



CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT IN AFRICA



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Climate Change Impacts on Food Security in Africa: A Review

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Abstract

Across the continents of Africa, the landscape is changing. The snowy caps of Mount Kilimanjaro, Kenya and Elgon are melting. The shorelines of Lake Chad, Tanganyika and Victoria are receding; Lake Chad is one-twentieth of the size it was 35 years ago. Droughts and floods, out-of-season rain and dry spells are affecting the welfare of millions of people. The suspected root of the problem, climate change is a reality for the people of Africa. These and many other changes have led to unreliable farming seasons and low water supplies – a dire problem for a continent almost entirely dependent on rain for its agriculture. It is in response to the above that this paper has focused on the review of the climate change impacts in Africa particularly, on food security and associated resources. Africa's policy makers must accept that, far from being a long – distant threat, climate change is a phenomenon that is already happening, and despite the fact that Africa has contributed little to the build-up of greenhouse gases in the global atmosphere, it is already affecting Africans particularly in the area of food security. Consequently, the West has a moral responsibility to Africa and other developing countries to make resources available to adapt to the predicted impact of climate change. Some developed countries have shown a strong commitment to tackling the problems of climate change and development in Africa through the implementation of several adaptation programmes. But while such efforts may contribute to reducing Africa's vulnerability to climate changes, the best adaptation is still mitigation. Giving out aid to support Africa's adaptation to climate change does not remove developed countries moral obligations to cut down greenhouse gas emissions. No amount of aid can shield Africa from the adverse impact of climate change. While African governments can integrate climate concerns into development policies, the West must also curb greenhouse gas emission or Africa will not be able to achieve sustainable development.

Introduction

Many countries in Africa depend on natural resources that are sensitive to changes in climate. Water supplies for example, already suffer from high rainfall variability in many parts of the continents. With reservoir levels already dangerously low, projected changes in the climate look set to put further pressure on water availability which may lead to local or regional conflicts and are certain to affect the economic development of the continent. Similarly, a changing climate is likely to affect food security. Over half the African population lives in rural areas, dependent on the marginal cropping conditions in semi – arid and sub-humid areas, where rainfall is extremely unreliable. Further climate variability could leave many African countries reliant on food aid from the west. Climate change will affect not only natural resources bases but could also have implications for human health. Vector borne diseases such as malaria are already

placing national healthcare systems under strain. Such diseases are driven in part by climate change with several African countries including Kenya and Uganda, experiencing increase in malaria outbreaks that can largely be explained by recent changes in temperature and rainfall. (APF and NEPAD, 2007)

While Africa is vulnerable to the predicted effects of climate changes, the lack of industrial activity and development in the region means it contributes very little to the greenhouse emissions at the root of the problem. Ironically, Africa has been short changed and largely over looked in much of the global discourse and policy development relating to climate change. The continent has no official mention in the United Nations convention for climatic change (1994) or in the Kyoto protocol (1997), the two principal document of the cooperative institution designed by the United Nations to tackle global change. The assumption is that Africa's interests are covered as part of the wider group of developing countries but this is misguided so long as Africa does not command any significant influence in the developing countries negotiating bloc often referred to as G77.

The truth is that, for Africa, climate change is not just another issue to surface in a long history of injustice, deplorable neglect and oppression suffered by Africa at the hands of industrialized countries and indeed the rest of the world. Like the slave trade and colonialism before it, the handling of climatic change and its mitigation by the global community strongly indicates that the world continues to see Africa and its inhabitants as mere resources. Where is the justice when those whose resources have been plundered, and upon whose labour the economy of the west was built are left alone to face the drastic climatic consequence of that economic development?

