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Environmental Degradation of Niger Delta Basin Area: The Impacts of Oil and Gas Exploration and Exploitation on Inhabitants and the Effects on the changing climate, South-south Nigeria

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Abstract

Climate change has been a serious Pandemic to humanity traced to hydrocarbon exploration, exploitation, refining, distribution, marketing, burning of fossil fuel and subsequent release of potent greenhouse gases that have severely polluted the Environmental space. This has further made man's habitation on earth to be non-conducive with earth temperature that keeps rising unpredictably and uncontrollably. Fossil fuel has been the major source of carbon emission through the various media of the air we breath, the land we cultivate our food, the water we drink, the rivers that replenish our aquifers and more recently, the transportation apparatus that moves man around. This has led to biodiversity loss, series of cancer and other respiratory diseases, especially on the vulnerable children and women. Obviously, this assessment has shown the need for real solutions with nations globally embracing clean sources of renewable energy to ameliorate this Pandemic. Compressed natural gas vehicles, electric cars, solar appliances, wind energy, biomass, hydroelectric sources of energy are some of the alternatives that are crucial to make the earth more habitable for mankind. The Niger Deltas area is a typical example with vast hydrocarbon reserve which as at 2024 stood at 37.50 billion barrels for Oil and Condensate and 209.26 trillion standard cubic feet of gas deposit reserve. The total volume of crude oil produced for the year 2024 was 578,521,740 barrels. The daily average production of about 1,580,369 barrels within the time interval has just risen to about 1,700,000 barrels, all with attendant environmental menace. The high oil and gas production capacity of the Basin area has led to unprecedented and severe contamination of the ecosystem. In essence, contributing significantly to global warming. This study therefore elucidates the environmental condition of the area and therefore conclusively suggest more modern mitigative and adaptative approach like CO2 sequestration and renewable energy to reduce the impacts of oil and gas production in an area where millions call home.

Keywords: Akata Formation, CAPEX= Capital Expenditure, Carbon Sequestration, FDP= Field Development Plan, OPEX=Operating Expenditure, Romanche chain.

1. Introduction

The Niger Delta is one of the world's largest wetlands and includes by far the largest mangrove forest in Africa. Within this extremely valuable ecosystem, oil exploration and production activities are widespread. Human activities and these activities raise a number of issues such as depletion of biodiversity, coastal and riverbank erosion, flooding, oil spillage, gas flaring, noise pollution, sewage and wastewater pollution, land degradation, soil fertility loss and deforestation just to mention a few (Ndubuisi and Asia 2007). Oil exploration and exploitation has been ongoing for several decades in the Niger Delta with severe impact on the environment and has adversely affected people inhabiting that region. Environmental impact Assessment is also critical prior to any form of clean-up that will come up in the area (Ibrahim et al 2025a) to mitigate adverse impacts of any form of negative effects of such. The volatile quickly penetrating and viscous properties of petroleum have wiped out large areas of vegetation. When spills occur close to and within the drainage basin, the hydrologic force of both the river and tides force spilled petroleum to move up into areas of vegetation. The effects of intensive oil resource extraction on the environment of the (Aigbedion et al. 2007) oil bearing Niger Delta communities and environmental problems such as resource degradation and pollution in the Niger Delta communities has shown there will be need for adequate clean-up of most notable areas.

The negative implication of oil spillage (Tolulope 2004) to the environment emphasized the extent of hazards and the tendency of petroleum products pollution to the environment. The prevention of environmental degradation is a task that must be pursued vigorously. Identification of problems, design and applying appropriate sanctions (Nenibarini 2004) is a major issue that need to be resolved and has to start with change in the present judicial system and attitude towards the litigation of environmental issues as well as a reform in environmental policies. The public health status is highly threatened with severe contamination of soil, water and air media (Ibrahim et al 2025b) if nothing is done on this critical environmental issue. Moreso, the new Institute of Environmental Practitioners of Nigeria (supreme environmental body) just signed and Gazetted by law will have a big task to contend with in regulating the environmental space due to flagrant abuse by Nigerians.

