

Climate Change and Adaptation in Nigeria: Some Background to Nigeria's Response - III

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Abstract. This concluding part of the larger paper evaluates some aspects of the Nigeria's vulnerability to the impacts of climate change and discusses potential adaptation strategies that can help in coping with or reducing the impacts of the change in the agriculture and forestry sectors. The vulnerabilities of the various parts of the country were computed, using a wide range of socio-economic parameters and physical environmental factors. The results show that there had been important variability in the rainfall and temperature regimes which 'expose' the country to severe impacts of climate change. The vulnerability assessment further shows that the country's resilience to climate change impact is very weak especially in the Sudano-Sahelian zone. Considering the nature of the vulnerabilities, the paper proposed a number of adaptation strategies mainly in the Agriculture and Forestry sectors. The paper concludes that development and implementation of appropriate policy instrument will be important in ensuring that the country effectively addresses its adaptation challenges.

Keywords: Nigeria, climate change, vulnerability, adaptation, exposure, forestry, agriculture.

1. Vulnerability to Climate Change

In order to effectively address adaptation to climate change, it is critical to have a clear perception of the vulnerabilities of ecological, economic and social systems within a country. This will provide some guide as to the type of interventions that each part of the country require and the financial resources needed. The IPCC Third Assessment Report (TAR) defined vulnerability as the degree, to which a system is susceptible to, or unable to cope with adverse effects of climate change, including climate variability and extremes. Three main elements which are more or less mutually exclusive are involved in any assessment of vulnerability. They include the exposure of a system to climate variations, its sensitivity and adaptive capacity [35, 36, 37, 1]. *Exposure* is the degree of climate stress to which a particular unit or system is exposed. The stress could be changes in climate conditions or variability in climatic behaviour including the magnitude and frequency of extreme events [38]. Using agriculture as an illustration, the less dependent an agriculture system is to climate the less exposed it is. In this respect a well irrigated farming system will be less exposed to drought than a rain-fed system since its immediate source of water is not necessarily rainfall. It should be noted that the efficiency of the irrigation method in use will influence the vulnerability of the irrigation system itself. A system where the surface method of irrigation is dominant is more exposed than one with the drip method. The latter method is more efficient than the former in water use. *Sensitivity* is the degree to which a system is affected, adversely or otherwise, by climate-related stimuli'. It is the degree to which a system is modified or affected by an internal or external disturbance or set of disturbances. This measure, which reflects the responsiveness of a system to climatic influences, is influenced by both socio-economic and ecological conditions and determines the degree to which a system will be affected by environmental stress. There are a number of crop models such as the EPIC that simulate crop responses if there are variations in critical factors of growth [e.g. 39]. Such models are however constrained in practical

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relevance by the fact that they consider only a few crops and limited sites. Their assessments are therefore not too suitable for broad based assessment. *Adaptability* is the degree to which adjustments or modifications are possible in practices, processes, or structures of systems to anticipated or actual changes of climate. It is a measure of the resilience or resistance to negative climatic stimuli as well as the coping capacity of a community or nation. Coping capacity is usually considered as a sub-system under adaptation. It refers to the degree to which systems or practices can be adjusted or modified to respond to changing conditions. Adaptation is influenced by the quality of the *resistance* and *resilience* of a system. It is also affected by the *readiness* of a given system to act on the potential opportunities for adaptation. Systems that are resilient are able to return back to a steady state after a period of perturbation.

In the present study, we attempt an assessment of some aspects of Nigeria's vulnerability to climate change using a wide range of data available at the national and regional levels. The report here is limited to the assessment of some aspects of the adaptive capacity of the country. The indicators used in the analysis of the vulnerabilities are selected around four key issues: technology, wealth, infrastructures and institutions. They include ownership of home, status of marriage, access to water, use of mass media, literacy level, HIV/AIDS prevalence, use of firewood, under five mortality, use of mosquito nets by children and the pregnant women, professionalism and women headship of household. These data were obtained from the Nigeria's Bureau of Statistics, Abuja. The results of the analyses of rainfall and temperature reported above were integrated into the measurement of vulnerability. All of these are known to affect the adaptive capacity of a community or nation. For instance, the prospects of adaptation in terms of knowledge and readiness/willingness to adapt are related to access to mass media. A lot on adaptation issues is disseminated nowadays on the media and the greater the access that the individual has to the media the greater the prospects of adopting one adaptation strategy or the other. HIV/AIDS prevalence is also a strong adaptive indicator. Communities with low prevalence would spend less resource on medicare and would therefore have more to deploy to adaptation.

