

Strengthening Energy and Ecosystem Resilience in Nigeria



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Summary of Report

Despite a huge crude oil income, Nigeria's population faces increasing levels of poverty. This - coupled with the deterioration of key ecological zones such as desert expansion in the north or coastal and delta flooding in the south - makes Nigeria very vulnerable to climate change-related events. Some key steps could be taken to reduce Nigeria's vulnerability and to increase the country's resilience. Recommendations include: improving the country's governance structure; increasing investments in sustainable energy; developing and mainstreaming a National Adaptation and Action Plan; increasing access to climate change information; and empowering the population to contribute to adaptation activities.

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Country Overview

Perhaps the greatest singular challenge faced by Nigerians today is the increasing level of poverty. About seventy percent of the 141 million inhabitants subsist under one dollar a day while over 90 percent live on less than two dollars a day¹. Despite huge crude oil income, living standards in Nigeria are sliding below Sub-Sahara African averages. Climate variability in terms of seasonal drought and flooding already exacerbates the pressure on the poor. A consistent change in the climate will constrain efforts to combat poverty, stimulate equitable growth and protect social and ecological systems.

Nigeria's key ecological zones are under severe threat. Desert expansion within the Sudan-Sahel northern zone and flooding in the southern coastal and delta zones are intensifying. Despite these climate-related emergencies, public awareness of the dangers posed by climate change remains inadequate.

The Federal Government of Nigeria has taken some steps in addressing the issue of climate change. As part of its obligations to the United Nations Framework Convention on Climate Change, the government has published a First National Communication on Climate Change, set up a national focal point on climate change and a unit to facilitate Nigeria's participation in the emerging carbon market.

Beyond the Federal Government, States and Local Governments have hardly developed any interest on climate change issues. There is no consistent and coherent response from the private sector on impacts and opportunities created by climate change on business. Much of the existing climate change activities in the country have been driven mostly by civil society with the supported from donors. This has created a significant knowledge base and engagement with the media. However, access to climate change information has been limited due to the worsening conditions of human development in Nigeria.

Extreme poverty has doubled over the past two decades and presently affects over two-thirds of the Nigerian population. Of the 177 countries assessed in 2006, Nigeria ranks 159 in the Human Development Index. As public policy, population increase and environmental change widen the social gap, scarcity, scramble over resources and social conflict will make the target of eradicating extreme poverty by 2015 unachievable.

The literacy rate in Nigeria is 48.7% and the net primary enrolment is 60%. More women than men experience illiteracy with the ratio of female to male enrolment at primary level being 0.89 and reducing to 0.55 at the tertiary level. Infant mortality rate is 101 per 1,000 live births while maternal mortality ratio is 800 per 100,000 live births. Among the ages 15-24 the rate of HIV prevalence is 3.9%.

¹ Nigerian poverty statistics is from Human Development Report 2006.

The structure of primary energy consumption is: natural gas 43.3%; petroleum products 22.3%; hydropower 4.3%; and, traditional biomass 30.1%. Energy demand by sector is distributed as follows: industry 10.7%; transport 29.9%; household 45.9%; and, services 13.5%². Traditional fuels make up about one third of primary energy consumption while modern renewable energy consumption represents less than 5%. With anticipated development of coal power plants, the fossil content of the Nigerian energy consumption pattern is increasingly fossil-based.

Energy poverty is entrenched in Nigeria. About 85 million, representing approximately 60 percent of the population have no access to electricity services. Less than 20 percent of rural areas have some form of electricity service coverage. In all, the electricity consumption per capita is about 100kwh. Government has embarked on a massive investment program to increase the capacity of the electricity supply industry. This will double the generation capacity from fossil sources. Even though attention is beginning to be paid to renewable electricity, it is only an insignificant fraction of the total public sector energy investments.

The Nigerian energy sector is highly vulnerable to shocks. The crisis in the Niger Delta is a source of instability to the upstream petroleum supply industry. Since over half of all refined petroleum products are imported, poor households and commuters are at the mercy of international oil prices. Increasingly, the reliance on large hydropower for about a third of electricity supply is under pressure as dams dry up, especially in the dry seasons. Desert encroachment and high population growth are key issues during the current fuelwood crisis. The resilience of the Nigerian energy system is weak as climate change, bad governance and widespread poverty intensify the vulnerability of the energy economy.

The challenges of energy security and access are compounded by inefficiency and poor environmental governance. Per capita energy sector CO₂ emission in Nigeria is 0.5tCO₂/toe. Even though this figure is relatively low, the environmental fallout of the energy sector in Nigeria is glaring. The Niger Delta is perhaps one of the world's most polluted environments. Oil pollution and gas flaring has damaged agricultural land and marine ecology irreversibly.

