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Oil and Gas Resources Management and Environmental Challenges in Nigeria

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Abstract: Nigeria is richly endowed with crude oil and natural gas deposits, which are the country's main source of energy and foreign exchange earnings. These deposits are concentrated at the Niger Delta region which has attracted the presence of multinational oil/gas companies to the area. This paper analyses the impact of oil and gas development on the rich biological diversity of the region and its consequences on the development of the region and the nation at large. The paper further reviews the abject poverty of the oil/gas producing communities whose source of livelihoods, fisheries resources, agricultural soils/farmlands, forests, clean water, fresh air and housing are being destroyed due to poor energy resource management. The magnitude of destruction and frustration is reflected in unending conflict and insecurity in the region leading to many shut-in productions which pose a governance challenge as the country's economy and development is heavily dependent on oil and gas production.

Key words: Energy resources management, poverty, governance challenges, conflicts and development.

1. Introduction

The study area Nigeria is located in the Sub-Sahara Africa within geographic coordinate 4°N-14°N and 3°E-15°E, having a total area of 923,800 km^2 which is about 14% land area of West Africa [1]. The country is richly endowed with crude oil and natural gas deposits which are Nigeria's main source of energy and foreign exchange earnings.

Oil exploration in Nigeria started with a modest beginning in 1908 with the discovery of deposits at Araromi area of the present Ondo State. The industry presently has over 400 production and storage facilities in the oil-bearing region. These deposits are concentrated at the Niger Delta region of the country, which has attracted the presence of multinational oil/gas companies to the area.

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Niger Delta region is described as one of the most fragile ecosystem in the world. It is Africa's largest delta and the third world largest mangrove forest. It is one of the largest wetlands in the world, with about 2,370 km^2 consisting of rivers, islands, creeks, swampy terrain and estuaries. The stagnant swamps cover 8,600 km^2 and the coastline spanning is over 450 km [2, 3]. The mangrove forest covers 54,000 km^2 of the region, while the landmass is over 70,006 km^2.

Niger Delta region consists of four distinct ecological zones, coastal island zone, mangrove swamp zone, freshwater zone and rainforest zone [4]. The ecosystem of the area supports numerous species of terrestrial/aquatic flora and fauna and human life. The mangrove forest provides timber.

The ecology of the area is influenced by the tides of the Atlantic Ocean and flood regions of River Niger. The region which lies at the coastline of Nigeria has very low elevation with the possibility of inundation in the event of sea level rise due to climatic changes.

Politically the zone is divided into nine states: (1) Abia, (2) Akwa Ibom, (3) Bayelsa, (4) Cross River, (5) Delta, (6) Edo, (7) Imo, (8) Ondo and (9) Rivers, as shown in Fig. 1. The region is made up of 185 local governments of over 800 communities from 12 major ethnic groups, with a population of about 30 million people.

1.1 Impact of Oil and Gas Development

There are 6,638 oil wells scattered all over the Niger Delta region from inception till August 2008; about 3,628 oil wells are onshore. The production activities is still marked with unsustainable patterns of resource exploitation, leading to biodiversity loss, pollution of surface and underground aquifer and fractured livelihoods. The impacts of hydrocarbon deposits exploration in the Niger Delta region has left trails of degraded environment, deforestation, soil fertility loss, low agricultural yield, fishery resource decline, flooding, coastal/marine erosion and health challenges due to gas flares, oil spills and fire outbreaks.

Over the five decades of oil and gas exploration in the Niger Delta region there have been records of various categories of oil spillages, from minor to major spillage attributed to operational/equipment failure, human error, accidents, sabotage, pipeline vandalization, pipeline and storage tanks corrosion/leakages and sandout/erosion/waves.

Between 1976 and 2010, a total of 13,030 oil spill incidents that resulted in the discharge of 3,257,362.44 barrels of oil into the terrestrial, coastal and marine environment were reported in the Niger Delta region. Figs. 2 and 3 indicate the oil spill data, while Fig. 4 shows sabotage incidents.