2. Niger Delta Basin Area

Nigeria has a coastal line of approximately 85km towards the Atlantic Ocean lying between latitude 4°15' to 4°50' and longitude 5°25' to 7°37' with a land mass of about 28000km² area within the coastal region (Fig. 1). The surface area of the continental shelf is 46300km². The coastal areas consist of freshwater swamp, mangrove swamp, beach ridges sand bars, lagoons marshes and tidal channels. Nigeria has a total land mass of 923,768km² with 918,768km² being terrestrial land and 13000 km² being aquatic. The coastal area is humid with a mean average temperature of 24-32°C and coastal area has an average annual rainfall ranging between 1,500-4,000m. Nigeria has two large main rivers; the River Niger and River Benue (Fig. 1). There are several river tributaries that channel into the Atlantic Ocean directly, while other river channels flow into the Chad basin or into the lower Niger to the Atlantic sea. The Niger Delta is located at the apex of the Atlantic coast of Southern Nigeria and is the world's second largest delta with a coastline of about 450km which ends at Imo river entrance. The region is about 20,000km² as it is the largest wetland in Africa and among the third largest in the world (Powell et al 1985). 2,370km² of the Niger Delta area consists of rivers, creeks, estuaries and stagnant swamps and depobelts that cover approximately 8600km², the Delta mangrove swamp spans about 1900km² as the largest mangrove swamp in Africa. The Niger Delta is classified as a tropical rainforest with ecosystems comprising of diverse species of flora and fauna both aquatic and terrestrial species. The region can be classified into four ecological zones; coastal inland zone, freshwater zone, lowland rainforest zone, mangrove swamp zone and this region is considered one of the ten most important wetlands and marine ecosystems in the world.

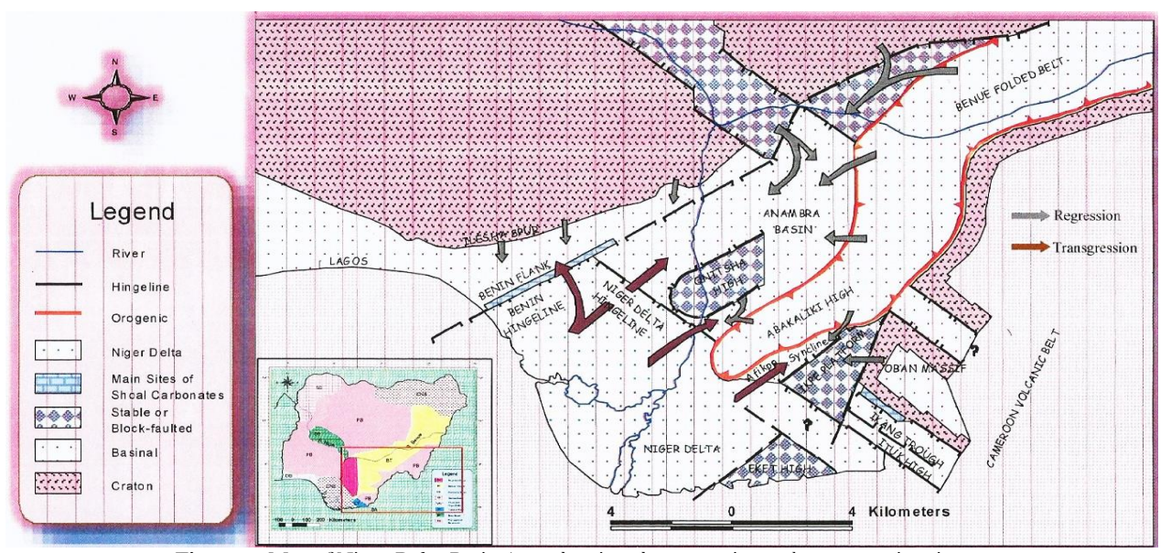

Figure 1. Map of Niger Delta Basin Area showing the regressive and transgressive rivers.

In the region of the Niger Deltn, rifting during the Late Cretaceous has led to the shaping of the Delta. After rifting ceased, gravity tectonism became the primary deformational process and shale mobility induced internal deformation and occurred in response to two processes. More importantly, fracture zones (Romanche, charcot and chain) developed that cut across into the Dahomey basin deposit, southwestern Nigeria, Togo and Benin republic (Fig. 2). The Niger Delta is among the ten most important wetland and marine ecosystems in the world. The oil industry located within this region has contributed to the growth and development of the country which is a fact that cannot be disputed but unsustainable oil exploration activities has rendered the Niger Delta region one of the five most severely petroleum damaged ecosystems in the world.

