Environmental Problems of Hydrocarbon Exploration and Production in Nigeria: An Overview

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ABSTRACT

Nigeria is a member of Organization of Petroleum Exporting Country (OPEC), and produces average of 2.2 million barrels of oil per day and 100 million cubic feet of gas (about 2.9 million m^3) per day. Both foreign and indigenous oil companies participate in exploration and production of hydrocarbon in Nigeria. The activities in Nigerian petroleum industry that may cause environmental problems include disposal of drill cuttings and refinery wastes; gas flaring; accident associated with drilling, transportation and processing of hydrocarbon; and sabotage that may lead to oil spills. It has been estimated that about 70% of daily gas production in Nigeria (i.e about 2.03 million barrels) is flared and average of 120,000 barrels of oil are lost through oil spills every year. The adverse impacts of these activities in the environment constitute the environmental problems of hydrocarbon exploration and production in Nigeria, and they include land degradation; destruction of forests, crops and aquatic life; health hazards; and pollution of water resources. These problems may be mitigated by adopting the use of environmentally friendly technologies/measures such as treatment of wastes before disposal, reduction of gas flaring and prevention of accidents/sabotage that may lead to oil spills in hydrocarbon exploration and production activities in Nigeria.

Key words: Gas flaring, health hazards, hydrocarbon, land degradation and water pollution.

1.0 INTRODUCTION

Environment may be defined as "the sum of all external influences and conditions affecting life and development of an organism, individual or community" (Vesilund, 1979). It is an integral part of human existence. Human activities contribute a lot of toxic materials and pollutants into the environment and render it unsafe for plants, animals and humans inhabiting therein. This in a nutshell is environmental pollution, the entry of pollutants into the environment causing disturbances or stress in the ecosystem, which have some undesirable effects on humans and other organisms in the ecosystem.

Hydrocarbon exploration and production activities have been going on in Nigeria for several decades (from nineteen fifties) particularly in the Niger Delta region. The area has actually experienced increased activities of exploration and production, refining, and product marketing operations in the last 44 years (1970-2014). About 2.2 million barrels of oil per day are currently being produced in the Niger Delta region of Nigeria.

Nigeria Delta is situated in Gulf of Guinea (Fig.1). It has an area of about 300,000km^2, a sediment volume of 500,000km^3 and a sediment thickness of over 12,000m (Hospers, 1965; Short and Stauble, 1967; Abam and Amosu, 1999). It consists of diverse ecosystem of mangrove, fresh water swamps and rain forest, and is the largest wetland in Africa, but due to oil pollution caused by oil exploration and production activities, the area is now characterized by contaminated streams and rivers, forest destruction and biodiversity loss. In fact, the area is an ecological wasteland. The devastation of the ecosystem has affected the livelihood of the indigenous people, who depend on the ecosystem and it's resources for survival, leading to increased poverty and displacement of the people. Various ethnic nationalities such as Urhobos, Ijaws, Ogonis, Effiks, Isokos, Itsekiris etc reside in the region (Omajemite, 2008). Odeyemi and Ogunseitan (1985) estimated that 5 million barrels of oil have been spilled into the Niger delta region as a result of oil industry activities.

In this paper, the hydrocarbon (oil/gas) exploration and production activities in Nigeria and their associated environmental impacts or problems are discussed.