The African Region

Previous assessments (Hulme, 1996; ICPC, 1998) concluded that the African continent is particularly vulnerable to the impact of climate change because of factors such as wide spread poverty, recurrent droughts, inequitable land distribution and over dependence on rain fed agriculture. Timely response actions were considered to be beyond the economic means of some countries. Determination in terms of trade, inappropriate policies, high population growth rates and lack of significant investment, coupled with a highly variable climate, have made it difficult for several countries to develop to pattern of livelihood that would reduce pressure on the natural resources base. The main background factors that need to be kept in mind in assessing the vulnerability of the African region to climate change, particularly the capacity of African governments to respond proactively to changes that are largely not their making or under their control are as follows:

- **Diversity** – The term 'African Region' is a much diversity of climate, landform, biota, culture and economic circumstance within the region as there is between it and South America or Asia.

- **Climate** – Africa is predominantly tropical, hot and dry. There are small regions of temperature (cool) climates in the extreme south and north. Parts of West Africa, as well as the western part of central Africa, are humid with substantial rainfall during the wet season. Most of the human population occurs in the sub humid and semi-arid zones.
- **Development status** – Measured by almost any index of human well being, Africa contains the poorest and least developed nations of the world. Per capita gross domestic product (GDP), life expectancy, infant mortality and adult literacy are all in the bottom quartile globally when averaged across Africa. The general weakness of the science and technology infrastructure, in particular, the relatively small numbers of technically trained professionals limits the rate at which adaptive research can be performed or implemented.
- **Food supply** – More than half of the African population is rural and directly dependent on locally grown crops or food harvested from the immediate environment. Per capita food production has been declining over the past two decades. The result is widespread malnutrition, a recurrent need for emergency food aid, and increasing dependence on food grown outside the region.
- **Dependence on Natural Resources** – The economics of most African countries is strongly based on natural resources: Agriculture, Pastoralism, Logging, Ecotourism, and Mining are dominant. Climate variations that alter the viability of these activities for better or for worse, have very high leverage on the economy.
- **Biodiversity** – About one-fifth of the world's plants, birds, and mammals originate or have major areas of present conservation in Africa.
- **Low capacities for state** – initiated interventions- Governance structures typically are under-funded. In many instances, they have been undermined by military coups, despotism, tribalism, corruption, maladministration and economic adjustments programs imposed by the international financial community. Communication from capitals to the remotest provinces by road, rail, air or telephone, often is unreliable and slow.
- **Disease burden-insect** – Vector diseases such as malaria and trypanosomiasis; water borne diseases such as typhoid, cholera and schistosomiasis; and poverty related disease such as tuberculosis are prevalent in Africa. Water and food security are closely linked with health. The HIV/AIDS pandemic is placing great strain on the health infrastructure. Health mortalities lead to great loss of production potential.
- **Armed conflict** – There has been chronic armed conflict in several regions of Africa almost continuously for the past 3 decades. This weakens the ability of the nations involved to respond to climate change

and adds large refugee populations to the local population which must be supported by the environment.

- High external trade and Aid dependence – Very little industrial beneficiation takes place in Africa. Many Africa countries have a negative trade balance, particularly as a result of heavy international debt-serving burdens and are chronically dependent on financial aid from the developed world.

The African Climate

Africa is a vast continent and it experiences a wide variety of climate regimes. The location, size and shape of the African continent play key roles in determining climate. The pole ward extremes of the continent experience winter rainfall associated with the passage of mild – latitude air masses. Across the Kalahari and Sahara deserts, precipitation is inhibited by subsidence virtually throughout the year. In contrast, moderate to heavy precipitation associated with the inter-tropical convergence zone (ITZC) characterizes equatorial and tropical areas. Because the movement of the ITZC follows the position of maximum surface heating associated with meridional displacement of the overhead regions of the sun, near equatorial regions experience two rainy seasons, whereas regions further pole ward experience one distinct rainfall season. The mean climate of Africa is further modified by the presence of large contrasts in topography (Semazzi and Song, 2000) and the existence of large lakes in some parts of the continent.

