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A Review of Some Impacts of Oil Pollution on Biodiversity of the Niger-Delta, Nigeria

Louis Uchenna Onyeneke

Department of Geology/Geophysics, Alex Ekwueme Federal University Ndufu-Alike, Nigeria
onyenekeuchenna@gmail.com; uchelouis2@yahoo.com

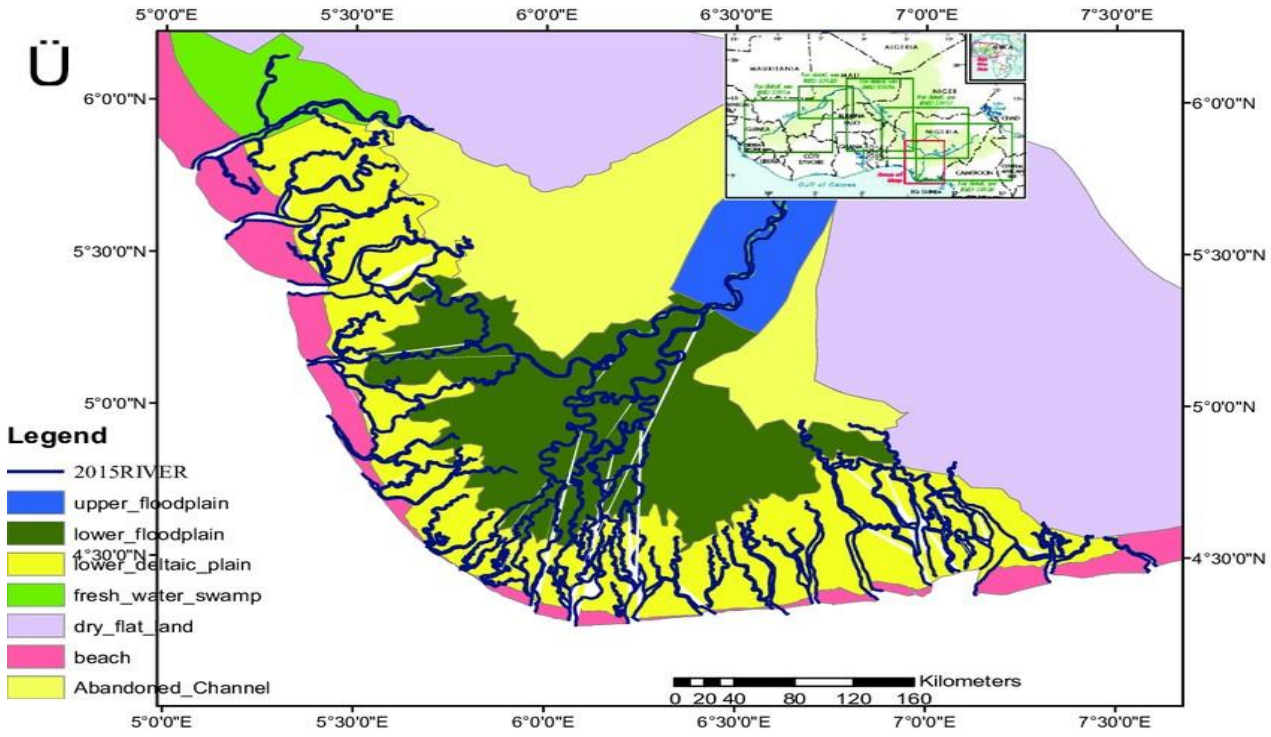
Abstract *Gas flaring, explosions/fire outbreaks, oil leaks/spills from transport lines, chemicals and effluent discharges into the environment have adversely affected the balance in the distribution and population of biodiversity, especially the endangered fauna and flora species within the region. Apart from urbanization, climate change, and tree felling, the excessive extraction and production of oil and gas are the most responsible for the disturbance and loss of biodiversity in the Niger Delta. This paper summarizes the adverse implication of the oil/gas prospecting and production on biodiversity and the actionable framework put in place by the government for the protection of the environment and conservation of biodiversity in the Niger Delta region of Nigeria.**KEY WORDS**: Nigeria, Niger Delta, Biodiversity, Oil prospecting, excessive extraction, Environment, actionable framework, conservation, climate change, endangered fauna/flora.*