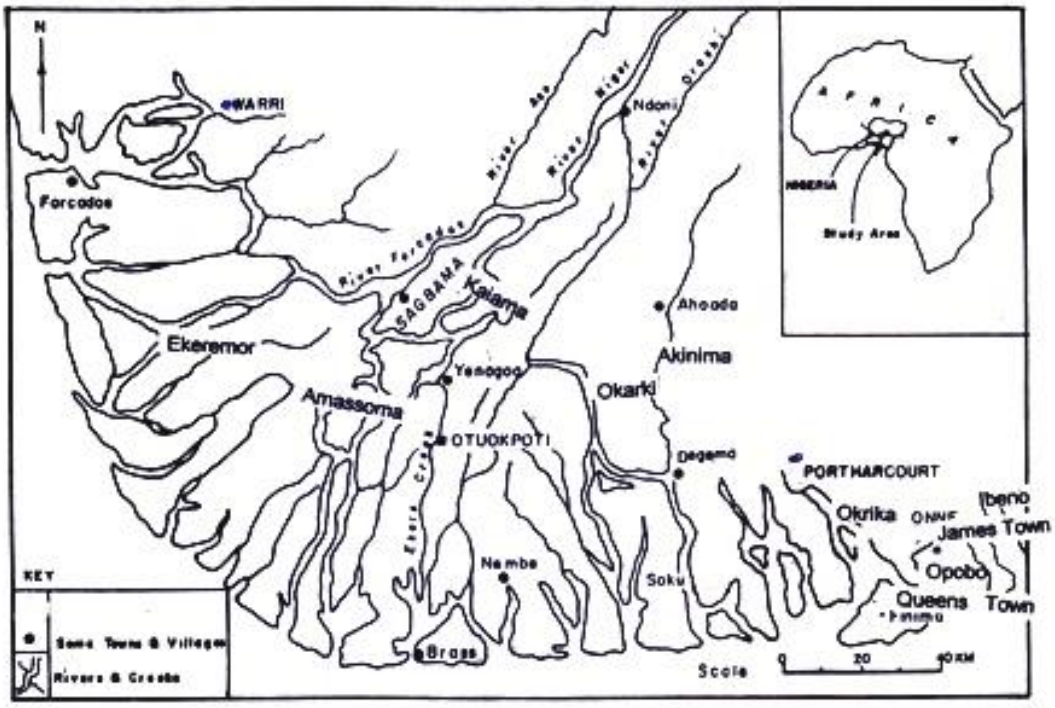


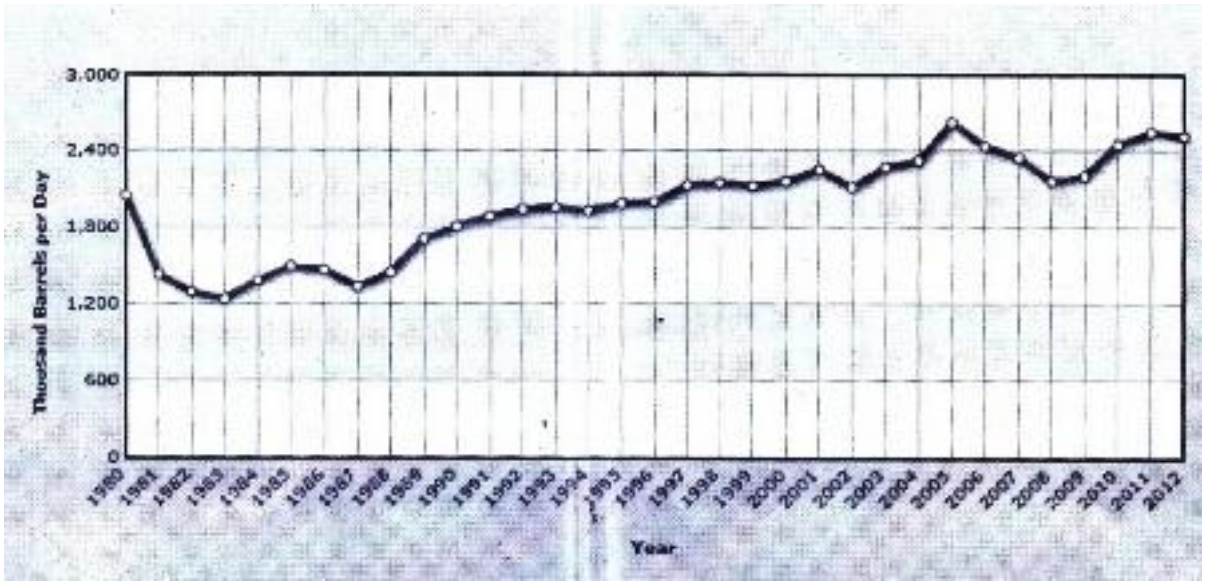
Fig. 1 Map of Niger Delta (After Abam and Amosu, 1999)

2.0 STATISTICS OF HYDROCARBON EXPLORATION AND PRODUCTION IN NIGERIA

The history of petroleum prospecting in Nigeria is a fairly complex one. This historical issue proceeded in three distinct stages as follows: the pre-independence era, 1903-1960, the pre-OPEC membership, 1961-1971, and to present.

Nigeria has been a member of Organization of Petroleum Exporting Counties (OPEC) since 1971. It has the largest natural gas reserve in Africa, has the second largest oil reserve in Africa and is the African continent's primary oil producer. As of the 1980s oil revenue provided 90% of Nigeria's foreign exchange earnings and 85% of the government revenue (Odeyemi and Ogunseitan, 1985), with estimated reserves extending beyond 20-30 years (NNPC, 2012). Shell D'Arcy was the pioneer oil company in Nigerian which started commercial production in 1958 with a production rate of 5100 barrels perday and a peak production of 2.44 million barrels per day over the next few years (NNPC, 2012).

