ENVIRONMENTAL CHALLENGES ASSOCIATED WITH OIL SPILLAGE AND GAS FLARING IN NIGERIA: A REVIEW

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ABSTRACT

A review is presented of the environmental challenges associated with oil spillage and gas flaring in Nigeria. It analyzes the types, causes, and remediation processes, for oil spillage and the prevention and control measures available for minimising environmental problems of oil spills in the oil-producing communities of Nigeria. Generally, Oil spills cause series of severe aquatic and terrestrial pollutions and they impact negatively on crop production, due to soil infertility that results from the destruction of soil microorganisms, thereby causing dwindling agricultural productivity, plus other side effects on human health. The potential harmful effects of gas flaring on the environment including global warming and human exposure to acute harmful substances that cause respiratory problems (such as asthma and chronic bronchitis) are critically considered. Likewise other chemicals like benzapyrene, which causes cancer, and benzene, which causes leukemia and other blood-related disease are highlighted. Gas flaring also causes acid rain which corrodes homes and other local structures. Some techniques that should be utilized to prevent and control these challenges have been outlined and some policy recommendations made, to help curb abuses by multinational oil and gas companies operating in the country.

INTRODUCTION

Nigeria as a nation is vigorously involved in industrial and other economic activities for growth and development. One of such activities is crude oil exploration and exploitation, and this has contributed enormously to the growth of the nation since its independence (EIA, 2005). This notwithstanding, oil exploitation has caused a lot of environmental atrocities in the oil producing communities of Nigeria and the negative impacts have accumulated over the past half a century.

Crude oil was first discovered in commercial quantity in Nigeria in 1959, at Oloibiri in Bayelsa State of Nigeria. Since then oil exploitation has continued, resulting in what is today termed environmental destruction, due largely to the neglect and negative attitude of the multinational companies regarding environmental management in Nigeria.

The world today recognizes the significance of environmental sustainability to the development of nations. In fact, one of the cardinal objectives of the Millennium Development Goals (MDGs) is to ensure environmental sustainability. It then implies that there should be reduction in environmental pollutions (Eregha & Irughe, 2009).

OIL SPILLAGE, GAS FLARING AND ENVIRONMENTAL CHALLENGES

Nigeria is the largest producer of crude oil in Africa and the 15th largest producer in the world, producing a daily average of about 2.5 million barrels (CIA, 2010) and this accounts for over 90% - 95% of Nigeria's foreign earning and 80% government revenue respectively. Because of this huge oil production, Nigeria is one of the countries that introduce greenhouse gases through gas flaring into the environment, thereby modifying the state of the environment. Nigeria had the second largest gas flaring volume – about 15 billion cubic meters (BCM) after Russia, according to the estimation by Elvdge *et al.*, (2009). Gas flaring contributes enormous amounts of greenhouse gases, hence causing climate change (IPCC, 2001).

The Department of Petroleum Resources estimated that 991.89 million barrels of petroleum were spilled in Nigeria between 1976 and 1996. Out of this a total of 2.4 million barrels were spilled in 4,835 incidents (approximately 220 thousand cubic meters). A UNDP report states that there have been a total of 6,817 oil spills between 1976 and 2001, which accounted for a loss of three million barrels of oil, of which more than 70% was not recovered. Most of these spills (67%) occurred offshore, a quarter was in swamps, and 6% spilled on land. Some spills are caused by sabotage and thieves, however, most are due to poor maintenance by oil companies, thereby causing marine and soil contamination of the environment (UNDP, 2006).

This review paper examines the environmental challenges inherent in these "twin" problems (oil spillage and gas flaring) in Nigeria and proffers solutions to these devastating challenges in the country.

GENERAL OVERVIEW OF OIL SPILLAGE

In Nigeria, 50% of oil spills is due to corrosive pipelines and tanker accidents; 28% is due to sabotage, and 21% are due to oil production operation while 1% of the oil spill is due to engineering drills, inability to effectively control wells, failure of machines and inadequate care in loading and unloading of oil vessels. Oil bunkering is also a source of oil spill. Oil spills have caused a lot of environmental problems in Nigeria, as they have degraded most agricultural lands and turned hitherto productive areas into waste lands with increasing soil infertility due to the destruction of soil micro-organisms, leading to dwindling agricultural productivity. Farmers have therefore been forced to abandon their lands to seek non-existent alternative means of livelihood. Aquatic lives have also been destroyed with the pollution of traditional fishing grounds, exacerbating hunger and poverty in fishing communities in Nigeria.

