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ARTICLES

Nigeria's Response to the Impacts of Climate Change: Developing Resilient and Ethical Adaptation Options

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Abstract Global climate change will have a strong impact on Nigeria, particularly on agricultural production and associated livelihoods. Although there is a growing scientific consensus about the impact of climate change, efforts so far in Nigeria to deal with these impacts are still rudimentary and not properly coordinated. There is little evidence of any pragmatic approach towards tracking climate change in order to develop an evidence base on which to formulate national adaptation strategies. Although Nigeria is not alone in this regard, the paper asserts that National Climate Change Adaptation Strategy could help address this situation by guiding the integration of climate change adaptation into government policies, strategies, and programs, with particular focus on the most vulnerable groups and the agricultural sectors. There is an urgent need to adopt abatement strategies that will provide economic incentives to reduce the risk from disasters, such as developing agricultural practices that are more resilient to a changing climate.

Keywords Climate change · Agriculture · Nigeria · Adaptation · Sustainability · Resilience

Introduction

Nigeria has a population of 154 million people (Taylor 2010) and covers an area of 923,768 km^2 (Federal Department of Agriculture (FDA) 2008). The physical and climatic diversity of Nigeria (Fig. 1) supports the growth of a wide variety of crops. Although famous for the crude oil resource, agriculture is strategic to the Nigerian economy, supplying food, raw materials for industries, earning foreign exchange,

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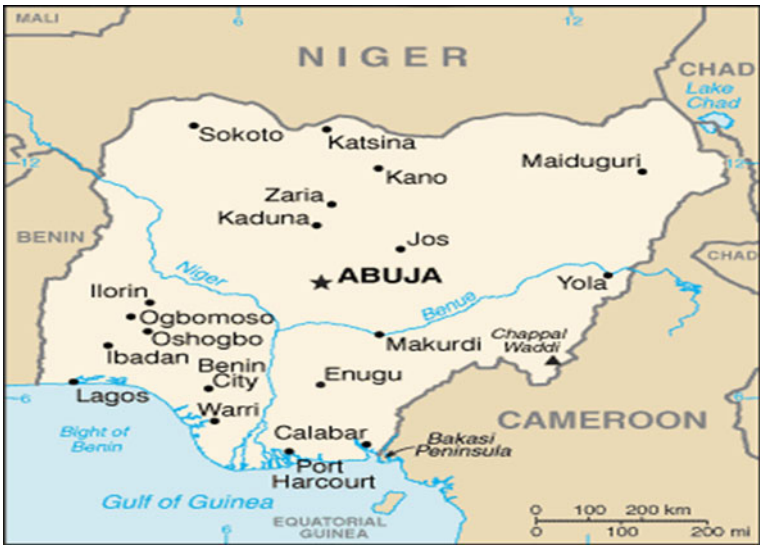

Fig. 1 Location map of Nigeria

providing markets for the industrial sector and forms a key contributor to wealth creation and poverty alleviation (FDA 2008). According to Adapide (2004), at the turn of Nigeria's political independence in October 1960, agriculture was the dominant economic sector, contributing about 70% of the Gross Domestic Product (GDP), employing about the same percentage of the working population, and accounting for about 90% of foreign earnings and Federal Government revenue. Today the reverse is the case; according to Nigerian Tribune (2011) the crude oil sector accounts for about 80% of total revenue and 90% of foreign exchange earnings. Notwithstanding this change, the country is the world's leading producer of cowpea, cassava, and yam, and agriculture continues to be central to the livelihoods of many Nigerians with more than 70% of the population deriving their livelihood from agriculture and agro allied activities (Federal Department of Agriculture 2008). The agriculture sector accounts for 5% of total export, provides 88% of non oil earnings, and contributes about 41% of the GDP, 85% of which is from crops sub-sector (Federal Department of Agriculture 2008). About 94% of the agricultural output is accounted for by small scale, subsistent farmers farming less than 2 ha (Federal Department of Agriculture 2008). Such small scale contributions are particularly threatened by climate change due to limitations of scale and low adaptation potential.