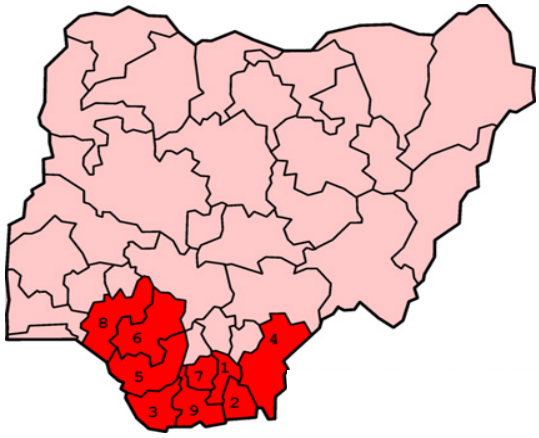

Fig. 1 Map of Nigeria showing the states of Niger Delta.

Oil spill to the oilmen is part of the production process but the worst nightmare to the host community. Spills in the ecosystem have immediate and long-term negative effect to the environment as most of the oil is not recovered. The 2010 oil spill data indicates that of 17,651 barrels spilled into the ecosystem only 1,328.7 barrels were recovered. Oil in the environment pollutes the water sources, destroys the soil fertility, and causes fire outbreak, making it impossible for the community members to derive benefit from the environment, some of the impacts last for decades. Oil in the aquatic

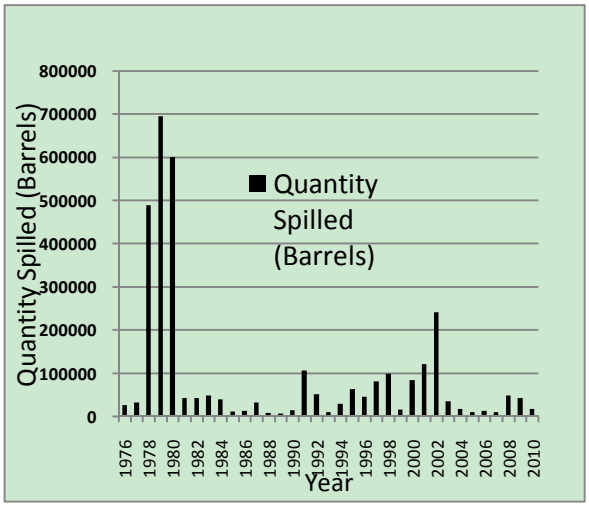

Fig. 2 Oil spill data during 1976-2010. Source: Ref. [5].

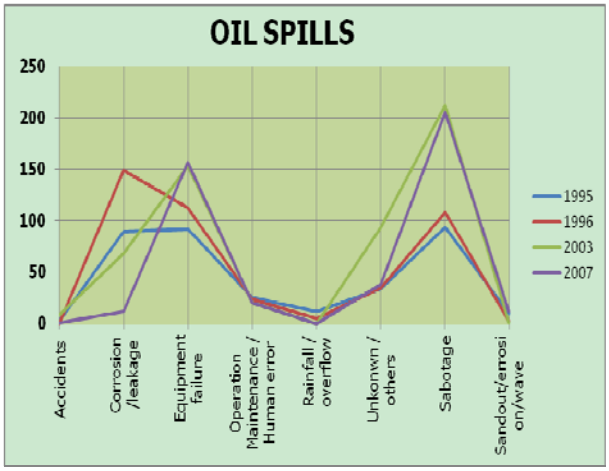

Fig. 3 The causes of oil spills from 1995 to 2007. Source: Ref. [5].

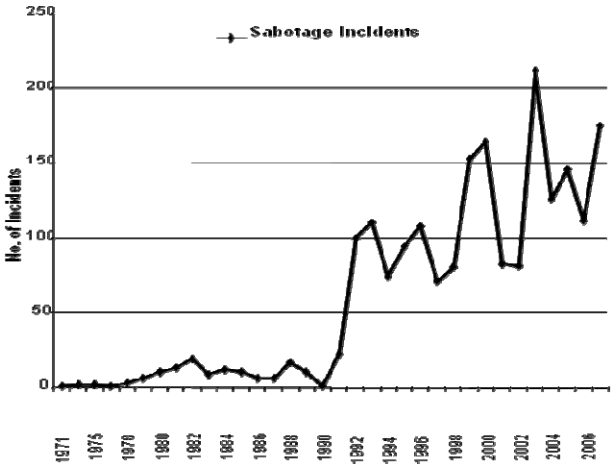

Fig. 4 Sabotage incidents from 1971 to 2008. Source: Ref. [6].