In a study of the socio-economic impact of oil pollution, it was stated that crude oil exploitation has had adverse environmental effects on soils, forests and water bodies in various host communities in Nigeria. Farmers have lost their lands, and are consequently forced to emigrate to other communities in search of livelihood; thereby exerting additional pressures on natural resources in such areas (Omofonmwan and Odia, 2009). It is noteworthy that, the devastating consequences of oil spill in Nigeria with its eventual hazards on both aerial and terrestrial environments lead to an irreversible chain effect on both the biodiversity and agricultural activities through contamination of the ground water and soils. Spills also contribute to the contamination and death of fishes all of

which affect the economy and human health adversely (Vidal, 2010).

Types of Oil Spillage
Oil spill is categorized into four groups namely:

Minor Spill: Minor spill occurs when the volume of the spilled oil is less than 25 barrels in inland water or less than 250 barrels on land, or in offshore or coastal water that does not pose a threat to public health or welfare.

Medium Spill: Medium spill takes place when the volume of the spill is 250 barrels or less in inland waters or 250 to 2,500 barrels on offshore and coastal waters.

Major Spill: Major spill occurs when the oil discharged to inland water is in excess of 250 barrels in offshore or coastal waters.

Catastrophic Spill: Catastrophic spill refers to any uncontrolled well blow-out, pipeline rupture or storage tank failure which poses an imminent threat to the public health or welfare.

Causes of Oil Spillage
Oil spills may result from natural or man-made reasons.

Natural Causes
Oil spills may occur naturally owing to natural disaster movement of tectonic plates and also as a result of inadequate trap system. Oil spill can be caused by natural seepage, especially in the ocean. As tectonic plates shift, they may release oil from reserves trapped at green depths such as drilling oil from beneath the ocean floor. Underwater pipelines, when ruptured or cracked by the movement of tectonic plates also cause oil spill. When petroleum forms at such depths, it slowly fills the tiny hole within nearby porous rocks, known as reservoir rocks.

Man-Made Causes
Oil spills can also occur due to various man-made reasons which include: Carelessness (such as oil bunkering/ sabotage), Oil Siphoning, Terrorism and Accidents (e.g. tanker accidents and accidents during production operations).

Environmental Challenges Associated With Oil Spillage in Nigeria

Marine Contamination
The impact of oil spill on marine life depends largely on the physical and chemical characteristics of the particular oil and the way these changes feature with time, a process known as weathering.

The specific gravity, viscosity, chemical composition and toxicity of the pollutants are some of the main factors which determine the likely impact of oil on sea organisms. The type of environment exposed to the spill is also important, e.g. sandy, rocky, salt marsh or mangrove habitat. When oil spills into the ocean, it is especially likely to harm animals and plants at two interfaces (places where different things come together): (i) Near the surface of the water, where water and air meet and (ii) Along the shore, where water and land meet.

The communities' shorelines have been washed away or eroded due to the high volume of deep-sea exploration and exploitation activities. With the expansion of oil production, over the years, the incidence of oil spills has greatly increased. In an attempt to shorten travel time and improve access to oil fields and production facilities, oil companies have constructed canals that in some cases have caused salt water to flow into fresh water zones destroying freshwater ecological systems. The toxic effects of oil on marine life depend on the duration of exposure and concentration of oil in the environment (Numilo & Badejo, 2001). The pressure of toxic component does not

always cause mortality, but may include temporary effects like narcosis and the tainting of tissues, which usually subside over time (Aminbani *et al.*, 1996). Oil spills in the ocean destroy small sea organisms, fish, seabirds, sea mammals, shorelines and may contaminate the ocean floor for many years after the event (Amaiz, 2013).

Fresh Water and Groundwater Contamination

In fresh waters, oil contamination can result in severe impacts on the habitats 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, 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 sediment, 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.

Soil Contamination

Oil hampers proper soil aeration as oil film on the soil surface acts as a physical barrier between air and the soil. Oil pollution affects the physico-chemical properties of the soil such as temperature, structure, nutrient status, microbial flora and pH (Okereke *et al.*, 2007).

