

Effects of Illegal Refineries On Aquatic Life in The Niger Delta, Nigeria: A Review

Igbani Flourizel¹; Ronald Winifred Ahulimen² and Tatah Gideon Weapngong³

^{1&3}Department of Fisheries and Aquaculture, Faculty of Agriculture and Life Sciences, Federal University Wukari, KM 200 Katsina-Ala Road, PMB 1020 Wukari, Taraba State, Nigeria.

²Department of Biological Sciences, Faculty of Pure and Applied Sciences, Federal University Wukari, Orchid ID: 0009-0006-3670-4079.

¹Email: igbani@fuwukari.edu.ng, +2347086003973.

²Email: abhulimen@fuwukari.edu.ng. Taraba State, Nigeria.

³Email: gideontatah105@gmail.com.

doi: <https://doi.org/10.37745/ijepr.13/vol12n1117>

Published December 09 2023

Flourizel I., Ahulimen R.W. and Weapngong T.G. (2024) Effects of Illegal Refineries On Aquatic Life in The Niger Delta, Nigeria: A Review, *International Journal of Environment and Pollution Research*, 12(1),1-17

ABSTRACT: *The effects of illegal refineries (“kpo-fire”) and aquatic life in the Niger Delta are reviewed on fish species and ecological systems. The biodiversity of the region has seriously been damaged, killing fishes and aquatic wildlife. Illegal artisanal refining strongly pollutes the ecosystems (air, water, and land); resulting to human ill-health, food insecurities, fish massive mortalities, to mention a few. And, the Federal Government trying to curb the menace, succeeded in doubling the effects by using its military Joint Task Force (JTF) to blow up illegal refining stations (refineries), killing humans, animals, fishes, microbes and generating carbon in the atmosphere, which precipitates as acid rain and sleet to the terrestrial and aquatic ecosystems. Illegal refining is practiced due to failure of the multi-national companies and the Federal Republic of Nigeria government on mitigation and compensation to the Niger Delta, especially engaging the youth on meaningful venture. Nevertheless, there is a ceaseless call by the Niger Delta region; to cushion the effects of illegal refineries. It is crystal clear that lives (humans, animals and fishes) are endangered in the Niger Delta and the illegal refineries needs to be stopped to save the region and its rich biodiversity of flora and fauna forthwith.*

KEYWORDS: fisheries, pollution, biodiversity, crude oil, aquatic resources, conservation.

INTRODUCTION

Illegal crude oil refining or artisanal refining or oil bunkering refers to activities or processes that involve crude oil theft and locally refining them through the use of local resources, using traditional knowledge and skills with little or no application of modern technology (Douglas, 2018). It is a local oil fractional distillation method that involves heating crude oil over a specific range of boiling points in a fabricated oven to extract petroleum products, with the residue being discharged into the environment without consideration of the impact and consequences to the ecosystem (Barenboim *et al.*, 2015; Douglas, 2018). The rudimentary materials for this illegal refining involve drums and metal pipes welded together, in which

crude oil is heated and the resultant distillate crude products (kerosene, fuel, and diesel) are collected, cooled, and condensed in tanks for consumption (Barenboim *et al.*, 2015; Douglas, 2018). These products are readily available at cheap prices for the average man, consequently satisfying local energy demand. The artisanal refinery has created jobs for many youths in the region at the detriment of the ecosystem (SDN, 2015). The production and Marketing system is highly organized with some producing, while others are marketing and distributing these products to communities within and outside the region (SDN, 2015; Douglas, 2018). “Kpo-fire” is a local slang used to describe the artisanal refinery process, which is coined from the explosive sound heard when oil is used as the fuel for the refining purpose, and the term is also used to describe kerosene, fuel, and diesel gotten from artisanal refining (Douglas, 2018).

Poverty and low standard of living despite the available resources in the Niger Delta is one of the major causes of increasing illegal refineries. The artisanal refinery is a business that is fast growing and has spread in all communities with oil fields in the Niger Delta region (SDN, 2015; Ikezam *et al.*, 2021). The rapid development of artisanal oil refining camps across the region has resulted in a semi-structured, informal, and highly entrepreneurial economic system that is managed and operated in each local area along a discrete five-stage value chain, which includes; tap installation, tapping point operation, supply of stolen crude for export and local refining, local refining into products stage, and distribution and sale of refined products (SDN, 2015). Oil theft is aided in Nigeria by pragmatic collaboration between security authorities, militia organizations, the local populace, and oil company employees (SDN, 2015; Bello and Amadi, 2019; Romsom, 2022). Hot-tapping and cold-tapping are two ways used by artisanal refineries to undertake oil bunkering and steal thousands of barrels of oil per day from existing oil pipelines (SDN, 2015). In an effort to encourage private investors into the petroleum downstream sector, preliminary licenses were issued to 26 private companies between year 2002 and 2004, to help build both refineries and petrochemical companies, but up to date, little success story has been recorded. Although some made effort to commence, the companies experienced difficulties at different phases of the project and had to stop. The reasons given include: insufficient funds for capital project, political issues, and government price regularization on products, un-conducive environment, power and security challenges and the unwillingness of the Federal Government to support local investors. The operational private refineries in Nigeria include the Ogbelle Topping plant fully owned by the Niger Delta Petroleum Resources (NDPR) and the University of Port Harcourt modular topping refinery where both atmospheric and vacuum analysis can be carried out for the purpose of research and development.

Crude oil exploration and exploitation is very lucrative and it is the major source of revenue in Nigeria (Anejionu *et al.*, 2015; Romsom, 2022). Approximately 250,000 barrels of crude oil are stolen daily in Nigeria with the majority sold internationally while about 25% stay in the Niger Delta for illegal oil refining and consumption (SDN, 2015; Romsom, 2022; Ufuoma, 2022). The Sea Fisheries Act makes it illegal to take or harm fishes within Nigerian waters by use of explosives, poisonous or noxious substances. Inland Fisheries Act focuses on the protection of the water habitat and its species and prohibits the taking or destruction of fish by harmful means.