Fig 2: Nigeria crude oil production by year (NNPC, 2012)



According to NNPC(2012), production rates dropped to 1.5 million barrels per day from the activities of 10 international companies working, 122 fields, and containing over 970 oil wells. Nigeria has four oil refineries with an estimated total refining capacity of 445,000 barrels per day (Onuoha, 2008; Anifowose, 2008), the first and oldest being the Port Harcourt refinery, commissioned in 1965. It had an initial capacity of 35,000 barrels per day, which was later expanded to 60,000 barrels per day of light crude oil. The Port Harcourt refinery was the second refinery with a capacity of 150,000 barrels per day (Odeyemi and Ogunseitan, 1985; Ukoli, 2005). Anifowose (2008) and Onuoha (2008) cited in their studies that the region has about 606 oil fields with 355 situated on shore; 251 situated offshore with 5,284 drilled oil well and 7,000km of oil and gas pipelines

Table 1: 10- Year Crude Oil Delivery to Local Refineries (barrels) (NNPC, 2012)

Year/ Month	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
January	5,993,853	2,483,016	5,983,056	4,810,351	2,685,066	2,893,632	2,125,766	716,823	4,083,799	3,492,781
February	4,982,421	2,012,809	5,589,582	3,039,826	2,234,536	3,291,262	3,040,897	3,060,425	3,609,478	1,906,801
March	7,443,845	2,821,685	5,988,374	3,172,552	2,249,380	4,431,482	4,006,060	2,352,101	3,894,555	2,931,772
April	2,767,300	3,888,934	6,075,123	2,994,304	1,232,864	4,377,080	3,414,846	3,134,953	4,117,505	2,402,827
May	2,749,641	3,083,853	4,915,000	4,158,527	1,517,062	3,268,082	1,352,087	2,605,238	3,731,062	3,325,182
June	2,386,962	2,961,654	5,515,575	4,163,054	64,019	5,172,816	454,078	2,236,701	1,858,737	2,106,952
July	2,434,701	1,927,614	6,478,713	3,667,209	1,226,648	4,481,025	651,259	3,267,638	3,477,555	3,499,512
August	2,545,646	2,106,705	5,868,095	3,890,287	1,783,707	3,229,892	586,440	3,974,407	4,546,160	1,078,699
September	2,501,612	3,481,178	6,851,321	3,563,340	1,391,712	3,334,504	1,608,500	4,264,236	4,983,723	3,353,766
October	3,772,309	3,887,653	6,212,096	2,305,349	2,051,091	1,791,004	1,498,988	3,166,771	4,007,730	3,108,667
November	3,174,867	2,288,860	6,285,320	2,575,825	1,549,041	2,408,345	864,654	4,209,203	3,025,405	5,136,399
December	3,476,515	7,018,603	6,423,225	2,994,304	398,063	2,640,910	0	1,712,667	1,057,683	2,571,175
Total	44,228,532	37,962,564	72,185,480	41,334,928	18,383,189	41,320,034	19,633,555	34,709,973	45,393,392	34,926,533

Nigeria's oil revenue has been on the exponential climb as the prices of crude oil have continued to surge giving the country a range of 55%n to 60% over and above the 2011 budget benchmark price of $65. According to the National Bureau of Statistics, revenue from oil exports rose by 46% to $59 billion in 2010 as prices increased and companies raised output on improved security in the Niger Delta. Nigeria earned $196 billon from oil and gas exports in the four years up to 2010 as with oil revenue accounting for 80% of government income and 95% of foreign exchange income. State owned Nigeria National Petroleum Corporation (NNPC) accounts for more than 50% of oil production and over 40% of gas supply, but a large number of International Oil Company (IOC) partners contribute to a forecast rise in oil production from an estimated 2.34 million b/per day by 2015 subject to OPEC quota policy. Gas production should reach 59 billon cubic meters by 2015, up from an estimated 35 billion cubic meters in 2010.

Table 2: 10-Year Crude Oil Export (barrels) (NNPC 2012)

Year/ Month	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
January	63,927,693	75,326,188	67,456,297	71,062,565	70,562,458	56,793,954	57,020,656	67,145,981	74,668,111	69,067,879
February	64,213,985	73,082,052	62,778,436	66,829,351	58,955,150	63,301,286	57,280,104	67,468,691	64,340,771	66,348,663
March	62,890,237	75,697,415	70,136,144	66,289,600	63,803,365	59,582,300	63,302,135	70,768,401	67,931,602	66,315,592
April	62,068,333	72,073,593	63,695,905	63,576,883	63,456,006	54,376,043	53,621,759	67,260,046	66,794,717	71,735,025
May	67,533,578	73,106,924	75,223,196	65,258,457	63,129,755	62,968,369	68,367,535	67,550,277	66,363,645	65,002,709
June	63,036,788	72,205,187	67,719,039	68,187,970	61,246,627	54,205,316	62,116,894	74,591,290	70,527,957	74,880,498
July	64,221,765	75,792,843	75,770,411	72,460,015	70,740,161	57,417,639	61,994,406	75,843,753	70,650,154	70,214,352
August	70,681,872	76,725,509	70,382,521	67,340,856	63,249,476	60,596,105	66,450,920	69,009,003	73,173,567	79,637,780
September	67,776,052	74,100,218	69,157,525	64,917,141	70,353,429	64,361,582	63,242,730	77,962,880	62,053,681	69,325,453
October	68,273,106	71,407,315	68,979,056	70,966,162	68,214,009	56,072,988	71,442,502	76,732,148	70,585,656	63,045,795
November	68,883,971	68,135,235	74,118,223	70,727,123	65,930,520	61,136,734	64,972,801	71,161,171	62,976,593	60,033,979
December	72,577,076	70,425,870	78,714,746	70,379,949	72,194,901	61,607,478	78,482,761	79,208,660	70,014,740	74,564,323
Total	795,984,478	878,077,349	844,151,498	817,996,072	791,826,519	724,479,796	769,195,205	864,702,101	822,082,224	830,772,648