Nigeria has some of Africa's largest and most polluted cities – including Lagos, Kano and Ibadan. Measurements have recorded high concentration of harmful gases from vehicular traffic and the result of poor urban transportation planning. However, indoor air pollution from inefficient wood stoves represents a major public health concern, especially for women and children. Nigerian households predominantly depend on wood for cooking and heating.

² Primary energy demand and consumption statistics is from Draft National Energy Master Plan 2006.

Anticipated Areas of Vulnerability and Associated Consequences

Virtually all aspects of life in Nigeria are vulnerable to impacts of climate change. Five areas are particularly important³:

Human Settlement and Health

In both rural and urban areas, human settlement and health are currently being affected by changes in climate. This is especially the case for settlements around the coast and in areas bordering the Sahara Desert.

Key infrastructure, especially along the Atlantic coast has over the years become very vulnerable to the impacts of sea level rise. This is particularly the case for the nation's financial hub, Victoria Island in Lagos. Hundreds of millions of US dollars have been spent in building ocean surge protection for this vital national economic nerve centre.

Saving Victoria Island

Victoria Island is the commercial, financial and leisure district of Lagos. The area harbours industrial infrastructures worth billions of dollars, a large human population, very fragile ecosystems such as wetlands, mangroves barrier and lagoon systems, non-fuel minerals, vast variety of fisheries, fauna and floral resources. The white sandy Bar Beach is perhaps the best known tourist destination in the Lagos area.

The foreshore of Victoria Island is a low coastal plain with beach ridges farther inland. Beach crest elevation is between 3-4m above sea level. The beach has been the site of the fastest erosion rates in Nigeria averaging 25-30m per year and one of the fastest eroding beaches in the world. A one meter sea level rise would flood 18,00km².

The Bar Beach is a great coastal challenge to Nigeria. Presently there is less than one meter of the beach width left. The Federal Government of Nigeria and the Lagos State Government have tackled the problem through beach nourishment. This involves the dumping of several millions cubic meters of sand, and sometimes boulders to enhance stability. The first such measure was undertaken in 1958-1960 and the last in 2002-2003. A major problem associated with beach nourishment is the fact that requires a continuous process to maintain a stable beach.

In other parts of the country flooding has become more frequent, which results in huge gully erosion, especially in the south-eastern parts of the country. Erosion threatens human settlement and disrupts agriculture.

³ This section draws heavily from the collaboration between Nigerian Environmental Study/Action Team and the Global Change Strategies International: Nigeria Climate Change – Executive Summary of Five Multi-Sector Surveys on Nigeria's Vulnerability and Adaptation to Climate Change.

Huge amounts of money are voted annually to pay for erosion control in all parts of the country.

The Sahara Desert has consistently expanded its frontiers deep into Nigeria. Desertification of the country has been accentuated by increased temperature and irregular precipitation. Sand dunes have replaced fertile agricultural land in the northernmost parts of the country. The cost in human lives and the economy is great.

Both climate induced desertification and extreme inundation in the south has resulted in shrinking resources upon which livelihood depends, creating eco-refugees. Scarcity of settlement, agricultural and pastoral land is the main flashpoints of conflicts in the country. If the current trend continues, the greatest sources of insecurity and instability in the country will remain resource and environmental conflicts.

Extreme climate conditions such as high wind, heavy rainfall, heat and cold can result in wide-ranging scenarios such as tropical storms, floods, landslides. Attending to these climatic emergencies may stretch the capacity of public health infrastructure and diverts resources from the task of delivering healthcare services.

The dispersion of pests and diseases can be affected by climatic conditions such as temperature, precipitation, sunshine and wind. This affects crop yield and food security, as well as animal and human health. Malaria, cholera, typhoid fever, dengue cerebro-spinal meningitis are some of the diseases whose impacts may be exacerbated.

Water Resources, Wetlands and Freshwater Ecology

Water resources management for domestic, agriculture, industrial and energy uses are challenging in Nigeria. The lack of access to water for various uses is more severe in the northern parts of the country. A major concern is the frequency and severity of drought. This has major impacts on agriculture and other water-related activities. Two drought incidents in the 1960s and 1970s resulted in the death of millions of cattle, goats and sheep. Denudation caused by droughts increases the severity of erosion.

In the southern parts of the country, the low-lying 850km Atlantic coastline from Lagos to Calabar is prone to sea-water intrusion into coastal freshwater resources and therefore vulnerable to climate change. There is already a high incidence of coastal erosion and flooding.

The Drying of Lake Chad

The Lake Chad was once one of Africa largest bodies of fresh water. In the 1960s it had an area of more than 26,000km² making it the fourth largest lake in Africa. By 2000 the lake has shrunk to 1500km² - only 5% of its original size. Lake Chad borders four countries: Cameroon, Chad, Niger, and Nigeria and supports the livelihood of more than 20 million people. The largest source of water to the lake is the Chari River and provides about 90% of Lake Chad's water. It is very shallow with about 7 meters at its deepest and therefore remains sensitive to seasonal fluctuations in size.