Humans have adapted to patterns of climate variability through land – use systems that minimize risk, with agricultural calendars that are closely tuned to typical conditions and choices of crops and husbandry that best reflect prevailing conditions. Rapid changes in this variability may severely disrupt production systems and livelihoods. The climates of Africa exhibits high inter - decadal variability. Rainfall variability in the Sahel derives from factors such as atmosphere dynamics (Lamb 1978, Folland et al, 1986) and is modulated by land surface effects related to soil moisture, vegetation cover, dust and so forth (Charney, 1975; Zeng et al, 1999). There is emerging evidence that aerosols and dust also may be important factors in modulating the variability of the African climate (d' Almeida, 1986). These studies provide overwhelming evidence of an extremely dense and deep (reaching several kilometers) dust layer in the Sahel / Sudan during the main dust season from November to April.

Observational records show that the continent of Africa is warmer than it was 100 years ago (IPCC, 1996). Warming through the 20th century has been at the rate of about 0.05°C per decade, with slightly larger warming. In June, July August (JJA) and September – November seasons than in December, January, February (DJF) and March – May (Hulme *et al.*, 2001). The five warmest years in Africa have all occurred since 1988, with 1988 and 1995 the two warmest years. This rate of warming is not dissimilar to that experienced globally. The climate of Africa has experienced wetter and drier intervals during the past two

centuries. The most pronounced periods were during the 20th century. A very intense dry period much like the current one, also prevailed for two to three decades during the first half of the century.

Key Regional Concerns in Africa

Closely related to food production are certain factors which must be addressed in a bid to achieving sustainable food production in Africa. Prominent among these are water resources and vector-borne diseases. There is no doubt that climate change will have great impact on these and consequently, a multiplier effect on food security. This is corroborated by APF and NEPAD (2007) which opined that climate change is a major threat to sustainable growth and development in Africa, and the achievement of the Millennium Development Goals. To them, Africa is particularly vulnerable to climate change because of its over-dependence on rain-fed agriculture, compounded by factors such as widespread poverty and weak capacity. They identified the long-term impacts to include changing rainfall pattern affecting agriculture and reducing food security, worsening water scarcity, shifting vector-borne diseases, rising water stress, etc.

Climate Change and Water Resources in Africa

Water resources are inextricably linked with climate, so the prospect of global climate has serious implications for water resources and regional development (Riebsame *et al.*, 1995). Efforts to provide adequate water resources for Africa will confront several challenges, including population pressure; problems associated with land use, such as erosion/siltation; and possible ecological consequences of land use change on the hydrological cycle. Riverine fisheries will be affected, because with a potential warming of 3.5°C projected for the next century, productivity of the Gambia River is estimated to increase to about 13-21% (Jallow *et al.*, 1999). There would be little or no effect on the stability of the present habitat for some fish and shrimp species. In contrast, warming of more than 3°C will have negative impacts on habitats for catfish, and warming of more than 4°C will reduce the suitability of the present habitat for herring (Scholes, 1993). Climate change, especially change in climate variability through drought and flooding will make addressing these problems more complex. The greatest impact will continue to be felt by the poor, who have the most limited access to water resources. Political goals such as self – sufficiency in food production and in general, socio-economic development cannot be achieved under severe water scarcity (Falkenmark, 1989). Growing water scarcity, increasing population, degradation of shared water ecosystems and competing demand for shrinking natural resources distributed over such a huge area involving so many countries have the potential for creating bilateral and multilateral conflicts (Glieck, 1992).

Climate Change and Vector-borne Diseases in Africa

In recent years, it has become clear that climate change will have direct and indirect impacts on diseases that are endemic in Africa. Following the 1997-1998 El Nino event, malaria, Rift Valley fever and cholera outbreaks were recorded in many countries in east Africa. The meningitis belt in the drier parts of west and central Africa is expanding to the eastern region of the continent. These factors superimposed upon existing weak infrastructure, land-use change, and drug resistance by pathogens such as *Plasmodium falciparum* and *Vibrio cholera*. Other than pigs, domestic livestock in Africa are concentrated in the arid and semi-arid zones. This is because the more humid areas were historically prone to livestock diseases such as *nagana* (a trypanosome carried by tsetse fly – Ford and Katondo, 1977), typically support grasses of low digestibility (Scholes, 1990, 1993), and often are densely settled by crop agriculturalists. The overwhelming majority of these animals feed predominantly off natural grasslands and savannas, although crop residues are an important supplement during the dry season.