The tectonic framework of the continental margin along the West Coast of equatorial Africa is controlled by Cretaceous fracture zones expressed as trenches and ridges in the deep Atlantic ocean. The fracture zone ridges (Figs. 1 and 2) subdivide the margin into individual basins and in Nigeria, form the boundary faults of the Cretaceous Benue-Abakaliki trough, which cuts far into the West African shield. The trough represents a failed arm of a rift triple junction associated with the opening of the South Atlantic ocean. In this region, rifting started in the Late Jurassic and persisted into the Middle Cretaceous as published. After rifting ceased, gravity tectonics became the primary deformational process. For the given depobelt, gravity tectonics were completed before deposition of the Benin Formation and are expressed in complex structures, including shale diapirs, roll-over anticlines, collapsed growth fault crests, back-to-back features, and steeply dipping, closely spaced flanked faults. These faults mostly offset different parts of the Agbada Formation and flatten into detachment planes near the top of the Akata Formation.

The climate of the Niger Delta region varies from the hot equatorial forest type in the southern lowlands to the humid tropical in the northern highlands and the cool mountain type in the Obudu-plateau area. The wet season is relatively long, lasting between seven and eight months of the year, from the months of March to October. In the

northern and northwestern parts of the Niger Delta region, the rain may be delayed by as much as four weeks, thereby extending the dry season, which in recent times, tends to last for four to five months. There is usually a short break around August, otherwise termed the "August break".

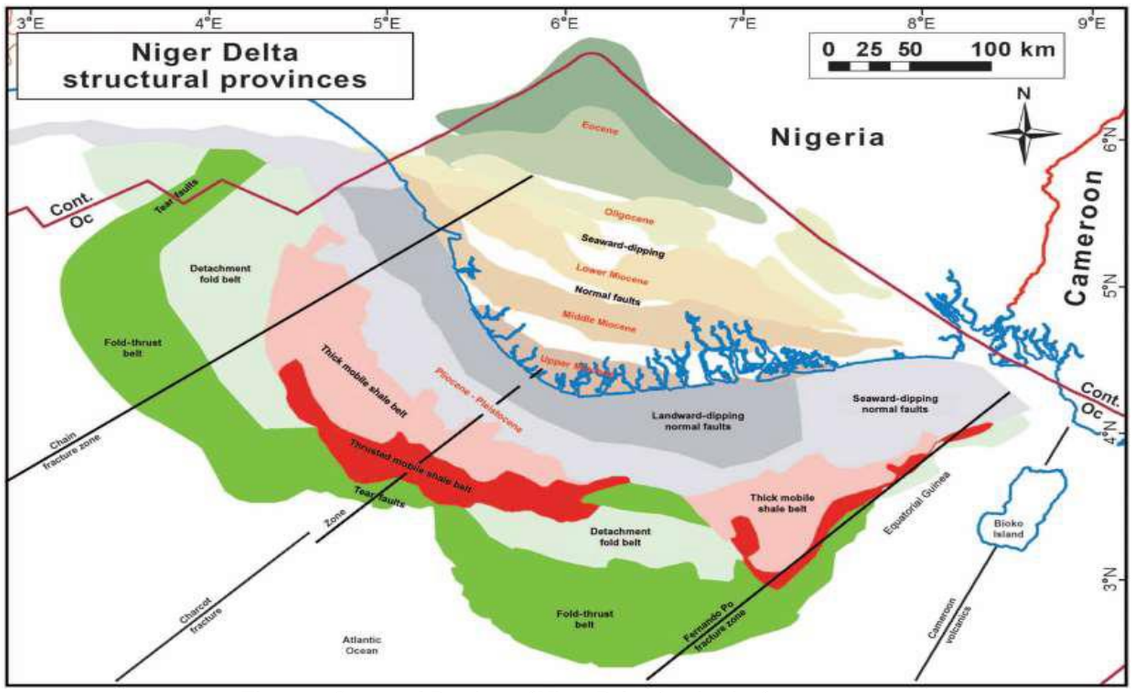

Figure 2. Structural Province of Niger Delta showing its fracture zones.

