
Risk and Environmental Implications of Oil Spillage in Nigeria (Niger-Delta Region)

Saleh M. A¹., Ashiru M. A²., Sanni J. E³., Ahmed T. A⁴., & Muhammad S⁵.

^{1, 2, 3 & 5}Department of Civil Engineering Technology,
P.M.B 001 Federal Polytechnic Nasarawa, Nasarawa State.
Nigeria

⁴Department of Architectural Technology,
P.M.B 001 Federal Polytechnic Nasarawa.

Nigeria (Zip code 962101)
salehtawa@yahoo.com

Abstract

Oil is liquid petroleum hydrocarbons that exist as natural resources for exploration. These resources can be spilled in our environment, due to deliberate or accidentally factors. Similarly, oil spillage refers to the unlawful release of liquid petroleum hydrocarbons within the environment, resulting from accidental factors and or due to deliberate human activities. Sabotage, oil theft and bunkering are the major phenomenon causing oil spillage in Nigeria, with an annual economic loss of \$3 - \$8 billion in addition to \$2.3 billion spent on security of pipelines and repairs. These are eminent in the year 2010 to 2012 respectively. Consequential effects of oil spillage and pollutions within the Nigerian environments includes: Jeopardising the ecosystem, Loss in economic values, Tourism sector of the economy is affected, Industrial activities are hampered, and loss of human lives due to pipelines explosion and fire out breaks during vandalisation. However, only effective mitigation measures in the form of prevention and control can be taken to curtail these menaces of oil spillage and pollutions, as well as the application of Civil Engineering Simulation of Catchment Modelling with InfoWorks CS V15.0 for Urban Drainage Design and Analysis for oil pipeline networks. And if this is not taken with serious concern, the consequential affects are environmental and exploration risk and uncertainty.

Keywords: *Environment; Hydrocarbon; Oil; Spillage, Pollution; Risk; Mitigation.*

1.0 Introduction

Risk is a domain that contains set of probability and or occurring frequency of a known threat or opportunities as well as the size of the consequences the occurrence may cause. However, this phenomenon is attributed to oil exploration and its facilities. Oils are physically and naturally existing chemical resources, which are composed of two elements, namely; carbon and hydrogen compounds. However, crude oil are sometimes referred to as “black gold” And the chemical classification of the carbon and hydrogen is referred to as hydrocarbons (AIE, 2017). While crude oil exists in nature, as unrefined petroleum product, its compositions are hydrocarbon deposit and some organic materials (Investorpedia, 2017a). Crude oils are mixtures of hydrocarbons which occurs in liquid forms in an underground geological formation, and are extracted as a liquid which undergoes heating as the first stage of separation technique to obtaining different components of resources called distillation (Investorpedia, 2017b). While petroleum products are the act of processing crude oil as well as some liquids during petroleum refining processes and at blending facilitated plants. Similarly, petroleum is generally a broad categories, encompassing crude oils as well as

petroleum products. (Crude oil, 2017 and USEIA, 2016). It's a known fact that virtually all projects embarked on, has certain risks and uncertainty. Risks are the combinations of possibility or number of occurring time which defines a threat and the gravity of the consequence of its occurrence. While uncertainty in theoretical concept that can be defined as a lack of certainty involving variability and or ambiguity in any project lifespan, such as in general concepts of oil explorations and its facilities (Saleh M. A., 2015). Hence, no environmental project is termed risk free in its nature.

1.1 Liquid petroleum (oil) spillage

Majority of the environments hosting oil producing companies in Nigeria are virtually polluted, resulting from oil exploration as well as negative human activities. Oil spillage refers to the unlawful release of liquid petroleum hydrocarbons within the environments, due to accident and or intentional human factors; hence this is regarded as oil pollution. These phenomenon occurs in different forms, and it is attributed to several factors such as; equipment failures and human error (leakages/spills during processing and at refining plants, drilling rigs and from oil wells, rusting / corrosion of oil piping and installations, improper maintenances of infrastructures, the release of crude oils from offshore platforms) *table 1; figure 1* (NNPC, 2013) as well as persistence menace of deliberate sabotage/damaging pipelines and the theft of crude oils by vandals which cost the Nigerian nation billions of dollars *table 1; figure 1 and table 2* respectively, (Amnesty International, 2011 and NNPC, 2013).