The drought during the 1970s made the northern half of the lake completely dry and turned the southern basin into a densely vegetated area with scattered swamps and open pools. It seems likely that the lake will shrink further and possibly disappear altogether over the course of the 21st century.

Dropping water levels have affected irrigation projects as can seen in the case of the Southern Chad Irrigation Project. This project's goal was to irrigate 67,000 hectares of land but as water levels fell in the 1980s irrigation could not take place. Currently there are many floating islands in the lake that are home to a wide variety of wild life. This source of biodiversity will be completely lost if the lake continues to shrink. The income level of the fishermen around the lake has also decreased drastically over time. The daily fish catch has now reduced from 230,000 tons to barely 50,000 tons annually. Conflicts between pastoralists and farmers are a regular occurrence as herders have been forced to move out of the lake to the wetter south. The Sahara desert in the north is rapidly moving into the lake further compounding the situation.

A change in climate brings about alterations in rainfall patterns, water levels and volumes of lakes, ponds, rivers and streams, and frequency of drought and storms. According to the NEST/GCSI study⁴, increasing global warming and high temperatures are having the following consequences:

- Reduced water volume of streams and rivers, arising from different scale of water diversion for rudimentary irrigation activities, siltation of stream beds due to deposition of materials by water run-off, as well as evapo-transpiration;
- Drying up of water sources due to increased evapo-transpiration, and loss of vegetation in head waters;
- Deficiencies in freshwater availability will worsen the already poor sanitary and health conditions in these areas. Uncontrolled disposal of wastewater and human wastes further deteriorates the water quality. This leads to high organic matter levels in surface and ground water and increases the rate of water-borne diseases such as cholera, hepatitis, typhoid and malaria;
- Reduced stream velocity due to loss of gradient from siltation; and,

⁴ NEST/GCSI (2004) Nigeria climate change – executive summary of five multi-sector surveys on Nigerian vulnerability and adaptation to climate change. Ibadan: NEST/GCSI)

- Rapid rate of siltation of river/stream beds due to transport, and deposition of eroded materials from heavy rainfall-induced flooding, etc.

Wetlands in Nigeria comprise a wide range of coastal and inland habitats such as estuaries, flood plains, freshwater marsh, peat lands, swamp forests, open coasts and lakes of some certain depths. According to this study global warming will result in the following:

- Rise in sea-level resulting in the flooding of low-lying areas, inundation of coastal wetlands beach erosion, changes in sedimentation, and biodiversity loss;
- Salt water intrusion into coastal fresh water resources;
- Decline in flora and fauna, especially in the wetlands (currently home to over 2,000 species of plants and animals);
- Reduction in the biological productivity of the wetlands due to increased weather/heat stress as well as progressive desiccation;
- Greater frequency and intensity of thunderstorms and floods that threaten coastal ecosystems; and,
- Rapid rate of siltation of river/stream beds due to the transportation of terrestrial materials into streams, arising from heavy rainfall-related overland flow and flooding, frequency of storm, drought, flooding, etc.

Energy, Industry, Commerce and Financial Services

Climate change is affecting Nigeria's energy sector profoundly. The large hydropower plants in Kainji, Jebba and Shiroro together represent about one-third of the country's total installed electricity generating capacity. They are therefore key to the security of electricity supply in the country. However, in the past decade, these plants have produced significantly lower energy as result of low water levels in their reservoirs. This is a result of excessive drought that lead to evapo-transpiration affecting water volume and the capacity of the power plants to produce optimally.

About 50 percent of Nigeria's oil production is offshore. Others are in the low-lying Niger Delta coastal areas. Both offshore and onshore installations are threatened by wind and wave activity. Sea-level rise, coastal inundation, windstorms, floods and tornadoes associated with climate change will exert considerable impacts on the oil and gas industry.

The shortage of wood for cooking, especially in Northern Nigeria today represents one of the greatest energy crisis facing the country. Desertification exacerbated by climate change has drastically reduced the availability of wood for cooking.

Industries that are dependent on climate sensitive resources or conditions e.g. agro businesses, construction, infrastructure, transportation, pollution control are potentially vulnerable to changes in the climate. However, the potential impact on these industries will depend on the nature of raw

material they consume, the geographical location of such industries, the dynamics of consumer behaviour and government policies.

The insurance industry in Nigeria is beginning to experience the impact of climate change. The surge of the ocean along the Victoria Island financial and commercial districts may have resulted to significant insurance claims. Though farmers may not have traditionally hedged returns on their harvest through insurance policies future modernization of agriculture may impact significantly on the finance industry.

Agriculture, Food Security, Land Degradation, Forestry and Biodiversity

Peasant farming dominates agriculture in Nigeria. As a result the proportion of irrigated farming is small, making Nigerian agricultural output sensitive to climate change. Lately, the pattern of rainfall has changed and effected the commencement of the planting season, resulting in poor harvest yields.

