Nigerian Research Journal of Chemical Sciences **(ISSN: 2682-6054)**
Volume 9, Issue 1, 2021

Oil spill and the Effects on the Niger Delta Vegetation: A Review

[*1]O. J. Akpoghelie, [2]U. A. Igbuku and [3]E. Osharechiren

[1]Department of Chemistry, Federal University of Petroleum Resources, Effurun, Nigeria

[2]Department of Science Laboratory Technology, Delta State Polytechnic, Ozoro, Delta State, Nigeria

[3]Delta State Oil Producing Areas Development Commission, Warri, Delta State

*Corresponding Author: comradeogaga@yahoo.co.uk

ABSTRACT

The Niger Delta region of Nigeria is an environmentally fragile region that is covered by the natural delta of the Niger River and the neighbouring areas of the east and west. The region has a large reserve of crude oil and natural gas resources. The region has experienced crude oil leaks that had contaminated and degraded surface and ground water; land and air. The effects of oil spills on the Niger Delta vegetation are massive with extended impacts on the environment and had also affected the physical, ecological, psychological, social, economic and health of the Niger Delta people. This paper reviewed the causes of oil spill in the Niger Delta region and the effects on the Niger Delta vegetation.

Keywords: Oil Spill, Niger Delta, Vegetation, Petroleum, Ecological and Health Effects

INTRODUCTION

The Niger Delta area of Nigeria is a densely populated region sitting directly on the Gulf of Guinea on the Atlantic Ocean where the Niger River divides into several tributaries [1]. The region extends along the coast from Benin River on the west to the Imo River on the east. This area has a massive amount of crude oil deposits such that exploration, exploitation and production with industrial installations like pipeline materials, flow stations, gas clusters and gas flaring sites are in place [2]. The region is seen as Africa's most important oil producing region [3]. The region is undoubtedly the most attractive region for investment in Nigeria. It is full of life and natural resources with diverse culture and heritage. It is the driving force behind the economic growth in Nigeria [4]. The economy depends on natural resources such as crude oil. It

lies under the earth crust and while in this state, it does not have any economic value until it is discovered, drilled and brought to the surface.

Crude oil is a naturally occurring petroleum product which is composed of hydrocarbon and other organic materials. This crude when explored and through other anthropogenic means, may spill into the environment. The Environmental Pollution Center defined oil spills as any spill of crude oil or oil distilled products (gasoline, diesel fuels, jet fuels, kerosene, Stoddard solvent, hydraulic oils, and lubricating oil) that can alter the concentration of the chemical component of the surface of the land, air, and water environment [5].

Literature revealed that chemicals released into the environment in the past had possibly resulted to the changes, alterations or disturbance to the environment perceived to be deleterious or undesirable [6, 7]. Anthropogenic activities may result to the deposition of crude petroleum products into nearby rivers and its combustion pollutes the air with significant health risks [8]. This process leads to oil spill pollution. Oil spill pollution refers to the negative contamination or impact on the environments and living organisms, including humans [1], due to the discharge into the environment of various organic compounds that make up crude oil and oil distillate products, the majority of which include various hydrocarbons and other chemical components. Some of the constituents are heteroatom compounds (S, N, O), metals, organic and inorganic compounds. Hydrocarbons are made exclusively from carbon and hydrogen atoms which bind together in various ways, resulting in paraffin's (normal alkanes), isoparaffins (isoalkanes), aromatics (such as benzene or various PAHs), cycloalkanes and unsaturated alkanes (alkenes and alkynes).

The Niger Delta environment in Nigeria had witnessed the traffic of this petroleum crude into her vegetation's including both swamp and land locations where oil exploration occurs. The process where crude oil and other hydrocarbon are spilled into the environment either intentionally or unintentionally, had led to environmental degradation in the region.

This study owes its significance to the facts that the Niger Delta region is made up of rivers, lakes, coastal lagoons, mangroves, peat lands, coral reefs and other land locations. Oil exploration in this region is managed by the joint venture (JV) companies who collectively control about 95% of Nigeria's crude oil production, leaving the balance to indigenous companies operating some marginal oil fields [9].

Literature and general survey reveal that this region with all its natural endowments of oil and gas which drives the economy is poverty ridden, coupled with high rate of unemployment, underdevelopment, rural - urban migration and environmental degradation in the region. This region which is made up of small land mass, mangrove swamps, fresh water swamps and rain forest is now characterized by contamination of streams and rivers; and destruction of biodiversity in the forests due to oil pollution in the area.

The aim of this study is to examine the causes of oil spill in the Niger Delta region and review the effects on her vegetation.