Many urban and rural families also keep poultry. About 80% of the grazing lands of Africa are in savannas, a vegetation formation that consists of a mix of trees and grasses. Grass production in the savannas is strongly depressed by tree cover, because domestic livestock predominantly eat the grass in these systems, future changes in tree cover are an important issue from the point of view of carbon sequestration and livestock production. Tree biomass ultimately is related to climate and soil type, but the mechanism appears to be via fire frequency and intensity. In addition, emissions of tropospheric ozone (O_3) precursors would decrease if savanna burning were reduced. The disadvantage would be a more than proportional decrease in livestock carrying capacity, as a result of the nonlinear suppressive effects of stress on grass production.

The IPCC Special Report on Regional Impacts of Climate Change (IPCC, 1998) acknowledges that climate will have an impact on vector-borne diseases. The assessment in that report is limited to a qualitative analysis of the impacts. The report identifies the scarcity of disease distribution maps and models as a handicap to establishing current baseline limits. In the case of malaria, however, a continental effort – Mapping Malaria Risk in Africa – is underway. No such parallel efforts, however, are underway for other diseases in the African continent that may be affected by climate change (e.g. arboviruses, trypanosomiasis, and schistosomiasis). No specific references are made to water and food-borne and epizootic/epidemic diseases in Africa.

Climate change and food security

Present and future prospects for food security are significant determinants of the impacts of climate change. Major impacts on food production will come from change in temperature, moisture levels, ultraviolet (UV) radiation, CO_2 levels, and pests and diseases. CO_2 enrichment increases photosynthesis rates and water –use efficiency (WUE). The direct effects are

largest on crops with C_3 photosynthetic pathway (wheat, rice and soybean) compared with C_4 crops (maize, sorghum, millet and sugar cane). Increase in local temperatures may cause expansion of production into higher elevations. The grain filling period may be reduced as higher temperatures accelerate development, but high temperatures may have detrimental effects on sensitive development stages such as flowering, thereby reducing grain yield and quality. Crop/water balances may be affected through changes in precipitation and other climatic elements, increased evapo-transpiration and increased WUE resulting from elevated CO_2 .

International agricultural systems and socioeconomic condition at the household level are major elements of vulnerability. Agriculture is not only a vital source of food in Africa; it also is the prevailing way of life. An average of 70% of the population live by farming, and 40% of all exports are earned from agricultural products (WRI, 1996). One-third of the national income in Africa is generated by agriculture. Crop production and livestock husbandry account for about half of household income. The poorest members of the society are those who are most dependent on agriculture for jobs and income. On average, the poor from developing countries of Africa spends 60 – 80% of their total income on food (Odingo, 1990; WRI, 1998; FAO, 1999b). Agriculture and household income are characterized by large inter annual and seasonal variations. The annual flow of income normally rises and peaks during the harvest season. Non agricultural and migrant, off-farm wage incomes are substitutes during the dry season. The period preceding the harvest is critical because farmers engage in "unemployment – induced" immigration to urban centers as one of the strategies for coping with scarcity. Fluctuations in annual food production resulting from climate variability place a heavy reliance on food aid, at the national and household levels.

Food securities in Africa are already affected by extreme events, particularly droughts and floods (Kadomura, 1994; Scoones *et al.*, 1996). The ENSO floods in 1998 in east Africa resulted in human suffering and deaths as well as extensive damage to infrastructure and crops in Kenya (magadza, 2000). Floods in Mozambique in 2000 and Kenya in 1997 – 1998 sparked major emergency relief as hundreds of people lost their lives and thousands were displaced from their homes (Brickett *et al.*, 1999; Ngecu and Mathu, 1999). The cost in Kenya alone was estimated at US\$1 billion (Ngecu and Mathu, 1999). Droughts in 1991-1992 and 1997-1998 affected livelihoods and economies and heightened renewed interest in the impacts of climatic hazards (Kadomura, 1994; Campbell, 1999). For example, the impacts of the 1991-1992 droughts in Zimbabwe are estimated to have been 9% of GDP (Benson and Clay, 1998). Such climatic episodes can serve as an analog of climate change.