1.1. Calculating Vulnerability

Following the definition provided above, Vulnerability can be expressed scientifically as follows:

$$V = (fI - A_dC)$$

Where V is vulnerability, I is potential impact, and A_dC is adaptive capacity

As agriculture/forestry remains the most important employer of labour and the sustenance for the majority of Nigerians, we limited our assessment of vulnerability here to issues relating to it. The sector is pertinent because Nigeria's agriculture is largely rudimentary and food cropping is to a large extent rain-fed.

The indicators of vulnerabilities used here broadly define Nigeria's adaptive capacity. To ensure that all indicators are comparable, their values were standardized to a range of 0 to 100. Also, indicators were recalibrated such that high index values suggest high vulnerability in all cases. To ensure that each variable has appropriate value in the analysis, the data were subjected to Principal Component Analysis (PCA). The use of the PCA also ensures that the contribution of each variable to the model is adequately incorporated in the analysis. The PCA makes each of the indicators orthogonal and therefore unique in the data sets [e.g. 40]. Scores of the indicators are then summed together to give the overall assessment of vulnerability to climate change.

The results of the relative vulnerability assessment are shown in Figure 9. The results show that vulnerabilities vary broadly across the country. The most vulnerable is the northeastern zone followed by the northwest while the southwest is the least followed by the south east. The implication of these is that what require attention for effective adaptations are not the same in all the zones of the county. Thus, detail analyses of the various zones based on some critical parameters are needed in order to adequately respond to their adaptation needs. Quite clearly, a generalized approach to adaptation would not yield the right results. Each ecological zone has to be addressed by considering those specific aspects of its socio-economic development that is most critical to strengthening its adaptive capacity. In the northeast, the issue of water stress is critical. The development of two major earth dams - Tiga and Challawa along Komodogu-Yobe basin in the last two decades or so have been a challenge. The erstwhile invaluable ecological system of the Nguru-Hadejia wetlands which had attracted the International Union for Conservation of Nature (IUCN) [41]

has been impaired by the reduced flow of water into it. Furthermore, increasing aridity in many parts of the zone is making it more and more difficult to practice rain-fed agriculture. Greater attention would have to be paid to the issue of providing water for food cropping and animal husbandry in the zone to make it possible for that part of the country to adapt to climate change. The situation is the similar in the northwest.

It is worthwhile to note the relatively more favourable conditions of the north central zone. Part of the explanations is the preponderance of earth dams in the zone especially in Kano State which could be influencing the volume of rain received in the zone. The zone probably has a better prospect for enhanced livelihood than many other parts of the country.

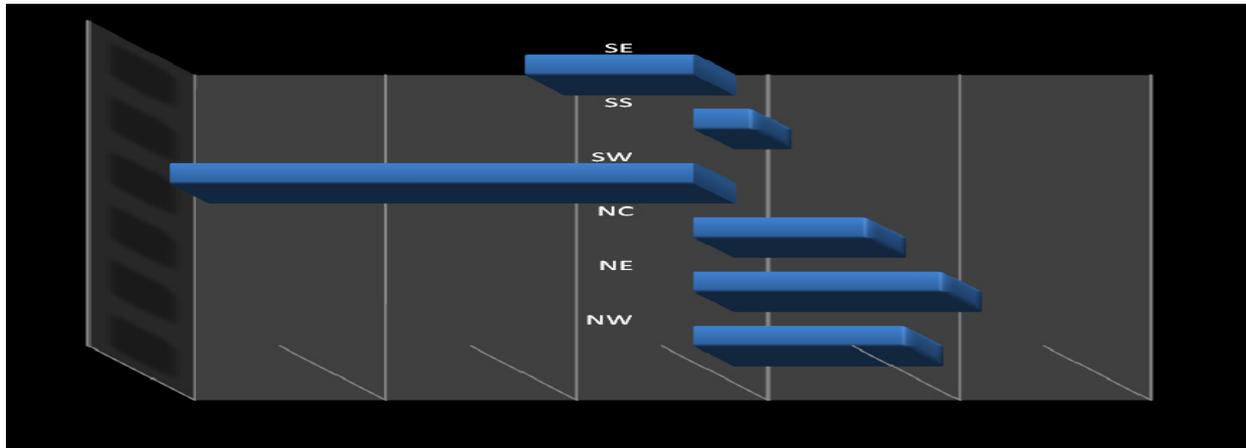


Fig. 9: Graphical analysis of relative vulnerability to climate change in Nigeria.