Oisahoin (2008) reports that impacts on people and their livelihoods resulting from climate change is greater in Africa than in many parts of the world. On average the continent is 0.5°C warmer than it was 100 years ago (IPCC 1996). Changing weather patterns conditions are creating new complex emergencies where poorer countries that are affected by famine, drought, and floods, are often accompanied by outbreaks of infectious diseases. Already Nigeria has experienced definite shift in the long-term rainfall mean towards more arid conditions (Adesina and Adejuwon

1994). Slater et al. (2007) asserts that there are large uncertainties in current climate change projections due to gaps in climate change science, uncertainties over crop responses, in complex socio-economic relationships, and in the lack of detail in current climate change and ecosystem models (Slater et al.2007). However, there are very obvious changes in rainfall patterns; with respect to timing and duration the Sudan Sahel region of Nigeria has suffered a 3–4% decrease in rainfall per decade since the beginning of the nineteenth century (Muhammad 2008). Succinctly, divisions between the rainy and dry seasons, when planting dates were pre-planed resulting in predictable and bountiful harvest are no more. Erratic weather conditions preclude the planning of agricultural activities in the country. Indeed, Nigeria's national capability for assessing, forecasting, and planning for climate change mitigation and adaptation remains inadequate. The objective of this paper is to appraise the response of Nigeria to climate change impacts in the country through a review of the literature to assess how a sound, ethical environmental policy can be established.

Vulnerability and Impact of Climate Change in Nigeria

Developing countries are more vulnerable to climate change than developed countries, because of the predominance of agriculture in their economies, the scarcity of capital for adaptation measures, their warmer baseline climates and their heightened exposure to extreme events (Parry et al. 2001). Thus, climate change may have particularly serious consequences in the developing world, where some 800 million people are undernourished (Slater et al. 2007). Of great concern is a group of more than 40 "least-developed" countries, mostly in sub-Saharan Africa, where domestic per capita food production has declined by 10% in the last 20 years (Slater et al. 2007). Thus, climate change impact will aggravate the already "in crisis" situation in some of these countries. Podesta and Ogden (2008) assert that West Africa suffers the greatest losses due to climate change; these amounting to between 36 and 44% of the losses for the entire continent and between 42 and 60% of agricultural regional GDP. Seven countries are predicted to suffer the largest average losses in the agricultural sector with Nigeria suffering the highest in the group (Podesta and Ogden (2008).

Nigeria will suffer from climate-induced drought, desertification, and sea level rise (Podesta and Ogden 2007). Already, approximately 1,350 square miles of Nigerian land turns to desert each year, forcing both farmers and herdsmen to abandon their homes (McCarthy 2006). Muhammad (2008) reports that desert, which now covers about 35% of Nigeria's land mass, is advancing at an estimated 0.6 km yr^{-1} while deforestation is taking place at 3.5%yr^{-1}. The desert belt has moved from Maidugri to Kebbi, Kano/Kaduna to Sokoto; a distance of about 1,200 km westward and about 800 to 900 km southwards, while the Savannah interface between desert and forest is observed to be now around Oyo, Osun, Kogi, and Makurdi—about a 1,200 km shift to the south (Fig. 1). Environmentally, Nigeria's climatic regime is being severely disrupted leaving its forests and water resources at risk. Studies show that biological productivity in Nigeria is decreasing

(Adesina and Adejuwon 1994) with an additional consequence of severe fuelwood shortages as a result of increased pressure on the forest in locations where desertification has spread. According to Ikeme (2008) potential impacts of climate change on Nigeria runs through the entire sector of the country's economic, social, and environmental landscape. For example, the projected impact of climate change on electricity generation and hydroelectric dams due to impact of reduced water flows on energy production and supply causing severe disruptions to economic activities. This threat is made more acute as Nigeria relies heavily on hydroelectricity, which accounts for over 36% of its electricity energy budget (Ikeme 2008). The result would also have a significant effect on the industrial/manufacturing sector, as well as the commercial and social activities of the nation.

