The Challenge of Climate Change in Africa: A Case Study of Nigeria

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Abstract
Climate change is one of the most critical environmental challenges confronting mankind in the 21st century. The consequence of climate change affects the poor and the rich countries of the world. This paper examines the challenges of climate change adaptation in Africa with emphasis on Nigeria. It considers the implications of climate change on agriculture, biodiversity water resources, social - economic activities and the human security dimension. The study observes that the necessary institutional, manpower, research and technological requirements required for adaptation is lacking in Nigeria. The paper concludes that although there are necessary policy frameworks, they are weak in terms of implementation and enforcement due to lack of political will and weak governance structure in Nigeria

1. Introduction

Never in the history of man has the issue of climate change been so topical at national and international levels as it is today. Climate change and its projected impacts on the environment and socio-economic system now constitute the most important environment problem that mankind faces in the 21st century.

Two major factors account for the prominence now given to the issue of climate change in global politics. First, is the frequency of occurrences of extreme weather event such as floods, droughts, heat and cold waves experienced in different parts of the world in recent years and the devastating effects of these severe weather conditions on human lives and property as well as national economics?

Second, the realization that man through his various socio-economic activities is capable of inadvertently influencing global climate for good, or ill, but in many cases for ill (Ayoade, 2003).

The increase in the average global temperature experienced since the early 1970s and the occurrences of weather anomalies such as drought and floods in various parts of the world seem to provide the signal for impending change in the climate of the world as we know it.

According to the fourth Assessment Report of the Intergovernmental Panel on Climate Change (2007), climate change and global warming will have serious implications in

Africa. It is estimated that by 2020 between 75 million and 250 million people are to be exposed to increased water stress due to climate change. Agricultural production, including access to food, in many African countries and regions are projected to be severely compromised by climate variability and change. The area suitable for agriculture, the length of growing season and yield potential, particularly among the margins of semi-arid and arid areas are expected to decrease.

In Nigeria, despite the vulnerability of the country to issues of drought and desertification, floods and ocean surges due to see level use, little progress has been achieved in the areas of climate change adaptation. What are the factors responsible for this and what strategies should be put in place for the implementation of the National Adaptation Plan of Action against climate change in Nigeria form the objective of this paper. In addressing this, the paper will consider the concept of climate system, global warming debate as well as evidences and impacts of climate change, strategies to climate adaptation and the challenges to implementing them.

2. **Climate System**

In order to understand why climate varies, we have to examine the mechanisms that give rise to climate. Climate depends on the nature of the general circulation of the atmosphere which is determined by a complexity of factors and processes that constitutes the global climate system. The global climate system according to Ayoade (2003) includes the atmosphere (air), the hydrosphere (water), the biosphere (living organism), the lithosphere (land) and the cyosphere (ice and snow) interacting with one another under the influence of solar energy. He observed that the climate state of a place at any given period is determined by three crucial factors:

i. The amount of solar energy received by the climate system, which depends on the solar output, the extent of radiation losses in space before reaching the earth's atmosphere, the distance of the earth from the sum and the angle till of the earth's axis of rotation.
ii. The way this energy is distributed and absorbed over the earth's surface which depend on the earth's atmosphere composition, its topography, extent of ice and snow cover and the distribution of continents and ocean.
iii. The nature of the interaction processes between the components making up the global climate system.

It is the variation in any of these factors that causes climate change variability.

3. **The Global Warming Debate**

That the earth's temperature is rising is an undisputed fact. There is however disagreement on two issues namely the cause of the global warming and whether or not the process will continue or will be reversed and how.

One school of thought ascribed warming to the effect of greenhouse gases such as Co_2, Methane and Nitrous oxides produced mainly by human activities. Thus, the warming trend from the late 1880 to the mid 1940 has been attributed to the effect of $C0_2$ produced by industrialization following the industrial revolution of the late 19^{th} century. In contrast, the cooling trend from 1940 to the 1960 was attributed to the cooling effect of aerosols produced also by industrialization. The global warming since the 1970 has been ascribed to the increasing emission of methane and nitrous oxides by various human activities.

There is a minority opinion in the literature on the debate on global warming. They argued that global warming does not exist or that if it exists it has been exaggerated (Ayoade, 2003). It is further argued that the surface network of global weather stations have recorded a rise in temperature of 05^0c during the last century including a rise of $+0.15^0$c since 1980, NOAA satellites which measure surface temperature for the whole earth have recorded no rise in global temperature in the last 20 years (that is since 1980) for which data are available.