Irrespective of whether climate change will cause more frequent or more intense extreme events, it is apparent that many aspects of African economies are still sensitive to climatic hazards. At the local level, some coping strategies are less reliable (Jallow, 1995) – for instance, Campbell (1999) notes that plants and

trees used as food by pastoralists in southern Kenya declined between 1986 and 1996. National governments often struggle to provide food security during times of crisis (Ayalew, 1997; Gundry *et al.*, 1999). The tragic death of as many as 250,000 people in the Sahel drought of 1968-1973 (UNCOD, 1977) demonstrates the vulnerability of humans to desertification. As desertification proceeds, agricultural and livestock yields decline, reducing people's options for survival. Desertification in Africa has reduced by 25% the potential vegetative productivity of more than 7 million km², or one-quarter of the continent's land (UNEP, 1997). Desertification consists more of degradation of the productive capacity of patches well outside open-sand deserts rather the inexorable encroachment of open sand onto green lands. Arid lands can respond quickly to seasonal fluctuations. Indeed, analysis of 1980-1990 NDVI data to track the limit of vegetative growth along the Sahara-Sahel margin revealed wide fluctuations. Desertification reduces soil fertility, particularly base cation content, organic matter content, pore space and water –retention capacity. Desertification also reduces vegetative productivity, leading to long-term declines in agricultural yields, livestock yields, plant standing biomass and plant biodiversity. These changes reduce the ability of the land to support people, often sparking an exodus of rural people to urban areas. Breaking the strong connection of people to the land produces profound changes in social structure, cultural identity, and political stability. For national and international agencies, the cost of climatic hazards – impacts, recovery and rehabilitation may result in a shift in expenditure from reducing vulnerability to simply coping with immediate threats (Dilley and Heyman, 1995).

Adaptation to Climate Change Impacts in Africa

Like changes in precipitation and discharge regimes call for a wide range of adaptations. Broadly, these adaptations will include;

- Refinement of early warning systems.
- Shared basin management, necessitating international agreements.
- Water use strategies, especially demand management, in industry, settlements and agriculture.
- Intensified monitoring to improve data reliability.
- Intensive research into energy usage and alternate renewable energy at household and industrial levels.
- Intensive research into design of infrastructure facilities such as roads and telecommunications to withstand extreme events.
- Intensive research into flood control management technology.
- Innovation in building designs (e.g. to minimize urban flooding).
- Research into and commencement of coastal defense facilities.
- Research into adaptive Agricultural strategies.

Understanding how climate affects the transmission of diseases will lead to enhanced preparedness for early and effective interventions. Monitoring drug sensitivity to commonly used anti-malaria drugs and antibiotics will prevent the

use of ineffective interventions. Communities that are exposed to water-borne diseases such as cholera could reduce the risk of infections by using safe drinking water technologies. Remote sensing is increasingly becoming an important tool in forecasting the risks of transmission in malaria and cholera. Hay *et al.* (1998) have shown that the normalized difference vegetation index (NDVI) correlated significantly with malaria presentation, with a lag period of 1 month. NDVI is a function of climatic factors that are similar to those that affect malaria transmission. Ability to use remote sensing to accurately detect parameters such as ground moisture that determine flooding could provide local officials with sufficient warning to allow for implementation of specific mosquito control measures before a disease outbreak (Linthicum *et al.*, 1990, 1999). In the case of cholera, it is now possible to utilize remote sensing and computer processing to integrate ecological, epidemiology and remotely sensed spatial data for the purpose of developing predictive models of cholera outbreaks (Colwell, 1996).