Since 2012, the Nigeria military Joint Task Force (JTF) had tried to curtail illegal oil mining activities across the region, destroying thousands of illegal crude oil refining centre and seizing over 500 boats conveying stolen crude oil. In 2012, over 2000 crude oil suspected thieves were arrested, and over 5,000 illegal refineries were destroyed. Despite the efforts by the Nigeria military in combating illegal refineries, they continue to soar; and it seems almost impossible to be stamped out (Relief WEB. 2013). Illegal refineries use crude/local materials and methods to distil the crude oil into its various components (Balogun, 2015). During the illegal refining process of crude oil, only sub-standard kerosene, petrol and diesel are obtained by the refiners; while the remaining crude oil components are discarded untreated as waste products into the environment. In most cases, when these illegal refineries are destroyed by the Nigeria military, further harm is being done to the environment. This is because more petroleum products are discharged indiscriminately into the environment. This had been found to contaminate the environment mostly swampy areas with petroleum hydrocarbons and heavy metals.

The operations of artisanal refineries are carried out in the creeks where the environmentally dangerous hydrocarbons are discharged directly into the atmosphere and waterways thereby constituting severe degradation and pollution to the surrounding environment (Odubo and Onyige, 2019).

However, the activities of artisanal refineries have truncated conservation measures and rapidly promote extinction in the oil-rich region of the Niger Delta. The region is regarded globally as a biodiversity hot spot with the World Wide Fund for Nature (WWFN) and Global 200 Ecoregion classifying it as a critically endangered ecosystem, while the World Bank (1995) posited that the region is the second most sensitive environment in Africa. The Federal Environmental Protection Agency (FEPA) Act acknowledges DPR as the principal authority charged with the responsibility for the removal of oil-related pollution discharged into the environment but polluted sites are increasing daily. Other agencies include the NOSDRA which was established in 2004 by the Ministry of Environment charged with the National Oil Spill Contingency Plan (NOSCP) in compliance with the International Convention on Oil Pollution Preparedness, Response, and Cooperation, of which Nigeria is a signatory. NOSDRA seeks to achieve zero tolerance for oil spill incidences in Nigeria, while advocating for the restoration and preservation of the environment by ensuring good practices in oil exploration, storage, and production, to achieve sustainable development. National Environmental Standards and Regulation Enforcement Agency (NESREA) an agency administered by the Ministry of Environment with the embodiment of laws and regulations focused on the protection and sustainable development of the environment and its natural resources and prohibits the discharge of hazardous substances into the environment. While some of the laws and regulations put in place by the Nigerian government for environmental protection, planning, pollution prevention and control, and the conservation of Nigeria's biodiversity include: the Endangered Species (Control of International Trade and Traffic) Act was enacted to fulfill the obligation assumed under the Convention on International Trade in Endangered Species that focuses on the protection and management of Nigeria's wildlife and some of their species in danger of extinction due to overexploitation (NOSDRA. 2021).

Aim and Objectives of the Review

The aim is to review the effects of illegal refineries on aquatic life (fish) in the Niger Delta.

The specific objectives are to review the:

- i. Effects of illegal refineries on fish species.
- ii. Effects of illegal refineries on Niger Delta aquatic ecosystems.

Effects of Illegal Refineries in the Aquatic Ecosystems

Impacts of Illegal Refineries on Fish species

Approximately 112 illegal refineries were discovered in a particular community located along the OML 17 trunk lines in Ikwerre Local Government Area of Rivers State which amount to 99% of the discoveries on the heels of the recent efforts by the state government to bring to an end the economic sabotage brought as a result of the illegal refineries, as well as the health implications resulting from black soot pollution (Channels, 2022). Loss of biodiversity and destruction of habitats, largely due to topsoil degradation is a major adverse effect of artisanal refineries and oil pollution. Soil pollution by crude oil and its by products as a result of “Kpo-fire” is one of the most common environmental challenges in the Niger Delta. Oil pollution results in the destruction of the region's traditional local economic support systems of farming and fishing lands. Polluted soils by artisanal refining activities do not only deprive the soil of aerations by forming a coat on the topsoil but also kill soil microbes, fungi (micro and macro), and soil organisms that help in soil improvement (Douglas, 2018). Some of these wastes contain toxic components such as the PAHs, which have been reported to be the real contaminants of oil and the most abundant of the main hydrocarbons found in the crude oil mixture (Ndidi *et al.*, 2020).

The impact of artisanal oil refining in the Niger delta is tremendous and widespread covering biological, social (militancy, migration, and the rise of environmental refugees), and economic (nutritional deficiency and food shortages, destruction of traditional means of livelihood) aspects of both humans and the entire ecosystem.(Efenakpo *et al.*, 2018) Environmental effects of artisanal refineries include pollution of air, water, soil, contamination of plants, fishes, and animals with attendant health consequences following human consumption. However, the scope of impact was limited to; flora and fauna, air, soil, aquatic ecosystems, and the mangroves (Efenakpo *et al.*, 2022). The research results have shown that petroleum and its refined products have the ability of increasing the soil heavy metal concentrations above the World Health Organization (WHO) recommended permissible maximum limits (Vwioko *et al.*, 2016 and Akpokodje *et al.*, 2019). They observed drastic in some highly poisonous heavy metals (Ni, Cd, Co, etc). Concentrations, after soils samples were contaminated with petroleum products. Heavy metals are those metals with high relative density (greater than 5g/cm³), when compared with water (Fergusson, 1990; Akpomrere and Uguru, 2020). Heavy metals are persistence and non-biodegradable; therefore, they continue to accumulate in the ecosystems. This implies that plants and animals are continuously exposed to them throughout their life cycle, leading to increased toxicity if accumulated in high dosage (Espin *et al.*, 2014). Heavy metals pollution has become a global environmental problem whose concentrations in the soils have increased recently due to anthropogenic activities. Many researchers have been carried out on the effect

of heavy metals in plants morphological and physiological development; due to their phytotoxic effects, which varies from plants growth inhibition, chlorosis wilting and death in severe cases, this shows that a run off could poison the aquatic systems of oil (Ikhajiagbe *et al.*, 2018; Akpokodje and Uguru, 2019).

Osuagwu and Olaifa (2018) researched on the effects of oil spill on fish production in the Niger Delta. They stated that crude oil spill endanger fish hatcheries in coastal water and also contaminates commercially valuable fish flesh. They also examined the effects of oil spill on fish production in the Niger Delta of Nigeria from 1981-2015, using an estimable model based on Cobb Douglas production function. They stressed that oil activities depresses fish production in the long run because of the unwholesome environmental degradation that accompany exploration of crude oil region. They reported that the nature of operating equipment used by the oil companies including pipeline vandalization by errant youth of the region are contributory factors to the number of oil spills on the environment, which constitute a setback to fish production and agricultural productivity, resulting from the destruction of the aquatic ecosystem.