It is also argued that reading from available radiosondes match the measurements by NOAA satellites in showing no trend in global temperature. It is then suggested that the surface network of weather stations are perhaps, at least, partly measuring urban warming as most of these stations are located in or near urban centres.

It has also been pointed out that records from ocean surfaces show similar pattern of temperature rise to record from land surfaces. It has also been stated that available radiosondes data, though more limited than the surface records, show a warming tropospheric temperature of about 0.5^0c over the period of 1958 to 1998 in consonance with what the surface data indicate (Viner et.al, 2000). It is quite clear from the above, that the fact that the earth's air temperature has been increasing in recent years causing the phenomenon of global warming is well established beyond any reasonable doubt.

4. Evidence of Climate Change

Episodes of climate anomaly are both of historical and contemporary interest. Some of the episodes were highlighted by Olaniran (2002). The first one dates back to the biblical time of Noah (about 4000 years ago) when it rained for 40 days and 40 nights with resulting flood waters reaching 6m level and lasting 150 days. According to the biblical account, only Noah, his household and representative of animals/birds collected by him, survived

the prolonged and widespread flooding (Genesis Chapter 7, verses 4-20). Oguntoyinbo (1982) also cited the widespread famine of 1887 in southwestern Nigeria which was called "Iyans' Odidogbon" meaning "a famine which turned moat into an impassable trench" as well as a similar famine in the same area from 1903-1904 which was labeled "Iyank'ehins'ara" meaning a famine which caused man to turn his back on his relations. Ekiti land according to Olaniran (2002) had experienced "Iyanf' owo re mi" which means "famine in which life is saved by cash or cash survival famine.

In recent times, there was the Ogunpa flood disaster in Ibadan in Oyo State, Nigeria known in local parlance as "omi'yale, agbarayasobu" meaning that both residential and commercial area were invaded by floodwater. Perhaps, the worst flood in the history of city occurred on 31st August, 1980 with property damage estimated at N1.5 billion (see Akintola and Ikwuyatum, 2012).

Table 1: **Some Episodes of Rainfall Anomaly in History**

S/No	Date	Area Affected	Mode of Occurrence	Remarks	Sources
1.	About 4000 years ago	Biblical world of that time	40 days and 40 nights of continuous rainfall. The flood waters reached 6m level and lasted 150 days	Only Noah, his household and representatives of animal/birds collected by him survived by widespread flooding	Genesis Chap. 7:4-20
2.	About 3000 years ago	Egypt	7 years of abundant rainfall followed by seven years of severe drought	During the 7 years of abundance, the land produced plentifully. In the case of the 7 years of widespread famine, there was lack of food over the land	Genesis Chap. 41:47-56
3.	Between 974 and 852 B.C	Saaria	3 years without rainfall	There was widespread shortage of good food	1 Kings Chap. 18:1
4.	1887	Southwest Nigeria	Widespread famine	Iya Sodidogbun (a famine which caused man to turn his back on his relations)	Oguntoyinbo (1982) citing historical events reported by Ajayi
5.	1903-1904	Southwest Nigeria	Widespread famine	IyanK'ehinS'ara (famine which caused man to turn his back on his relations)	Oguntoyinbo (1982) citing historical events reported by Ajayi
6.	1910-1914	Hausaland	Widespread famine	Kakalaba	Thambyahillay, 1970
7.	1918	Southwest Nigeria	Widespread famine	Iyanlapelape (lapelape drought during which people trekked from Igboho to Ibadan (150km by shortest route to buy food items	Oguntoyinbo (1982) citing historical events reported by Ajayi
8.	1927	Hausaland, Nigeria	Widespread famine caused by drought	Called Yan Buhu	Thambyahillay, 1970

9.	1942	Hausaland, Nigeria	Widespread famine caused by drought	Called YarGusau	-do-
10.	1941-44	Ekitiland, Nigeria	Widespread famine	Called Iyanfowo re mi i.e. famine in which life is saved with cash	Adefolalu (personal communication)
11.	1945-46	SW Nigeria	Widespread famine	Iyan Abbatial	Oguntoyinbo (1982) citing historical events reported by Ajayi

(Source: Olaniran, 2002)

5. Major Greenhouse Gases and their Contributions to Global Warming

The major greenhouse gases produced by human activities are $C0_2$, methane, nitrous oxides and chlorofluorocarbons (CFCS). The emissions of greenhouse gases ranked by country are shown in Table 2.