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 Nigeria are enormous. Oil spills have degraded most agricultural lands in the Niger Delta States and have turned hitherto productive areas into waste lands. With increasing soil infertility due to the destruction of soil micro-organisms, and dwindling agricultural productivity, farmers have been forced to abandon their lands, to seek non-existent alternative means of livelihood (Chindah, 2000).

Effect on Human Health

The main problems with oil spill are the negative effects of ingesting toxic metals. Most of the oil-spill contaminated sites containing appreciable amounts of heavy metals and other contaminants, affect the health of people living in the neighbourhood of such disaster areas. The concentration of trace elements like Chromium and Barium detected in oil spill sites of the Gulf war were higher than permissible safe limits (Egbe and Thompson, 2010). Skin contact with certain Chromium compounds can cause skin ulcers. Ingesting large amounts of Chromium can cause stomach upset and ulcers, kidney and liver damages, even death.

The health effects of Barium depend upon the water-solubility of the compounds. Small amounts of water-soluble Barium may cause a person to experience breathing difficulties, increased blood pressures, heart rhythm changes, stomach irritation, muscle weakness, changes in nerve reflexes, swelling of brains and liver, kidney and heart damage. Serious respiration problems witnessed in many communities can be linked to environmental pollution. Respiratory problems, coughing up blood, skin rashes, tumours, gastro-intestinal problems, different forms of cancer, and malnourishment, were commonly reported ailments in many oil producing communities in Nigeria.

Remediation Processes of Oil Spills

Oil spills pose an immediate threat to the environment and require quick and thorough responses. The remediation of oil spills has to do with getting rid of the oil in order to avoid or reverse environmental damages. It is important to start removing oil promptly from contaminated areas because as time passes and the oil weathers, it causes more damage to the resources in its path.

The various methods employed in the removal of oil from the natural environment are usually referred to as clean-up techniques. Almost all clean-up techniques have the potential to cause additional damage but care has to be taken in employing any remedial method so as not to make matters worse. Zabbay (2004) asserts that the clean-up technique(s) applied for a particular spill depends largely on the type of oil, and the conditions present at the location and during the time of the spill. The various remediation processes can thus be broadly divided into two categories: long term processes, and short term processes. These categories are the result of the kind of techniques used for treatment of oil spills and the various advantages and disadvantages of techniques.

Short Term Processes

Short term processes, as the name implies are clean-up techniques that are brief. They include the following:

❖ *Containment and recovery with booms and skimmers*: This is usually the first measure used to attempt to clean up after an oil spill. Booms are long, floating plastic or rubber barriers placed around floating oil for the purpose of containing (limiting further spreading) and concentrating the oil for recovery. In addition, booms may be used to divert and channel oil slicks along desired paths, making them easier to remove from the surface of the water. After the oil is contained using booms, skimmers or boats that skim spilled oil from the water surface are used. Skimmers are floating devices used to recover oil from water. They come in different designs. The simplest skimmers are suction devices which remove oil from the water surfaces directly or via a weir, although these tend to pick up a lot of water at the same time (Uyigue and Agho, 2007).

❖ *Use of Dispersants*: Dispersants are a group of chemicals designed to be sprayed onto oil slicks to promote the formation of tiny oil droplets, and delay the reformation of slicks. Significant environmental and economic benefits can be achieved, particularly when other at-sea response techniques are limited by weather conditions or the availability of resources. In certain situations, dispersants may provide the only means of removing significant quantities of surface oil quickly, thereby minimizing or preventing damage to important/sensitive resources.

❖ *In-situ Burning*: In-situ burning is the term given to the process of burning oil slicks at sea, at or close to the site of a spill. Burning may be seen as a simple method which has the potential to remove large amounts of oil from the sea surface. The decision whether or not to burn a slick at sea is often contentious. Issues such as the distance of the oil from the damaged vessel or from a populated area, the potential toxicity of the resultant smoke, the nature of the oil, the likelihood of the burn being successful, and the fate of any unburnt residues, require careful attention before attempts are made to ignite the oil.