Some parts of the globe are faced with the phenomenon of oil spillage, which can be traced back to the discovery of crude oil in various parts of the world. Human factors resulting to oil spillage affecting various water bodies (rivers, oceans and seas) are approximated to be within the range of 0.740 – 1.734Mt/yr. And this phenomenon of spillage has been one of the major sources to environmental degradation for areas within which these resources is being harnessed *table 3*, (US Legal, 2016), (NNPC, 2013 and Adati A. K., 2012). This is known to be an industrial revolution having footprints on our environmental sustainability, and the subsequent destructions of the global ecosystem, as these phenomenons of spillage can take many months and or even years before the affected areas/environments could be cleansed up of the spills effectively.

Similarly, as the situation is in Nigeria and the oil producing regions (Niger Delta for example), there are virtually inconsistency of figures resulting to oil spillage (Ordinioha and Brisibe 2013). According to investigation carried out by (Amnesty International 2010 and NNPC 2013), within the past five decades. Oil spillage in the Niger delta environments has contributed to as much as 546Mgal, equal to 2066834834.06BL, and approximately equal to 11Mgal/yr., of oil spills. This is the same as 41639529.624ML/yr. Simultaneously, it has been reported by (UNEP 2011), regarding the chronic state of living in the local communities within Niger Delta regions, resulting from the persistence and the alarming rates of oil spills, which could be evaluated daily within and around the community, especially the Ogoni-Land. The menace of oil spillage in any community will leads to environmental oil pollutions, and thereby jeopardising the ecosystem, with a long term and expensive mitigation processes. However, only a committed and prudent government with a profound and effective legislative system can ensure sustainability practice within the oil sector.

2.0 Environmental oil pollution

Generally, pollution of whatever kind is so harmful to the natural environment and the ecosystem. And if this pollution is coming from oil, it means there is the likelihood that the

land (soil) and the water bodies are possibly to be at the receiving end (being polluted). It's a general phenomenon that all plants and animals thrive with the presence of water. Hence, oil doesn't dissolve in water, because oil can only float at the surface of water, which affects the existence and the quality of any water bodies and the aquatic environments.

Oil pollution is the direct contamination of the physical environment resulting from the presence of oil spillage (the discharge of liquid petroleum hydrocarbons), and can be attributed to irresponsible human activities. Sometimes, shallow water bodies are more prone to pollutions by oil spillage, and are apparently dangerous than deeper water bodies. It's however a known fact that, virtually all Nigerian water bodies are shallow in nature, except the Atlantic Ocean. Similarly, It's a known phenomenon that, oil can combine with muds as well as with dirty substances that floats on water surfaces, and subsequently drops down through the water body.

The risk and uncertainty associated to this is numerous, one of which is that, the oil has the ability to remain at the lower level of the water (river, ocean, or sea) for many years to come, thereby resulting to a harmful and deadly effects to the aquatic lives residing within and at the floor of the water body. Similarly, the cleaning process of such water bodies becomes extremely complicated and difficult, if such pollution is regarded to be in large amounts, volumes and or quantities. Also any resultant measure taken to revert such pollution, will be at the expenses of many existing futile. This is if and only if, effective sustainable measures are not taken at the earliest time possible. However, environmental sustainability requires effective awareness and preventive measures instead of mitigation processes. (Alaska, 2004; Saleh M. A., 2015; U.S. Fish & Wildlife, 2017). Generally, there is no single project that is termed risk free. Hence, risks can be managed, minimised, shared, transferred or accommodated, but it cannot be ignored (Saleh M. A., 2015). Oil spillage risks ranges from; environmental pollution (land/soil, water and air), loss of lives (humans, animals and plantations). Similarly, low productivity as well as resources and loss of capital, damage on structural facilities and long term mitigation and remediation measures are paramount.

3.0 Aim and Objective

The aim and objective of this research, is to outline the consequential impacts of oil spillage in Nigeria. And to proffer effective mitigation measures to curtail the environmental footprints it could live behind for the generation yet on born.

4.0 Materials and Methodology:

4.1 Materials:

This research adopted the use of Physical Environmental Impact Assessment (EIA), scholarly resourced materials such as; relevant published and unpublished articles, journal, conference and seminar proceedings, internet resourced materials, UNEP reports, NNPC, IMF statistical data, as well as Amnesty International declaration reports.

4.2 Method:

This involves quantitative as well as descriptive analytical review of the above relevant scholarly resourced data. So as to draw logical, comprehensive and effective facts to outlining oil spillage and its environmental implications within the Niger Delta region as well as other parts of Nigeria at large.