Table 2: Greenhouse Gas Emission by Country in 2007

Country	Change in Greenhouse fly Emission (1992-2007)	2007 per capital C02 Emissions (Metric Tones Per Person)	Share of 2002 Worldwide C02 Emissions
World Total	39.22%	4.52%	100.0%
China	154.42%	4.7	21.01%
USA	18.41%	19.94	20.08%
Russian	17.41%	11.83	5.59%
India	110.99%	1.25	4.68%
Japan	17.13%	9.91	4.22%
Germany	21.62%	10.13	2.79%
Canada	75.34%	17.91	1.97%
UK	2.62%	9.28	1.89%
South Korea	75.34%	10.69	1.72%
Iran	108.83%	7.5	1.64%
Italy	10.9%	1.92	1.54%
Australia	67.8%	21.99	1.53%
Mexico	44.48%	4.17	1.51%
South Africa	40.11%	9.35	1.15%
Saudi Arabia	84.29%	15.73	1.45%
France	5.84%	6.36	1.35%
Brazil	67.22%	2.05	1.33%
Spain	50.8%	9.47	1.29%
Ukraine	-33.8%	7.65	1.18%
Indonesia	76.38%	1.36	1.06%
Taiwan	133.01%	13.47	1.03%

Poland	-8.71%	7.83	1.01%
Turkey	99.86%	3.71	0.93%
The Netherlands	22.69%	15.78	0.87%
Thailand	1.45.82%	3.81	0.83%
Kazakhstan	-18.26%	14.16	0.72%
Venezuela	53.65%	6.6	0.57%
UAE	67.49%	38.46%	0.57%
Argentina	50.91%	4.14	0.55%
Egypt	70.34%	2.11	0.53%
Malaysia	116.3%	6.35	0.53%
Singapore	126.35%	33.86	0.52%
Belgium	15.59%	13.87	0.48%
Pakistan	97.02%	0.82	0.46%
Uzbekistan	27.52%	4.52	0.41%
Greece	35.02%	10.07	0.36%
Nigeria	9.97%	0.72	0.35%

Source: United Nations, 2007

Table 3: Major Greenhouse Gases and their Contributions

C02	55%
Chlorofluorocarbons	24%
Methane	15%
Nitrous Oxide	6%

Table 4: Stabilization of Atmosphere Concentrations: Reduction in Human Made Emissions of Greenhouse Gases Required to Stabilize Concentrations at Present Levels

Greenhouse Gases	**Reduction Required**
Carbondioxide	>60%
Methane	15-20%
Nitrous Oxide	70-80%
CFC-11	70-75%
CFC-12	75-85%
HCFC -22	40-50%

Source: IPCC**,** 1990

Table 5: Emission of Greenhouse Gases in Nigeria

S/N	**SOURCES**	**EMISSION IN GIGAGRAMS**

		$C0_2$	CH_4	N^20
1.	Fossil Fuel combustion	35672.224	5.036	0.915
2.	Industrial Process	1874.167	0.000	0.000
3.	Oil and gas systems	34625.893	115.936	0.84
4.	Biomass burning	0.000	0.28	0.84
5.	Land use changes	0.000	48.414	4.834
6.	Savannah burning	0.000	69.711	0.932
7.	Agricultural wastes	0.000	47.238	1.555
8.	Rice Production	0.000	19.110	0.000
9.	Ruminants	0.000	364.800	0.000
10.	Non-Ruminants	0.000	39.210	0.000
11.	Animal Wastes	0.000	83.603	0.000
12.	Municipal solid wastes	0.000	187.251	0.032
13.	Agricultural solids	0.000	0.000	0.000
14.	Natural	1038.958	66.225	0.000
15.	Coal Mining	0.000	0.480	0.000

(Source: Ologunorisa, 1991)

Table 6: Emission of Greenhouse Gases by Sectors

S/N	**SOURCES**	**EMISSION IN GIGAGRAMS**		
		$C0_2$	**CH_4**	**N^20**
1.	Household	3991.77	154.35	2.56
2.	Agricultural/Forestry	0.30	672.09	2.56
3.	Service	45.73	0.001	000
4.	Industry	10689.43	33.24	0.37
5.	Transportation	14558.81	4.09	0.20
6.	Energy Conversion	34635.36	116.36	0.38
7.	Primary Energy Conversion	34635.36	116.36	0.38
8.	Natural Resource	1038.96	66.23	0.00
	Total	**73,213.73**	**1,051.04**	**10.72**