Introduction : Protecting the environment and conserving biodiversity are part of the responsibilities of governments around the globe. Environmental degradation, (both natural and anthropogenic)reduces the quality of life of humans, fauna and flora species within a given ecological unit. Human's quest for industrialization, domestic needs and economic benefits lead to the degradation and destruction of several environments, to a larger degree than natural processes. Anthropogenic activities like tree-felling for domestic fuel uses, timber and construction; unsustainable agricultural practices; urbanization; unregulated oil/gas and natural mineral exploration/extraction processes pose a threat to the survival and diversity of species. Transport and industrial systems release obnoxious greenhouse gases into the air, the effects of this pollution could be felt on a regional scale though over a long period of time. It could lead to the alteration of both local and regional climates through global warming and subsequently, changes in climatic variables and/or extreme weather conditions such as increased sea levels and flooding, windstorms, changes in rain patterns, high temperatures etc. Humans, plants and animals in such a given environment may experience respiratory or carcinogenic problems, monuments, roofs and other civil structures maybe affected. Point source and non-point sources of water pollutants in soil and surface water resources through effluent discharges, fertilizers from nearby farmlands used in bumper food production, oil spill, home sewers etc. are detrimental to humans, flora and fauna species within a biota.

Nigeria's Oil and Gas resources have for the past four decades been a nuggets of mixed blessings. Since the commencement of oil exploration and exploitation in the Niger delta, the federal government of Nigeria has enjoyed lots of economic benefits while the host environment within the region continues to degrade.

Geology of the Niger Delta

The modern Niger delta started its growth after the Paleocene transgression which was followed by a cycle of deposition in the Eocene and continued till the present day (Hospers, 1965). The Niger Delta ranks twelfth in the list of geologic provinces with the largest known oil and gas reserves in the world (Tuttle et al;2021). The Descriptions of the physiography and geology of the Niger Delta are also summarized in the works of Allen (1965), Short and Stauble (1967), ERML (1997) and UNDP (2006).



Geologic map of Niger Delta showing major sedimentary environments as defined by the fluvial, tidal and wave-related processes, (Edirin Akpofure, 2019).

Environmental make-up of the Niger Delta

The ecology of the Niger Delta is characterized by several varieties of vegetation. Udo 1978 classified this region on the basis of its biodiversity, the four distinct ecological zones include the mangrove forest, freshwater swamp forest, lowland rainforest and vegetation derived from human disturbance. This classification is similar to the later work done by the World Bank (1995) which also identified four different ecological zones: freshwater swamp forests, mangroves, lowland rainforests, and barrier island forests. It consists of flat low lying swampy terrain that is crisscrossed by meandering and anastomosing streams, rivers and creeks, the largest wetland in Africa and third largest in the world (Emoyan et al., 2008).

Freshwater swamp forests:

Some authors identified several biodiversity in some freshwater swamps within the Niger Delta. These water resources are mostly used for household needs including cooking, bathing, drinking etc. The areas with freshwater resources are often referred to as freshwater swamps. Other habitats, such as the riparian and arable farmland are commonly found within the freshwater swamps

Mangroves:

The mangrove forests in the coastal region of the Niger Delta is very extensive in size, it is regarded as one of the most ecologically sensitive regions in the world. Almost 70% of the Nigerian mangrove ecosystem lies within the Niger Delta region (Tropical Research and Conservation Centre TRCC, 2022). The site falls under the Niger Delta wetlands region of Nigeria which is considered as a global biodiversity hotspot. The Niger Delta mangroves together with the creeks and rivers are a major source of food and livelihood for millions of people.

Low land forests

Although this area covers about 4,598miles of the Niger Delta region, there are growing concerns on the depletion of this forest, the portion of this region with few presence of forest is insignificant in size or diversity of species (for example, Ebubu forest). Today, most areas in this zone are in swidden agricultural systems (for shifting cultivation), which permit only oil palms and occasional mango trees to remain (Collins and Ertel, 2008). In 1995, the World Bank reported that Ogoni land which used to be covered with rainforest has greatly been converted to degraded bush and farmland.

Barrier island forests

Otherwise known as 'beach ridge island' forest. It is known also for its potentials for a game reserve due to the little elephant and hippopotamus population in it. At the middle of the coastal beaches and the estuarine mangroves is the freshwater forest. Although large portions of high quality forest with high concentrations of biodiversity exist, the forests are reportedly degraded (Ebeku,2005).