5.0 Research limitation

The unavailability of most recent/current data and figures at the time for the preparation of this research work, are the major limitations of this research work. This is so because, there are no such required resources on any of the relevant websites (government, NGO's etc.), alongside the bottleneck in the system that does not allow one to gain easy access to raw materials and figures when the need arises. Hence, the resourced data in usage are from the year 1998 to year 2010 respectively.

6.0 Results and Discussions

Table 1: Niger Delta main sources of oil spillage, range (1998 – 2007)

Year	Equipment Failure (%)	Human Error (%)	Sabotage/Theft (%)	(%) Σ	Yearly (%)
1998	28	12	65	105	6.45
1999	19	28	55	102	6.26
2000	34	39	40	113	6.94
2001	46	15	64	125	7.67
2002	39	20	67	126	7.73
2003	41	53	63	157	9.64
2004	38	32	96	166	10.19
2005	49	27	127	203	12.46
2006	37	39	187	263	16.14
2007	31	29	209	269	16.51
(%) Σ	362	294	973	1629	
Total (%)	22.22	18.05	59.73		100

Source: (NNPC, 2013)

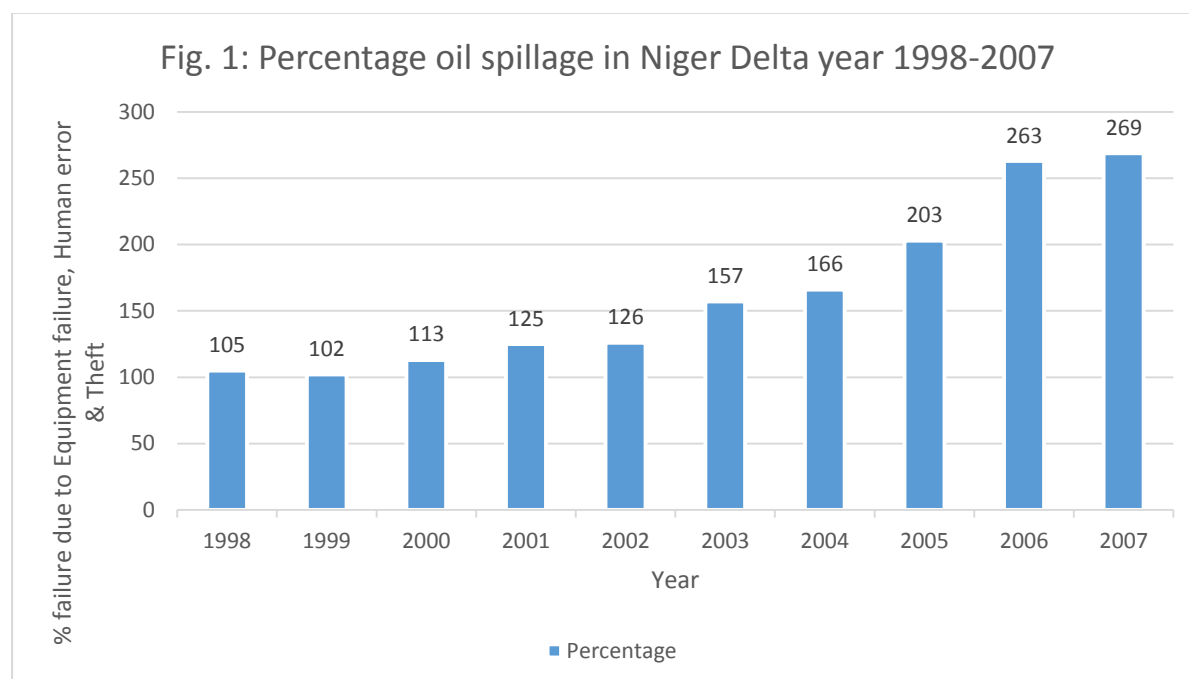


Table 2: Nigerian cost of oil theft