environment of the Niger Delta region is a death sentence to the aquatic life: birds, marine organisms and fishes (nesting ground) which have a serious longtime effect on the livelihoods of the host communities. It is worthy to note that in this region fishery industry thrives; all the settlements along the coast are fishing communities and they depend on the industry for their income generation.

Oil spilled into the aquatic environment washes into the coastal marshes, the mangrove forests and the wetlands, damaging the plants and making the area unsuitable for wildlife. The January 12, 1998 unprecedented spill of Mobil Producing Nigeria Unlimited operated 24-inch crude oil pipeline linking Idaho offshore platform with Qua Iboe terminal ruptured, spilling over 40,000 barrels of Bonny light crude into the Atlantic. The slick spread fast along the coastline, polluting the ecosystem covering a distance of over 960 kilometers. Not long afterwards, in March 1998, a 28-inch pipeline linking Jones Creek flow station with SPDC (Shell Petroleum Development Company) operated Escravos terminal, West of Niger Delta, ruptured releasing about 26,000 barrels of crude oil into the mangrove swamp and the rivers, exposing the fragile wetland to degradation. This spill impacted 34 communities of the Niger Delta region. There are also incidents of November 30, 2000 of Texaco Overseas Petroleum Company Unlimited (TOPCON's) 'Funiwa 5' blowout, that caused human and marine life causalities and the June 20, 2003 Chevron 24-inch crude oil pipeline spill of about 3,782 m^3 into the ecosystem. The mangrove forest of the Niger Delta which covers about 9,723 km^2, the largest in Africa, is gradually declining due to damages from incessant oil spill. The mangrove is the habitat and nursery for numerous fish species, including fin-fish, shellfish amongst others that are of commercial value in the region. The destruction of the mangrove exposes the sandy-beach to sea weaves and coastline erosion, exuberating the possibility of inundation of the region to sea level rise.

Contaminated surface fresh water and underground water supply due to oil spill is common site in the region. This makes for unsafe drinking water and increases health problems. There are even reports of contaminated underground water in areas that have not recorded spills, due to pollutant transport [7]. Oil-related health conditions such as skin rashes, eruptions and discharge have also been reported when the indigenes get in contact with polluted water bodies [8].

The spill on land, damages soil fertility and affects farmlands, which accountes for low agricultural yield among the host communities. As the region is a food producing zone in Nigeria, the issue of oil spill also challenges food security.

There have been incidents of fire outbreak due to oil spill; one of such is the 1998 Jesse Fire outbreak that claimed 1,000 lives including women and children due to pipeline oil spill.

Gas flaring and venting is another source of pollution to the ecosystem from oil and gas exploration and production operations. Nigeria has the worst flare rate in the world after Russia. The World Bank 2010 global estimated annual flared volume from satellite data is 134 billion cubic meters (bcm), Nigeria accounts for 15.2 bcm, making for 11.34% of the global flare rate. There are over a 100 flare sites in the Niger Delta region. Fig. 5 gives the Nigeria gas flare

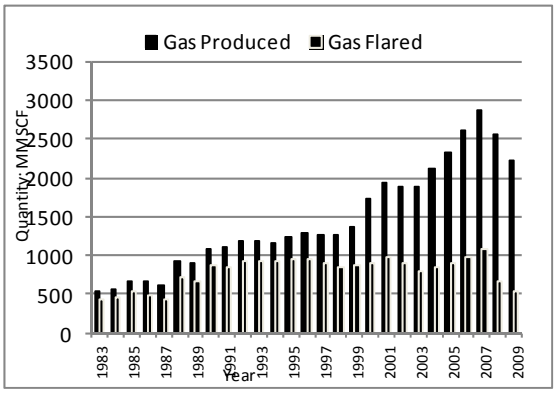

Fig. 5 Gas flare data from 1983 to 2009. Source: Ref. [9].

data from 1993-2009.