The social implication of climate change for Nigeria is multidimensional. In the first instance, projections suggest that Nigeria will experience massive environmental refugee migration. One of the most vulnerable areas is along the coastal region where an estimated 20 million people (22.6% of the national population) live (Ikeme 2008). The estimated number of people that would be displaced ranges from 740,000 for a 0.2-m rise to 3.7 million for a 1-m rise and 10 million for a 2-m rise (Awosika et al. 1992). Similarly, numerous economic activities are located within the coastal zone that will be seriously impacted upon, for example, coastal areas form the food basket of the region; estuaries and lagoons supporting industrial fisheries accounting for more than 75% of fishery landings in the region. According to Podesta and Ogden (2008), Lagos is one of the West African coastal megacities that the IPCC fourth assessment report (2007) identifies as at risk from sea-level rise by 2015. This, coupled with high population growth (Nigeria is the most populous nation in Africa, with 75% of the population under the age of 30) that will force significant migration and further contribute to political and economic turmoil. This situation is exacerbated by the lack of a pragmatic approach by the government to address the issue of population control coupled with inactivity regarding climate change adaptation.

Efforts in Understanding, Mitigating and adapting to Climate Change

Several efforts have been made towards understanding and curbing the impacts of climate change; these will be considered here at the international and national levels.

International Level

The first World Climate Conference took place in 1979, however, it was not until 1988 that the United Nations gave serious attention to climate change in response to growing environmental awareness and concern for the consequences of the phenomenon. The UN General Assembly at its 43rd session in 1988, adopted Resolution 43/53, titled: *Protection of global climate for present and future generations of mankind.* The mounting evidence about the role of enhanced greenhouse gases and the potential consequences for climate change and human

impacts prompted 154 countries around the world to sign the United Nations Framework Convention on Climate Change (UNFCC) in 1992. Global action to address climate change is spear-headed by the UNFCC, the Intergovernmental Panel on Climate Change (IPCC) via agreements emanating from the Copenhagen Conference and the Cancun agreement. Current international agreements aim to achieve stabilization of atmospheric greenhouse gas concentrations at a level that would prevent dangerous interference with the global climate system (Ikeme 2008).

The IPCC is the leading international authority on climate change; it was formed by the World Meteorology Organisation and the United Nations Environment Program to advise governments on the latest climate change science, its impacts and possible adaptation and mitigation responses. It publishes a major state-of-the-science and climate impacts report every 5 years (IPCC, 1990, 1995, 2001 and 2007). The IPCC 2007 assessment report states "that the low adaptive capacity of Africa is due in large part to the extreme poverty of many African countries, frequent natural disasters such as droughts and floods, a dominance of rain fed agriculture, as well as a range of macro- and micro-structural problems" (Boko et al. 2007 in IPCC 2007). Significant constraints also include limited support for climate risk management in agriculture and therefore a limited demand for such seasonal forecast products, limited scientific capacity and other scientific resources, particularly at the local level. Local adaptation is particularly acute as the rural poor often cannot adopt diversification as an adaptive strategy as they often have very limited diversification options available to them. Factors heightening vulnerability to climate change and affecting national-level adaptation include issues of local and national governance, civil and political rights and low levels of literacy. The most vulnerable nations in the assessment were those situated in Sub-Saharan Africa and specifically those states that have recently experienced conflict—Nigeria belongs to both of these "high-risk" categories.

The latest IPCC (2007) report suggests that Africa needs to focus on increasing adaptive capacity to climate variability and climate change over the long term. Reducing risks with regard to possible future events will depend on building of stronger livelihoods to ensure resilience to future climatic shocks. Institutions must play a critical role in successful adaptation; developing and designing proactive rather than reactive strategies to enhance adaptation. Interventions, such as agricultural capital stock and extension advice, national grain reserves, grain future markets, weather insurance, food price subsidies, cash transfers, school feeding schemes, micro-financing, and social welfare grants are just some of the tools used to enhance adaptation to climate change and mitigate impact of future shocks and stresses. The success of these mechanisms in overcoming such constraints can be enhanced if supported by local institutional arrangements developed on a long-term sustainable basis. These adaptive solutions should be mainstreamed into national development processes, with unprecedented collaborative efforts by governments, humanitarian and development agencies to find ways to move away from reliance on short-term emergency responses to food insecurity, to longer-term development-oriented strategies that involve closer partnerships with governments (IPCC 2007). Governments around the world are already implementing policies to mitigate or/and adapt to climate change impacts. For example, Okorie (2009) reported that