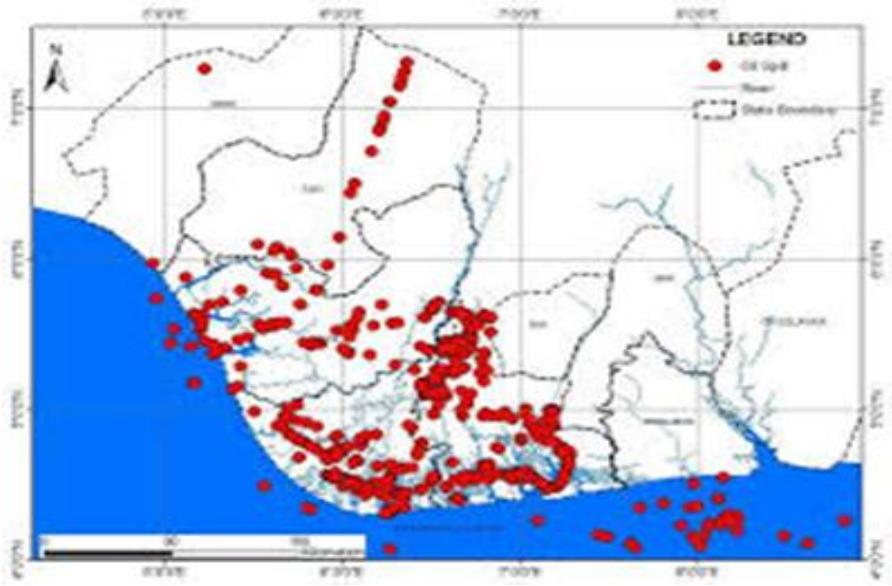

Figure 1: Map of the Niger Delta Coastal Areas of Nigeria

Causes of Oil Spill

Spill of crude oil or oil distilled products may find their way into the environment and pollute the surface of the land, air, and the water. This process of crude oil spill may occur from processes that range from crude oil search by complex seismic exploration, drilling and exploration. When crude oil is discharged into water surface, it floats and spreads out to form a thin layer of oil across the water surface [10]. Oil spills may also occur due to crude oil theft and sabotage of facilities, lack of maintenance of oil facilities among others. Oil spills may originate from natural or anthropogenic causes.

1. Natural Causes

Crude oil is spilled into the environment naturally in the form of oil that may seep from the bottom of oceans and enters the marine environment. Crude oil is formed during long periods of time through natural processes involving organic matter from dead organisms buried under the ground over a long period of time. Oil may spill naturally due to factors such as climatic conditions, disturbance, etc. Such natural oil spills may occur in oceans, due to eroding of sedimentary rocks from the bottom of the ocean [6-8, 10].

2. Anthropogenic Causes

Anthropogenic cause of oil spill are referred to those errors or/and the deliberate attempt that emanates from human activities which may include the processes involved during oil exploration such as drill cuttings, drilling mud and production fluids, produced fluids like oil and water and chemicals injected into drilling holes to control corrosion or aid separation of oil from water; processing of crude oil to finish petroleum products; oil theft; vandalized oil pipeline; equipment failure as a result of malfunctioning, age, over loading corrosion or abrasion of parts; handling and transport; storage and use of crude oil and any of its distilled products; poor maintenance culture of oil facilities resulting to oil leak into the environment and excessive pressure on oil facility [7, 8].

Type of Oil Spill

Oil spills occur when crude petroleum or its refined products enter the environment intentionally or unintentionally. It eventually finds its way into land and other water bodies through runoff.

Types of oil spill are:

1. *Category "A" Oil* - Very volatile and highly flammable

Category "A" oil is light fluid. It spreads quickly when spilled and has a strong odour. Category "A" oil is the most toxic but least persistent of all oils. If the oil soaks into the soil, the effects will be long lasting. In water, category "A" oils disperse readily but affect aquatic life in the upper water column. Category "A" oils include high-quality light crude oils as well as refined products such as gasoline and jet fuel. Toxic components of gasoline include benzene, a known carcinogen, and hexane which can damage nervous systems in humans and animals [11].

2. *Category "B" Oil* - Diesel-Like Products/Light Crude Oils

Category "B" oils are known as "non-sticky" oils. They are less toxic than category "A" oils but more likely to adhere to surfaces. According to Banerji [5], they can cause long term contamination. Lower-quality light crude oils and refined products such as kerosene and other heating oil's fall into category "B". They leave a film on surfaces, but the film will dilute and disperse if flushed vigorously with water. Category "B" oils are highly flammable and will burn longer than category "A" oils [11].