For the southwest and the south east, attention has to be paid on actions that would make whatever is on ground sustainable. One of these which is closely linked with agriculture is the forestry sector. This sector is important for overall environmental sustainability and socio-economic development of the country. Its relevance for carbon sequestration is particularly significant in the context of global warming [e.g. 42, 43]. The forest resources especially wood are already being exploited at the limits and at the present rate of exploitation are not sustainable [44]. Also, rising populations across the country is forcing more areas of land to be withdrawn from forest cover to other uses.

Fuelwood i.e. firewood and charcoal remains the most widely used domestic energy in Nigeria. Close to 60% of Nigerians even in the urban areas where wood command considerable commercial value, use fuelwood as a primary source of domestic energy [45]. This is impacting seriously the country's stock of wood. Already, there are deficits in the north and the middle belt. Most of the fuelwood required in the country comes from the south. A further pressure on the sector may create crisis in the economy which may wipe off whatever advantages that presently make the southwest and southeast to have stronger adaptive potentials. If the wood supply becomes critically problematic, the livelihood of many individuals that depend directly (i.e. wood vendors) and indirectly (house hold food providers and food vendors) would be adversely affected and this will impair their adaptive capacity to climate change. There is therefore a clear need to focus attention on making the forests and woodland of the south sustainable in wood production.

2. Adaptation Strategies for Nigeria

From the climate analyses and vulnerability assessment, the need for adaptation is very obvious. Water supply from rain could reduce in many areas as evaporation losses increases and rainfall reduces. In other places, risks of floods are higher as rainfall increases. Furthermore, the vulnerability assessment shows that the country has weak adaptive capacity. For example most farmers become completely helpless if any harvests fail. The Sokoto flood of 2010 which washed away large acreages of farm crops left many local farmers economically devastated as they had no significant alternative sources of livelihood. Here we present a suit of adaptive action, specifying in some instances how the adaptive capacity of the country can be strengthened.

Suggested adaptation strategies may be completely new to a community or they may simply be an improvement on what the community is already familiar with. Essentially, they are procedures that can

engender or enhance socio-economic wellbeing of societies. The attention here is mainly on the agricultural and forestry sectors. Following HBF [46], we list such actions that could be taken to make communities live better under a changed climate.

2.1. Issues in the agriculture/ forestry sector- crop production

Vulnerability in the agricultural sector is largely associated with access to water for crop use which is factor of the extant inability of the country to produce enough food to feed itself. The challenges that need to be addressed include increasing crop failure and loss of yields due to false start of rains, frequent intervening dry spells during the growing seasons, early cessation of growing season, crop damages by storms and flooding, rising temperatures as well as pest infestations [e.g. 47; 48]. Another significant issue is the per capita production of food by farmers which remains very low resulting partly due to smallness of holdings and leading to food deficit every year..

The environment of a large part of the south eastern zone presents its own challenge with respect to vulnerability. Apart from experiencing delayed onset, early retreat of rains, unsteady growing season, and other extreme climatic events the region's large distribution of loose acidic soils, extensive gully erosion, few reservoirs to support irrigation and growing urbanization are critical vulnerability factors. For instance, many parts of Anambra and Enugu States are ravaged by sheet and gully erosion. Some of the worse hit areas include the Anatu-Agulu-Nanka axis, the areas around Nkisi River, and Amambia and Ozubulu areas of Anambra state. Soil productivity in many parts of the region has been badly impacted with considerable reduction in food productivity [e.g. 49].

In the Sahelian parts of the north, invasion by sand is a threat to human activities. Farmlands and even houses are frequently submerged by sand, adding to the difficulties of producing food and sustaining other economic activities in the region. The BBC (Tuesday, January 23, 2007) reported that many homes, farms and wells are buried annually by sand from the Sahara desert in Yobe State.

2.1.1 Adaptation strategies to address crop production

Relevant adaptation strategies that can be adopted in addressing crop failures are as follows:

Provision of accurate and timely weather forecasting

A major factor of poor crop performances and low harvest is poor status of weather forecasting for the country. Timely and accurate weather forecasting are crucial to improving farming activities. This would require developing human capacity and appropriate infrastructure for weather forecasting and information sharing. Responsible agencies are the relevant research institutes and their extension arms. The option is of very high priority in every part of the country.

Enhancing agricultural extension services.

Agricultural extension officers have significant roles to play in improving farm productivity. They are trained to link farmers with scientist working on how to improve farm operations. They also help farmers to deal with difficulties that they may have on the field. In adapting to climate variability and change, this category of professionals would need to be further developed and empowered to function effectively. They would for instance be relevant in providing weather information based on local and indigenous knowledge and information about adaptive efforts that are working elsewhere.