Impacts of Illegal Refineries on Flora and Fauna

The Niger Delta is where most of these oil refining are carried out, the third largest wetland ecosystem in the world covering approximately 75000km²; the region consists of nine states and is endowed with crude oil deposits and a lot of biodiversities that have been immensely exploited, as well as abundant natural resources (Efenakpo *et al.*, 2018). It has the richest wildlife resources (flora and fauna) found in the country's rainforest ecosystem and harbours many locally and globally endangered species and approximately 60-80% of all plant and animal species found in Nigeria (Efenakpo *et al.*, 2018). Five distinct ecological zones namely: mangrove forest and coastal vegetation, freshwater swamp forest, lowland rain forest, derived savannah, and montane zone can be observed in the region (Efenakpo *et al.*, 2018). The region's wetlands and its rich biodiversity repository are changing rapidly due to several anthropogenic activities namely: oil spillage and gas pollution, urbanization and deforestation, invasive alien species, annual bush burning practice, and land clearing for agricultural purposes (Adekola and Mitchell, 2011; Efenakpo *et al.*, 2018). Consequently, raising concerns for the wetlands' health and biodiversity and communities relying upon its ecosystem services, they posited that the region which is the main seat of oil and gas production in Nigeria, is suffering from the destructive effects of oil and gas exploration and production in terms of enormous oil pollution, biological diversity degradation, and extinction (Bello and Amadi, 2019). Oil pollution from illegal crude oil venture distorts aquatic life which not only destroys the source of livelihood of fishers but also causes a shortage of supply of seafood (Albert *et al.*, 2018); it destroys the fertile soil as well as crop yields (Nwankwoala *et al.*, 2017; Ogbuagu *et al.*, 2011; Douglas, 2018); which makes it difficult for the farmer to farm as a means of livelihood. It also causes air pollution through the rapid spread of black soot (Onakpohor *et al.*, 2020; Simbi-Wellington and Ideriah, 2020). The impact of illegal refineries on the aquatic environment in the Niger Delta has raised questions of great concern in the minds of the inhabitants in the region who have suffered polluted air, contaminated environment, degraded forests, biodiversity loss, and high atmospheric temperatures (Anejionu *et al.*, 2015). Although, the economic impact of oil theft associated with these operations of the illegal refineries and on their host communities are

widely reported. Illegal refining of stolen oil is one of the major causes of oil spills in the Niger Delta while other causes include sabotage of oil installations, corrosion of pipe lines; storage tanks, and accidents in oil production operations (Efenakpo *et al.*, 2018; Bello and Amadi, 2019). These illegal refineries operators used local materials and methods in refining some petroleum products from the crude oil. The activities of the illegal refineries operators have become a menace in the region, and the Nigeria government is trying its best to curtail it.

The International Union for the Conservation of Nature and Natural Resources (IUCN), posited from the evaluation of coastal regions of eleven West African countries, that Niger Delta is unprotected due to the loss of substantial portions of their area which translates to the loss of biodiversity despite having over 70 Protected Areas (PAs) (Phil-Eze and Okoro, 2009; Bello and Amadi, 2019). There are over 119 mammal species, 201 bird species, 248 fish species, 30 reptile species, and over 850 vulnerable tree species in the Niger Delta region (Phil-Eze and Okoro, 2009). With a total coastline of 400 km, it accounts for about 50% of the Nigerian coastline and over 80% of the coastal fisheries production. Local modular refining of crude oil in the region causes pollution which is traumatic to the environment and biodiversity. Mankind cannot possibly exist alone without other important components of biodiversity (Bello and Amadi, 2019). All components have a symbiotic relationship and they work together to ensure continued existence (Lang and Benbow, 2013; Gross *et al.*, 2021). Several components of the region's biodiversity are important because they provide food, medicine, and raw materials for the production of other essential goods. The life of a man is indirectly threatened when there is a failure to control activities that destroy biodiversity and promote oil pollution. The common practice of certain contractors as well as security officers burning recovered stolen crude is not environmentally friendly and further damages the Niger Delta's ecosystem. These activities cause serious soil, and water contamination, as well as the loss of mangroves (Akinjide-Balogun, 2001). Although, the Nigerian government has taken steps to control and mitigate oil pollution and the conservation of her biodiversity to improve and protect the air, land, water, forest, and wildlife by using the instrumentality of agencies, laws, and policies nothing much has changed in the region as its still plague with oil and gas pollution. There are regional and international instruments in place for the mitigation of oil pollution and the conservation of biodiversity. Institutions created by law for the control and mitigation of oil pollution such as the DP saddled with the responsibility of the development of the nation's oil and gas resources, influence and achieve the optimum exploitation, conversion, and utilization of petroleum and its derivatives for the maximum benefit of Nigerians while ensuring minimal damage to the environment (Akinjide-Balogun, 2001). Nearly 1,000 species of fishes are found in Nigeria (Okafor *et al.*, 2010, FRN. 2010). Several species of fish have been reported in several part of the Niger Delta region of Nigeria. For instance, (FRN. 2010) reported the presence of 648 fish species in Cross River State.

Artisanal petroleum refining technology in the Niger Delta is a source of air pollution, hence impacting air quality (Onakpohor *et al.*, 2020). Artisanal refining is also responsible for the inputs of gaseous, solid, and liquid wastes into the environment (Avwiri and Ononugbo, 2012). The air quality of artisanal refining areas and their surrounding communities are poor as pollutants such as nitrogen dioxide (NO²), volatile organic compounds (VOCs), and ammonia (NH³) which are usually above the recommended limits by the World Health

Organization (Simbi-Wellington and Ideriah, 2020). Oil pollution gives rise to the occurrence of certain ailments such as respiratory tract irritation, (cough, catarrh, tearing), allergies, irritation of the eyes, irritation of the skin, exacerbation of asthma, lung cancer, chronic bronchitis, Chronic Obstructive Pulmonary Disease (COPD) and several other chronic lung diseases as some of the health effects in areas that have suffered from oil pollution in Nigeria (Oyadongha, 2021). This is often a result of inhalation of contaminated air, intake of oil-polluted contaminated food, and also as a result of the consumption of contaminated water. Hydrocarbon and black soot air pollution-related illnesses could assume an epidemic proportion and thus overwhelm the health facilities and health manpower resulting in the sudden collapse of the health sector (Oyadongha, 2021). Consequently, the health, environmental, economic, and social effects of hydrocarbon and black soot-related air pollution are dangerous to humans and the environment and must be given keen attention and speedy solution in stopping this looming epidemic from exploding and getting out of proportion and control.