3. *Category "C" Oil* - Medium Crude Oils/Intermediate Products

Category "C" oils are heavy and sticky. They do not spread as quickly or penetrate sand and soil as easily as lighter oils. Category "C" oils adhere strongly to surfaces. Category "C" oil does not easily dilute and disperse, making it especially detrimental to wildlife, such as fur-bearing marine mammals and waterfowl. Because it produces such a sticky film, a category "C" oil spill can severely contaminate intertidal zones, leading to expensive, long-term cleanups. Category "C" oils include most types of crude oil and bunker B and bunker "C" fuel oils. Such oils are prone to forming lumps of oil or emulsions [11].

***4. Category "D" Oil* - Heavy Crude Oils/Residual Products**

Category "D" crude oil is solid and has the least toxicity. The biggest environmental concern posed by category "D" oil occurs if the oil is heated and hardens on a surface, it makes cleanup nearly impossible. The U.S. Environmental Protection Agency points out that as the volatile components of some oils evaporate, they may leave behind category "D" residues [11].

***5. Non - Petroleum Oil* - Non-Floating Oils**

Synthetic oils and derived oils may cause contamination if released into the environment. Non-petroleum oils coat wildlife and can cause death due to suffocation or dehydration. Non-petroleum oils are slow to break down and easily penetrate soil, causing long-lasting damage to an affected area. Examples of non-petroleum oil products include cooking fats and synthetic oils.

The Chemistry of Oil Spill

When crude oil is spilled into the environment, it combines with other chemical substances, and are transformed into other substances capable of causing harm to both man and the environment.

Crude oil is a complex mixture of molecular compounds of comparatively volatile liquid of hydrocarbon compounds of hydrogen and carbon, though it also contains some nitrogen, sulphur and oxygen. Petroleum hydrocarbons are predominantly one of two types, aromatics or alkanes. Aromatics, which are based on a 6-carbon ring, tend to be the molecular compounds in oil that are the most toxic to marine life. This crude petroleum, while in the environment, the lighter component evaporates quickly within the first few days, but before the toxic compounds evaporate, they pose devastating effects on the environment, affecting marine and coastal ecologies. The thick oil also washes ashore creating reservoirs on the beaches of toxic chemicals that can have a lasting effect on the environment. The rest of the floating oil breaks up into globules, which is whipped by the wind into a brown, foamy substance. Oil spilled may remain in the environment as a thick, waxy oily material for several hours at extremely cold temperature. At a warm temperature, waters and sunlight break down the oil more quickly enabling bacteria to biodegrade it naturally [1, 2, 12].

Transport Fate of Oil Spill

The general fate and transport of spilled oil dictates its environmental effects and mainly involves the ability of oil to accumulate on top of water bodies forming oil slicks or non-aqueous liquids phase which are generally more resistant to degradation and natural attenuation than the dissolved compounds. From such oil slicks, evaporation of many volatile components of oil spill is the dominant process when the oil slick is in contact with air, such as in marine spills.

The dissolution of certain more soluble oil compounds happens along with some dispersion, diffusion, and advection. While the mechanisms contribute to the reduction of the oil spill and an increased efficiency of the oil spill cleanup, they also increase the mobility of oil resulting in potential spreading of the oil spill over large areas. The persistence of many individual oil components makes them accumulate in the environment and in living organisms. The oil resulting from spills is transported throughout the environment in various forms, and has various characteristics that influence its effects over the environmental elements [12].

Impact of Oil Spills

Oil spill could have negative impact to the environment. The outcome of oil spill from the Niger Delta environment reveals that oil spill occurs in the aquatic habitat and land [8]. When oil spills on land, it affects the growing condition of plants by making essential nutrients like nitrogen and

oxygen needed for plant growth unavailable to them [1, 2, 5, 6], hence affecting soil fertility which in turn affects crop yield. This process may lead to food shortage making malnutrition inevitable. Similarly, when oil is spilled in the aquatic habitat, it floats on the water surface spreading in thin film of oil and oil coats over long distances. It clings to every rock, grain of sand and stems of trees growing along the river bank. This process could prevent natural aeration and leads to death of marine organisms trapped below [6, 12]. The oil washes into coastal marshes, mangrove forests, or other wetlands, fibrous plants and grasses absorb oil, which can damage plants and make the area unsuitable as wildlife habitat. The oil eventually stops floating on the water surface and begins to sink into the marine environment. It has a similar damaging effect on the aquatic ecosystems, killing fishes and smaller organisms that are essentially linked in the global food chain. Fishes are poisoned and killed by the component of oil spill. These lost fishes and other sea foods are normally harvested and preserved by smoking and are sold to the public as food. Mutation and/or long-term damage to species is one of the most far-reaching environmental effects caused by oil spills. The severity of environmental damage caused by an oil spill depends on many factors, including the amount of oil spilled [1], type and weight of oil, location of the spill, species of wildlife in the area, timing of breeding cycles and seasonal migrations, and even the weather at sea during and after the oil spill [13].