❖ *Absorption*: Absorption is the technique employed in choppy or fast moving waters, when methods like containment and removal fail. In this method, sorbent materials such as tale, straw, sawdust and synthetic absorbents are added to the oil slick and then removed when they have soaked up some of the oil. These sorbent materials act like a big

sponge, removing oil. It should be noted however that contaminated absorbent materials must be treated as toxic waste, and they present disposal problems. Also, straw and sawdust can become water-logged and difficult to remove.

Long Term Processes

Long term remediation processes take longer time than short term processes. Bioremediation is the only long-term clean-up technique known. This involves the use of micro-organisms, such as bacteria, to remove environmental pollutants from soil, water, or gases. In other words, it is a process that uses micro-organisms to transform harmful organic compounds, like oil, into non-toxic and less dangerous compounds such as fatty acids and carbon dioxide (CO_2).

Prevention and Control Measures

Oil spills remain a persistent cause for concern, damaging the environment, posing health hazards and disrupting production (Uyigue and Agho, 2007). The petroleum industry undertakes a good number of measures in order to reduce the likelihood of oil spills. The measures include:

Upgrade of flow stations: This has to do with the improvement of the quality, standard or performance of the facilities in the station in order to prevent oil spill. Bund walls surround flare pits in flow stations. Flow station bund wall repairs ensure that the stations retain liquid, carried in their flare pits until they are evaluated. Also important are rehabilitation/repairs, replacement and burial of flow lines.

- *Spigging*: This involves the removal of debris from pipelines in order to minimize internal corrosion.

- *Cathodic Protection*: This is the prevention of electrolytic corrosion of a metallic material by making it the cathode in an electrolytic cell.

Rehabilitation of tanks is necessary to reduce the rate of oil incidents along the Nigerian coast, particularly as a result of vandalization. There are also several laws dealing with issues related to oil pollution in the environment. One of the socio-economic control measures could be prompt payment of compensation to the affected communities. Oil Companies rarely accept to pay compensation for damage caused by spills and leaks. In cases where they accept, their system of assessment and payment are often very cumbersome and unsatisfactory (Akpofure, 2008).

Environmental Challenges Associated with Gas Flaring in Nigeria

Nigeria has an estimated 157 trillion cubic feet of proven natural gas reserve, the 9th largest in the world. With this enormous quantity of gas, Nigeria is generally acknowledged as a gas province with little oil on it (Okoroji, 1996; Gaius Obaseki 1996; Eghre and Omole, 1999; Aghalino 1999, 2009). In spite of the massive endowment of natural gas, much of it is flared. With an elevated stock, the flaring is carried out through the top of a pipe or stack where the burner and igniter are located. This is a common practice in the oil production processes hence, it is not necessarily an ecological or social crime to flare gas. However, the Nigerian case attracts more attention because of the volume of the gas flared since the beginning of commercial oil production in the country. 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,

and/or storage for use as an energy source. If properly stored, the gas could also be utilized for community projects.

Gas flaring releases 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 than34.38 million metric tons in 2002, accounting for about 50% of all industrial emissions in the country and 30% of the total CO_2 emissions. While flaring in the Western World has been minimized, in Nigeria, it has grown proportionally with oil production (Bassey, 2008; Friends of the Earth Nigeria, 2008).

The International Community, the Nigerian Government, and the Oil Corporations seem to be in agreement that gas flaring needs to be curtained. However, efforts to do so have been limited, although flaring has been declared illegal since 1984 under section 3 of the "Associated Gas Reinjection Act" of Nigeria. While OPEC and Shell (the biggest natural gas flaring company in Nigeria), 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" (ERA, 2008).

Gas flares have potential harmful effects on the health and livelihood of the communities where they are carried out, as they release a variety of poisonous chemicals including nitrogen dioxide, sulphur dioxide, volatile organic compounds (e.g. benzene, toluene, xylene and hydrogen sulphide), as well as carcinogens like benzapyrene and dioxins. Humans exposed to such substances can suffer from a variety of respiratory problems. These chemicals can aggravate asthma, causing breathing difficulties and pain, as well as chronic bronchitis.

Benzene known to be emitted from gas flares in undocumented quantities is well recognized as a cause for leukaemia and other blood-related diseases. A study done by Climate Justice in Bayelsa State, estimated that exposure to benzene would result in eight new cases of cancer yearly alone (Ayool, 2011; Friends of the Earth Nigeria, 2008).