American president, Barack Obama has ordered his energy secretary (Steven Chu) to find ways by which America can change its energy policies and depend less on fossil fuel. A range of steps, such as those outlined above, must be implemented in conjunction with an international shift to a low carbon future.

National Level

At the national level in Nigeria some efforts have been made. A program entitled "Building Nigeria's Response to Climate Change (BNRCC)" has been implemented by the Nigeria Environmental Study/Action Team developed following an earlier initiative called the Canada-Nigeria Climate Change Capacity Development Project (CN-CCCD), implemented with funding from the Canadian International Development Agency. The goal was to build public awareness/understanding and support policies for optimal management of the climate change problem and develop capacity-building for a range of issues surrounding climate change in Nigeria. Through a series of workshops, consultations, and awards to intermediary organizations and research institutions, CN-CCCD has worked to reach a range of stakeholders with information on climate change, facilitated activities that enabled the country, in November of 2003, to submit its First National Communication to the Conference of the Parties. This indicated that a significant proportion of the economy is dependent on climate-sensitive natural resources, that resource conflicts, exacerbated by climate change, is the greatest source of insecurity in Nigeria, and that Nigeria's vulnerability to climate change mandates that the country evolves adaptive measures and contributes to international efforts in reducing emissions of greenhouse gases (FGN 2003). National priorities include assessing the vulnerability of sectors to different climate change scenarios, to develop, assess, and implement mitigation and adaptation options for climate change. Other priority areas include developing a legal framework, increasing public awareness, promoting research, and building virile institutions and partnerships between the public and private sectors to cope with climate change impacts. Preparation of the Second National Communication is developing from a consultative process. Nigeria has set up a National Focal Point—the Special Climate Change Unit—that constitute an Inter-ministerial Committee inaugurated following a Roundtable Committee discussion on climate change in August 2009 with action in progress to formulate a national policy on climate change. The senate approved in November 2010 the establishment of the National Climate Change Commission to coordinate efforts to tackle the adverse impacts of climate change in the country with the commission expected to be operational in 2011. A critical look at understanding the nature of climate change and its impacts on socioeconomic and geopolitical infrastructure in Nigeria, compared to the intending catastrophe and what is obtainable elsewhere, are still rudimentary; just at the level establishment of committees and agencies, conferences, workshop groups, and focus groups producing suggestions and papers. There is no clear evidence of concrete, proactive, and pragmatic approach towards tracking climate change incidence, early warning, research, mitigation, and adaptation.

Discussion: Urgent Action Required for a Way Forward

Many interactive processes determine the dynamics of food demand and supply: agro-climatic conditions, land resources and their management are clearly key components that are critically affected by distinct socio-economic pressures, including current and projected trends in population growth, availability, and access to technology and development (Fischer et al. 2005). Relatively small climatic shifts can trigger or exacerbate food shortages, water scarcity, the spread of disease, human migration and natural resource competition (Podesta and Ogden 2008). Once underway, this chain reaction becomes increasingly difficult to stop. The impact of climate change–induced migration will be felt throughout Africa, but its effects in Nigeria pose particularly acute geopolitical challenges, both manifested by internal and international migration (Podesta and Ogden 2008). The first domestic migratory wave will likely be from agricultural regions to urban centers where more social services are available. Such a situation will exacerbate the risk of state failure as central governments lose control over stretches of their territory and their borders.