Fishes have been widely studied in surface water resources in several water resources in the Niger Delta (Abowei and Hart, 2008; Abowei and Ogamba, 2013; Abowei *et al.*, 2007; Abowei *et al.*, 2008 and Aghoghhouwia *et al.*, 2016). Fish composition frequently found in surface water includes both shelled and fin fish depending on the habitat. In the present situation the fish composition, diversity and abundance is on the decreasing trend especially in surface water resources with high level of human interference (Izah *et al.*, 2018). The widespread artisanal oil refinery contributes to the growing decline of biodiversity such as wild flora and fauna in the Niger Delta. Flora and fauna in the region are severely impacted as these refineries pollute the air, water, soil, and the entire ecosystem. Faunas absorb heavy metals from polluted ecosystems which harm them. For animals such as birds that rely on beautiful plumage coloration for courtship, gaseous pollution (black soot) from artisanal refineries may also indirectly affects their reproduction. Flora absorbs hazardous substances such as the Polynuclear Aromatic Hydrocarbons (PAHs), from the residual waste deposited on the soil, water, and atmosphere. This affects plant growth and results in the reduction of the abundance and diversity of plant species. Yabrade and Tanee (2016) compared the Total Hydrocarbon Content (THC) and the Total Organic Carbon (TOC) in affected sites to total hydrocarbon and total organic carbon in the unaffected controlled site and observed that there was a significant increase in THC and TOC in refinery sites compared to the controlled sites. Thus, artisanal oil refineries can be disastrous to the ecosystem. More also, the process of photosynthesis is also impaired as a result of the collected. This could be attributed to the volume of petroleum products received by these points during the crude oil refining process. Similar results on the effects of petroleum products on the heavy metals concentrations in soils samples were reported by Iwegbue (2011) and Akpomrere and Uguru (2020). According to the Iwegbue (2011), the Ni, Cd and Zn concentration of crude oil impacted soils increased from 7.0 to 31 mg/kg, 0.02 to 1.12 mg/kg and 23 to 29.3 mg/kg respectively. High heavy metals concentrations in the soil have a lot of adverse effects on living things; therefore, it has become a great concern to agricultural production and environmental health (Ferguson, 1990; Goyer, 1997). The aesthetic scenery of the forest and the presence of fauna species that enhance ecotourism in the region can be affected as a result of the fragmentation of the wildlife habitat. Important ecosystem services such as recycling of water, air purification, and the amelioration of climate change can be disrupted. In addition, the production of crops and

fishing activities are also affected. Crops on farmlands will either die or have stunted growth. Oil spills on the river can as well affect the survival of aquatic organisms by blocking the flow of oxygen needed in the water. Shortage in the production of crops and the aquatic organism can result in a shortage in the food supply which can affect society. One very important effect of the discharge of illegal refineries waste is the loss of vegetation which provide food and shelter for both vertebrates and invertebrates, this leads to fragmentation of wildlife habitat, alteration of the local water cycle since trees play important role in water cycling and disruption of air purification role of trees due to reduced carbon sequestration and aggravation of climate change (Umechuruba, 2005).



Plate 1: Illegal refinery set on fire by the JTF (Oyadongha, 2013)

Impacts of Illegal Refineries on Mangrove Ecology

Severe damage has been done to the aquatic environment as a result of artisanal refining which has led to the loss of the mangrove plants in the region. Mangroves are a shelter for biological diversity consisting of diverse aquatic and terrestrial flora and fauna which include mammals (monkeys, antelopes, and manatees), mollusks (bivalves, oysters), crustaceans, fish, reptiles, and avian species (Onyena and Sam, 2020). Duke (2016) noted that a review of crude oil impact on mangroves shows that 37% of the global impact had occurred in the Niger Delta. Artisanal refining has caused pollution in many intertidal creeks which have left the mangroves denuded of leaves and stems, leaving roots coated in a bitumen like substance sometimes 1cm or thicker. The mangrove forest are spawning areas for fish and nurseries for juvenile fish and the extensive pollution of these areas is impacting the fish life-cycle (Albert *et al.*, 2018). The magnitude of the damage experienced on mangrove vegetation depends on the sensitivity of its pneumatic roots to petroleum waste (Asimiea, 2011). Dominic (2016) and Ikezam *et al.* (2021) reported that wastes from artisanal refining sites released into the river spread along the up and downstream river course due to tidal effects consequently leading to the death of mangrove plants, especially those close to the sites showing heavy

mortality of merchantable trees as a result of the wastes discharged from illegal refineries. As the mangrove plants die and decay, the soil stabilization properties of the roots are lost, leading to coastal erosion and breeding grounds for fish. The loss of vegetation drastically hampered the regeneration of species in the mangrove forest due to contamination of seeds and saplings on the forest floor (Asimiea and Omokhua, 2013). Onuh *et al.* (2021) noted that the continual failure of the clean-up programme in the Niger Delta is responsible for the increasing numbers of the artisanal crude oil-refining economy in the region. However, the government through the Nigerian National Petroleum Corporation (NNPC) has disbursed \$180m as a take-off fee for the 21 selected companies for the cleanup of Ogoni land which is part of the Niger Delta. The need for the project to be successful must be a priority for the government while creating synergy was security outfits to curb the oil refineries menace. The mangrove vegetation in the Niger Delta brackish water area includes five species namely *Rhizophora racemose*, *Rhizophora harrisonii*, and *Rhizophora mangle* (Red Mangroves), *Avicennia Africana* (White Mangrove), and *Laguncularia racemosa* (Black Mangrove). Other species of plants observed are the marine grass *Paspalum vaginatum*, and fern *Acrostichum aureum* which are all affected by waste from artisanal refineries (Balogun, 2015).