3. Materials and Methodology

This study has adopted data from past and present studies, viable reports of government and non- government bodies like Nigerian Bureau of Statistics, Nigerian Upstream Petroleum Regulatory Commission, Nigerian National Petroleum Company Limited, Central Bank of Nigeria, Nigerian Midstream Downstream Petroleum Regulatory Authority etc and existing published literatures. The study also relied on data obtained from International agencies like World Bank, United Nations Environmental Protection Programme reports, Amnesty International, International Monetary Fund, PwC etc. Published books, Conference and Seminar Papers, Journals were also consulted to get robust data on the subject matter. Questionnaires were designed and administered on inhabitants with favorable responses. The data obtained was analyzed using quantitative and descriptive method and from the analysis, logical deductions and sequential presentation of facts simulated as our major findings. The study has vividly shown through obtained processed data, the need for environmental restoration of the ecosystem with adequate clean-up exercise.

4. Hydrocarbon exploration and Production in the Area

A new era of hydrocarbon exploration and production has been enacted through the Petroleum Industry Act 2021. Exploration is now expected to cover inland sedimentary basins in Nigeria. Production activities are carried out under various production arrangement of Joint Venture (JV), Production Sharing Contract (PSC), Marginal Fields (MF) and Sole Risk (SR). Measurement of production volumes are done at the Wellheads, production platforms and the terminals (focalized production). Field Development Plans (FDP) impacts exploration activities in the oil and gas sector of Nigeria. FDP shows the potential investment and future economic benefits from the sector. NUPRC approved Field Development Plans (FDP) of an estimated oil reserve of 1,310 million Stock Tank Barrel (MMSTB) and estimated gas reserves of 10,251 billion Standard Cubic Feet (BSCF). The FDP Capital Expenditure (CAPEX) is valued at US$12.315 billion, Operating Expenditure (OPEX) at US$ 1.912 billion and the Abandonment Expenditure (ABEX) at US$379 million (Table 1). In recent time of 2025, new NNPCL GCEO of the main oil and gas player declared an increase to about 1,700,000 barrels new daily production capacity.

Table 1. Hydrocarbon reserve estimate in various Geologic terrains of Niger Delta, Nigeria.

Oil and Gas Parameters	Unit vol.	Deep Offshore	Land	Offshore	Onshore	Swamp	Total
Estimated Oil Reserves	MMSTB	54	341	230	685	-	1,310
Estimated Gas Reserves	BSCF	56	658	1,387	8,112	38	10,251
Estimated Condensate Reserves	MMSTB	-	-	19	35	0	55
Expected Oil Rate	BOPD	55,000	40,500	64,500	141,124	-	301,124
Expected Gas Rate	MMScf/D	19	158	527	1,116	50	1,870
Expected Condensate Rate	BCPD	-	-	19	-	300	319
CAPEX	US$' M	265	260	1,333	10,020	437	12,315
OPEX	US$' M	106	-	450	1,171	184	1,912
ABEX	US$' M	28	-	213	115	23	379

5. Oil Reserve

Crude oil reserve was 31.56 billion barrels in 2023 and 31.06 billion barrels in 2022 (Table 2). The increase of 0.50 billion barrels in oil reserves is attributed to recent discoveries, as reflected in the table below. This

demonstrates ongoing exploration efforts contributing to reserve additions, albeit at a modest scale. Further investments in exploration are essential to sustain growth and meet future production demands.

Table 2. Comparative hydrocarbon reserve estimate between 2022 and 2023 in the Delta.

Description	Unit of Measurement	2023	2022	Change	
				QTY	%
Crude Oil	Billion Barrels	31.56	31.06	0.50	1.6%
Condensate	Billion Barrels	5.94	5.90	0.0	0.7%
Associated Gas	Trillion SCF	102.59	102.32	0.3	0.3%
Non-Associated Gas	Trillion SCF	106.67	106.51	0.2	0.2%