Although gas flaring has been illegal in Nigeria since 1984, pursuant to Section 3 of the Associated Gas Re-injection Act No. 99 of 1979 and 1985, the government requires Oil Corporation operating in Nigeria to guarantee zero flares by January 1, 1984, then 2008, then 2010 and now a new deadline of 2012 by the Nigerian National Assembly, gas flaring and venting still persist [10]. The Act allows for some ministerial exemptions and/or payment of penalty of US$3.50 for every 1,000 standard cubic feet of gas flared; the Department of Petroleum Resource (DPR) grants permission to flare gas that cannot be marketed and that exceeds operational requirement by issuing Associated Gas Flaring permit but subject to the payment of the penalty. Although there has been shifting commitment with regards to zero flares target, yet the percentage of gas flared in Nigeria has drastically reduced from 83% of 1983 values to 24% by 2009, following the Associated Gas Re-injection Act No. 99 of 1979 and 1985, however a huge sum is lost to gas flaring. The estimate of the Bureau of Public Enterprises of Nigeria indicated that each year, the country losses between US$500 million-US$2.5 billion to gas flaring in ironic exchange of between US$150,000-US$370,000, collected from oil companies annually as penalty for flaring associated gas [11]. Flaring of gas instead of the flared gas being used at the domestic scales, particularly the host communities, deprives the country of cleaner, cheaper energy and speedy development.

Gas flaring in Nigeria has contributed more emissions of GHG (greenhouse gas) than any other source in Sub-Saharan Africa combined. It has climate change implications not only for Nigeria but to the rest of the world. Flares contain heat, toxins and particulates that adversely affect vegetation, humans, soil, water and livelihoods of the host communities. The impact of gas flares on the health of the host communities increases the risk of respiratory diseases, asthma, cancer and premature death. Reduced crop yield and acid rain has been attributed to the gas flares due to large volume of carbon dioxide, methane, oxides of nitrogen and sulphur it emits to the environment together with carcinogenic substances, such as benz(a)pyrene and dioxin; and unburnt fuel comprising of benzene, toluene, xylene and hydrogen sulphide. It is worthy to note that most of these flare sites have been on daily for the past five decades. Noise is another source of pollution that can scare wildlife around the area and impair hearing.

1.2 Poverty and Social Considerations

The Niger Delta region is the economic engine of the nation, from where the oil and gas that generates about 97% of the revenue is mined, but the local poverty of the region is yet to be touched by the resources. As indicated above the oil and gas industry activities in the Niger Delta region have adversely affected the biodiversity of the region and greatly improvised the communities. The Niger Delta region is one richly endowed fragile ecosystem. The Millennium Ecosystem Assessment described five major categories of ecosystem services: provision (production of food and services), regulating (control of climate and diseases), supporting (nutrient cycle and crop pollination), cultural (spiritual and recreational benefits) and preserving (maintenance of diversity) [12]. This range of services provided by the ecosystem which is vital for human welfare has been eroded in the region due to unsustainable manner of harnessing oil and gas

deposit in the region. The major identified impacts are: biodiversity loss, deforestation, soil fertility loss, agricultural yield decline, fishery resource decrease, flooding and coastal/marine erosion and health decline.

As the communities in the Niger Delta region are mainly farmers and fishermen, which depend on the natural resources, agricultural soil, water, fisheries and forests for their sustenance, any impact on the natural ecosystem will have implications on their livelihood and social order. It is common knowledge that reduction in productivity due to pressure on the environment will strip the people of the ability to generate meaningful income, thereby making them poor. Poverty can drive the poor to deplete the resources on which they depend on, further deepening their misery. Damages in the environment trigger off chain reactions that can result in ecological disaster. This fact is buttressed by the United Nations Human Development Report on Niger Delta "there is a strong feeling in the region that the degree and rate of degradation are pushing the delta towards ecological disaster" [13].