Biodiversity resources of the Niger Delta

Biodiversity in its actual sense simply means the population of fauna (birds, reptiles, insects, fishes, microorganisms, mammals and amphibians) and flora (all plant species), their variability, species and genes within an ecosystem.

Flora

Ubom (2010), reported the presence of 339 plant species in some Niger Delta states (Akwa-Ibom, Bayelsa, Cross River, Delta, Imo and Rivers) which are distributed into 88 families. According to the authors, *Elaeis* guineensis, Raphia hookeri, *Cocos* nucifera, Irvingia gabonensis, Hevea brasiliensis, Lonchocarpus cyanescens, Pterocarpus santalinoides and Dacryodes edulis are some of most utilized plants compared to the others. Typically, plant uses depend on the region and locality as well as its availability. Ohimain et al., 2014, reported that over 56 species of vegetation are found in Wilberforce Island, Bayelsa state, Nigeria. In Taylor creek, Akani et al., 2015, reported the presence of Raphia hookeri (Raphia palm), Mitragyna ciliata (Abura), Nauclea diderrichii (Opepe), Khaya ivorensis (Mahogany), Irvingia gabonensis (African bush mango), Elaeis guineensis (Oil palm), Musanga cecropioides (Umbrella tree), ferns, epiphytes and macrophytes in a freshwater swamp and riparian forests of the area.

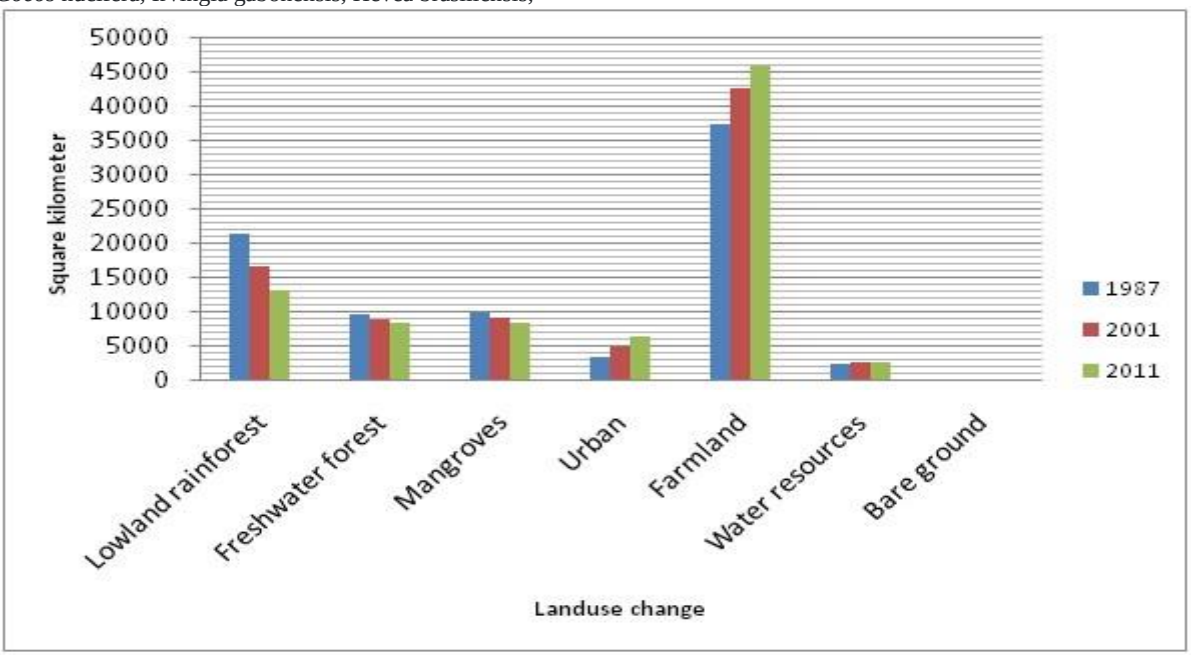


Figure 1 Land use change in the Niger Delta between 1987–2011. (Ayanlade, A., 2014).

Fauna

According to the World bank, the potentials of the Niger delta biodiversity have not been fully known because discoveries of new ecological zones and species have continued to occur and major groups such as higher animals and birds remain unstudied in large areas (World bank, 1995).

About 1,489 species of microorganisms are found in the Nigerian environment (Emma-Okafor et al., 2010).