5.1. The Nexus of Oil and Gas Production with Climate Change

Unabated combustion of all the present fossil fuel reserves will emit three times more carbon dioxide (CO_2) than carbon budget for 2°C of global warming, pushing temperatures to potentially catastrophic levels (Uyigue and Agho 2007). As the world moves towards the goal of net-zero emissions by 2050, the oil and gas sector's substantial contribution to global emissions means it has a vital part to play in the decarburization of the global economy. Globally, research has shown that the removal of fossil fuel subsidies could reduce carbon dioxide (CO_2) emissions by 0.5–2.2 Giga-tones annually by 2030, Continuing technological developments example like CO_2 sequestration and government support for low-carbon energy sources that threaten the dominance of fossil fuels in the global economy. Governments are increasing their support for cleaner energy through a range of support mechanisms, from grants and investments through to subsidies, tax rebates and loan guarantees. An illustrative example comes from Shenzhen, China, where three major bus operators received an annual subsidy of US$75,500 per vehicle to incentivize their transition to EVs. In June 2016, Nigeria endorsed the World Bank's Zero Routine Flaring by 2030 initiative. It also participates in the Global Methane Initiative, the Global Methane Pledge and the Climate and Clean Air Coalition. The Nigeria's National Plan to Reduce Short-lived Climate Pollutants released at the end of 2018, targets the oil and gas industry to reduce fugitive methane emissions and leakage by 50% by 2030 (Twumasi and Merem 2006).

Nigeria submitted its first Nationally Determined Contribution (NDC) to the United Nations Framework Convention on Climate Change in 2015. It included gas flaring reduction as a mitigation measure in its updated NDC, submitted in July 2021, where Nigeria commits to an unconditional reduction of 20%. The conditional reduction target is 47 percent. The update does not include unconditional contributions pertaining to the energy sector. Among the sector's conditional contributions are zero routine flaring by 2030 and a 60% reduction in fugitive methane emissions by 2031. Early oil and gas legislation such as the Petroleum Act 1969 and the Associated Gas Re-injection Act 1979 all included the prevention of atmospheric pollution and the conservation of resources with little or no result. The Associated Gas Re-injection Act 1979, prohibited gas flaring without the written permission of the minister in charge of oil and gas after January 1, 1984. However, measures to reduce flaring gained only limited traction of implementation and the deadlines for ending routine flaring were repeatedly postponed.

5.2. Oil Spillage and Flaring

Oil spillage has a major impact on the ecosystem into which it is released. Immense tracts of the mangrove forests which are especially susceptible to oil (mainly because it is stored in the soil and re-released annually during inundations), have been destroyed. An estimated 5% to 10% of Nigerian mangrove ecosystems have been wiped out either by settlement or oil (Tolulope 2004). The rainforest which previously occupied some 7,400 km² (2,900 sq mi) of land has disappeared as well. Spills in populated areas often spread out over a wide area, destroying crops and aquacultures through contamination of the groundwater and soils. The consumption of dissolved oxygen by bacteria feeding on the spilled hydrocarbons also contributes to the death of fish. In agricultural communities, often a year's supply of food can be destroyed instantaneously. The Niger River has been invaded by water hyacinth, which thrives in polluted environments but clogs waterways and competes with native plants. This series of spillage has led to severe contamination of the ecosystem with land, air and water pollution that finally translate into health challenges to inhabitants most especially diagnosis of cancer and other respiratory diseases (Ibrahim et al 2025b).

Figure 3. Land, water and air degradation in the Basin area traced to oil and gas spillage.

Nigeria flares more natural gas associated with oil extraction than any other country with estimates suggesting that of the 3.5 billion cubic feet (100,000,000 m^3) of associated gas (AG) produced annually, 2.5 billion cubic feet (70,000,000 m^3) or about 70% is wasted by flaring.–This equals about 25% of the UK's total natural gas consumption and is the equivalent to 40% of Africa's gas consumption in 2001. Statistical data associated with gas flaring are notoriously unreliable, but Nigeria may have wasted US$2 billion per year by flaring associated gas. Gas flaring also includes release of large amounts of methane which has a high global warming potential. The methane is accompanied by the other major greenhouse gas like carbon dioxide, SO_2 of which Nigeria was estimated to have emitted more than 34.38 million metric tons of such in 2002 alone, accounting for about 50% of all industrial emissions in the country and 30% of the total CO_2 emissions.

Table 3. Affirmative Research question responses compiled from the study Basin area.