Plate 2: Mangroves degraded by illegal refineries (CEHRD. 2019)

Impacts of Illegal Refineries on Aquatic Ecosystems

Aquatic ecosystems oil spills pollution is the single most important threat to freshwater, coastal, and marine ecosystems of the Niger Delta, and such impacts in the drinking water quality, testudines species (aquatic turtles), fisheries, and other aquatic organisms (IUCN Niger Delta Panel, 2018). Fishes have been driven away from shallow waters into the deep-sea as a result of pollution in the region. Oil attenuates oxygen in the water column and coats the breathing apparatus of aquatic organisms. The refining processes often lead to two drums of crude oil amounting to one drum of the product once refined, leading to a significant quantity of waste being released into the aquatic environment (Anifowose *et al.*, 2014; Albert

et al., 2018). Artisanal refineries like most industrial activities produce environmental hazards that are slow poisons (Asimiea and Omokhua, 2013). Specifically, it starves mangroves of oxygen by coating the breathing roots of the mangroves and scotches the tender structures of aquatic macrophytes of tidal freshwater vegetation. Untreated crude oil waste discharged indiscriminately into aquatic systems destroys the medicinal plant. There are growing concerns about the quality of fish and other seafood due to the accumulation of hydrocarbons with a serious health issue in the region. More also, the fisheries sector is suffering due to the destruction of fish habitat in the mangroves and highly persistent contamination of many of the creeks due to heavy metals transported during artisanal refining, making them unsuitable for fishing (Davies and Ekperusi, 2021). The contents of the effluents have serious toxicological effects on aquatic life, the environment, and humans. When industrial effluent and oil waste is discharged into a water body, it can cause depletion of dissolved oxygen due to transformation of organic components into inorganic compounds, loss of biodiversity through a decrease in amphipod population that is important in the food chain, eutrophication, and short-term toxicity in fish (Decker, 1981). Environmental pollution resulting from artisanal refining activity has altered the natural quality of the aquatic ecosystem thereby posing an adverse effect on the food chain.

Nwankwoala *et al.* (2017) analyzed soil samples from artisanal refining sites and recorded high levels of crude content from 1m, with concentration reducing with depth up to 3m. Once introduced in the environment, PAHs could be stable in soils and sediments thus, resist degradation and when absorb by organisms, could accumulate in adipose tissues and further transferred up in the trophic chain or web with lethal effects (Martens and Frankenberger, 1995; Ogbuagu *et al.*, 2011).

CONCLUSION

Oil pollution has for so long a time perpetrated the Niger Delta environment and biodiversity with little or nothing being done to alleviate the menace. The impacts of these illegal artisanal refineries on the aquatic ecosystems; the mangrove ecology, soil, farms, air, flora and fauna of the Niger Delta region. This in return has affected the general economy of the region negatively by reducing the number of persons involved in agriculture and fishing activities, it has also impacted negatively on the health of the people due to the improper refining methods employed. Total shutdown of all illegal refineries and appropriate improvement in the production and exploration process of crude oil and its products may mitigate its effects on the environment. To bring to a stop the seemingly unstoppable situation which has constantly harmed the biodiversity (fish and aquatic wild life) of the region, a call of stakeholders (oil companies, government, and host communities) in oil exploration and exploitation should work together in mapping out measures to deal with possible oil pollution and biodiversity loss. Nevertheless, oil exploration and production companies should sign agreements with the host communities and provide guarantors up-front to cover the cost of clean-ups and possible relocation of host communities in the event of oil pollution. Environmental Impact Assessment should be taken seriously and activities of oil companies should be properly scrutinized to ensure that they carry out due diligence and abide by best practices to prevent possible oil pollution and subsequent mishap to the environment. Furthermore, areas identified as having endangered species should be completely closed for oil production

activity. Environmental education and justice, youth empowerment through vocational training should be carried out, as well as cleaning, afforestation, and reforestation of degraded sites.

In an attempt to provide solutions to the above unfavorable scenario, the country is left with the following options: the establishment of more conventional refineries, legalization of illegal refineries, swapping of crude oil with refined products from other countries and setting up of modular refineries around the country. The establishment of more conventional refineries by both the government and private investors seems to be moving on a snail speed. Large capital requirement and un-conducive environment serve as major hindrances. The full deregulation of the downstream petroleum sector and government assistance in raising funds will help in tackling this problem. The further establishment of more conventional refineries if these factors are not fully looked into might not yield significant output.

The legalization of illegal refineries brings mixed feelings among citizens as while some individuals fully support the idea, the others see it as a means of encouraging theft. Refineries can be characterized as illegal when the source of raw material (crude oil) is gotten through unofficial means or the mode of operations is sub-standard. Currently, it is observed that the “bigger boys” now operate on sophisticated skid mounted automated refinery. Generally, problems associated with illegal refinery includes: pollution (air, land and water), production of yield cuts with bad specifications, fires and explosion scenario, loss of capital infrastructures and profits for the government, poor reputation of the country, community dispute and death of plants and animals (mostly fish). Although, the government should not legalize the illegal refinery operation, operational adjustments can be made to have a WIN-WIN situation.

Swapping of crude oil for refined products from other countries may serve as a temporary solution but definitely not a permanent one. There is also no direct measure of calculating the exact refined products for raw crude oil. It will also eventually lead to low employment rate within the citizens, bad reputation and more redundancy from the other established ones. This leaves the country with the most feasible option the establishment of modular refineries at strategic locations within the country.

The Federal Government’s failure to intervene and bring sustainable development to the region has also led to the initiation of militancy activities which is also a contributing factor to the growing numbers of these illegal refineries. The artisanal refinery is a major challenge to the petroleum industries, man, and its environment through its process of sourcing the raw material, mode of production, and after-use effect. These refineries carry out operations without putting in place measures of ameliorating the environmental impact. Signs of areas with illegal refinery activities are dirty water and sheen of oil visibly floating on the surface of the river, littering of river banks with lumps of oil, and dying vegetation along the riverbank and within the vicinity of the camp. The illegal refinery is the major source of pollution and the activities of artisanal refineries degrade the ecosystem which is the source of livelihood for rural people. The relatively low cost of sourcing the rudimentary materials for these illegal refineries also allows for quick setup of these operations and increases the numbers of “kpo-fire” refineries which poison aquatic life (fish and wildlife).