A study by Mendelsohn (2000) identified serious deficiency in African impact research, given the importance of efficient adaptation, presently, public infrastructure such as roads, long-term weather forecasts, and agricultural research and extension are inadequate to secure appropriate adaptation. This stance was corroborated by the findings of DFID (2009) in their assessment of Nigeria's vulnerability to climate change. According to the DFID (2009) report there exist extensive data gaps in Nigeria, with respect to assessing impacts and adaptation strategies; climatic data and trends, baseline natural resource and socio-economic conditions, location and importance of assets, extreme events and socioeconomic data, particularly acute at a local and regional level. Numerous policies coming out of BNRCC relating to environment and climate cover numerous sectors such as environment, energy, agriculture, health and sanitation, housing and urban development, and gender. However, many of these policies were formulated solely by the federal government using a top-down approach and lack proper implementation and enforcement. Furthermore, there is lack of proper coordination between these policies and the different economic sectors, which has limited the focus on climate change adaptation (Oisahoin 2008). The problem therefore is not only the issue of lack of policy but that of lack of political will to pursue their logical and efficient implementation. There also lacks a system to criticality assess the impacts of these policies and monitor effectiveness so that there can be feedback into developing new ones and appropriate policy.

Since over 70% of the Nigerian population derive their livelihoods from agriculture (FDA 2008) with the sector being crucial in the provision of food, income, raw material, and employment, there is need to invest money from crude oil into the agricultural sector and evolve adaptation strategies to safeguard the sector and the nation state. These adaptations include such initiatives as the development of early warning systems to enable timely remedial measures, effective water use strategies and intensive research into energy usage. A central element of adaptation approach should be ecosystem management and restoration activities such as forestation, watershed rehabilitation, effective water harvesting, and conservation.

These focal areas should promote best practices that are climate change resilient in agriculture and fisheries, including promoting the use of cleaner energy sources. Better planning to reduce the risk from disasters, together with developing agricultural practices that are more resilient to changing climates would also help mitigate climate change impacts.

Lending a voice to this call for action, Ogonnaya (2009) asserts that climate change is an "unprecedented" threat to food security and calls for a "climate-proof" model of development and massive emission cuts to avoid "possibly cataclysmic change." Although climates across Africa have always been erratic, scientific research and the experience, "indicate new and dangerous extreme" forecasts (Ogonnaya 2009). Climate change is an overwhelming development issue across Africa, unless we take genuine steps now to firstly, adapt, the consequences will be enormous. Deepening health hazards and poverty imposes on the government the responsibility to take proactive remedial measures. Secondly, public awareness and enlightenment must be a priority. Egbonugwu and Adegboye (2009) observed that the level of public awareness about environmental issues and the need to protect it for sustainable living is very low. Even lower is public knowledge about climate change and available adaptation and mitigation measures. Such an awareness deficit on these critical threatening issues must be urgently and decisively addressed (Egbonugwu and Adegboye 2009). Research on the nature of climate change and the socio-economic implications on Nigeria is necessary for developing adequate response strategies. Developing climate change science and its potential impacts on Nigerian agriculture, its people and the associated livelihoods is very important for both creating awareness, and providing the background information required for targeting policies. Indeed, lack of awareness is a major constraint to adequate forecasting and formulation of adaptation policies exacerbated by the paucity of climate data in Nigeria. Studies on national and regional climate change in Nigeria should be embarked upon and vigorously pursued in the short to medium term. The findings of such studies will be crucial for the formulation of adequate response and adaptation policies that are evidence-based and have the potential to engender long term sustainability.

For reducing it's contribution to climate change, the mandate for Nigerian energy planners is to institutionalize its development of energy efficiency and renewable energy with appropriate goals and timetables for increasing the use of renewable energy resources in areas where grid extension is too costly and where opportunities for the use of renewable energy sources is economically warranted. This should be accompanied by an inbuilt mechanism for stock-taking and reassessment of progress so that targets can be implemented and success measured. In addition to building institutional framework, Nigeria should also adopt specific regulatory measures such as establishing comprehensive air quality standards and create national energy efficiency codes that have the potential to be the driving force for rapid development of the country's energy efficiency and renewable energy opportunities. Market transformation mechanisms, similar to that adopted in some developed countries, and how these will encourage more rapid development of its energy efficiency and renewable energy potential, should be explored. This objective will obviously benefit

from an increase in government-industry collaboration; a key avenue for development rarely explored in Nigeria's development initiatives.