Between 2010 and 2020, it is projected that there will be a cumulative growth of 49.6% in Nigerian oil and gas production, with volumes rising steadily to 3.5 million b/per day by the end of the 10 year forecast period. Oil consumption is set to increase by 96.6% with growth slowing to an assumed 7.5% per annum towards the end of the period and the country using 567,000b/d by 2020

1.0 ENVIRONMENTAL PROBLEMS OF HYDROCARBON EXPLORATION AND PRODUCTION

The whole process of obtaining hydrocarbon; from exploration, production, processing, transportation, and even usage and consumption contribute one form of pollution or the other to the environment adversely; through pollution, which leads to all sorts of health and environment problems. According to Ellis (1994), crude oil is so dangerous that when the oil touches the leaf of food crops or whatever economic trees in its vicinity, the plant dried off immediately, this has a direct implication on agricultural production.

According to the final report of the research conducted by FEPA (2001), the petroleum industry is releasing hydrocarbons and other harmful effluents into the environment through the following operations:

1. The disposal of drill cuttings mixed with drilling muds which contain synthetic additives, some of which are toxic even at very low concentrations;
2. Gas flaring;
3. Evaporation pits of produced formation water which is in several orders of magnitude more saline than to be found on near surface exploitable aquifers;
4. The disposal of liquid refinery effluent which contain grease, phenols, cyanides, sulphides, chromium and biological oxygen demanding organic matters; and
5. Oil spills during storage, transportation and marketing of the products from the oil industry.

Therefore, it is not out of place to conclude that oil production activities have negatively impacted on the Niger Delta Region causing environmental, social and economic hardship to the inhabitants.

The various stages of hydrocarbon exploration and production which produce various pollutants and effluents into the environment are given below;

Exploration:

During on-shore exploration explosives are used. These explosives, are generally dynamite. The main component of dynamite is nitroglycerin. These can contaminate ground water resources, particularly in areas with shallow ground water level.

Drilling/Production:

During drilling and production of crude oil, drilling mud is used to stimulate production. Exploration and production activities produce pollutants which include: drilling muds, cutting, oil and greases, salinity, sulphides, turbidity, suspended solids, temperature, pH, heavy metals, Biological Oxygen Demand and COD.

Processing/Refining:

The pollutants during petroleum products processing include hydrocarbons, sulfur oxide, carbon monoxide, nitrogen oxides, participate matter, odours, ammonia and aldehydes among others. Others include; oil and greases, BOD, COD, phenol, cyanide, sulphide, suspended solids, toxic additives, hydrocarbons and total suspended solids.

Sources of emission in petroleum refining and petrochemical processes

Hydrocarbon: Barometric condenser, boilers, decoking operations, waste effluent handling equipment, blow down system, etc.

Sulfur oxide: acid sludge disposal, heaters, catalyst regenerators, treaters, etc.

Carbon monoxide: Compressor engines, coding operations,

Nitrogen oxides: Incinerators, etc.

Odours: Compressor engines, boilers etc.

Particulate Matter: Steam blowing, treaters, etc.

Ammonia: Treaters, coking operations, etc.

Aldehydes: Catalyst regenerators, catalyst regenerators, compressor engines.

These pollutants easily render soil resource unfit for agricultural practices. This is disastrous as the bulk of the populace depend heavily on agriculture as a means of sustenance. The Ogoni community, like many other mineral producing areas in Nigeria is indeed facing the problems of non-availability of agricultural land consequent upon the destructions from petroleum exploitations in the area.

Transportation/Marketing:

During transportation and marketing of crude oil, damage to oil pipeline and accident involving road trucks and tankers generate oil spill and hydrocarbon emission. These have a far more reaching effect on the environment (FEPA, 2001).

CASE HISTORY OF ENVIRONMENTAL PROBLEMS OF HYDROCARBON EXPLORATION AND PRODUCTION IN NIGERIA

3.1 Oil Spill

The inadvertent occurrence of oil spillage has far reaching consequences on man and other environmental resources. For example, Ikporukpo (1983) has observed that the uncontrolled movement of spilled crude oil results in the pollution of rivers, creeks, ponds and farmlands upon which the inhabitants of the oil producing areas depend. As a matter of fact, the incidence of oil spillage often results in total extermination of fish and crops.