Gas flares are often located close to local communities where villagers may risk working near heat of the flare. Many of these communities claim that nearby flares cause acid rain which corrodes their homes and other local structures, many of which have zinc-based roofing. Incidentally, due to lack of potable water in these communities, they resort to domestic rainwater harvesting (DRWH) of the suspected acid rainwater (Okereke *et al.*, 2006a; 2006b). Some people resort to the use of asbestos-based materials, which are stronger in repelling acid rain deterioration. Unfortunately, this only contributes to decline in human health and associated environmental degradation as exposure to asbestos increases the risk of lung cancer, pleural and peritoneal mesothelioma and asbestosis.

Whether or not flares contribute to acid rain is debatable, as some independent studies conducted have found that the sulphur dioxide and nitrous oxide content of most flares was insufficient to establish a link between flaring and acid rain. Older flares are rarely relocated away from villages, and are known to coat the land and communities in the area with soot and to damage adjacent vegetation. Almost no vegetation can grow in the area directly surrounding the flare due to the prevailing heat.

In November 2005 a judgment by the Federal High Court of Nigeria ordered that gas flaring must stop in Niger Delta Communities, as it violates guaranteed constitutional rights to life and dignity. In

a case brought against the Shell Petroleum Development Company of Nigeria (Shell), Justice C.V. Nwokorie ruled in Benin City that "the damaging and wasteful practice of flaring cannot lawfully continue". Till date, Shell has not ceased gas flaring in Nigeria.

One major problem, which the people had to contend with, is noise pollution. For example, the Utorogun Gas Plant in Delta State creates much noise and vibrations on the land and houses at about 6 kilometers radius from it (Ikelegbe, 1993) which could damage ear cells temporarily or permanently and can lead to speech impairment. Nigeria's low-lying coasts stand threatened by the effects of global warming. Of particular concern is the impact of rising sea levels, tidal waves and floods for example the 2012 flood ravaged almost all the coastal areas of the nation where hundreds of lives were lost and thousands of people were rendered homeless, and the Nigerian Metrological Agency (NIMET) subsequently predicted more rainfall in 2013.

CONCLUSION

Efforts have been made in this review to examine the environmental challenges associated with oil spillage and gas flaring in Nigeria. Types of Oil spillage, their causes, and general overview of oil spillage in Nigeria, have been discussed. Most of the pestilent challenges of oil spillage which degrade or destroy most agricultural lands plus the increasing soil infertility experienced due to the destruction of soil microorganisms have been revealed. Also highlighted is the fact that aquatic lives have been destroyed with the pollution of traditional fishing grounds, exacerbating hunger and poverty in fishing communities in Nigeria.

Severe environmental and ecological problems associated with gas flaring in oil producing communities in particular and Nigeria in general, have also been reviewed. These challenges include among others the release of large amounts of methane, which has a high global warming potential that causes acid rain that can corrode buildings and other local structures. It also raises sea levels, tidal waves and floods. Gas flaring also causes cancer and a variety of respiratory problems, as well as chronic bronchitis, leukaemia and other blood-related diseases.

RECOMMENDATIONS

To minimize the occurrence of oil spill and stop gas flaring in Nigeria, the following policy recommendations are made:

- Sabotage and oil bunkering can be stopped through proper engagement and empowerment of the youth and women groups and also through proper and adequate monitoring of pipeline and oil installations/facilities.
- Corrosion can be prevented by pipeline and flow line replacement, routine pigging and application of cathodic production systems, which are regularly monitored and upgraded where necessary.
- Oil spill response system should be upgraded.

- The creation of regional spill response centers along coast lines will help in managing oil spill problems.
- Clean Development Mechanism (CDM) can be used as an alternative tool to achieve the target of ending gas flaring in Nigeria.
- The existing gas flaring laws should be reviewed and implemented to the core.
- Effective management framework should be developed to allow flexibility in Nigeria's environmental governance
- The Government should increase the budgetary allocation for environmental institutions and their programmes.
- There should be a mandatory legislation for oil and gas prospecting companies to establish oil spillage and gas flaring compensation funds to take care of future incidents of oil spillage and gas flaring.
- The Nigerian Government should pass the "Petroleum Industry Bill (PIB)" into law and ensure its implementation.

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