Several climatic factors account for the problems of food insecurity in Nigeria. These include the variability in the onset and cessation of rainfall and its volume, extreme weather events, proliferation of pests and diseases and the effect of high temperatures.

Several factors account for land degradation. In Nigeria, the following indicators of climate-induced land degradation have been observed:

- Scorched and retreating forests resulting from temperature increases and evapo-transpiration;
- Deforestation, characterized by accelerated loss of forest cover, even though this can be accentuated by human activities;
- Reduced soil productivity when soil nutrients are removed due to erosion; and,
- Devastation of farmlands as a result of heavy rainfall-induced soil erosion, especially in the south-eastern part of the country.

Nigerian forests are affected by climate change in the following ways:

- Decreasing forest density and biodiversity loss
- Poor tree growth and development;
- Diminishing forest cover, particularly in the northern parts of the country;
- Increased incidence of pests and diseases that attack and decimate forest trees; and,
- Climate stress exacerbating exploitation pressure to depress forest regeneration.

In Nigeria, many species of plants and animals are becoming extinct. Several indicators of rapidly decreasing biodiversity include:

- The disruption and reduction of the fruiting intensity of some trees;

- Aberrations in animal mating habits, changes in bird and animal migratory patterns and changes in fish spawning patterns; and,
- The increasing extinction of rare and endangered species of plants and animals.

Coastal Zone and Marine Ecosystems

The Nigerian coastal region comprises a complex ecosystem that includes the Niger Delta. Climate change may have begun to affect Nigeria's coastal ecosystem in the following ways:

- Beach erosion and coastal flooding are widespread as a result of high waves generated by onshore windstorms;
- Mangroves adjoining estuaries are receding due to wave incursion and beach breaching;
- The receding shoreline and tidal incursion of between 30-60km around the Niger Delta suggests increasing salination;
- Sea-beds affected by storm waves threaten the integrity of offshore buried oil pipelines leading to rupture and oil spillage; and,
- Integrity of coastal engineering infrastructure and many industrial facilities are undermined by storm wave scouring and wave run-up, leading to possible closure of operations and job loss.

Country Assets Likely to Reinforce Adaptation

The ability to withstand and recover from climate change impacts is essentially about the capability of human development – enabled by a strong economy, supportive policy framework, vigorous civil society and strong knowledge base. As Nigeria confronts climate change, there are areas that could potentially be mobilized to enhance the resilience of the country to climate impacts. These areas can be found within the economy, the economic policy framework, civil society and epistemic communities.

The Nigerian Economy

The Nigerian economy is dominated by crude oil production and export. Oil accounts for about 20% of GDP, 95% of export earnings and 65% of budgetary revenues. Although agriculture employs about 70% of the workforce, its contribution to GDP is 17.3%. Industry accounts for 53% while services provide 29.5% of the GDP.

About 33% of the Nigerian land mass is arable land. Only 1% of the 306,691 sq. km of arable land is under irrigation. This provides a vast opportunity for modern irrigated farming in the country. Agricultural products include cocoa, groundnut, palm oil, corn, rice, sorghum, millet, cassava, yams, rubber, cattle, sheep, goats, pigs, timber, fish, etc. Before the emergence of crude oil, palm oil, coca and groundnut dominated exports. Today, Nigeria is a net food importer. Food production has lagged behind the increase in population.

The industrial sector in Nigeria produces crude oil, coal, tin, cement, textiles, hide and skin products, footwear, chemicals, fertilizer, printing, steel, ceramics, ship construction, etc. A challenging investment climate marked by poor infrastructure, especially power, insecurity, weak judiciary, high interest rates and inadequate access to skilled manpower have impeded the growth of these and other industries. Currently only 10% of labour is employed in industry.

The service sector is comprised of public services as well as businesses such as water supply, power, telecommunications, information, etc. This sector has grown over the years. With increased privatization and efficiency in the delivery of services, the prospects for growth in this area are bright.

Energy Sector in Nigeria

Nigeria is endowed with sufficient energy resources to meet its present and future development requirements. The country possesses the world's sixth largest reserve of crude oil. It is increasingly an important gas province with proven reserves of nearly 5000 billion cubic meters. Coal and lignite reserves are estimated to be 2.7 billion tons, while tar sand reserves represent 31 billion barrels of oil equivalent. Identified hydroelectricity sites have an estimated capacity of about 11,000MW. Nigeria has significant biomass resources to meet both traditional and

modern energy uses, including electricity generation. The country is exposed to a high solar radiation level of 3.5 – 7.0kWh/m²/day. Wind resources in Nigeria are however poor to moderate and efforts have yet to be made to test their commercial competitiveness.

The current installed capacity of grid electricity is about 6,000MW, of which about 67 percent is thermal with the balance being hydro-based. Between 1990 and 1999 no new power plants were built. Over the same period of time there was substantial government under-funding of the utility for both capital projects and routine maintenance operations. Generating plant availability is low and the demand/supply gap is crippling. Poor services have forced most industrial customers to install their own power generators, at high costs to themselves and the Nigerian economy.