(Source: Ologunorisa, 1991)

Table 7: Greenhouse Gas Emissions by State, in Nigeria

S/N	**SOURCES**	**EMISSION IN GIGAGRAMS**				
		$C0_2$	**CH_4**	**N^20**	**Total Emissions**	**% of Nigeria's Total Emissions**
1.	Abia	9.13	4.17	0.01	13.31	0.2

2.	Akwa Ibom	5733.60	23.30	0.33	5766.23	10.16
3.	Anambra (1988)	1277.04	53.36	0.38	1330.68	2.34
4.	Bauchi-Gombe	856.72	60.53	0.39	4284.13	7.55
5.	Edo-Delta	4282.89	0.71	0.53	4284.13	1.62
6.	Benue (1988)	473.07	25.87	0.30	499.24	0.88
7.	Bornu-Yobe	609.22	126.40	0.81	736.43	1.30
8.	Cross River	599.73	18.18	0.22	618.13	1.09
9.	Adamawa-Taraba	45.08	78.96	0.35	535.40	0.94
10.	Imo (1988)	3275.17	23.96	0.42	3299.55	5.81
11.	Kaduna	1367.17	35.45	0.29	1402.81	2.47
12.	Katsina	133.96	24.41	0.28	158.65	0.28
13.	Kano-Jigawa	1226.13	38.29	0.66	1265.08	2.23
14.	Kwara (1988)	931.04	57.77	0.21	989.02	1.74
15.	Lagos	8271.68	24.66	0.56	8296.93	14.62
16.	Niger (1988)	444.71	57.87	0.21	502.70	0.98
17.	Ogun	1296.90	14.15	0.22	1211.27	2.31
18.	Ondo-Ekiti	635.22	26.48	0.32	662.02	1.07
19.	Oyo-Ogun	1848.37	40.18	0.52	1889.07	3.33
20.	Plateau-Nassarawa	964.47	46.09	0.25	1010.81	1.78
21.	Rivers-Byelsa	20457.7	83.28	0.59	20.541.57	36.18
22.	Sokoto-Kebbi-Zamfara	634.21	95.00	0.72	729.93	1.29
	Sum of States	55,786.11	971.98	10.51	56,786.60	100.00
	Nigeria	73,212.73	1051.04	10.72	74,374.49	

Source: (Adapted from Ologunorisa, 1991)

Tables 2and 3, show the percentage contribution of the greenhouse gases to global warming. Chlorofluorocarbons also contribute to the depletion of ozone in the stratosphere. Over 80 percent of global warming is due to Co_2, chlorofluorocarbon and carbon monoxide produced mainly by activities involving the burning of fossils fuels like coal and oil. Hence, vehicular emissions and emissions from industrial establishments and thermal power stations are the major man made sources of $C0_2$ found in the atmosphere. Table 4 shows the level of reduction required to stabilize the concentration at present level. Table 5 shows the emission of greenhouse gases in Nigeria, while emissions by sectors and emission by state are shown in Tables 6 and 7 respectively.

6. **Projected Impact of Climate Change in Africa**The IPCC 2007 projected that by 2020, between 75 million and 250 million people would be exposed to increase in water stress due to climate change. If coupled with increased demands, this will adversely affect livelihood and exacerbated water-related problems.

- The area suitable for agriculture, the length of growing seasons and yield potential, particularly along the margins of semi arid and arid areas, are expected to decrease. This would further adversely affect food security and exacerbate malnutrition in Africa.
- Local food supplies are projected to be negatively affected by decreasing fishery resources in large lakes due to rising water temperatures, which may exacerbate by continued over fishing.
- Towards the end of the 21st century, projected sea-level rise will affect low lying coastal areas with large population. The cost of adaption could amount to at least 2-10 percent of Gross Domestic Product (GDP).
- Mangroves and coral reefs are projected to be further degraded, with additional consequences for fisheries and tourism.

Health

- Projected climate change-related exposures are likely to affect the health status of millions of people, particularly those with low adaptive capacity.
- Increases in malnutrition and consequent disorders, with implications for child growth and development.
- Increased deaths, diseases and injury due to heat waves floods, storms fires and droughts.
- The increased frequency of cardio-respiratory diseases due to their concentration of ground level ozone related to climate change and
- The altered spatial distribution of some infectious diseases vectors.