The poverty level in the Niger Delta although in an oil-bearing zone has been on the increase since 1980s with a slight decline between 1996 and 2004. The human development index—a measure of well-being encompassing the longevity of life, knowledge and a decent standard of living for the region is low according to the UNDP Niger Delta Human Development Report. A score of 0.564 (with 1.0 being the highest score), is far below countries or regions with similar oil and gas resources, such as Saudi Arabia in 2000 is 0.800; in 2003 United Arab Emirates is 0.849, Kuwait is 0.844, Venezuela is 0.799 and Indonesia is 0.697.

The oil producing regions of the Niger Delta have benefited very little from the oil wealth. With an annual oil revenue of US$40 billion accounting for about US$300 billion for over half a century of oil production which has gone directly into the Federal exchequer, the GDP of the region stood at 0.570. This has brought about a feeling of marginalization, frustration and neglect by a people from whose land 95% of the country's foreign exchange earnings and 80% of budgetary revenues are generated, while their expectation are unmet. The agitation for the actualization of the people's aspiration has leaded various groups in the region, particularly militant youths resorting to violence in order to claim a share of the oil wealth.

1.3 Governance Challenges and Political Stability

The Niger Delta region is experiencing deep crisis over underdevelopment, resource control, citizenship rights and environmental degradation due to oil and gas activities. Coupled with the high population density and weak income generation as a result the destruction of traditional occupation of farming, fishing and lumbering due to oil and gas activities in the region and lack of basic social amenities, there are envisaged higher pressure tending towards escalated violence and visible threats to political stability. Violent conflict in the region has been between militants and government forces, between host communities and militants' verses multinational oil and gas companies over agitation for a share of the oil wealth. These conflicts have leaded to abduction, hostage taking of oil workers, kidnapping, work stoppages and pipeline vandalization. The spate of violence in the region has caused many shut-in productions, which has affected the price of crude oil in the international market and the operations of other nations. Nigeria is Africa largest and the 6th world largest producer of petroleum, with an estimated 37.2 billion of proven oil reserve as at January 2010 and an oil production capacity of about 2.9 million barrels per day (bbl/d) as at the end of 2009. EIA estimated that close to 40% of the country's oil production is exported to the United States, accounting for almost 14% of US petroleum consumption [14]. Other importers of Nigeria's crude include: Europe (24%), Asia (20%), Brazil (10%) and South Africa (4%).

2. Methods and Data

Methodology involves data acquisition, calibration and verification. The evaluations adopted in this study were based on the components of the IPCC common methodology. The study therefore identified habitats and areas highly susceptible to the effects of oil and gas exploitation as indicated in Fig. 6.

The study developed the biophysical assessment of the oil and gas activities in the Niger Delta region adopting proximity and overlapping analysis. The analytical techniques involved the application of descriptive and discourse approach. The impacts and vulnerability assessment were based on the cartographic representation of the terrain and identification of sensitive areas at risk.

3. Results

The results of the analysis are presented in Figs. 2-5. Figs. 2 and 3 depict the oil spill data, while Fig. 4 shows sabotage incidents.

The data of the gas flared in the region from 1993-2009 is represented in Fig. 5. Because the country's oil fields lack the infrastructure to produce and market associated natural gas, it is flared.

4. Discussion

From the analysis of the research and data gathered it is evident that there is a colossal damage to the ecosystem and its services of the Niger Delta region due to oil and gas companies activities and this has severe consequences on the livelihoods of the host communities who has to co-exist with the unabating anthropogenic perturbation of their environment. This findings is further buttressed by the recent UNEP report in the region, which indicated that "there are a significant number of serious location threats to human health from contaminated drinking water to concerns over the viability and productivity of the ecosystems". The report further stated that the pollution had gone deeper than many have previously supposed [15]. It is worthy to note that the people in this zone rely heavily on the environmental resource for sustenance, therefore its degradation shall lead to deprivation and poverty which in this instance has further resulted in conflicts, restiveness, abduction and work stoppages. This is a case of environmental pollution unfolding into political instability.

Unfortunately the lack of political will be acted by government at the three tire: national, state and local levels, which has endangered not only to the health of the people but to the their environment which is classified as one of the most fragile ecosystem in the world.