There have been reports of several fish species in many parts of the Niger Delta region of Nigeria. For instance, The Nigerian government reported the presence of 648 fish species in its fourth annual biodiversity report of 2014 for just Cross River State.

Many species of edible insects in the Niger delta namely: *Heteroligus meles* (Yam beetle), *Brachytrupes membranaceus* (Crickets), *Zonocerus sp* (including Grasshopper and Praying mantis), *Rhynchophorus phoenicis* (Palm weevil/Edible worm), *Apis mellifera* (Bees), *Rhinoceros oryctes* (Rhinoceros), *Daraba (Sceloides) laisalis* (Egg fruit borers), *Macrotermes* sp. (Termites),, *Sitophilus oryzae (*Rice weevil), *Callosobruchus maculatus* (Bean beetle), *Dermestes maculatus* (Fish/hides beetle), *Gonimbrasia belina* (Mopane worm), *Musca domestica* (House flies), uncertain species of Cotton stainer, aphids and locust have been reported by (Okore et al., 2014).

(Lameed, 2009) reported the variability of bird population with respect to locations. They are characterized by 19 species (villages and farmlands), 49 species (forest area), 14 species (river bank and beaches) in Kwale forest with predominant species being African Black kite (Milvus migrans) and pied hornbill (Tochus nasutus).

S/n	Order	Family	Common name	Scientific name	Status	Conservation effort
	Reptiles					
1	Chelonia	Pteomedusidae	West African Mud turtle	*Pelusions castaneus*	Endangered	Nil
2			West African black turtle	*Pelusios niger*	Endangered	Nil
3		Dermochelidae	Leatherback turtle	*Dermochelys coriacea*	Endangered	Nil
4		Chelonidae	Green turtle	*Chelonia mydas*	Endangered	Nil
5			Olive ridley	*Lepidochelys olivacea*	Endangered	Nil
6			Hawksbill turtle	*Eretmochelys imbircata*	Endangered	Nil
7	Crocodylia	Crocilidae	Nile crocodile	*Crocodylus niloticus*	Endangered	Nil
8			African dwarf crocodile	*Osteolamus tetraspis*	Endangered	Nil
9	Squamata	Veranidae	Nile monitor lizard	*Varamus niloticus*	Endangered	Nil
10			Forest monitor lizard	*Varanus ornate*	Endangered	Nil
11		Pythonidae	Royal python	*Python regius*	Endangered	Nil
12			Rock python	*Python sebae*	Endangered	Nil
	Aves/Birds					
13	Pelecaniformes	Pelethronodae	Pink-backed pelican	*Pelecanus rufescens*	Endangered	Nil
14	Coconiformes	Adeidae	Grey heron	*Ardea cinerea*	Endangered	Nil
15			Goliath heron	*Ardea goliath*	Endangered	Nil
16			Purple heron	*Ardea purpurea*	Endangered	Nil
17			Great egret	*Egretta alba*	Endangered	Nil
18			Little egret	*Egretta garzetta*	Endangered	Nil
19			Cattle egret	*Ardeola ibis*	Endangered	Nil
20			Squocco heron	*Ardeola rolloides*	Endangered	Nil
21			Black-crowned night heron	*Nycticorax nycticorax*	Endangered	Nil
22		Scopidae	Hammercop	*Scopus unbretta*	Terminated	Nil
23		Ciconidae	White stork	*Ciconia ciconia*	Endangered	Nil
24			Abdim's stork	*Ciconia abdimii*	Endangered	Nil
25			Saddle-billed stork	*Ephippiorhynchus senegalensis*	Endangered	Nil
26	Falconiformes	Accipitaridae	Palm-nut vulture	*Gypohierax angolensis*	Endangered	Nil
27			Hooded vulture	*Neophron monachus*	Endangered	Nil

Ogaga Dean Efenakpo, 2018.Some species of wildlife resources found in the Niger Delta Region and their Conservation Status.

Significance of Biodiversity

Biological diversity comprises three levels: Species diversity: the variety of different species; Genetic diversity: the variety of genes contained in plants, animals, fungi and microorganisms; and ecosystem diversity: all the different habitats that exist.