Coastal Systems and Low Lying Area

- Coasts are projected to be exposed to increased risks including coastal erosion, due to climate change and sea level rise. The effect will be exacerbated by increasing human induced pressures on coastal area.
- Increase frequency of coral bleaching events and widespread mortality.
- Coastal wetlands including salt marshes and mangrove are projected to be negatively affected by sea level especially when they are constrained on their land ward side, or starved of sediment.
- Many million more people are projected to be flooded every year due to sea level rise by the 2080s.
- The numbers affected will be largest in the Mega Deltas of Asia and Africa while small islands are especially vulnerable.

Ecosystems

- The resistance of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change associated disturbance (e.g. flooding, droughts, wild fire, insects, ocean acidification) and other global change drivers (e.g. land use, change, pollution, over exploration of resources).
- Approximately 20-30 percent of plant and animal species assessed so far are likely to be at increased risk of extinction if increases in global average temperature exceed 1.5-2.5^{0}c.
- The progressive acidification of oceans due to increasing atmospheric carbon dioxide is expected to have negative impacts on marine shell forming organisms (e.g. corals) and their dependent species.

Security Challenges

Climate change will lead to pressure on food and livelihood. This would lead to populist and/or military coups in a number of countries. This will produce continuing instability in Africa, in particular. Between 1980 and 2001, there were 95 attempted coups in Africa, 33 percent were successful (Brown, Hamil and Mcleman, 2007). Popular discontent over livelihood security was a contributing cause of many of these. It may even lead to the outbreak of conflicts. For example, a June 2007 report by the United Nations Environment Programme (UNEP) suggested that the outbreak of conflict in Darfur region of Sudan has in part been driven by climate change and environmental degradation.

Selected Impact of Climate Change in Nigeria

Table 8 to 11 shows some selected impact of climate change in Nigeria especially the vulnerable areas.

Table 10: Projected Total Land loss Due Erosion

Low Estimate				**High Estimate**				
SLR	**0.2m**	**0.5m**	**1.0m**	**2.0m**	**0.2m**	**0.5m**	**1.0m**	**2.0m**
Barrier	177	284	584	1167	118	289	602	1204
Mud	403	1008	2016	3456	403	1008	2016	3456
Delta	2846	7453	15125	18398	2865	7500	15332	18803
Strand	79	197	395	575	85	212	446	677
Total	3,445	8,942	18,120	23,596	3,471	9,009	18,396	24,140

Source**:** Awosika et al., 1992

Table 9: Physical Effects of Potential Sea Level Rise (SLR) and Natural System Projection to 21st Century

		Units presently	no ASLR	ASLR I	ASLR II
1.	Erosion rate	m/y	10-15	165-19	20-25
2.	Erosion area lost**	km2	26-45	55-120	130-330
3.	Inundation and erosion**	Km2	3,000	7,000	15,00
4.	% of total area lost due to inundation and erosion	%	15%	35%	75%
5.	Subsidence	*	*	*	*
6.	Salinity				
	(i) Salt wedge intrusion	*	*	*	*
	(ii) Seepage	*	*	*	*
	(iii) Seepage salinity	*	*	*	*
7.	Natural system responses				
	Agriculture (7,940 km2)	Km2	794	2,779	5,955
8.	Number of Villages impacted	No.	50	200	350
9.	Number of people displaced	No.	150,000	1-2m	2-3m

No quantitative data available,
**; ASLR = Accelerated Sea Level Rise .
Source: Awosika et al., 1992.

Table 10: Estimated Number of Villages to be Impacted by SLR Along the Four Nigeria Morphological Zones and Their Value (US$'000,000).