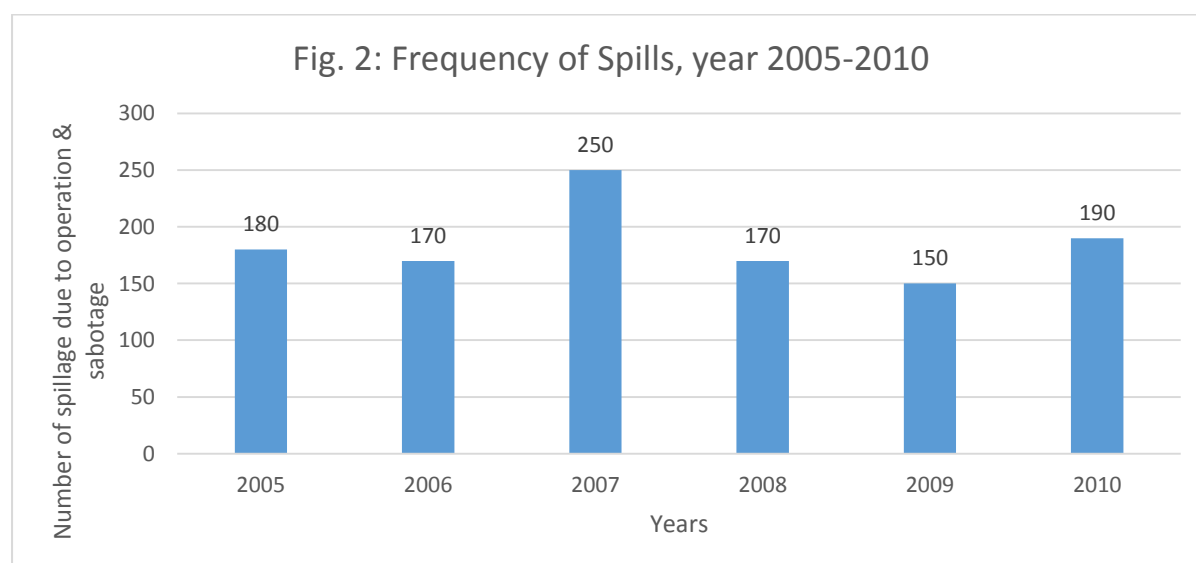
Theft particulars	Nigerian oil theft descriptions
Oil theft values	An annual estimated values of stolen oil within Niger Delta region worth the sum of \$3 - \$8 billion
Cost implications of public oil theft	The government of Nigeria (NNPC) evaluated several billions of dollars revenue lost through oil theft as at 2011, in addition to \$2.3 billion spent for security of pipelines and repair within the year 2010 and year 2012 respectively.
Direct casualties	During peak periods of the Niger Delta's conflicts, an estimate of 1000 people deaths are recoded annually. However, It isn't all of these figures that are directly linked to oil thefts. Some are kidnapping related to oil theft cases
Environmental cost implications	Majority of the cases linked with oil spills, are the direct handwork of sabotage/vandals who are into crude oil theft. The pollution effects of these spillage are pronounced on the fuel stocks, both human and animal health, plantation agricultures, water bodies, as well as the soils.

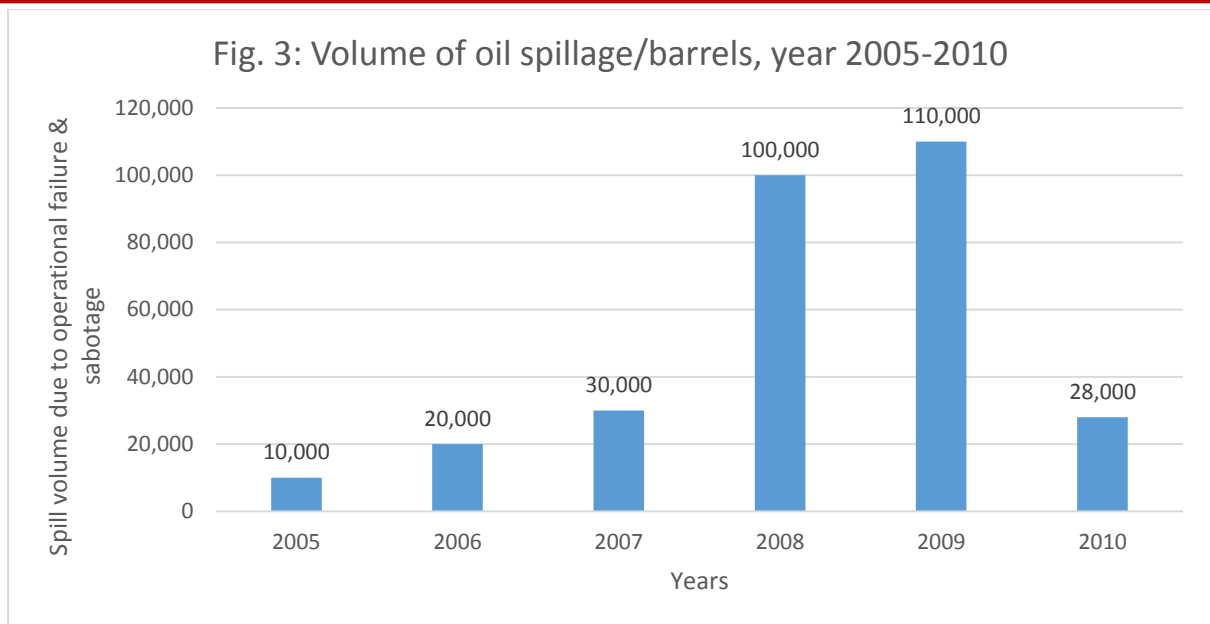
Source: (Amnesty International, 2011)