Recommendations

Phytoremediation can be used to detoxify and repair oil spilled systems plants such as *Eupatorium capillifolium* (dog fennel), Hibiscus cannabinus (herbaceous West African plant species) has been used to repair oil spilled ecosystem. The need for the project to be successful must be a priority for the government while creating synergy with security outfits to curb the oil refineries menace. Oil exploration and production companies should sign agreements with the host communities and provide guarantors for possible relocation of host communities in the event of oil pollution. Activities of oil companies should be properly scrutinized to ensure that they carry out due diligence and abide by best practices to prevent oil pollution and subsequent to the environment. Areas identified as having endangered species should be completely closed for oil production activity. Environmental education and youth empowerment through vocational training should be carried out such as cleaning, afforestation, and reforestation of degraded environment/aquatic ecosystem. Regardless of the multi-complex situation of artisanal refineries in Niger Delta, regional cleanup sites along problem areas could help contain spills more quickly, speeding up the cleaning process. The Nigerian military JTF should use better ways to deal with illegal crude oil refiners not to damage the aquatic ecosystems the more.

The continuation of empowering able bodied youths on crude oil pipe line surveillance and the establishment of modular refineries in the region will reduce bunkering, illegal refineries, vandalism; safe lives and biodiversity.

REFERENCES

- Decker, J. C. (1981). Potential health hazards of toxic residues in sludge. In sludge-health risk of land application. Ann. Arbon. Science. Public. Inc. 1997; 85-102.
- Ferguson, J. E. (1990). The Heavy Elements, In Chemistry, Environmental Impact and Health Effects. Oxford, Pergamon Press., 211–212.
- World Bank (1995). Defining an Environmental Strategy for the Niger Delta. World Bank, Washington DC. Industry and Energy Operations Division, West/Central Africa Division.
- Martens, D. A., and Frankenberger Jr, W. T. (1995). Enhanced degradation of polycyclic aromatic hydrocarbons in soil treated with an advanced oxidative process—Fenton's reagent. Soil and Sediment Contamination, 4(2), 175-190.
- Goyer, R.A. (1997). Toxic and essential metal interactions. Annual review of nutrition, 17, 37-50.
- Dublin-Green, C. O., Awosika, L. F. and Folorunsho, R. (1999). Climate Variability Research Activities in Nigeria, a report published by the Nigerian Institute for Oceanography and Marine Research, Victoria Island, Lagos, Nigeria.
- Limson, J. (2002). Environmental Remediation in Nigerian oil Regions. Science in Africa.co.za. Archived from the original.
- Umechuruba, C. I. (2005) Health impact assessment of mangrove vegetation in an oil spilled site at the Bodo West Field in Rivers State, Nigeria. Journal of Applied Sciences and Environmental Management (ISSN: 1119-8362) Volume 9 Number 1.

- Vwioko, D.E., Anoliefo, G. O. and Fashemi, S.D. (2006). Metal concentration in plant tissues of *Ricinus communis* L. (castor oil) grown in soil contaminated with spent lubricating oil. *Journal of Applied Sciences and Management*, 10(3):127-134.
- Abowei, J.F.N Sikoki F.D, Hart A.I, *et al.* (2007). Fin fish fauna of fish fauna of fresh water reaches of the lower Niger river, Niger delta. *Nigeria journal of aquatic studies* (3):21-28.
- Abowei, J.F.N Tawari C.C, Hart A.I, *et al* (2008). Fin fish composition, abundance, and distribution in lower Niger river Niger delta, Nigeria. *International journal of tropical agriculture and food system* 2(1):46-53.
- Abowei, J.F.N and Hart, A.I (2008). Fisheries characteristics of the fresh water reaches of the Lower Niger River, Niger Delta, Nigeria. *Journal of applied science and environmental management*. 12(1)5-11.
- Anifowose, B. (2008). Assessing the Impact of Oil and Gas Transport on Nigeria's Environment, U21 Postgraduate Research Conference Proceedings 1. The University of Birmingham UK.
- Onuoha, F. C., (2008). Oil pipeline sabotage in Nigeria: dimensions, actors and implications for national security L/C. Africa. Security. Review. Institute. Security. Studies. 17 (3).
- Phil-Eze, P. O. and Okoro, I. C. (2009). Sustainable biodiversity conservation in the Niger Delta: a practical approach to conservation site selection, *Biodivers Conserv* 18:1247–1257.
- Vidal, J. (2010). "Nigeria's agony dwarfs the Gulf oil spill. The US and Europe ignore it." *The Observer*. Government's national oil spill detection and response agency (NOSDRA) says that between 1976 and 1996 alone, more than 2.4m barrels spilled in the delta.
- Federal Republic of Nigeria. (FRN. 2010). Abuja:Fourth National Biodiversity Report.
- Emma-okafor, L. C., Ibeawuchi, I.I., Obiefuna, J. C. (2010). *Biodiversity conservation for sustainable agriculture in tropical rain forest Nigeria*. *New York science Journal*, 3(1)81-88.
- Ubom, R. M. (2010). Ethnobotany and Biodiversity Conservation in the Niger Delta, Nigeria. *International Journal of Botany*. (6):310–322.
- Asimiea, A. O. (2011). The effect of Climate Change on the Nigerian Coastline: A case study of the Niger Delta. www.bipublication.com. *International Journal of Advanced Biotechnology and Research*. Vol. 2 Issue 2, pp 291-295.
- Avwiri, G. O. and Ononugbo, C. (2011). Assessment of the Naturally Occurring Radioactive Material (Norm) Content of Hydrocarbon Exploration and Production Activities in Ogbia/Egbema/Ndoni Oil/Gas Field, Rivers State, Nigeria (c) African Society for Scientific Research Co-Published by Human Resource Management Academic Research Society 572.
- Ogbuagu, D. H., Okoli, C. G., Gilbert, C. L., and Madu, S. (2011). Determination of the contamination of groundwater sources in Okrika Mainland with Polynuclear Aromatic Hydrocarbons (PAHs). *British Journal of Environment and Climate Change*, 1(3), 90-103.
- Adekola, O. and Mitchell, G. (2011). The Niger Delta wetlands: threats to ecosystem services, their importance to dependent communities and possible management measures, *International Journal of Biodiversity Science, Ecosystem Services and Management*, Vol. 7, No. 1, 50–68.