Table 1: Nigeria's Energy Reserves/Potentials

Resource	Reserves	Reserves Billion toe	% Fossil
Crude oil	33 billion bbl	4.488	31.1
Natural gas	4502.4 billion m ³ (159 trillion scf)	3.859	26.7
Coal & Lignite	2.7 billion tones	1.882	13.0
Tar Sands	31 billion bbl oil equiv.	4.216	29.2
Sub-Total (Fossil Fuels)		14.445	100.0
Hydropower, large scale	10,000MW		
Hydropower, small scale	734 MW	Provisional	
Fuelwood	13,071,464 has (forest land 1981)	Estimate	
Animal waste	61million tones/yr	Estimate	
Crop Residue	83million tones/yr	Estimate	
Solar Radiation	3.5-7.0kWh/m ² -day		
Wind	2-4 m/s (annual average)		

Source: Renewable Energy Master Plan (2006).

By 2005, the transmission network consisted of 5000km of 330 kV lines, and 6000km of 132 kV lines. The 330 kV lines fed 23 substations of 330/132 kV rating with a combined capacity of 6,000 MVA or 4,600 MVA at a utilization factor of 80%. In turn, the 132 kV lines fed 91 substations of 132/33 kV rating with a combined capacity of 7,800 MVA or 5,800 MVA at a utilization factor of 75%.

Table 2: Commercial Power Generation in Nigeria

Source of power	Capacity in MW	%
Afam	986	
Egbin	1320	
Sapele	1020	
Delta	912	
Thermal	4238	69
Kainji	760	
Shiroro	600	
Jebba	570	
Large Hydro	1930	31
Total	6168	100

Excerpts from Agagu, O.(2002) Developments in the electric power sector, May 1999 – 2002.

The distribution grid consisted of 23,753 km of 33 kV lines and 19,226 Km of 11 kV lines. In turn, these fed 679 substations of 33/11kV rating and 20,543 substations of 33/0.415 and 11/0.415 kV ratings. In addition, there were 1,790 distribution transformers and 680 injection transformers.

The transmission network is overloaded with a wheeling capacity less than 4,000 MW. It has a poor voltage profile in most parts of the network, especially in the North where inadequate dispatch and control infrastructure, radial and fragile grid network, frequent system collapse, and exceedingly high transmission losses are prevalent.

Access to electricity services is poor in Nigeria. About 60 percent of the population – approximately 85 million people are not served. Per capita consumption of electricity is approximately 100kWh in comparison to 4,500kWh, 1934 kWh and 1379 kWh in South Africa, Brazil and China, respectively. Under a business-as-usual scenario, the proportion of Nigerians without access to electricity services will continue to increase over time. The Rural Electrification Program began in 1981 focuses exclusively on grid extension; costs per connection remain high and annual rate of connection is low.

The Federal Government is undertaking comprehensive reforms to address the electricity situation in the country. The enactment of the Electricity Power Sector Reform Act (2005), establishment of the Nigerian Electricity Regulatory Commission, Rural Electrification Agency and the unbundling of the national utility are concrete legal, regulatory and institutional steps that will begin to address the challenges of the sector. Presently, a new wave of investments in the power generation championed both by the government and the private sector has commenced.

National Economic Empowerment and Development Strategy

Nigeria's economic development and poverty reduction strategy document is the National Economic Empowerment and Development Strategy (NEEDS). It is a home-grown blue print for reforming the Nigerian economy, stimulating growth and addressing the rising poverty.

NEEDS has three main pillars: building human capital by investing in a social charter that improves health, education and employment; promoting private enterprise, and changing the way government delivers services.

The past few years have seen an appreciable investment in the social sector. Programs have been established for primary health care, immunization, malaria and HIV/AIDS prevention. In many states, primary and secondary school enrolment has significantly increased, while new universities have been licensed. The poor performance of the industrial sector has however not allowed for increases in employment. Untapped manpower reserves are huge in Nigeria.

A key pillar in the Federal Government's policy is the stimulation of private sector growth. The Government has recently concluded the first phase of consolidating the banking industry. The insurance industry has also undergone a consolidation process to create stronger and more responsive insurance industry. The latter is important as a strong insurance industry will be key in managing risks associated with climate change.

A major part of ongoing reforms is the privatization of service delivery. The power sector, telecommunication, aviation and other public enterprises have been returned to private ownership. Initial results show an improved service delivery. One particular case in point is the privatization and liberalization of telecommunications. From 0.5 million phone lines in 1999, Nigeria has now about 30 million mobile phones. The development of such infrastructure is important for building community resilience to off-set shocks arising from climatic factors.