The Department of Petroleum Resources estimated that 1.89 million barrels of petroleum were spilled into the Niger delta between 1976 and 1996 in 4,835 incidents. A UNDP report (UNDP, 2006) states that there have been a total of 6,817 oil spills between 1976 and 2001, which account for a loss of three million barrels of oil, of which more than 70% was not recovered.

In Nigeria, 50% of oil spills is due to corrosion of pipelines and tanker accidents, 28% is due to sabotage, and 21% is due to oil production operations while 1% of oil spill is due to engineering operations, including inability to effectively control wells, failure of machines and inadequate care in loading and unloading oil vessels. Oil bunkering is also a source of oil spill.

Most of these spills occur off-shore (69%), others (31%) in swamps and on land. Some spills are caused by sabotage and thieves, however most are due to poor maintenance by oil companies.

These tremendous losses adversely put off fishermen and farmers out of active economic engagement, and this has a backward integration in the national economic development. Worst still, is the fact that such disengaged farmers and fishermen often found it almost impossible to fit into other economic activities and thus, worsening the unemployment situation (Ikporukpo, 1983). With increasing soil infertility due to the destruction of soil micro-organisms, and dwindling agricultural productivity, farmers have been forced to abandon their land, to seek non-existent alternative means of livelihood. Aquatic life has also been destroyed with the pollution of traditional fishing grounds, exacerbating hunger and poverty in fishing communities (Gbadegesin, 1997).

Table 3: Analysis of oil Spillage in the Niger Delta (Uyidue and Agho, 2007)

Year	No of spill	Qty spilled(barrels)	Qty recovered (barrels)	Qty lost to the environment (barrels)
1976	128	26157	7135	19021.5
1977	104	32879.25	1703.01	31176.75
1978	241	489294.75	391445	97849.75
1979	238	94117.13	63481.2	630635.93
1980	257	600,511.02	42416.83	558094.2

1981	173	42722.5	5470.2	37252.3
1982	151	42841	2171.4	40669.6
1983	187	48351.3	6355.9	41995.4
1984	155	40209	1644.8	38564.2
1985	129	11876	1719.3	10157.3
1986	208	12905	522	12358
1987	228	31866	25757	25757
1988	166	9172	1955	7207
1989	258	5956	2153	3803
1990	378	14150.35	2785.96	12057.8
1991	453	108367.01	2785.96	105912.05
1992	495	51187.9	1476.7	49711.2
1993	417	8105.32	2937.08	6632.11
1994	158	35123.71	2335.93	32787.78
1995	154	63677.17	3110.02	60568.15
1996	178	39903667	11838.07	38716.87
Total	**4647**	**2369470**	**549060.38**	**1820410.5**

The largest individual spills include the blowout of a Texaco offshore station which in 1980 dumped an estimated 400,000 barrels (64,000m^3) of crude oil into the Gulf of Guinea and Royal Dutch Shell's Forcados Terminal tank failure which produced a spillage estimated at 580,000 barrels (92,000m^3). A landmark united nations study into the long term environmental impact of oil production in Nigeria says that oil spills have led to acute health risks for the residents and widespread environmental damage that may take as many as 30 years and $1 billion to clean up.

Causes of oil spill in Nigeria include;

- Carelessness (such as oil bunkering, sabotage and oil siphoning).
- Accidents (such as tanker accidents and accident during production operation).
- Terrorism.

Consequences of Oil Spill in Nigeria

Loss of Mangrove Forest:

Vegetation in the Niger River Delta consists of extensive mangrove forests, brackish swamp forest, and rainforests. The large expanses of mangrove forests are estimated to cover approximately 5,000 to 8,580km^2 of land (Nwilo and Olusegun, 2007). Mangroves remain very important to the indigenous people of Nigeria as well as to the various organisms that inhabit these ecosystems.

Human impact from poor land management upstream coupled with the constant pollution of petroleum has caused five to ten percent of these mangrove forests to disappear. The volatile, quickly penetrating, and viscous properties of petroleum have wiped out large areas of

vegetation. When spills occur close to and within the drainage basin, the hydrologic force of both the river and tides force spilled petroleum to move up into areas of vegetation.

Mangrove forests are included in a highly complex tropic system. If oil directly affects any organism within an ecosystem, it can indirectly affect a host of the other organisms. These floral communities rely on nutrient cycling, clean water, sunlight, and proper substrates. With ideal conditions they offer habitat structure, and input of energy via photosynthesis to the organisms they interact with. The effects of petroleum spills on mangroves are known to acidify the soils, halt cellular respiration, and starve roots of vital oxygen.