SLR Screnario (m)								
	0.2		0.5		1.0		2.0	
Villages Along	Count	Value ($Mil)	Count	Value ($Mil)	Count	Value ($Mil)	Count	Value ($Mil)
Barrier	7	2.2	16	5.1	32	10.2	58	18.5
Mud	30	9.5	75	23.9	150	47.7	200	63.6
Delta	110	35.0	275	87.5	550	175.0	800	254.5
Strand	16	5.1	40	12.7	80	25.5	125	39.8
Total	163	51.8	406	129.2	812	258.4	1,183	376.4

Source: French and Awosika, 1993

Table 11: Chronology and Causes of Floods in Nigeria (1953-2000)

S/N	Location	Date	Cause	Damage
1.	Ibadan Oyo State 1956	1953 (3 September)	Heavy down-Pour	Houses destroyed and thousands of people rendered homeless
		1960	Urban induced	
		1963	Urban induced	
		1973	Collapse of Eleyele Dam	
		1978	Water works	
		1980	Urban induced	
		1982	Heavy rainfall	
		1984	Urban induced	
		1986	Urban induced	
			Urban induced	
			Urban induced	
2.	Edo State July	1980	Collapse of Ojirami dam Failure due to heavy rainfall	218 people rendered homeless N2.2 million naira worth of property destroyed
3.	Borno State	1988	Heavy rainfall in Gadaka town	Killed 9 persons and 50 houses destroyed
4.	Imo State	1988	Gully erosion	10,000 people rendered homeless
5.	Kano, Kano State	1988	Bagauda Dam failure	206,376 families rendered homeless; 31,147 farmlands destroyed
6.	Lagos State	June 1988	Heavy rainfall	3,000 people rendered homeless
7.	Akure, Ondo State	1988	Heavy rainfall	Property worth millions of Naira destroyed
8.	Rivers State	1988	Heavy rainfall in Port	Rendered 6,000 people homeless and property worth
9.	Lagos State	July 1990	Harcourt Heavy rainfall	Millions of Naira destroyed left many dead and thousands of people were rendered homes.
		1991	Heavy rainfall	Flooded houses washed of fences and roads
10.	Kwara Sate	1988	Heavy rainfall dam failure	100 villages destroyed; 10,000 families displaced; 72km of farmland destroyed. 440 hectares of sugar cane plantation destroyed.
11.	Sokoto State	1988	Heavy rainfall	74 villages affected by the flood.
12.	Kano State	October 1992	Tiga Dam failure	15 houses destroyed; 162 rendered homeless; 6

				hectares of farmland destroyed.
13.	Niger State	September 1994	Heavy rainfall Niger river banks	50 hectares of farmland destroyed plus 15 deaths overflowing its
14.	Jos, Plateau	August 1995	Lamiga Dam. Heavy rainfall	24 people killed; 50 houses washed away; N2 million worth of property washed away.
15.	Osun State	August 1995	Erinle Reservoir overfilled due to heavy rainfall	Destroyed farms and roads
16.	Niger State	October 1998	Kanji Lake flooded due to the release of excess water.	Affected communities along Jabba to Pategi; 100,000 people displaced N300 million worth of sugarcane destroyed
17.	Borno State	November 1998	Mega Dam. Heavy rainfall	46 houses destroyed; N1.5million worth of farmland destroyed.
18.	Imo State	1999	Heavy rainfall	50 lives were lost; farmland submerged and oil installation destroyed.
19.	Kogi State	1999	Heavy Rainfall, spill over from Shiroro dam	Thousands of people rendered homeless.
20.	Niger State	1999	Shiroro dam failure due to Heavy downpour	16 people killed; thousands of people rendered homeless.
21.	Cross River State	2000	Heavy rainfall	200 houses submerged; damaged and cut off the highway.

(Source: Akintola and Ikwuyatun, 2008)

7. **Who is Most Vulnerable?**

Although climate change is a global problem, IPCC (2007) report has shown that some countries have a greater degree of vulnerability to the impact of climate change than others. The report shows that:

- Countries within the tropics are likely to experience more incidences of tropical storms caused by climate change.
- Also, countries with significant lengths of coastline will be more threatened by sea-level rises induced by climate change.
- Countries with poorly developed infrastructure, insufficient public health systems, and/or low levels of emergency preparedness will experience more negative impacts of climate change.

- Countries whose economies and livelihood have a greater sensitivity to climate related events such as rainfall, wind, (etc.) will be more affected.

8. **Adaptation Strategies Climate Change**

Human Health: General adaptation measures include improved medicare services, health surveillance and sanitation programmes, improved water purification and pollution control, and health education. To combat the increased occurrence of vector-borne diseases, pesticide use would be increased and vaccination efforts could be pursued particularly for vulnerable population groups. To tackle heat related illness, communities could explore options for making their environment cooler (for example shade trees, white roofs).

Agriculture

- Farmers can change the crops or crop varieties that they plant to more drought and salt resistant species.
- Water management and irrigation systems could be improved and the use of fertilizer increased.
- Farmers could adapt their planning schedules and tillage practices; employ better watershed management and land use planning and improved food storage and distribution system.