S/N	Descriptive Research questions	Provided affirmative answers (%)
1	Are there main factors contributing to environmental degradation in the Niger Delta region?	97
2	Are there different forms of environmental degradation in the Niger Delta region?	92
3	Are there impacts of environmental degradation on the environment, people, and economy of the Niger Delta region?	97
4	Are there socio-economic consequences of environmental degradation in the Niger Delta region?	98
5	Has government policies and regulations contributed to preventing and addressing environmental degradation in the Niger Delta region?	96
6	Are there stakeholders involved in the management of the Niger Delta region's environment, and are their roles in mitigating environmental degradation?	79
7	Are the current mitigation measures effective in addressing environmental degradation in the Niger Delta region?	87
8	Is there potential of renewable energy sources as a sustainable solution to environmental degradation caused by fossil fuels in the Niger Delta region?	89
9	is there role of multinational oil companies in environmental degradation, and what is their responsibility in mitigating their impact?	90

The fishing industry is an essential part of Nigeria's sustainability because it provides much needed protein and nutrients for people, but with the higher demand on fishing, fish populations are declining as they are being depleted faster than they are able to restore their number leading to massive importation to satisfy local consumption. Fishing needs to be limited along the Niger River and aquacultures should be created to provide for the growing demand on the fishing industry. Aquaculture allows for fish to be farmed for production and provide more jobs for the local people of Niger delta area. The Niger River is an important ecosystem that needs to be protected, for it is home to 36 families and nearly 250 species of fish, of which 20 are endemic, ie they cannot be found anywhere else on Earth. With the loss of habitat (Tables 3 and 4) and the climate getting warmer, every prevention of temperature increase is necessary to maintain some of the marine biodiversity.

Table 4. Affirmative Research question responses compiled from the study Basin area (ctd).

S/N	Descriptive Research questions	Provided affirmative answers
1	Are there attitudes and perceptions of the community towards environmental degradation, and how do they participate in mitigation efforts?	91
2	To what extent are the people of the Niger Delta region aware and understanding of environmental degradation and its consequences?	45
4	Has environmental degradation affected the availability and quality of natural resources in the Niger Delta region?	87
5	Has sustainable and effective mitigation measures can be recommended for environmental degradation in the Niger Delta region?	65
6	Are there strategies can be put in place to promote environmental conservation and sustainable development in the Niger Delta region?	71
7	Are there potential of eco-tourism as a means of sustainable development and environmental conservation in the Niger Delta region?	51
8	Are there role of education and awareness programs in promoting environmentally responsible behavior in the Niger Delta region?	79
9	Are there costs and benefits of addressing environmental degradation in the Niger Delta region?	95

6. Mitigation Measures

6.1. Bioremediation

Bioremediation of the polluted Basin area can be done via biological components in the remediation or clean-up of any of the sites. A study conducted in Ogbogu located in one of the largest oil producing regions of south-south Nigeria has utilized two plant species to clean up spills. The first stage of clean-up involved Hibiscus cannabinus, a plant species indigenous to West Africa. H. cannabinus is an annual herbaceous plant originally used for pulp production. This species has high rates of absorbency and can be laid down on top of the water to absorb oil. The oil saturated plant material is then removed and sent to a safe location where the hydrocarbons can be broken down and detoxified by microorganisms. The second stage of bioremediation involves a plant known as Vetiveria zizanioides, a perennial grass species. V. zizanioides has a deep fibrous root network that can both tolerate chemicals in the soil and can also detoxify soils through time.

6.2. Renewable Sources of Energy

Renewable is the future energy for the world economy. Nigeria will obviously need diversify energy source to renewable and gas as transition fuel by investing more in gas production, solar energy, biomass etc. This is currently inevitable with the trend of world cleaner energy demand for sustainable economic growth. Just as demand for oil will decline in the nearest future, demand for gas will obviously increase astronomically. Moreso, Electric vehicles and CNG powered vehicles will strongly come up globally. More importantly, over the years, several policies and programmes have been developed for the energy sector. Here, it was assumed that the various programmes outlined in the Nigerian energy/climate policies will be realized. Nigeria's electricity supply system can be grouped into two: centralized (grid-connected) and decentralized (off-grid) systems. The centralized system consists of the large-scale generation of electricity at centralized facilities such as large hydro and thermal plants. The decentralized electricity supply system consists of a few kilowatts to megawatt capacities such as captive diesel and gasoline generator sets as well as renewable energy technologies (such as solar home systems, streetlights and mini-grids). Generally, renewable energy is derived from sources that can be replenished and in line with this, a wide range of renewable energy sources have been discovered to include the wind, hydro, biomass and solar energy.