Table 4: Depletion of mangrove and swamp in some states in the Niger Delta (Nwilo and Olusegun, 2007)

Location	Environment	Impacted Area (ha)	Nature of Incidence
Bayelsa State			
Ekeni	Freshwater Swamp Forest	20	Oil Spillage
Etegwa/Nembe	Freshwater Swamp Forest	20	Oil Spillage & Fire Outbreak
Ekeibu	Freshwater Swamp Forest	30	Oil Spill Incidence
Peremabiri	Freshwater Swamp Forest	30	Oil Spill Incidence
Adebawa	Freshwater Swamp Forest	10	Oil Spill Incidence
Diebu	Freshwater Swamp Forest	20	Oil Spill Incidence
Tebidaba	Freshwater Swamp Forest Mangrove	30	Oil Spill Incidence
Nembe creek	Mangrove Forest	10	Oil Spill Incidence
Azuzuama	Mangrove	50	Oil Spill Incidence
Delta State			
Opuekebe	Barrier Forest Island	90	Salt Water Intrusion
Jones Creek	Mangrove Forest	30	Spillage & Burning
Ugbeji	Mangrove	2	Refinery Waste
Ughelli	Freshwater Swamp Forest	10	Oil Spillage-Well head leak
Jesse	Freshwater Swamp Forest	8	Product leak/Burning
Ajato	mangrove		Oil Spillage Incidence
Ajalu	Freshwater Swamp Forest		Oil Spillage Incidence
Uzere	Freshwater Swamp Forest		Oil Spillage Incidence
Aliwalo	Freshwater Swamp Forest		Oil Spillage Incidence
Kwale	Freshwater Swamp Forest		Oil Spillage Incidence
Okomoro	Freshwater Swamp Forest		OC
Ughelli	Freshwater Swamp Forest		Oil Spillage Incidence
Ekakpare	Freshwater Swamp Forest		Oil Spillage Incidence
Ughuvwughe	Freshwater Swamp Forest		Oil Spillage Incidence
Ekerejegbe	Freshwater Swamp Forest		Oil Spillage Incidence
Ozoro	Freshwater Swamp Forest		Oil Spillage Incidence
Odimodi	Mangrove Forest		Oil Spillage Incidence
Ogulagha	Mangrove Forest		Oil Spillage Incidence
Otumgu	Mangrove Forest		Oil Spillage Incidence
Macraba	Mangrove Forest		Oil Spillage Incidence
20 sites			Oil Spillage Incidence
Rivers State			
Rumuolwumasi	Freshwater Swamp	20	Oil Spillage
Rukpoku	Freshwater Swamp	10	Oil Spillage

An area of mangroves that has been destroyed by petroleum may be susceptible to other problems: these areas may not be suitable for any native plant growth until bacteria and microorganisms can remediate the conditions. A particular species of mangrove, rhizophora racemosa lives better in the delta system. As the soils supporting rhizophora racemosa become too toxic, a non-native invasive species of palm, Nypa fruitcans, quickly colonizes the area. This invasive species has a shallower root system that destabilizes the banks along the waterways, further impacting sediment distribution lower in the delta system. Nypa fruticans also impedes navigation and decreases overall biodiversity. In place where Nypa fruticans has invaded,

communities are investigating how the palm can be used by local people. The loss of mangrove forests is not only degrading life for plants and animals, but for human as well. These systems are highly value by the indigenous people living in the affected areas. Mangrove forests have been a major source of wood for local people. They also are important to a variety of species vital to subsistence practices for local indigenous groups, who unfortunately see little to none of the economic benefits of petroleum. Mangrove also provide essential habitat for rare and endangered species like the manatee and pygmy hippopotamus. This clash among governing bodies, oil corporations, and the people of Nigeria ha resulted in sabotage to petroleum pipelines, further exacerbating the threat to mangrove forests. The future for mangrove forests and other floral communities is not all negative. Local and outside group have provided funds and labors to remediate and restore the destroyed mangrove swamps. The federal government of Nigeria established the Niger Delta Development Commission (NDDC) in 2000 which aims to suppress the environmental and ecological impacts petroleum has had in the region. Government and non governmental organizations have also utilized technology to identify the source and movement of petroleum spills (Nwilo and Olusegun, 2007).

Depletion of fish population:

The fishing industry is an essential part of Nigeria's sustainability because it provides much needed protein and nutrients for people, but with the higher demand on fishing, fish populations are declining as they are being depleted faster than they are able to restore their number. Fishing needs to be limited along the Niger River and aquacultures should be created to provide for the growing demand on the fishing industry. Aquaculture allows for fish to be farmed for production and provide more jobs for the local people of Nigeria.

Overfishing is not the only impact on marine communities; climate change, habitat loss and pollution are all added pressures to these important ecosystem. The banks of the Niger River are desirable and ideal locations for people to settle. The river provides water for drinking, bathing, cleaning, and fishing for both the dinner table and trading to make a profit. As the people have settled along the shores of the rivers and coasts, marine and terrestrial habitats are being lost and ecosystems are being drastically changed. The shoreline along the Niger River is important in maintaining the temperature of the water because the slightest change in water temperature can be fatal to certain marine species. Trees and shrubs provide shade and habitat for marine species, while reducing fluctuation in water temperature (Mollies, 2005).