Adaptations by farmers and herders in Africa to climate change and desertification have involved diversification and intensification of resource use (Davies, 1996; Downing *et al.*, 1997). Resourceful diversification responses by women in Bambara and Fulbe household in Mali (Adams *et al.*, 1998) reflect the importance of women in guiding adaptation strategies across Africa. In southern Kenya, Maasai herders have adopted farming as a supplement to or replacement for livestock herding (Campbell, 1999). In Kano, Nigeria, peri-urban vegetable gardening has expanded (Adams and Mortimore, 1997), revealing a common diversification trend in small cities across West Africa. In northern Cameroon, Fulbe herders have increased the number of herd displacements between pasture areas and even resorted to long-distance migration, sometimes introducing significant changes to their way of life (Pamo, 1998). Other adaptations to desertification involve more efficient management to resources. In Niger, farmers with access to credit will adopt low-cost, appropriate technology for wind erosion control, including wind breaks, mulching, ridging and rock bonds (Baidu-Forson and Napier, 1998).

Conclusions and Recommendations

If the climate adaptation strategies are to take root and flourish, the projects and ideas should be driven from within Africa. Enlisting the media to disseminate information will enhance climate change adaptation. Climate change is a pressing poverty issue that will not only hinder achievement of the millennium development goals, but could even undo modest gains in economic growth the continent has recorded in the past few years yet African governments continue to ignore climate change, doing little to integrate it into development policies. Largely this lack of interest can be attributed to many competing problems for African development. For example, sub-Saharan Africa has the highest rate of HIV/AIDS and maternal and infant mortality in the world, along with the lowest life expectancy and sanitation. Many African governments feel that their limited funds are better spent by dealing with these more immediate

development crises. This is especially true for governments that see climate change as a problem of the future. Why should government use their short political tenure to deal with problems anticipated to occur in the future? But Africa cannot afford to ignore the role that climate change plays in exacerbating these immediate development problems. Africa's policy makers must accept that far from being a long distant threat, climate change is a phenomenon that is already happening and already affecting Africans. For example, the continent has seen new outbreaks of diseases such as malaria in previously unaffected areas like the African highlands and increased aridity in northern and southern Africa with resultant losses in household and national incomes. It is true that the climate change is a creation of affluent western countries, and that of Africa has contributed little to build -up greenhouse gases in the global atmosphere. As such, the west has a moral responsibility to Africa and other developing countries to make resources available to adapt to the predicted impacts of climate change.

While continuing to engage in international climate change negotiations, African governments also need to include climate change in their own national development policies. Some developed countries have shown a very strong commitment to tackling the problem of climate change and development in Africa – several donors have invested substantially in reducing Africa's vulnerability to climate change through the implementation of several adaptation programmes. But, while such effort may contribute to reducing Africa's vulnerability to climate change, the best adaptation is still mitigation. Giving out aid to support Africa's adaptation to climate change does not remove developed countries' moral obligations to cut down greenhouse and gas emissions. No amount of aid can shield Africa from the adverse impacts of climate change. While African governments can integrate climate concerns into development policies, the West must also curb green house gas emission or Africa will made be able to achieve sustainable development. It is time for Nigeria in particular to evolve a paradigm shift in its energy policy. The heavy dependence on imported tri-cycles. Motorcycles, power generators, used vehicle importation, etc., in recent times has contributed significantly to greenhouse gas emissions.

Besides, African countries must of necessity invest in its human capacity to study the more fundamental issues of global climate change and its impacts. There is capacity at the applied management level in Africa, and this must be strengthened by a strong science based capacity. The increasing number of international environmental treaties and agreements will require even greater capacity for analysis and delivery of timely reports. It is becoming increasingly clear that most environmental problems such as climate change require integration of many disciplines and methods of analysis. There should be a shift in interest and focus from global scales to regional and local scales. Models that help to integrate scientific findings with management and policy issues are needed. These models called integrated assessment models are required at regional and sub-regional levels and should link climate change and environmental issues with sustainable development.

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