Ethical Considerations

From empirical evidence it is apparent that the Developing World, especially African countries, will bear the major brunt of a problem caused by global collective action of which they are the least contributor. High levels of poverty and low levels of human development further limit the capacity of Africa to manage risks due to climate change. Although Nigeria needs to do something pragmatic to address the impacts of climate change this should be supported by the global community. According to United Nations Statistics Division (2010) Nigeria emits 95,272 metric tonnes of CO_2, which account for about 0.32% of global emissions, this is very minimal compared to the world leading CO_2 emitters; China (22.30%), US (19.91%), India (5.5%), Russia (5.25%) and Japan (4.28%). Nigeria, will inevitably be subjected to the International climate change abatement measures, and should begin now to put adequate climate change abatement institutions and regulatory framework in place. In as much as the developed nations should urgently and significantly cut down their emission level, developing nations like Nigeria should at the onset embrace clean and renewable energy alternatives in their quest for economic growth. This though may be more expensive in the short run, but will pay off in the long run, as they will be compensated via the Clean Development Mechanism (CDM) instrument. This is the most ethical, rational, and justifiable thing to do. As the industrial nations are responsible for the vast majority of global pollution, these countries have the moral responsibility of funding global remediation expenses. Additionally, the industrially advanced nations need to assist developing countries with funding and technical assistance to conduct environmental and economic impact analyses and establish sound environmental practices to protect the health of their citizens. Oil-producing countries should be compensated for their projected income losses in the event of the implementation of the Kyoto protocol and assisted in their economy diversification. Nigeria can only be sure that its interest is protected in the emergent global abatement strategy if it increases its level of participation in international negotiations. In addition, findings from research on all dimensions of the climate change can be used to guide policy development and developmental trajectories. The developing world should feed into the CDM provided of the Kyoto protocol and emphasize on the provision of substantial monetary aid and invest heavily in forestation scheme. The benefits; such as carbon sequestration, esthetic appeal, biodiversity conservation (especially the endangered species), ecological and human welfare, though are construed with intrinsic values, are enormous and surely out-weigh the visible physical structures that many politicians are much more interested in. The success due to climate change mitigation and adaptation will impact more on long-term sustainable development rather than immediate physical infrastructure that will fade away with the passage of time. Finally, globalization of markets means that Nigeria's competitive edge may be jeopardized if it fails to apply environmentally sensitive methods of energy abstraction and consumption in its economic development.

Increased government participation in the global climate change deliberation in order to negotiate a better world trade deal for Nigeria and Africa is necessary.

Conclusion

Climate change impacts in developing countries such as Nigeria are a global issue, long-term and involve complex interactions between demographic, climatic, environmental, economic, health, political, institutional, social and technological processes. Science, economics, and philosophy have to combine to form a cohesive alliance (Brandolino 2010). It therefore means that for Nigeria to achieve sustainable productivity in the face of the climate change there has to be an alliance among all sectors and disciplines in the economy. Nigeria cannot afford to continue ignoring the potential impacts of the global climate change and the impact on its oil-based economy. The paper infers that though Nigeria should capitalize on the emission concession afforded it for its low historical contribution to the climate change problem, it is in its interest to begin to introduce measures to reduce its greenhouse gas emissions, develop and apply more sustainable renewable energy alternatives to abort the negative impacts of climate change on its economic, social, and environmental resources. It is imperative that the Nigerian economy be diversified and steered away from fossil fuels both in terms of production and consumption. An ethical policy needs to address "sustainable development through ecosystem management requiring changing human values, economics, and ecological realities, ideas, and knowledge. The three core values that need to be addressed in policy making are protection of human health, sound ecological practices and resource sustainability. Climate change abatement should be a concern to the nation, its resources and interaction with the world. Stewardship of the planet is a moral task which demands us to do what is right; what is right will engender future long term environmental stability and maximize the potentials for national development.

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