- Abowei, J.F.N, and Ogamba E. N. (2013) Effects of water pollution in Koluama area, Niger delta; fish species composition histology, shrimp fishery and fishing gear type. *Research Journal of Applied Science and Engineering Technology*, 6(3): 336-372.
- Asimiea, A., and Omokhua, G. (2013). Environmental impact of illegal refineries on the vegetation of the Niger Delta, Nigeria. *Journal. Agriculture. Resources*, 13(2), 121-126.
- Taylor, A. (2013). Nigeria's Illegal Oil Refineries. Available online at [https://www.theatlantic.com/photo/2013/01/nigerias-illegal-oil-refineries/100439/accessed 20/2/2022](https://www.theatlantic.com/photo/2013/01/nigerias-illegal-oil-refineries/100439/accessed%2020/2/2022).
- Oredein, O. (2013). Shell Sees Rise in Crude Theft in Nigeria. Dow Jones News wire. www.businessfox.com/news/2020/3/4.
- Relief WEB (2013). Raising Niger Delta oil theft threatens security available at; <https://reliefweb.int/report/Nigeria/raising-niger-delta-oil-theft-threatens-security>.
- Espin, S., Martínez-Lopez, E., Jimenez, P., Maria-Mojica, P. and García-Fernández, A.J. (2014). Effects of heavy metals on biomarkers for oxidative stress in Griffon Vulture (*Gyps fulvus*). *Environmental Research*, 129: 59-68.
- Nigerian NRC (NNRC) (2014). The Environment, Social and Economic Impact of Illegal Oil Refining in the Niger Delta. [Http://nigerian nrc.org/blog/anonymous/enviro-socandec.impactof-illegal-oil-refining-niger-delta](http://nigerian-nrc.org/blog/anonymous/enviro-socandec.impactof-illegal-oil-refining-niger-delta).
- Anifowose, B., Lawler, D., Van der Horst, D., and Chapman, L. (2014). <https://doi.org/10.1111/area.12065>. Evaluating interdiction of oil pipelines at river crossings using Environmental Impact Assessments: evaluating interdiction of oil pipelines at river crossings. *Area*, 46, 4-17.
- Stakeholder Democracy Network (SDN) (2015). 'Communities not Criminals – Illegal Oil Refining in the Niger Delta'. London, United Kingdom. 46pp Available at: <https://www.stakeholderdemocracy.org/sdn-report-communities-not-criminals-illegaloil-refining-in-the-niger-delta>.
- Balogun, T.F. (2015). Mapping impacts of crude oil theft and illegal refineries on mangrove of niger delta of Nigeria with remote sensing technology. *Mediterranean journal of social science* 6(3) 150-155.
- Barenboim, G. M., Borisov, V. M., Golosov, V. N., and Saveca, A. Y. (2015). New problems and opportunities of oil spill monitoring systems. . <https://doi.org/10.5194/piahs-366-64-2015> *International. Associatiom. Hydrological. Science*, 366, 64-74.
- Aghoghhouwia, O.A. Ohiman E.L, and Izah S.C. (2016). Bioaccumulation of heavy metals in different tissues of commercially important fish species from Warri River, Niger Delta, Nigeria, *Biotechnology Research*.
- Yebrade, M. and Tanee, F. B. G. (2016). Assessing the impact of Artisanal Refining on Vegetation and Soil Quality: A case study of Warri Southwest Salt Wetland of Delta State, Nigeria. *Resources. Journal. Environment Toxicity*. 10(4): 205-212.
- Duke, N. C., (2016). Oil spill impacts on mangroves: recommendations for operational planning and action based on a global review. *Mar. Pollution. Bull*.
- Dominic, A. A. (2016). Impact of the illegal oil business and Nigeria economy: the experience of crude oil theft, bunkering, and pipeline vandalism in the 21st century. *International. Journal. Advanced. Academic, Resources, Arts Human & Education*., 2(8).

- Nwankwoala, H. O., Harry, M. T., Amangabara, G. T. and Warmate, T. (2017). Impacts of Artisanal Refining, Activities on Soil and Water Quality in Parts of Okrika and OguBolo Areas of Rivers State, Nigeria. *Journal of scientific achievements* volume 2, issue 9, page: 13-19.
- Ikhajagbe B., Anoliefo G.O., Ohanmu E.O. and Aliu E. (2018). Effects of different Cadmium Levels on the Growth and Yield Parameters of Wild Vigna. *Studia Universitatis Babeş-Bolyai Biologia*, LXIII, 2, 169-182.
- IUCN (International Union for the Conservation of Nature) Niger Delta Panel, (2018). Developing a biodiversity conservation strategy for the Niger Delta; Integrating Biodiversity Considerations into SPDC's Operation.
- Douglas, S. I. (2018). Effect of Illegally Refined Crude oil ("kpo- fire") Residue on Soil Fungi. *International Journal .Current .Microbiological .Applied. Science*. 7(12): 3309-3316. <https://doi.org/10.20546/ijemas.2018.712.382>
- Efenakpo, O. D., Ijeomah, H. M., and Ayodele, A. I., (2018). Threat and Conservation of Wildlife Resources in Niger Delta Region of Nigeria. In: Ogunjinmi, A. A, Oyeleke, O. O., Adeyemo, A. I., Ejidike, B. N., Orimaye, J.O., Ojo, V. A., Adetola, B. O. and Arowosafe, F.C. (eds.) *Wildlife Management in Nigeria; the Roadmap for Biodiversity Conservation*. Proceedings of the 2nd Wildlife Society of Nigeria (WISON) Conference held in Ondo, Pp.259 – 267.
- Albert, O. N., Amaratunga, D., and Haigh, R. P. (2018). Evaluation of the impacts of oil spill disaster on communities and its influence on restiveness in Niger Delta, Nigeria. <https://doi.org/10.1016/j.proeng.2018.01.136>. *Proc. Eng.*, 212, 1054-1061.
- Izah, S. C., Aigberua, A. O. and Nduka, J. O. (2018). Factors affecting the population trend of biodiversity in the Niger delta region of Nigeria. *International Journal of Avian & Wildlife Biology*, 3(3):199-207. DOI: 10.15406/ijawb.2018.03.00085
- Osuagwu, E. S. and Olaifa, E. (2018). Effects of oil spill on fish production in the Niger Delta. *PLOS ONE* 13 (10): 0205114. <https://doi.org/10.1371/journal.pone.0205114>. www.journals.plos.org.
- Mamudu, A., Okoro, E. E, Olabode O., F.B. Elehinafe *et al* (2019). Challenges and prospects of converting Nigeria illegal refineries to modular refineries.
- Odubo, T. R. and Onyige, C. D. (2019). Environmental degradation and livelihood vulnerabilities in the Niger Delta: Examining the role of artisanal crude oil refining. *International Journal of Innovative Social Sciences and Humanities Research* 7(4): 45 -52.
- Akpokodje, O. I. Uguru, H. and Esegbuyota, D. (2019). Evaluation of phytoremediation potentials of different plants' varieties in petroleum products polluted soil. *Global Journal of Earth and Environmental Science*. 4(3):41-46.
- Akpokodje, O.I. and Uguru, H. (2019). Impact of Farming Methods on Some Anti-nutrients, Nutrients and Toxic Substances of Cassava Roots. *International Journal of Scientific Research in Science, Engineering and Technology*, 6 (4): 275-284.
- Bello, A. T., and Amadi, J. (2019). Oil Pollution and Biodiversity Conservation in Nigeria: An Assessment of Legal Framework. *Journal of Geoscience and Environment Protection*, 7, 354-371. <https://doi.org/10.4236/gep.2019.78024>.
- CEHRD (Center For Environment, Human Right Development) (2019). Environmental health, human rights and gender baseline for Ogoni land clean-up. Center for environment, Human right development Port Harcourt Nigeria.