Effects of Oil Spill on the Niger Delta Vegetation

The effects of oil spills on the Niger Delta vegetation is observed to be massive with extended impacts. Though, an oil spill can have severe short and long term effects, especially when organisms are considered on an individual basis, it has impacts on the environment. Survey revealed that it has also affected the physical, ecological, psychological, social, economic and health of the Niger Delta people. This paper will look at the economic, ecological and health implication of spilled oil on the Niger Delta premises.

1. Economic Effects

Survey revealed that oil spill has massively contaminated coastal land, rivers, lakes and ocean. This process has resulted to low economic value of agricultural products from the region [14]. Ogbogbo [14] stated that the effects of oil spill in the Niger Delta have massive effects on the ecosystem thereby making coastal land and other vegetation unsuitable for agricultural production and fishing, and therefore, the livelihood of the people of the region is jeopardized

[15]. Oil facilities such as pipelines are laid under the earth across oil producing communities where such lands are used for agricultural purpose. Spill occurring through mechanical damage to oil pipeline by vandals or from poor maintenance culture and the illegal refining of oil may result to explosion and then fire outbreak. During rain, spills are washed into rivers, streams, lakes, rivers and maybe, the ocean thereby polluting them. While oil spill has negative effects on aquatic organism, it also affects water quality and creates imbalance in the ecosystem [16], thus reducing the standard of living, creating unemployment and causing economic retrogression.

2. Ecological Effects

Oil spill is a source of environmental pollution and it has adverse effects on the ecosystem [17]. The ecosystem is observed to have a complex structure as shown by several interacting species. When the system is exposed to oil spill and other sources of pollution, the chemical composition of the habitat involved and quantity of the oil to which organisms are exposed are important factors determining how populations will respond to the spilled oil. Some biochemical traits enable some species more likely to be exposed to oil than others, especially, the habitat and depth of the species [18]. The spill oil depletes the oxygen content in both terrestrial and aquatic environment thereby limiting the amount of oxygen available to living organism, hence resulting to the death of organism [19]. The death of these organisms reduces their population size, which in turn affects the food chain. The implication is food shortage and then starvation, and maybe malnutrition. In the aquatic habitat, toxicity pathways in different species are numerous and some examples may include ingestion of crude or petroleum products, accumulation of contaminants in tissues, DNA damage, impacts to immune functioning, cardiac dysfunction, mass mortality of eggs and larvae, e.g., in fish, loss of buoyancy and insulation for birds, and inhalation of vapors [20-25]. When oil is spilled on agricultural land or when spilled oil in the aquatic environment is leached into coastal land through flood, it prevents water absorption by the soil thereby depriving plant of oxygen. It may have adverse effect on soil nutrient and fertility leading to land degradation and its activities, hence affecting agricultural productivity [26].

3. Health Implication on Human

Oil spill is becoming a normal occurrence in the Niger Delta. Crude oil bioaccumulation through the consumption of contaminated edibles or by breathing crude vapour or mist could have

adverse effects on man [27]. Effects may range from low or high concentration from prolonged exposure and may result to reproductive toxicity, immunotoxicity, genetoxicity and carcinogenicity [27]. ATSDR [28] reported that high exposure results to fatigue, headache, transient nausea, possible vomiting, self–limiting diarrhea and drowsiness. Prolong exposure may damage the nervous system such as peripheral neuropathy [28]. It may also result to throat and stomach irritation, skin irritation, defect in blood immune system, liver, spleen, kidney, developing fetus, lung and even cancer [27].

CONCLUSIONS

The Niger Delta region in Nigeria has massive oil and gas reserves which drive the Nigerian economy [29]. The Niger Delta is made up of a complex ecosystem of diverse species of the terrestrial and aquatic habitat and it is observed to be the largest wetland in Africa. Oil exploration is still ongoing in the region, and while the benefits of oil and gas exploration and productions in Nigeria are not in doubt, the consequent environmental impact of oil explorations in the Niger Delta region cannot be discountenanced. With the challenge of environmental degradation, pollution of surface and ground water, air pollution and health effects in the region, the major sources of livelihood of the inhabitants that depend on agriculture had been destroyed. These disadvantages in the region have massive implication on unemployment, starvation, malnutrition, chronic health and environmental defects. Stakeholders should design a blueprint to rescue the region from further environmental disaster, having in mind that sea food killed as a result of oil spill and other environmental pollution may find their way into the market. Note that no matter who you are and what you do, your immediate environment comes first.

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