Table 3: Volumes of Oil spills and its causes, range (2005 – 2010)

Year	No. of spills	Volume of spills/barrels	Major causes (%)
2005	180	10,000	Operational (5%) & Sabotage (95%)
2006	170	20,000	Operational (50%) & Sabotage (50%)
2007	250	30,000	Operational (70%) & sabotage (30%)
2008	170	100,000	Operational (50%) & Sabotage (50%)
2009	150	110,000	Operational (10%) & Sabotage (90%)
2010	190	28,000	Operational (20%) & Sabotage (80%)

Source: (NNPC, 2013)





7.0 Effects of oil spillage and pollutions on the environments.

There are multiple environmental implications of oil spillage and pollution in Nigeria and the world at large. Some of these consequential effects are disastrous to the principal victims; man, animals and the ecosystem.

7.1 Industrial activities are hampered:

Virtually all industries use clean water sources from boreholes, rivers, oceans and or sea for industrial productivity. If much of these water bodies are polluted by oil spills, it jeopardises industrial plants such as; power, desalination, nuclear and water treatment plants etc. This is so because, treating heavy oil polluted water is however expensive and complex. And these subsequently contaminate pipes and other industrial facilities and operations.

7.2 Loss in economical values of the environment:

Highly concentrated oil spillage is so complicated during cleaning processes and whatever the amount of efforts invested is a waste until completed. Similarly, cleaning oil spills requires very huge capitals to achieve certain cleaning effectiveness. Thus, the outcome of the cleaning process may not attain 100% efficiency. Some of the effects of oil spillage is the loss of the crude oil itself, and the money that could have been realised economically from the spilled oil. It is ideal to note that oil is a precious resource and highly expensive in all its processes.

7.3 Environmental ecosystem are Jeopardised:

The closest enemy to ecosystem is, oil spillage/pollution. With special emphasis on the marine environments. But, this depends on the area from which the spillage occurs, as well as its sensitivity to the inhabited organisms. Consequential effect of oil spills on the aquatic lives are, the drastic reduction in the populations of such animals resulting from unavailability and or decrease on their nesting/breeding habitats, low life cycle expectations resulting from poisonous nature of the marine environment due to oil spillage and the altering / variability of the water temperature. Furthermore, it also degrades quality of the receiving water bodies for a longer period of times. As well as affects the coastal area (shore lines and sandy beaches).

7.4 Tourism sector of the economy is affected:

This sector of the economy is seriously hampered, as most of the game reserves, ranch, mangroves/swamp areas, and water springs, as well as water related recreational activities are virtually or completely dies off. This leads to the risk of loosen biodiversity with devastated ecological footprints, income generation is lacking and mitigation cost is high with complicity through longer durations of years. Similarly health and safety of the environment is jeopardised.

8.0 Preventive and control measures for oil spillage and pollutions:

Solving the phenomenon of oil spillage and pollutions requires more of preventive as well as effective controlling measures in any parts of the world, with more emphasis on Nigeria. Environmental Impact Assessment (EIA) coupled with sustainable exploration processes are the watch word, which is to be taking seriously with greater concerns prior and during oil exploration.

The first principal victims of oil spillage and pollutions are the lands as well as natural water bodies. Therefore, environmental sustainability is of paramount important to safeguarding our natural environment and the ecosystems. However, some of the preventive and controlling measures of oil spillage and pollutions include:

8.1 The introduction of effective disaster management process:

The mechanical parts and pipeline connectivity (facilities), of the oil plants, as well as oil tankers and ships, requires a thorough and strict quality analysis and control, so as to provide maximum safety against the possibility of oil spills. Similarly, global and or individual country should focus more seriously on the issues of oil spills and pollutions with the view to devising an effective and sustainable disaster management plans.

8.2 The use of trained personnel to minimise risks:

The applicability of drilling process of oil fields should only be entrusted to skilful and trained personnel. Thus, risks and uncertainty of spills and pollutions can be controlled to the lowest severity. If this is not adhered to, it will lead to loss of human lives due to fire and explosion outbreaks, degradation of the natural environment and high cost of mitigation processes are encountered.