The Niger River is an important ecosystem that needs to be protected, for it is home to 36 families and nearly 250 species of fish, of which 20 are endemic, meaning they are found nowhere else on earth (Chindah and Braide, 2000).With the loss of habitat and the climate getting warmer, every prevention of temperature increase is necessary to maintain some of the marine environment. Other than restoring habitat, pollution can also be reduced. Problems such as pesticides from agricultural fields could be reduced if a natural pesticide was used, or the fields were moved farther away from the local water ways. Oil pollution can be lower as well, if spills were reduced then habitat and environmental impacts could be minimized. Oil contamination affects the fish population and affects the farmers that rely on fishing to support their families. By enforcing laws and holding oil companies accountable for their actions, the risk of contamination can be greatly reduced (Amaize, 2012). By limiting the devastation caused

by disturbances to the marine environment, such as pollution, overfishing, and habitat loss, the productivity and biodiversity of the marine ecosystems would increase.

Impact on Crop Production

Oil spill on crops causes great damage to the plant community due to high retention time of oil occasioned by limited flow. Oiled shoots of crops like pepper and tomatoes may wilt and die off due to blockage of stomata thereby inhibiting photosynthesis, transpiration and respiration. In fact the germination, growth, performance and yield of these crops are stifled by oil spillage.

The environmental consequences of oil pollution on the inhabitants of Niger Delta are enormous. Oil spills have degraded most agricultural lands in the State and have turned hitherto productive areas into wastelands. With increasing soil infertility due to the destruction of soil micro-organisms, and dwindling agricultural productivity, farmers have been forced to abandon their land, to seek non-existent alternative means of livelihood (Chindah and Braide, 2000).

Fresh water and groundwater contamination

In fresh waters, oil contamination can result in severe impacts on the habitat because the movement associated with water is minimal, as compared to marine environment. Stagnant water bodies cause the oil to remain in the environment for long, resulting in prolonged exposure of the plants and animals (Chindah and Braide, 2000). In the case of flowing streams and rivers, the oil not only tends to collect on plants and grasses growing on the banks but also interacts with sediments, thereby affecting the organisms. In cases where a stream that provides potable water is affected by a spill, the people in the area will suffer the problem of obtaining potable water.

3.2 Natural Gas Flaring

Nigeria flares more natural gas associated with oil extraction than any other country, with estimates suggesting that of the 3.5 billion cubic feet (100,000,000 m^3) of associated gas (AG) produced annually, 2.5 billion cubic feet (70,000,000 m^3), or about 70% is wasted via flaring. This equals about 25% of the UK's total natural gas consumption, and is the equivalent to 40% of the entire African continent's gas consumption in 2001. Statistical data associated with gas flaring are notoriously unreliable, but Nigeria may be wasting US $ 2.0 Billion per year by flaring associated gas. Flaring is done as it is costly to separate commercially viable associated gas from the oil. Companies operating in Nigeria also harvest natural gas for commercial purposes, but prefer to extract it from deposits where it is found in isolation as non-associated gas. Thus associated gas is burned off to decrease costs.

Gas flaring is generally discouraged as it releases toxic components into the atmosphere and contributes to climate change. In Western Europe, 99% of associated gas is used or re-injected into the ground. Gas flaring in Nigeria began simultaneously with oil extraction in the 1960s by Shell-BP. Alternatives to flaring are gas re-injection, or to store it for use as an energy source. If properly stored, the gas could also be utilized for community projects.

Gas flaring release large amounts of methane, which has a high global warming potential. The methane is accompanied by the other major greenhouse gas, carbon dioxide, of which Nigeria was estimated to have emitted more than 34.38 million metric tons of carbon dioxide in 2002, accounting for about 50% of all industrial emissions in the country and 30% of the total carbon

dioxide emissions. While flaring in the west has been minimized, in Nigeria it has grown proportionally with oil production.

The international community, the Nigerian government, and the oil corporation seem in agreement that gas flaring needs to be curtailed. Efforts to do so, however, have been limited. While OPEC and Shell, the biggest flarer of natural gas in Nigeria, alike claim that only 50% of all associated gas is burnt off via flaring at present, these data are contested. The World Bank reported in 2004 that, "Nigeria currently flares 75% of the gas it produces".

Gas flares have potentially harmful effects on the health and livelihood of the communities in their vicinity, as they release a variety of poisonous chemicals including nitrogen dioxide, sulphur dioxide, volatile organic compounds like benzene, toluene, xylene and hydrogen sulfide, as well as carcinogens like dioxins. Humans exposed to such substances can suffer from a variety of respiratory problems. These chemicals can aggravate asthma, breathing difficulties and pain, as well as chronic bronchitis. Benzene known to be emitted from gas flare in undocumented quantities is well recognized as a cause for leukemia and other blood-related diseases. A study done by Climate Justice estimates that exposure to benzene would result in eight new cases of cancer yearly in Bayelsa State alone.