Biodiversity plays an enormous role in the continued existence of humans in many diversified ways, for example, insects act as pollinators of plants. Biodiversity is critical to life on earth for a number of good reasons: Promoting Soil Formation; the soil provides natural habitat for a number of burrowing organisms and specific microbes species that play a special role in nutrient cycling. Provision of food resources for humans; Several animals, mainly insects such as bees, are responsible for pollination. This process guarantees the production of fruits, seeds and other foods that can be consumed by both wild animals and people. Thus, pollination ensures the sustainability of agroforestry, green belts and urban gardens, essential to feed the large number of people living in communities. Promotion of quality life and wellness; the preservation of biodiversity can enable the creation of safe and healthy spaces for leisure and social activities.

Fast recovering from natural disaster; Biodiversity is extremely important for climate regulation. The roots of the plants allow greater water infiltration in the soil and help retain moisture in the soil over time, and the transpiration of the leaves helps in the formation of rain clouds and increases the humidity of the air. These factors, among many others, can help mitigate extreme events such as droughts, fires and floods. Maintaining food web; By preserving biodiversity, we also preserve trophic chains. In this way, predatory animals can control the population of animals that present risks to human health. For example, fish are predators of mosquito larvae and skunks are known to prey on scorpions. Biodiversity plays an essential role in the Overall sustainability and growth, life processes including stabilization of the climate, protection of watersheds, soil and nurseries and breeding grounds.

Effects of oil/gas exploration and production on biodiversity

All the processes and stages of oil/gas production ranging from its prospecting, site investigation and mobilization, exploitation, production, storage, refining distribution/transportation of product, marketing, terminal operation, pose a lethal risk to the environment and biodiversity within the oil-prolific Niger-delta region of the country. Apart from social destabilization, underdevelopment of host communities, global warming and risks of flooding, loss of biodiversity is also directly eminent.

The Niger delta has a land mass of almost 72,000km2, plays host to 800 oil-producing communities, and is the most impacted by oil spillage and gas flaring. It has about 900 oil wells, 100 flow stations and gas plants, over 1,500 km of trunk lines, and some 45,000 km of oil and gas flow lines, the Niger Delta has become synonymous with oil pollution, recording an average number of 221 oil spills per year (Osuji, 2001).

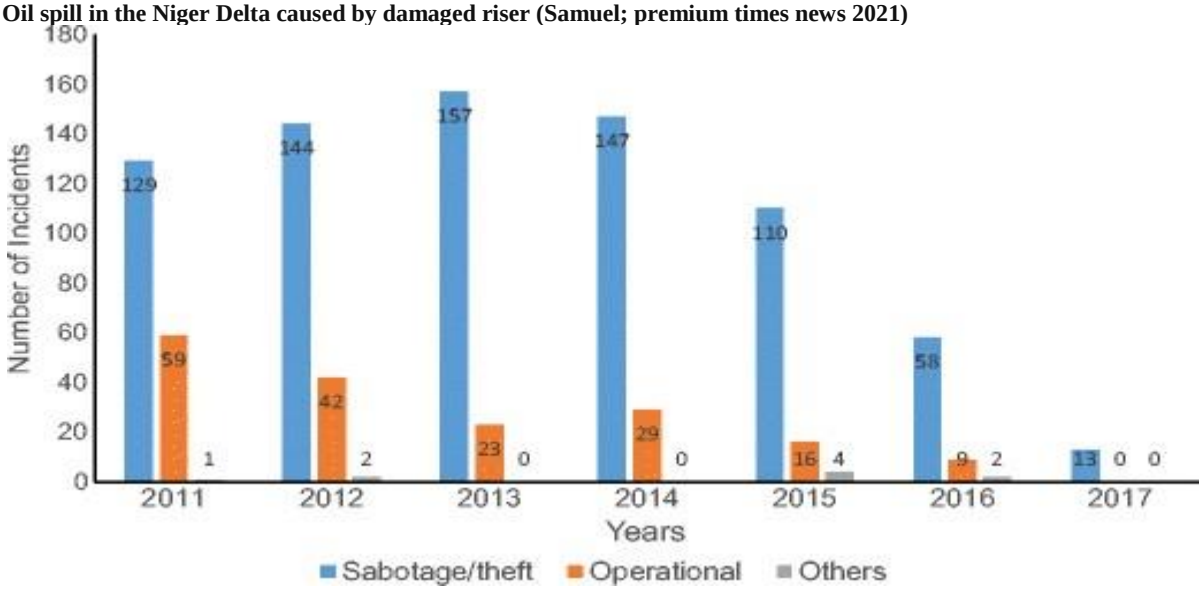
When Geologists prospect for Oil and Gas, the operations usually involve surveying, clearing of seismic lines, and heavy use of dynamites for geological explosions. The deflagration of dynamite in aquatic environments leads to narcotic effects and mortality of fish and other faunal organisms (Zabbey, 2004). Explosions weaken or even