The NEEDS also established a framework to address the effectiveness of public service delivery. Nigeria has now a Bureau of Public Service Reforms working to improve the overall performance of government agencies. A key aspect of these reforms is the campaign against corruption. Over the years, corruption has become endemic in government business and has endangered growth and poverty reduction in the country. Though much remains to be done, progress against corruption is being made.

Civil Society Assets

There are several traits within the Nigerian civil society that position it well to address the impacts of climate change. One is traditional community self-reliance and knowledge, the other is within the non-governmental movement (NGOs).

In most of Nigeria, especially in rural areas, community self-organization is strong. Services are delivered and there is the collective management of emergencies. The tradition of sharing during unfavorable harvests and ability to predict weather conditions are elements of community resilience.

Increasingly, NGOs bring new insights, approaches and idealism into local resource management. Several well known NGOs have grown and prospered in Nigeria in the past few years, and these include the Nigerian Environmental Study/Action Team, Nigerian Conservation Foundation, Country Women Association of Nigeria, etc. These organizations bring new strengths that the country can count on in managing the resilience of communities to the climatic hazards.

Research and Development

There is significant growth in the number and capacity of epistemic communities in Nigeria. Many of these knowledge-based bodies are situated within the country's several universities. Others are independent research centres, such as the African Institute for Applied Economics, International Center for Energy, Environment and Development, etc. Research and development are key in Nigeria's efforts to grapple with the complexities of climate impacts. They assist in providing early warnings; analyzing complex ecological trends; identifying alternative options for public policy; and, assisting local communities in developing coping mechanisms.

National Resilience Mode

The national mode of resilience seeks to assess the degree to which various sectors of the national ecosystem, infrastructure and livelihood can absorb shocks and remain within a sustainable state; the degree to which these sectors are capable of self organization; and their ability to build capacity for learning and adaptation.

	Resilience in key sectors	Characteristics and needed investments	Moderate Climate Warming Scenario	Maximum Climate Warming Scenario
1	Human settlement and health	The capacity of human settlement and health to contain present shocks from climate variability and change is overstretched. Nigeria already has climate refugees as people flee degraded ecologies. The country needs to transform its agriculture from more vulnerable peasant farming to less climate dependent modern and more capitalized farming. Incentives will be needed in stimulating investments in efficient, modern and sustainable farms.	A moderate climate warming scenario without a corresponding increase in resilience will exacerbate the stress on livelihood and reinforce health challenges occasioned by growth of pests and diseases.	If temperature increases exceed the 20 scenario, pressure on livelihood will result. This will mean more scarcity of resources, competition and conflicts in proportions that the ecosystem and social system will have no capacity to absorb.
2	Water resources, wetlands and fresh water ecology	Nigeria’s water resources are unevenly distributed with intense drought in the North and high precipitation and flooding in the South. The Niger Delta ecology is further compromised by oil pollution. Attempts are being made to implement a water resource management strategy that seeks to address these challenges. Investments are needed in sustainable irrigation infrastructure and the development of redistributive water polices.	The resilience of Nigeria’s water resources and fresh water ecology is presently under pressure. A 20 scenario provides no relief for the gaps in the resilience capacity. More Nigerians will be affected by water scarcity and environmental degradation. However, the scenario may provide an opportunity for a new paradigm of water resources management to emerge. This will empower local communities to take better charge of water resources in their area rather than depending on the present centralized administration	A maximum climate warming scenario for water will have disastrous consequences. It will compound already existing water scarcity in the country and stretch the land’s capacity to manage flooding and erosions. This will result in emergencies of monumental proportions. Presently, Nigeria is not prepared for this scenario.

3	Energy, industry, commerce and financial services	<p>Nigeria is experiencing a major energy supply crisis. The security of petroleum supplies is exacerbated by problems in the Niger Delta. Power shortages. For connected communities power shortages will result in less than 50% availability of electricity. Eighty five million Nigerians have no access to electricity at all. Wood for cooking is scarce. As a result of the inadequate supply of power, industrial and commercial growth is stunted. The insurance industry is unprepared for catastrophes that a changing climate could bring. Nigeria needs to change its colonially-inherited energy governance; from conventional and centralized sources to one that is more diversified and decentralized. This will also require more investments in renewable energy and energy efficiency, especially in the power sector.</p>	<p>of water resource management.</p> <p>The hydropower potential of Nigeria has been decimated by drought. In an attempt to cope, new investments are being made in fossil power plants. A further decrease in available water for hydropower will make the country even more dependent on polluting hydrocarbons in a volatile and climate sensitive region. The petroleum industry is concentrated in the Niger Delta. These are low-lying ecosystems with intense storms and sea-level rise. While the petroleum industry has the capacity for self- readjustment and adaptation, hydro-based electricity generation may not have the capacity to adjust to a 20 scenario climate warming scenario.</p>	<p>A maximum climate warming scenario will present formidable challenges to oil and gas infrastructure offshore and in the Niger Delta. This will increase the cost of production and significant loss of infrastructure. Extreme temperatures and low precipitation, especially in the North, will alter Nigeria's energy equation by wiping out hydro electricity contribution to the energy economy.</p>
4	Agriculture, food security, land degradation and biodiversity	<p>Most of Nigeria's agriculture is still based on rain-fed peasant farming. This makes agriculture and food security climate sensitive and fragile. The capacity to re-adjust the sector is undermined by widespread poverty and unsupportive policies. Investments are needed to modernize Nigeria's agriculture systems. This includes the</p>	<p>A 2°C global warming scenario will increase challenges in food and in the agricultural industry. A policy change that facilitates access to vital resources – biotechnology and finance - are needed to create a more resilient system.</p>	<p>An extreme climate warming scenario will wipe out subsistent agriculture and contribute to even greater poverty. Anticipating and building resilient structures will demand an overhaul of economic thinking in the country. This is needed to secure food production in the future and secure rural</p>