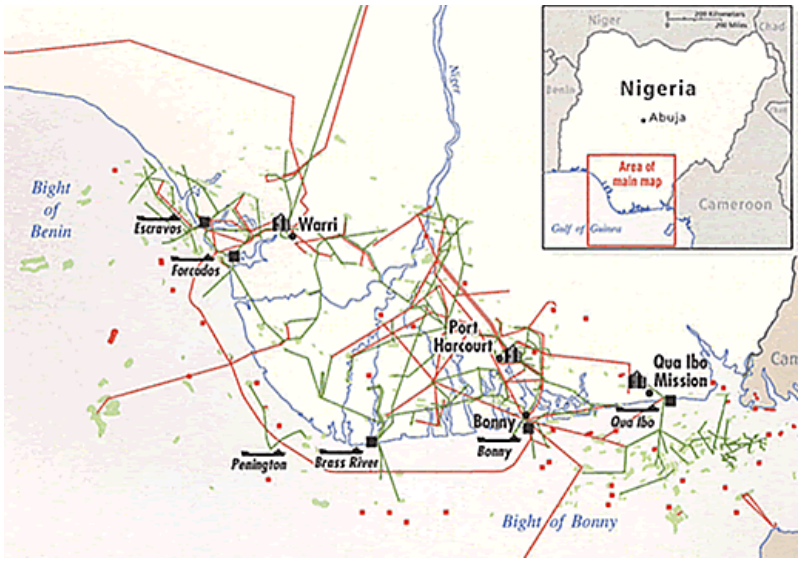

Fig. 6 The oil infrastructure in Niger Delta. Source: US Government [14].

5. Conclusions

Undoubtedly the oil and gas deposits in the Niger Delta region have yielded great wealth for Nigeria but not without its ecosystem damage leading majorly to biodiversity loss, agricultural yield decline, fishery resource damage and development perversion.

Biodiversity otherwise known as biological diversity, in a broad sense, is nature's wealth and is usually described at three different levels: genes, species and ecosystem diversity [16]. The benefits of biological diversity can be considered under ecosystem services, economic and social values. Therefore its loss affects life, even the human life. The concern about the spate of environmental destruction, loss of species and ecosystem, leads to the signing by 150 government leaders at the 1992 Rio Earth Summit. The Convention is on biological diversity, dedicating to conservation and sustainable use of biological diversity which is the key to sustainable development. The convention is about the people, our needs for food security, medicines, fresh air and water, shelter, a clean and healthy environment in which we live. In 2010, at the 10th COP in Nagoya, Japan the UN declared the period 2011-2020 as the UN decade on biodiversity [17]. It is imperative then for the government of nations to implement policies that ensures conservation of biological diversity and sustainable use of its components.

Although there are legal frameworks that guide oil and gas exploitation in Nigeria, the resource exploration in the Niger Delta region is far from being sustainable. Sustainability requires that production systems must not cause undue depletion of the natural resources or threaten the environment. As highlighted in this paper, there is a colossal damage to the ecosystem of this region and massive destruction of the people's livelihoods, exuberating poverty. Summarily there are agricultural yield decline as a result of soil contamination translate to lesser food available to households-food insecurity and lower incomes. Fishery resource damage means low protein intake, health challenges and weaker income for the fishing communities. Deforestation from oil and gas exploration threatens the sustenance of the local forest-dependent community, affects wildlife, lumbering and trade, income generation and contributes to climate change challenges.

Enforcement of the policies and legal regime to check environmental degradation in the country is poor due to weak institutional governance and shifting commitments both at the local and national levels. The government at both the sub-national and national levels must be responsive, adopt and implement science-based policies that protect the people and the environment. These proposed policies must be sustainable encompassing the three pillars of sustainability; economic; social and environmental factors. The government should work to avert high risk of exposure of all life forms and the ecosystem to pollution from the oil and gas activities. The government must be very effective and accountable, with a mission of responding to the aspiration of the people. It should make for social inclusion, which delineates the feeling of marginalization, frustration and anger in this region that fuels violence tunicates development not only in the region but in the nation at large.

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