Expanding and optimizing existing irrigation infrastructures;

Expansion and efficiency of irrigation facilities are important to reduce or completely eliminate crop failures due to drought and increased evaporation. Efficient irrigation also allows extended farming into the dry season. This strategy is appropriate throughout the country but is of overwhelming relevance in the drier north. The option is of high priority although it involves heavy financial input.

Adoption of drought-tolerant and early maturing varieties of crops.

This strategy is relevant in every part of the country as water stress may be limiting or soil productivity has declined. Switching to new crops will become crucial in many locations for farmers to have rewarding harvests. This practice is by no means a new phenomenon. The adoption of cassava for example derived from a realization that it offered better returns on soils of lower fertility than many other crops. Cassava is also tolerant of drought.

Diversifying livelihoods to improve income.

Diversity in livelihood affects the incidence and depth of poverty. Thus vulnerability can be reduced by enhancing diversifying livelihoods. In this respect, crop farmers can combine farming with raising livestock like chickens, rabbits, grass cutters, pigs and goats in an integrated manner to enhance their income. Diversifying livelihood requires guided decision making and NGOs, research institutes as well as the various communities have key roles to play in identifying what is best for the individual to combine with his primary engagement to improve his socio-economic wellbeing. The option is of very high priority and is a low cost.

Increasing and upgrading crop storage facilities.

Nigeria has poor storage facilities for harvests. Consequently a lot of harvests particularly of vegetables and fruits are wasted. This cannot continue under a less favourable climatic regime. Also, there is a need to raise local storage to meeting international requirement of for food banking to prevent hunger. Currently, Nigeria is far from meeting the target. Indigenous strategies for various crops need to be identified and further developed for adoption. Also, suitable improved methods of storing harvests should be identified and encouraged.

Control of pests – insects and birds.

In agricultural history, pests have been real threats to harvests. Their impacts could be more severe as climate changes. For pests attacking crop plants on the farm, early detection of their breeding sites is critical in controlling the pests before the swarms begin to move. There are biological, mechanical and chemical methods of controlling pests and diseases. The biological method if carefully selected is generally more effective and environment friendly. The method involves using natural enemies to reduce or eliminate pests. Birds are vicious pests especially on rice farms. Large portions of rice yields are lost to birds every year. Various bird scaring techniques can be used to scare birds away. Netting rice farms from birds is also working but the initial cost is high. Pest control is relevant nationally but is expensive. Some pests such as beetles destroy grains after harvests. The Purdue Improved Cowpea Storage (PICS), which was introduced in Nigeria during the final quarter of 2009, is excellent for protecting beans from the beetle. PICS is a straightforward idea: it seals the bags up in hermetically-sealed plastic that does not allow air in, limiting the survival of insects that damage cowpeas. This eliminates the need to use any chemicals for storage [51].

Pest control usually assumes an international dimension as pests often operate along ecological zones which may traverse boundaries of many countries (e.g. <http://www.lubilosa.org/>). Thus it usually requires the cooperation of countries in a region. The responsible authorities are international agencies and government. The measure is important everywhere but especially in the north where pests infestations are more frequent.

Growing more cover crops like potatoes and melon to protect soils from erosion (e.g.52)

Sheet erosion is a factor of soil loss in many parts of the Nigeria and is severely limiting crop performances [53]. This type of erosion can be reduced by including spreading crops like potatoes, melon and groundnut in the farming cycle to curb loss of top soil. The option can be adopted in every part of the country, it is of high priority.

Stabilizing gullies and erosion sites

Large and expanding gullies are found in many parts of the country especially in the north-east [54,55] and the south east zones. These are serious environmental problems and are significant threat to food production. Gullies can be prevented or stabilized using cover cropping and mechanical methods. Methods that can be used include the Silt Terrace Erosion Prevention inventions (STEP), Revetment panel and Erosion Control bags. The need to adopt these options is urgent in threatened areas but the costs are high. The implementers are government agencies and NGOs.

Improving the monitoring and evaluation of agricultural activities with realistic and measurable indicators.

Monitoring and Evaluation (M&E) is crucial to determining the progress and success of intervention programmes. It provides information on where success is being achieved as well as what needs to be improved. Measurable indicators have to be developed to assess the various components of the country's agriculture system. The actors are the farmers, extension officers and line ministries. The cost is in the medium range and the option is of very high priority.