Wind energy in Nigeria is currently at a speed of about 10 metres (m) height ranging between 2.1 m/second and 8 m/s with the highest values (greater than 7 m/s) located in the northern part of the country. Estimates for the technical potential for wind is at 3.2 GW considering only 1% of the suitable land for such energy can be utilized for project development (Twumasi and Merem 2006). Apart from the coastal and offshore locations, the wind speed in southern Nigeria is relatively low, while higher wind speeds are experienced in the northern region. Currently, there is no estimate of offshore wind potential in Nigeria. However, the Federal Ministry of Power says that it is conducting an offshore wind mapping. For this study, it is assumed that only onshore wind turbines will be deployed in Nigeria. The target of the National Renewable Energy Action Plan (NREAP) is to achieve 0.17 GW of grid-connected wind capacity by 2020 and 0.8 GW by 2030. Similarly, Nigeria has a large hydro potential of around 24 GW and a small hydro potential of about 3.5 GW. This potential for the most part of the country is yet to be exploited. In 2015, Nigeria had about 1.9 GW installed capacity of large hydro and about 60 megawatts of small hydro (ECN, 2014) power stations.

Exploiting the huge potential of biomass resources in the country, especially in the form of agricultural residues for power generation is feasible and will also go a long way to resolving the current energy crisis in Nigeria. While there exist many biomass options for power generation, this study considers only agricultural residues as feedstock for biomass power plant. Nigerian National Bureau of Statistics living standards survey conducted has shown there was only about 18% access to clean cooking (gas and electric stoves) in Nigeria in 2019. However, international statistics suggest that access to clean cooking in Nigeria was around 13% in the same year. The data discrepancies may be attributed to the differences in survey, measurement techniques and what constitutes clean cooking. Most cooking uses traditional biomass, which indicates that air quality can be substantially improved by moving to other technologies and many deaths associated with air pollution avoided. As shown in previous studies, global fossil fuel employment may drop by 80% in 2050 due to an envisaged 2°C temperature rise global compliant that will make countries shift to renewable (Paris Agreement, 2015). Renewable-based employment will in-turn increase fivefold. This projection need nurturing local development of abundant renewable energy resources that would potentially spur local innovative renewable energy champions in such a scenario. This would enable the creation of local jobs and spin-off industries.

For Solar Energy, Sunlight is one of our planet's most abundant and freely available energy resources. The amount of solar energy that reaches the earth's surface in one hour is more than the planet's total energy requirements for a whole year. The generation of power through the use of the Sun's radiation is principally regarded as solar power. There are two methods by which we can obtain energy from the sun and they include: direct and indirect methods. The natural procedure involves photovoltaic (PV), while the indirect way is to use sunlight to boil and heat water to supply power. Nigeria has a landmass of about 924 km^2 with an average irradiance per unit area of 5.535 KWh/m^2 and an average incident solar energy of 1831.06 kWh annually. The country's sunshine hours range from 9 hours in the far north to 3.5 hours in the southern part of the country. With an average of 6 hours per day of sunlight, the government receives about 4.85 x 1012 kW/h of the Sun's energy (3.8 x 1023 kW/s) per day, equivalent to the energy derived from about 1.082 million tons of oil per day. From these statistics, it is clear that a considerable amount of energy can be generated and utilized from the massive solar radiation available to combat the epileptic energy supply. Accordingly, generating power from solar would be beneficial for those in rural areas and other areas that do not have a direct connection to the national electricity grid system. In Nigeria, solar energy has been utilized in various forms such as solar PV for rural electrification and solar pumping for groundwater production, but still as low as 9% utilization rate in Nigeria.