Forestry Wildlife and Biodiversity

- For managed forests, managers can change the species and varieties of wildlife planted and harvested to more adaptation to potential climate change effects.
- Effort could be made to increase the efficiency of raw materials use and change the product mix to utilize other species.
- Forest managers could also use integrated Pest Management to manage species resistance to potential or probable increase in their exposure to harmful pests.
- Regarding wildlife and biodiversity, managers could assist with species migration or re-introduction of species, ecosystem could be restored and/ or reforested, step could be taken to control disease and invasion.
- Water managers and policy makers could choose to put into place a number of supply and demand adaptations or policy tools that would prepare for the effect of climate change.

- Supply adaptation include constructing new water infrastructure, modifying existing physical infrastructure and designing alternative management techniques for existing water supply systems.
- Demand adaptations could range from conservation efforts and improved efficiency in households, agriculture and industry to changes in technology, to market and price driven transfers of water to other activities.
- Policy tools for adaptation include demand side management, taxation removing subsidies to foster conversation, and improved water management regulations.

Coastal Region/Resources

Adaptation option for Coastal resources include:

- Protecting the resources by constructing dams, creating wetlands; accommodating the change by designing new building codes and protecting threatened ecosystem; planning retreat from rising sea level and perhaps enacting regulation against new coastal development. Strengthening fisheries management, and finally, improving the design standards for offshore structures that may be at risk with rising sea levels.

Other Practices Include:

- Addressing drivers of vulnerability (reducing poverty, addressing capability shortages).
- Building response capacity (by improving weather and water resources management practices).
- Managing climate risk (through disaster risk reduction, climate proofing of investment schemes and programmes, introducing drought resistant crops).
- Confronting climate change (through action that focus exclusively on addressing specific impacts, such as relocating communities and fields, building dykes to counter rising sea level and so on). Consequently, adaptation should be mainstreamed into existing development policies, poverty reduction strategies, sector policy and development programmes at national and local levels. In key areas (infrastructure, water resources management, agriculture, disaster preparedness) the cost of adaptation must therefore be factored into investment strategies.

Adaptation requires economy, wide planning and measures at different scales:

- Continent wide, through the Africa Union/NEPAD African Partnership Forum, thereby creating political commitment.
- At regional level (e.g. trans-bounding river basin organizations) promoting joint management, research, knowledge and information, early warning systems.

- At national level, mainstreaming climate change into policies, plans and budgets.
- At local level, by integrating adaptation in rural and urban planning, disaster preparedness and
- At individual household level, in order to increase resilience.

9. Challenges to Climate Change Adaptation in Nigeria

Nigeria was one of the 154 countries that initiated the Rio de Janeiro Climate conference in 1992, and it became a party as soon as the Convention came into force. Nigeria was party to the ratified Convention on the 2th August, 1994 and has also signed the Kyoto protocol. By 27th November, 1994, Nigeria became committed when the Convention entered into force. As a signatory to UNFCCC under the Non Annex 1parties, some of Nigeria's obligations include the following:

Produce four key National Communications.

Produce four indepth review summaries.

Produce demonstrable progress report.

Produce the National Adaptation Programme of Action.

Produce Global Climate Observing System (GCOS) Report.

A review of some key policy documents shown in Table 14 shows that there is weak policy on climate change and only indirect references are made to this important issue (Oladipo, 2009). Despite the weak national policy on climate change, Nigeria has, nevertheless, taken the challenge of climate change seriously. The first National Communication was produced in November, 2003. A stakeholders' initiation workshop on the Second National Communication (SNC) took place in December 2006.

Nigeria created a special Climate Change Unit (SCCU) within the Federal Ministry of Environment with the Secretariat in Abuja. The Unit was created to implement the Convention and the protocol activities. There is also a Presidential implementation Committee on the Clean Development Mechanism (CDM) in the Presidency. The Department of Meteorology in the Ministry of Civil Aviation was upgraded to a full-fledged Nigeria Meteorological Agency (NIMET) in 2003 to enhance climate data and climate monitoring systems.

