigeria by learning from the UK is discussed in details. Nigeria and other developing countries should be able to learn from the United Kingdom that there is a direct relationship between oil activities and gas flaring, hence facilities to avoid gas flaring activities should be planned and established from the onset of the activities.

Environmental justice and sustainable exploration of oil and gas are the basis for assessing and understanding the impacts of oil and gas on the environment while

looking for ways to intervene at the social level to empower the local population and communities on educating them on their rights to request equity from multinationals operating in their community.

5.2 RECOMMENDATION

After careful analysis of information, data and facts given, one will clearly see that the continuous activities of unsustainable production of oil and gas in the Niger delta region is a real danger for the present generation and the generation to come. To remediate the situation the following recommendations could be looked at:

1. There should be a strict environmental impact assessment in the future prior to the establishment of an oil and gas company to understand the risk run by the local and residents of the area.
2. Oil companies should absolutely stop gas flaring. Instead, options like re-injection of the gas into oil wells should be looks at or even using chemical alternatives. The option of chemicals will greatly help where there is absence of pipeline transformation network.
3. There is need of a stronger and more efficient health insurance system especially for those living in the Niger Delta region.
4. There should be increased participation and programs with communities where pipelines are located.
5. The existing environmental laws in Nigeria should be revised and reinforced.
6. There should be regular maintenance of the pipelines in other to avoid problems of rupture
7. Private indemnities together with the government should be promoted to provide social amenities

5.3 SUGGESTIONS FOR FUTHER STUDIES

1. The call to abolish gas flaring in Nigeria has been a topic of discussion for almost 50 years now. If this is still subject of today's discussion means that there is a fundamental problem and the solutions so far are not the best. There should be more studies to understand unspoken facts that could contribute to the failure of this target.
2. There should be more study of flaring points and zones that were affected by spills in Nigeria to understand the relationship between flaring zones and the impact on the local brands.
3. More studies on development initiatives, community engagement and multinationals investments should be carried out

REFERENCES

- Arscott, L. (2004). Sustainable Development in the Oil and Gas Industry.
- Board of Directors, Equitable Origin Inc. (2015). *EO100™ for Onshore Conventional Oil and Gas Operations*.
- Brian Towler. (2014). The Future of Oil and Hubbert's Peak Oil Theory.
- British Petroleum . (2002). *Health, Safety and Environment*.
- Chux Ibekwe. (2014). *Corruption in Oil Revenue Distribution and Conflict in Bayelsa State, Nigeria*.
- Dan Hassey . (2014). *2014 Global Oil Supply and Demand Outlook* .
- Deborah J. Shields. (2016). Applying Sustainable Development Principles and Sustainable Operating Practices in Shale Oil and Gas Production.
- Dickson Ekpe. (2014). *Oil Exploration and Poverty in the Niger Delta Region of Nigeria: A Critical Analysis*.
- Energy Information Administration. (2012). *Annual Energy Review* .
- Eric Neumayer. (2009). Corruption, the Resource Curse and Genuine Saving. *Environment and Development Economics*.
- Goodwin, B. (2017). *Handbook of Disaster Risk Reduction & Management*.
- INTERNATIONAL ENERGY AGENCY . (2002).
- International Energy Agency. (2006). World Energy Outlook.
- National Archives. (2008). *legislation.gov.uk*. Retrieved from <https://www.legislation.gov.uk/ukpga/2008/27/contents>
- Nwafor, J. C. (2006). *Environmental Impact Assessment for Sustainable Development: The Nigerian Perspective (1st ed.)*.
- Oil and Gas Economic report. (2008). Retrieved from <http://oilandgasuk.co.uk/wp-content/uploads/2015/05/EC009.pdf>
- Omorotionmwan. (2005). Gas Flaring In Nigeria.
- Organization of the Petroleum Exporting Countries. (2018). Monthly Oil Market Report.
- Osuoka, A. I. (2005). *Oil and Gas Revenues and Development Challenges for the Niger Delta and Nigeria*. Lagos: UN Department of Economic and Social Affairs.
- Pinkse, K. a. (Kolk and Pinkse, 2007). market strategies for climate.
- Shell. (2004). *Health and Safety regulations*.
- Smith, Norman J. (1978). *The Genesis of the North Sea Oil and Gas Industry*.
- The Department of Trade and Industry . (2002). *A scoping impact for an environmental impact field programme in tidal energy*.
- United Nation Organisation . (2017). *Sustainable Development goals*.
- United Nations Development Programme. (2016). Retrieved from <http://www.undp.org/content/undp/en/home/sustainable-development-goals.html>
- Wikipedia. (n.d.). Retrieved from https://en.wikipedia.org/wiki/Oil_and_gas_industry_in_the_United_Kingdom
- wikipedia. (2018). Retrieved from wikipedia: https://en.wikipedia.org/wiki/Oil_and_gas_industry_in_the_United_Kingdom
- Wolf et al. (2004). *Etiologies of inflammation-driven carcinogenesis*.
- World Bank. (2017). Nigeria's Flaring Reduction Target: 2020.