8.3 Other preventive and control measures for oil spillage and pollutions includes:

- Continuous routine inspection of oil facilities on sites;
- Enactment of effective laws and regulations;
- The utilization of standby emergency units/teams
- The use of Civil Engineering Simulation of Catchment Modelling with InfoWorks CS V15.0, to provide for design and analysis for oil pipeline networks and reservoirs, in order to:
 - justify & identify cost effective infrastructural improvement on oil networks;
 - Provide for practical operational method for real time control of oil networks;
 - Effective prediction and or modeling oil flooding and pollution during spillage;
 - Evaluate sediment transportation throughout pipe networks;
 - Evaluates the impact of climatic variability on piping systems;
 - Identifying intermittent discharges solutions through piping networks;
 - Analyse infiltration and inflow from pipe networks;

- Provide for design and assessment for possible runoff control and retention of oil from damaged pipe networks; and
- Assess oil and pollution control measures.
- The utilization of Nigerian launched satellite in space (Nigeria Sat 1) For:
 - Geographical mapping and spot shots;
 - Providing the extents of pollution to coastal water and areas covered;
 - Clear identification of oil spill positions;
 - Identifying the persistence menace of pipeline vandals; and
 - The information above will provide for rapid response and cleanup of affected regions/areas of concerns etc.

8.4 The application of Bioremediation:

Employing bioremediation measure means, the use of bacterial and plants in cleaning up oil spillage in swampy/mangrove and marine areas. This is achievable via active binding of pollutants plant roots, absorptions and accumulations of non-harvestable plantations which are usually effective in wetland areas or by humus molecules and the physical sequestrations of metal. Similarly, the application of decomposed plant enzymes in treating polluted water bodies

9.0 Conclusion:

The risk of oil spillage if not evaluated, its consequence is not known, Oil spillage and pollutions as a matter of urgency, are phenomenon that requires active and effective prevention and control measure. Otherwise it is a fast growing threat envisaged to consume our environment and deplete the ecosystem in the Niger Delta and other parts of Nigeria. These phenomenon is attributed to human deliberate and or negligence activities which are; sabotage and oil bunkering/theft, human error and equipment failure as well as lack of effective planning and turnaround maintenances on oil facilities, as well as sustainability practice is lacking in virtually all ramifications of oil exploration process. Similarly, very huge amount of money is directly lost through oil bunkering and theft, with an estimated value of stolen crude oil stands at \$3 - \$8 billion annually. While the lowest volume oil spills/barrels was estimated to be 10,000 barrels, with a frequency of 180 spills in 2005, and only 5% of these spills were attributed to operational factor, while 95% is as a result sabotage. However, this figures are continuously on the increase, as in the year 2009, 110,000 barrels were lost to spillage with a frequency of 150 times, with only 10% operational factor and 90% due to activities of sabotage by humans.

10.0 Recommendations:

- Environmental Impact Assessment (EIA) as well as Best Practice Environmental Options (BPEO) should be the watch word prior and during any physical projects within the environment;
- The Nigerian government should encourage oil bunkers and illegal refineries to form modular refineries so as to curtail Sabotage and to boost oil productions;
- The government should provide and promote effective sensitization and awareness to the people at all level in the society, and to reward environmental excellent practice;
- The Nigerian government need to have in place effective and stringent measures to prosecute offenders, while providing social needs of the encompassing societies;
- Highly sensitive surveillance needs to be on oil vandals as well as bunkering activities by militants, and their in-cooperation into units of tax forces;

- The government of Nigeria should give full autonomy to regulatory agencies/bodies with constitutional backings to sanction and prosecute oil companies and their subsidiaries, for not adhering to meet international oil exploration and environmental standards;
- The Nigerian government should act very fast to safeguarding and recovery of contaminated and polluted lands as well as natural water sources.
- An utmost measure needs to be ensured by the Nigerian government in alleviating yearnings and the sufferings of the people in the oil rich zones.

11.0 Nomenclature

Acronyms	Descriptions
BL	Billion litres
CS	Collection System
Mgal	Million gallons
IMF	International Monetary Fund
Mgal/yr.	Million gallons annually
ML/yr.	Million litres annually
Mt/yr.	Million tons per year
NGO's	Non-Governmental Organisations
NNPC	Nigerian National Petroleum Cooperation
UNEP	United Nations Environment Programme
V15.0	Version 15.0
\$	American Dollars
%	Percentage
∑	Summation

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