destroy the overlying soil strata, causing increased siltation and turbidity, lowering the penetration of sunlight into water and thus, impairs the photosynthetic productivity of surface waters. Siltation of such waters can lead to the blockage of the gills of benthic fauna. Deflagration of nitroglycerin increases the nutrient loads (especially nitrate) in surface waters leading to the eutrophication or hypoxia of such waters.

Laying of oil and gas pipelines involves clearing of vegetation for pipeline tracks. This reduces habitat area, segregates natural population and may also have adverse effects on breeding behavior in the Delta fragments rich ecosystems such as rainforests and mangroves. (Collins et al.,2008).

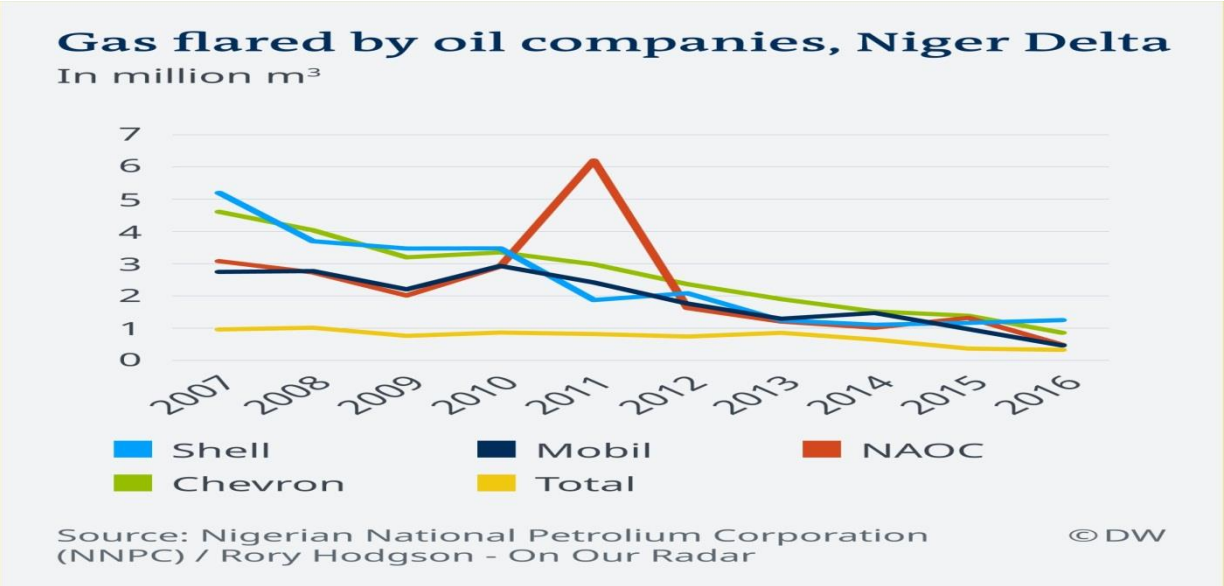
Oil spills penetrate into the structure of the plumage of birds and the fur of mammals, reducing its insulating ability, and making them more vulnerable to temperature fluctuations and much less buoyant in the water. Natural seeps as a form of oil spillage are considered to be less of a problem because ecosystems have adapted to such regular releases. Oil spills in the Niger delta are mainly through tankers and vessels during transport, accidental discharges at offshore oil platforms, pipeline leakage/rupturing, discharges from refineries/urban centers and theft/sabotage. On a general note, the adverse effects of oil spillage depend on the nature and type of crude oil, the level of oil contamination, the type of environment, and the selective degree of sensitivity of individual organisms (Collins et al.,2008).

Oil spill in the Niger Delta caused by damaged riser (Samuel; premium times news 2021)



Oil spill incidents, including intentional sabotage and operational, in Niger Delta from January 2011 to March 2017 (According to data from Shell Nigeria).