		introduction of new knowledge, improved seedlings, technologies and better funding.		livelihood and employment.
5	Coastal zone and marine ecosystem	About 850km of Nigeria’s Atlantic coastline is characterized by sensitive ecosystems and high level of infrastructure investments. Sea level rise is already compromising the integrity of the ecosystem and security of investments. The Federal Government is currently spending hundreds of millions of US dollars in preventive barriers along the coast of Victoria Island. The oil sector appears capable of building offshore structures that can withstand storms and sea-level rise.	In the event of a 2 ⁰ C scenario, several areas including Lagos will remain threatened by sea-level rise. The capacity to address even more flooding will be challenged. With the high level of development along the coast, human settlement and investments can only be salvaged at some cost to the economy.	An extreme climatic warming will raise the stakes for the coastal areas and marine ecosystem. Climate change will lead to high and erratic oil prices as increased shocks cause greater instability and insecurity in the region. It will also stretch the capacity of the insurance industry to manage risks and place a high burden on the Nigerian economy.

Increasing Resilience and Ensuring a Good Quality of Life

In many ways, poverty separates the climate resilient from the vulnerable. The poor are less likely to absorb shocks, less empowered to self-organize and build capacity for learning and adaptation. Tackling poverty and building adaptation capacity more often than not are two sides of the same coin.

The Federal Government of Nigeria has set ambitious targets to achieve a double digit economic growth and meet both NEEDS and MDGs goals. Under normal circumstances, these are ambitious. Climate change makes the achievement of these goals even more daunting. If new thinking and approaches do not occur, a climate scenario above 2⁰C will reverse the effects of current reforms – leading to increased resource scarcity, poverty and conflicts.

Certain steps can be taken to enhance Nigeria's resilience to climate change. These steps include:

1. unlocking of the country's various reserves of assets;
2. instituting good governance;
3. embarking on sustainable energy investments;
4. developing and mainstreaming a National Adaptation Action Plan;
5. increasing access to climate change information; and,
6. empowering people.

Unlocking National Assets

Nigeria has several "reserves" of assets that are currently unavailable in the struggle against widespread poverty and environmental decline. One such crucial asset is the country's vast arable land mass. Only about one third of the arable is used for food production and this is mostly rain-fed peasant-worked agriculture. The country needs to improve the effectiveness of existing dams and invest in new small and medium sized sustainable dams. This will assist in hedging the scarcity of water during droughts.

Another important national asset is the country's human capital. Nigerian institutions of higher learning turn out over 500,000 graduates annually although only a few of them find any employment years after graduation. Creating an enabling environment for the private sector to grow and stimulating employment through massive public works programs will assist in creating jobs and reducing poverty.

The capacity to innovate is a key national asset. Despite significant resources expended on research and development in Nigeria, linkages between research and the market place are weak. More research on drought and disease resistant crops are needed. Biotechnology could also assist in ensuring food security and the protection of the ecosystem.

Capital flight from Nigeria to other countries is significant. Most of this runaway capital is owned by Nigerians themselves. The government must put in

place a mechanism to attract the return of both legal and illegally exported funds. Creating a favourable investment climate and intensifying the drive to return looted funds are important steps that must be taken.

Good Governance

In building capacity to adapt to climate change, increasing access to resources must be complemented by improvements in governance. Three key areas of governance are particularly crucial:

1. public finance;
2. energy management; and,
3. environmental governance.

Only a few years ago, Nigeria won the gold medal in corruption by being number one on the Transparency International league table. While some countries may have since overtaken the Nigeria on the international ranking, corruption remains a key factor in Nigeria's underdevelopment. An eradication of wastes from the public sector will unleash resources to combat poverty and stimulate growth – paving the way for the emergence of a stronger and more prosperous society capable of withstanding climate change induced shocks.

Environmental governance in Nigeria remains corrective – responding to new and potential dangers to the ecology rather than being pro-active. Sustainable development demands a mainstreaming of environmental concerns within key economic and social development processes. A good start would be the aligning of sustainable development concerns, especially adaptation issues within the second phase of the NEEDS – Nigeria's economic empowerment and development strategy document.