From the foregoing discussions, Nigeria is yet to implement a very clear policy on climate change adaptation. The country is yet to prepare any National Adaptation Programmes of

Action (NAPA), which could easily identify urgent priorities and needs that would enhance adaptive strategies to climate change and variability. There is also the absence of implementable National Climate Change Policy or strategy. At the national level, specific funding of climate change is still very limited to supporting the Special Climate Change Unit. Specific initiatives that could strengthen the country's preparedness for climate change adaption does not exist (Oladipo, 2009).

Another concern is the limited human and institutional capacities to deal with climate change uncertainty and model impacts. Institutional and professional competences are yet to be fully built to be able to develop and implement appropriate preparedness actions for climate change adaption. There are very few experts in the country. Adaptation challenge is not well understood. The situation according to Oladipo (2009) is compounded by inadequate climate data. Huge data gaps exist with respect to assessing impacts and adaptation strategies. Key data gaps include (i) Climate data and trends (ii) Baseline natural resources and socio-economic conditions (iii) Location and importance of assets, and (iv) Accurate data on extreme events such as drought, flooding and coastal flooding, and socio-economic data at local and regional levels.

Table 12: Summary to Climate Change in National Environmental Policies in Nigeria

S/N	Policy	References to Climate Change	Remarks
1.	National Policy on Environment (1999 Revised)	No direct mention. References only to climate change impacts (e.g. flood erosion, drought and desertification in Chapter 5)	As this policy was reviewed in 1999 (5 years after Nigeria was party to the UNFCC, it should have included a specific section on climate)
2.	Nigeria National Agenda (1999)	No specific reference to climate change	Chapter 2 indirectly dealt with some adaption or mitigation issues while addressing ways to address the challenges of environmental problems in the country (e.g. Deforestation, erosion control, combating desertification and mitigating the effects of drought, disaster preparedness and management).

3.	National Drought Desertification policy (2007)	Climate change was treated in Chapter 5	The short chapter covered the major issues related to climate change in the context of drought and desertification. It made a few policy statements and provided strategies for implementation.
4.	National Drought Preparedness plan (2007)	No specific mention of climate change	Indirectly addresses some adaption issues for drought mitigation.
5.	National Forest Policy (2006)	No direct mention of climate change	Some climate change adaptation or mitigation measures (e.g. tree planting for carbon credits, drought and desertification amelioration) were discussed without specifically saying so.
6.	National Forest Control Policy (2005)	No specific attention was paid to the issue of climate change	The introductory section of the policy document made reference to climatically – introduce hazards that constitute major ecological disasters, which are constraints to suitable land and water management in Nigeria.
7.	National Policy of Food and Nutrition (2005)	No direct mention of climate change	Crop harvesting and food processing was highlighted as adaptation technologies.
8.	National food security programme (2005)	Both direct and indirect reference to climate change and climate change adaptation	Mention of desertification uncontrolled grazing/livestock migration as threats to food production. Suggestion for the use of Jatrapha for biofuel production (cleaner energy) and for combating desertification.
9.	Agricultural Policy (2001)	No direct mention of climate change	The recommended use of appropriate technologies and farm practices for food production.
10.	National Policy on Population for sustainable Development (2004)	A good mention of climate change almost directly.	Section 4.3 draws the relationship between population, development and environment. The document makes suggestions for adaptation for a healthy relationship.

(Source:Oladipo, 2009)

There is limited practical guidance on adaptation, which could support integration of adaptation plans into the national development planning and process. There is also a general conflict between climate change and competing development agendas such poverty reduction, education and health for all accelerated economic growth.

Other problems are low of awareness of the populace on current environmental challenges particularly climate change and the urgency to address them. There is need for climate change education and curriculum to increase awareness.

10. Conclusion

Developing countries, most especially in Africa, must brace up to the realities of climate change. They must invest heavily on adaptation measures to protect their citizens from climate related hazards. They should integrate climate into their development agenda, build institutions, invest in capacity building and formulate and implement the entire necessary climate and environmental policies that will ensure sustainable development. One could foresee a brighter future only if Africa can also fight against poverty, bad governance, political marginalization and absence of basic infrastructure. The core challenge at the local level according to Ologunorisa (2011) is to develop the framework and capacity to:

(i) Assess the vulnerability of sectors and sections to different scenarios of climate change impact.
(ii) Develop, assess and implement mitigation and adaptation options, and
(iii) Strengthen the negotiating ability in climate change transactions.

If the developed countries cannot provide the required fund, technology and capacity building necessary for adaptation, Africa may have no options than to follow the unsustainable path some of the developed countries took to attain their current level of development.

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