Gas flaring and its implications on the environment have revealed in a study conducted by Okezie and Okeke revealed that there was a complete loss in productivity of all crops cultivated about 0.2km from the Izombe flow station, 45% loss of those about 0.6km away, and around 10% loss in yield for crops one kilometer away from the flare (Okezie et al;1987).



Leakages and fire outbreaks are part of the hazards involved during the actual production and transportation of natural gas (which is mainly methane). What could be referred to as Nigeria's worst fire outbreak which killed well over 1,098 people, destroyed extensive farmlands including the fauna and flora of the immediate environment was as a result of pipeline gas explosion within the Ethiope west local government area (Segun, 2018). Another fire incident which occured in 2004 on the Nigerian Liquefied Natural Gas (NLNG) pipeline along the Kala-Akama and Okrika mangrove swamps was as a result of leaked pipeline (Collins et al;2008). This uncontrolled fire outbreak lasted for three days (Zabbey, 2004). Populations of endangered fauna and flora species within the affected area were lost.

Conservative efforts

There have been several legislative frameworks put in place by the government to regulate the operations of the Nigerian oil industry with regards to Prospecting and Production. Unfortunately, a meager amount of these legislative acts and decrees, provide guidelines on issues of pollution (Salu, 1999). Some of these laws include:

I. The Petroleum (Drilling and Production) Regulations 1969, Sections 25 and 36

Ii. Mineral Oil (Safety) Regulations 1963

Iii. Convention on the Prevention of Marine Pollution Damage 1972

Iv. Endangered Species Decree Cap 108 LFN 1990

V. Federal Environmental Protection Agency Act Cap 131 LFN 1990

Vi. International Convention on the Establishment of an International Fund for Compensation for

Oil Pollution Damage 1971

Vii. African Convention on the Conservation of Nature and Natural Resources 1968

Viii. Harmful Waste Cap 165 LFN 1990

Iv. Associated Gas Re-Injection Act 1979

The objectives of these regulations is: To establish Guidelines and Standards for the Environmental Quality Control of the Petroleum Industry taking into account existing local conditions and planned monitoring programs. To provide, in one volume, for the operator and other interested persons a comprehensive' integrated document on pollution abatement technology, guidelines and standards for the Nigerian Petroleum Industry. To standardize the environmental pollution abatement and monitoring procedures, including, the analytical methods for various parameters (Ephraim, 2014).

Conclusion and recommendations

Apart from deforestation, urbanization, unsustainable agricultural practices/land uses, and invasion by alien fauna species, oil and gas operations (exploration and exploitation) constitute by far, more-severe threat to the sensitive ecological health of the Niger delta area leading to loss of biodiversity. Available literature has shown that the quantity of oil spills across the Niger delta are on the decline, its occurrences have also been on the increase. Oil spillage has led to the loss of so many flora and fauna species at the lowlands forest region. When shellfish and fish ingest oil, it could cause variations in their reproduction, rates of growth or death.

When in contact with oil, the insulating ability of fur-bearing mammals such as sea otters and the water-repelling abilities of a bird's feathers can easily be destroyed, exposing them to harsh conditions. Many birds and animals also swallow oil and are poisoned when trying to clean themselves or eating oiled prey. Other species with no direct contact can easily be affected too, either through starvation since oil gives the

affected prey an unpleasant smell and taste; or by actual ingestion of these prey. This can in turn disrupt the food chain, and cause extinction of endangered species such as crocodiles, hippos and the white-crested monkeys, as well as scarcity of food resources.

Apart from oil spill, fauna and flora community can be affected in the case of gas explosion and fire, this can adversely affect the local community who rely on plants for fuel, traditional medicine or furniture. Land areas gutted by fire are detrimental to burrowing and microorganisms in the soil, leaving a once arable land unproductive.

The protection of biodiversity of the Niger delta can't be over emphasized; this can be achieved by sufficiently implementing the enacted legislation by the concerned government agencies through adequate funding, training of staff, monitoring, vertical incident reporting, rapid response centers for oil spills, incorporation of local efforts for information reporting, the use of qualified professionals for environmental policies/decision-making and streamlining the responsibilities between agencies to eradicate duplication of duties. Strictness in the investigation and punishment of offenders (both the agency staff, private and corporate persons) can't be over-emphasized.
The identification, remediation of environmentally degraded areas and palliative compensation is highly imperative, which is the main objective of the National Policy on Environment(NPE), (FEPA, 1991) Section 2(c).

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