Energy governance refers to the efficient management of energy resources to achieve security of supplies, access to services and environmental sustainability. All aspects of the energy sector in Nigeria are in one crisis or the other. Wood - as the energy source for the poor - is in short supply, leading to high costs and increased deforestation. Electricity reaches just over one third of the population and is currently available less than eight hours per day. Paradoxically, Nigeria imports most of its refined petroleum products. In many ways, the energy sector is ripe for reforms from the old order of centralized and conventional fuels towards a new paradigm of energy governance and diversity.

Energy governance reform must shift from monolithic control of the energy sector to the devolution of service provision to regional and local governments, private sector and civil society. This empowerment process would enhance energy security and create opportunities for interdependence. Nigeria must also move away from the over-dependence on finite fossil fuel sources towards a more diversified resource base. This will open up opportunities for increased renewable energy and energy efficiency utilization.

Sustainable Energy Investments

As Nigeria devolves and diversifies its energy sector, certain investments become compelling. These includes scaling up climate change resilient investments in renewable power supply, efficiency in wood stoves use and rapid transition away from wood dependence, construction of a national gas grid to enable the building of small scale gas power plants and increased access to LPG for household cooking. Further, energy efficiency improvements and the use of combined heat and power generation ought to be considered.

Nigeria has currently launched a Renewable Electricity Action Program (REAP). The objective of REAP is to expand the contribution of renewable energy in power generation to 5%⁵. The program is a ten-year investment framework seeking to deliver 5TWh of electricity and 1.2million tons of CO₂ reduction within the same period. It also includes small hydropower, biomass cogeneration, solar PV and wind power.

Renewable Electricity Action Program Targets

- 5% contribution of renewable electricity to total generating capacity, excluding large hydro power
- 735 MW cumulative renewable electricity generating capacity
- 5TWh of energy
- 2 Million new connections
- 1 Million Solar Home Systems
- 2,000 Rural solar school electrification
- 2,000 Rural solar clinics electrification
- 10,000 solar street lights
- 500,000 jobs
- 100 billion Naira (approx.780 million USD) renewable electricity industry
- 1.2 MT CO₂ emission reduction

To achieve the potentials of the REAP, the Federal Government must mobilize financial resources, especially from the private sector. Enabling policy reforms including electricity market expansion policies must also be implemented. An environment must be created that allows the participation of other stakeholders, including regional and local governments, communities and NGOs.

About 80% of households in Nigeria are dependent on the use of wood for their cooking and heating needs. Investments are needed to rapidly expand the use of improved woodstoves. Further, there is a strong case to build government programs that stimulate the transition away from wood stoves to kerosene, LPG, biogas and electricity. Transition towards more efficient and modern cooking energy currently lacks a strong champion.

⁵ This figure excludes large hydropower.

In many cases, the use of cogeneration technologies presents low-hanging fruit opportunities in the production of electricity from cement, steel, LNG and sugar plants. Cogeneration should therefore be part of the toolkit for bridging the demand and supply gaps in electricity.

Mainstreaming Climate Change Adaptation

Nigeria has not yet begun the process of developing a National Adaptation Action Plan. Completing this process is important in meeting international commitments as well as drawing a national roadmap for addressing the challenges of climate change adaptation.

A key document in Nigeria's development process is the NEEDS. It provides a framework for economic and development policy from 2004-2007. As the country embarks on the review and development of NEEDS -2, it is crucial that climate change adaptation issues are mainstreamed in this policy. From the NEEDS, adaptation relevant expenditures will be reflected in the mid-term public finance framework as well as annual budgets.

Increasing Access to Climate Change Information

Public awareness on climate change, Nigeria's vulnerability, climatic impacts, mitigation measures and opportunities in the carbon market is very limited in Nigeria. Running successful adaptation programs must be built on people. Sustainability of climate change initiatives are ensured when action is demanded by citizens. Climate change information through media activities, high visibility projects and use of credible institutions like religious bodies and community based organizations will be required.

A Return to Equity

Often resilience to climate change is addressed in terms of building the capacity of structures, infrastructures and institutions to absorb and adapt to shocks. In as much as enabling systems matter, resilience is in-built in people; when given the appropriate support mechanisms they are empowered to change their livelihood, society and environment.

The greatest human challenge of the 21st century is widespread poverty. It degrades the resilience of individuals so much so that even in rich developed countries, the poorest remain the most vulnerable. The devastation of Hurricane Katrina in the world's most powerful country (USA) starkly illustrates this fact.

The challenges of climate change impacts should put people at the centre of development work by narrowing the gap between the rich and the poor. There is a need to return to the search for social equity abandoned in the neo-liberalism of 1980s. The challenges of climate change adaptation can be met by building resilience in people.

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