Gas flare is often located close to local communities, and regularly lack adequate fencing or protection for villager who may risk working near heat of the flare. Many of these communities claim that nearby flares cause acid rain which corrode their homes and other local structures, many of which have Zinc-based roofing. Some people resort to the use of asbestos-based material, which is stronger in repelling acid rain deterioration. Unfortunately, this only contributes to the decline of personal health and the health of their environment. Asbestos exposure increases the risk of forming lung cancer, pleural and peritoneal mesothelioma, and asbestosis.

4.0 SUMMARY AND CONCLUSION

Environmental problems of hydrocarbon exploration and production in Nigeria refer to the impacts of activities in the Nigeria petroleum industry on Nigerian environment (physical, chemical and biology resources) and human or social environment (oil workers and host communities). Human activities in the petroleum industry that may cause environmental problems include disposal of drill cuttings, gas flaring, disposal of liquid refinery effluents and oil spills. According to UNDP (2006), over 6800 oil spills occurred in Nigeria between 1976 and 2001 which led to loss of 3 million barrels of oil. The causes of these spill have been traced to corrosion of pipelines, tanker accidents, sabotage and accidents associated with oil production operations.

The adverse impacts of these spill and other activities on the Nigerian environment include land degradation, destruction of forest/crops, destruction of aquatic life, health hazards and pollution of water resources (surface and groundwater). Strategies to mitigate these problems include use of environmentally friendly technologies in drilling/processing of petroleum oil/gas, treatment and disposal of waste associated with the operation, as well as prevention of industrial accidents amongst oil workers and sabotage in oil industry installations.

REFERENCES

Abam, T.K.S. and Omusu, W.O. (1999). An Appraisal of River Erosion Mitigation in the Niger Delta. Journal of Min. and Geol. Vol. 35 (2), pp. 259-268.

Amaize, E. (2012). "Nigeria: Pollution in Niger Delta-Oil Firm, Fish farmers fight. Vanguard.allafrica.com

Anifowose, B. (2008). Assessing the Impact of Oil and Gas Transport on Nigeria's Environment. U12 Postgraduate Research Conference Proceeding 1, University of Birmingham UK.

Bloomberg, (2011). Nigeria signs Gas Supply Agreements with Shell, Chevron for Power Stations.

Chindah, A.C. and Braide, S.A., (2000). The Impact of Oil Spills on the Ecology and Economy of the Niger Delta. In proceedings of the workshop on Sustainable Remediation Development Technology held at the Institute of Pollution Studies, Rivers State University of Science and Technology, Port Harcourt.

Ellis G. (1994). Shell in Nigeria: what are the issues? http:www.essentialaction.org/shell/issues.htm

FEPA (2001). Delta State Environment Action plan. Final Report 95p.

Gbadegesin, A. (1997). The Impact of Oil Exploration and Production Activities on the Environment; Implications for Peasant Agriculture. A seminar paper on oil and the environment, organized by Friedrick Elbert Foundation, Port Harcourt.

Hospers, J., (1965(. Gravity field and structure of the Niger Delta, Nigeria, West Africa. GSA Bull. 76.pp. 402-422.

Ikporukpo, C.O. (1983). Environmental Deterioration and Public Policy in Nigeria. Apply Geography. Vol.3. pp 303-318. Jimoh, H.I.

Molles, M.C. (2005). Ecology Concepts and Application. 3rd Edition, McGraw-Hill Company Inc, New York.

Nigerian National Petroleum Corporation (NNPC) (2012). Annual Petroleum Industry Review (December, 2012) NNPC, Abuja, Nigeria.

Odeyemi, O. and Ogunseitan, O.A. (1985). Petroleum Industry and its Pollution Petential in Nigeria. Oil and Petroleum Pollution 2: 223-229. Elsevier Applied Science Publishers Ltd, England.

Omajemite, B.U. (2008). The Economic Dimensions of the Niger Delta Conflicts. In Omotor et al (eds), Conflict Management and Peace Building in Africa. Volume 11.

Onuoha, F.C. (2008). Oil Pipeline Sabotage in Nigeria: Dimensions, Actors and Implications for National Security L/C African Security Review.

Short, K.C. and Stauble, A.J., (1967). Outline Geology of Niger Delta. AAPG Bull., 51, pp. 761-779.

Ukoli, M.K. (2005). Environmental Factors in Management of the Oil and Gas Industry in Nigeria. www.cenbank.org

UNDP, (2006). Niger Delta Human Development Report, P 76.

Uyidue, E. and Agho, M. (2007). Coping with Climate Change and Environmental Degradation in the Niger Delta of South Nigeria, Benin Community Research and Development Centre (CREDC).

Vesilund, P.A., (1979). Pollution. In; Social Consequences of Engineering (A. Kardestuncer, ed.), Royed and Fraser Publishing Company, San Franciso, pp.143-153.