Helping farmers to secure agricultural insurance

Although globally, the insurance sector is becoming weary of taking up risks in climate-related ventures (http://www.consumeraffairs.com/news04/2005/katrina_scruggs.html) especially after the Katrina experience in the US, the sector has a major role to play in the nation's effort to build resilience to climate change. The sector should be strengthened and supported beyond the recent recapitalization to assist individuals particularly farmers to cope with the adverse effects of climate change such as crop failures, damages to farms and crops and loss of life.

2.1.2 Adaptation options for wetlands

The changing state of wetlands requires urgent response and the following measures could be adopted:

Provide frequent artificial flooding downstream of earth dams

Wetlands are dying as a result of decrease in the floodwater down slope of earth dams. For instance, the famous Hadejia-Nguru wetland complex is being impacted by reduced seasonal flooding due to water storage upstream [56]. One option is to release water for artificial flooding downstream from time to time. This measure is relevant especially in areas with large dams such as Challawa, Tiga and Bakolori in the northern part of the country. Responsible agencies are the Ministry in charge of water resources and river basin development authorities under them.

Switching to short-lived hardy crops

As soil water level drops in many wetlands, switching to short-lived hardy crops could be an excellent option that the farmer can consider. The option is suitable across the country. Its cost is low once the variants of the crops to be grown are identified. The responsible agencies are research institutes, extension workers, and the community.

Recharging wetlands, digging boreholes & providing additional irrigation water;

Wherever feasible, recharging wetlands with alternative sources of water should be attempted. This can be achieved by building more small reservoirs or mining water from boreholes located around the wetlands. The option is good but the cost is high. Responsible agencies are river basin authorities, NGOs and the communities.

Improving transportation between the rural areas and urban centres.

Part of the problem of food insecurity in the country is poor transportation infrastructures which hangs the wellbeing of the farmers on the goodwill of roving middlemen. Farmers are forced to part with their produce at give-away prices to traders who have the wherewithal to transport them to the urban markets. Sometimes, perishable farm products particularly vegetables are lost because they cannot be transported to the markets in time. Improving transport facilities is a thus very relevant measure which should be a priority of governments at all levels.

2.2. Forestry sector

It is ecologically significant to restore the vegetal cover of the country especially the tropical forests and woodlands because of their huge impacts on the environment and socio-economic activities. A suite of adaptation strategies can be adopted. These are biodiversity improvement, control of access to protected areas and social re-engineering approaches.

The first has to do with afforesting with suitable indigenous and exotic species. This strategy is applicable nation wide i.e. including the desert-threatened environment of the north and the swamps of the coastal areas. They are as useful in developing windbreaks against the incursion of deserts in the north and as they are relevant in restoring the mangroves of the coastal areas in the south. The cost is high but it is of high priority to meet wood and other needs. The implementers are NGOs, research institutes, Government agencies and the communities.

The second category of options relate to controlling access to the forest. It also involves controlling wildlife population particularly in fragile ecosystems. Access control involves physical fencing and legislation. Fencing is expensive going from a figure of ₦52,000 per hectare [42]. Legislation costs are low but substantial financial resources are required to maintain forest guards and equip them. The option is of very high priority and is applicable everywhere. The implementers are Government, NGOs and the community.

Livestock access and games population control in reserves are also important in the Sudan and Savanna belts where overstocking is already a problem, its main advantage being the prevention of overgrazing. It is applicable in the games reserves of the Savanna belts, and is of high priority. The implementers are the government and NGOs.

The third approach is *social re-engineering* which is to assist local people in developing positive attitudes towards forests resources and their maintenance. When communities are made to own the forests and are encouraged to have the right attitude to the ecosystem, bush burning and careless felling of trees can be significantly reduced. The cost is low but it is generally of high relevance.

3. Conclusion

This paper has shown that climate change is real and is happening in Nigeria. The overall trend is that minimum and maximum temperatures are on the increase at a pace that is higher than global estimates, and wetter regimes are setting in particularly in the guinea savanna. Vulnerability is unfortunately high. Poverty is high, income is low, HIV/AIDS prevalence is notable in some areas and among other things, physical infrastructures are either not there or in bad shape. The country therefore needs to focus on adaptation. If such suggestions as made here are effectively pursued, the country's vulnerability to change in climate will reduce appreciably. Of course, appropriate policy instruments are needed to make all of these happen. Government needs to ensure that her current effort at producing a Climate Policy is quickly brought to conclusion and that the policy is implemented. The good thing is that ability to adapt is an excellent index of socio-economic development which the country needs at this time.

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