6.3. CO_2 Sequestration (Waste to Wealth Carbon Capture Technology)

The CO_2 can be captured from the large point source in the Delta area, such as several oil and natural gas processing plant and typically stored in a deep geological formation. Around 80% of the CO_2 captured annually can be re-used for enhanced oil recovery (EOR), a process by which CO_2 is injected into partially depleted oil reservoirs in order to extract more oil and then is largely left underground. Since EOR *utilizes* the CO_2 in addition to *storing* it, CCS is also known as carbon capture, utilization, and storage. CCS facilities capture carbon dioxide before it enters the atmosphere. Generally, a chemical solvent or a porous solid material is used to separate the CO_2 from other components of a plant's exhaust stream. Most commonly, the gas stream passes through an amino solvent, which binds the CO_2 molecule. This CO_2-rich solvent is heated in a regeneration unit to release the CO_2 from the solvent. The CO_2 stream then undergoes conditioning to remove impurities and bring the gas to an appropriate temperature for compression. The purified CO_2 stream is compressed and transported for storage or end-use and the released solvents are recycled to capture more CO_2 from the facility.

7. Conclusions

Nigeria is at a key juncture to capitalize on its abundant renewable energy resources potential which is far more than the non-renewable ones to meet up with the growing need of its population while simultaneously addressing socio-economic challenges. To do so requires a broad and comprehensive set of policies for all the sectors of its economy which will facilitate the transition away from fossil fuel with all the economic and health benefits that would follow. Gas utilization will still be economically useful, viable and beneficial to its economy at least till 2050. Renewable energy technologies will be key in achieving a sustainable clean energy mix for Nigeria to meet up with its 2050 target because it is a global race among nations. More importantly, adequate clean-up of oil and gas spill in most sites of the Niger Delta is crucial to restore the ecosystem and livelihood of millions of inhabitants in a place commonly called home.

References

Aigbedion, I., Iyayi, S. E., & Agbeboh, G. U. (2007). Prospect assessment and risk analysis: Example from Niger Delta, Nigeria Basin. *World Applied Sciences Journal, 2*(6), 569–574.

Ibrahim, O. O., Ngozi-Chika, C. S., Ashioba, C., & Ibrahim, B. D.-H. (2025a). Environmental impact assessment and geological evaluation of non-associated gas wells in Forcados-Yokri block, Burutu Area, Delta State, South-South Nigeria. *The American Journal of Applied Sciences, 7*(8), 10–24. https://doi.org/10.37547/tajas

Ibrahim, O. O., Bewaji, S., Mohammed, A. I., Saheed, A. Y., Abdullah-Abdulsalami, F. H., & Umar, M. M. (2025b). Geosciences and public health medicine: The nexus of an evolving society in a highly dynamic environment. *Nigerian Journal of Engineering Science Research, 8*(1), 70–86. https://doi.org/10.5281/zenodo.15829278

Ndubuisi, A. L., & Asia, I. O. (2007). Environmental pollution in oil producing areas of the Niger Delta Basin, Nigeria: Empirical assessment of trends and people's perception. *Environmental Research Journal, 1*(1–4), 18–26.

Nenibarini, Z. (2004). Impacts of extractive industries on the biodiversity of the Niger Delta. In *Proceedings of the National Workshop on Coastal and Marine Biodiversity Management* (pp. 53–59). Nigerian National Petroleum Corporation (NNPC).

Powell, C. B., White, S. A., Ibiebele, D. O., Bara, M., Dut Kwicz, B., Isoun, M., & Oteogbu, F. U. (1985). Oshika oil spill environmental impact: Effect on aquatic biology. In *Proceedings of the NNPC/FMHE International Seminar on Petroleum Industry and the Nigerian Environment* (pp. 168–178). Kaduna, Nigeria.

Tolulope, A. O. (2004). Oil exploration and environmental degradation: The Nigerian experience. *International Information Archives, 2*, 387–393. (Paper No. EIA04-039). International Society for Environmental Information Science.

Twumasi, Y., & Merem, E. (2006). GIS and remote sensing applications in the assessment of change within a coastal environment in the Niger Delta region of Nigeria. *International Journal of Environmental Research and Public Health, 3*(1), 98–106. https://doi.org/10.3390/ijerph2006010098

Ukoli, M. K. (2005). Environmental factors in the management of the oil and gas industry in Nigeria. In *United Nations Development Programme (UNDP), Niger Delta Human Development Report* (pp. 185–186). UNDP. https://www.cenbank.org

Uyigue, E., & Agho, M. (2007). *Coping with climate change and environmental degradation in the Niger Delta of Southern Nigeria*. Community Research and Development Centre (CREDC). http://credcng.org