- Simbi-Wellington, S. W. and Ideriah, T. J. K. (2020). Assessment of Air Quality in Mangrove Forest around Gas Flare in Awoba Flow Station in Rivers State Nigeria. *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)*. DOI: 10.9790/2380-1302013847 e-ISSN: 2319-2380.
- Akpomrere, O. R. and Uguru, H. (2020). Uptake of heavy metals by native plants growing around an abandon crude oil refining site in southern Nigeria: A case study of African stargrass. *Direct Research Journal of Public Health and Environmental Technology*, 5 (2): 19-27.
- Bebetidoh, O. L., Kometa, S, Pazouki, K, and Norman, R. (2020). Sustained impact of the activities of local crude oil refiners on their host communities in Nigeria, *Heliyon* 6; e04000.
- Onakpohor, A., Fakinle, B. S., Sonibare, J. A., Oke, M. A., and Akeredolu, F. A. (2020). Investigation of air emissions from artisanal petroleum refineries in the NigerDelta Nigeria. *Heliyon*; 6(11):e05608. DOI: 10.1016/j.heliyon.2020.e05608.
- Ndidi, N., Bekinbo, D., and Gbenene, T. J. (2020). Impact of Illegal Crude Oil Refining in Jike-ama River of Bille Kingdom, Rivers State, Nigeria, *International Journal of Biochemistry Research and Review* 29(6): 46-51.
- Onyena, A. P., and Sam, K. (2020). A review of the threat of oil exploitation to mangroveecosystem: <http://www.elsevier.com/locate/gecco>. Insights from Niger Delta, Nigeria, *Global Ecology and Conservation*.
- Oyadongha, S. (2021). Kpo-fire: Anxiety as strange soot envelops Yenagoa, <https://www.vanguardngr.com/2021/12/kpo-fire-anxiety-as-strange-black-sootenvelops-yenagoa/> Accessed 18/03/2022.
- National Oil Spills Detection and Response Agency (NOSDRA) (2021). National Oil Spills Monitor, <https://oilspillmonitor.ng/>.
- Gross, E., Jayasinghe, N., Brooks, A., Polet, G., Wadhwa, R. and Hilderink-Koopmans, F. (2021). A Future for All: The Need for Human-Wildlife Coexistence. (WWF, Gland, Switzerland).
- Ikezam, P., Elenwo, E. I., and Oyegun, C. U. (2021). Effects of Artisanal Refinery on the Environment, Public Health and Socio-Economic Development of Communities in the Niger Delta Region. *Environmental Management and Sustainable Development*, 10 (3), 97-111.
- Onuh, P. A., Omenma, T. J., Onyishi, C. J., Udeogu, C. U., Nkalu, N. C., and Iwuoha, V. O. (2021). Artisanal refining of crude oil in the Niger Delta: A challenge to clean-up and remediation in Ogoni land Local Economy, 36:6, 468-486.
- Davies, I. C., and Ekperusi, A. O. (2021). Evaluation of Heavy Metal Concentrations in Water, Sediment, and Fishes of New Calabar River in Southern Nigeria. *Journal of Limnology and Freshwater Fisheries Research*, 7(3): 207-218. <https://doi:10.17216/LimnoFish.816030>.
- Channels, T.V. (2022). Illegal Refineries Discovered In Rivers. Available online: <https://www.channelstv.com/2022/01/23/112-illegal-refineries-discovered-inrivers> Accessed 20/3/22.
- Romsom, E. (2022). Global oil theft: impact and policy responses. WIDER Working Paper. UNU-WIDER. United Nations University world institute for development economics research 47pp/16 <https://doi.org/10.35188/UNU-WIDER/2022/147-1>.

Efenakpo, O. D., Daves, I. C, Onuchukwu, N. C and Kejeh, A.C. (2022). Illegal oil refining and its implications on the niger delta ecosystem. Institute of Geosciences and environmental management, Rivers State University.

NOSDRA (National Oil Spill Detection And Response Agency). (2022) National Oil Spill Response Agency.

Wikipedia (2022). Environmental issues in the Niger Delta. https://en.wikipedia.org/wiki/Environmental_issues_in_the_Niger_Delta.

Ufuoma, V. (2022). NNPC calls for special court to prosecute oil theft, laments loss of \$1.5bn to vandals. International Centre for Investigative Reporting (ICIR), 8/04/2022. Available at [icir.org/nnpc-calls-for-special-court-to-prosecute-oil-theft-laments-loss-of-\\$1.5bn-to-vandals](http://icir.org/nnpc-calls-for-special-court-to-prosecute-oil-theft-laments-loss-of-$1.5bn-to-vandals).

UNU-WIDER. (2022). United Nations University World Institute for Development Economics Research, <https://doi.org/10.35188/UNU-WIDER/2022/147-1>, 47pp /16.