

## Exploring the Synergy between Climate Change, African Food and Economic Crises in the 21<sup>st</sup> Century

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### Abstract

Food and agriculture is at the heart of humanity's civilization and its celebration is common across many sub-Saharan African religions and cultures due to its importance in our continuity (Shah 2010). However, this trend of celebration has been substituted with inadequacy, want, hunger and many nutritional health issues following the weather-related food crises of the last the 20 years across Sub-Saharan Africa. Although the sub-Saharan Africa contributes the lowest level of carbon emissions in the world, the impacts of climate change is unexpectedly severe in relation to agriculture, drought, and desertification. The resultant effect is the infliction of a three pronged crises of climate, food, and economic on sub-Saharan African countries. The economic crisis being a direct consequence of the other two is largely manifested because of the largely agrarian nature of many Sub-Saharan African economies. Fresh studies on the effects of climate change on agriculture predict that, without proper mitigation and adaptation policies, sub-Saharan African countries will suffer the most. This article will review the extent of the deteriorating state of food availability including financial factors; unequal distribution of land; unsustainable use of natural resources such as water, and threats to biodiversity, along with a special analysis of the impacts of climate change on agriculture. This article also presents the need for social protection, to address the challenges of climate change and global economic shocks as well.

### Background and Introduction

Climate change is a defining challenge of our times, and it's increasingly recognized as a major human security issue that poses serious global threats. Conscious of the threats to humanity's existence and planetary survivals, concerns about climate change has recently become so acute as to supersede human anxiety over all other forms of environmental disturbances (Martine & Guzman, 2009). According to the Intergovernmental Panel on Climate Change (IPCC) (2007c: 30) "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level". The Fourth Assessment Report of the IPCC warns further that climatic changes will result in a variety of direct problems, including increased frequency of extreme weather events, flooding, storms, drought, desertification, increases in sea temperatures, heat and cold waves, the melting of glaciers and permafrost (IPCC, 2007a, 2007b, 2007c, 2007d; UNFCCC, 2007). In the long run, sea level rise and abrupt changes in sea currents pose major threats to coastal areas, ecosystems and geophysical cycles.

The report also notes that while poor countries and poor people are most vulnerable, even advanced societies remain inadequately adapted to the risks posed by current climate, let alone climate change to have significant ecological, social, economic and political impacts, including effects on food production, water availability, intensification of wildfires, mud-streams, bleaching of corals, changes in epidemic vectors and extinction of pollinators (IPCC, 2007a, 2007b, 2007c, 2007d; UNFCCC, 2007). As noted by Fraser, Hubacek, Simelton, Quinn and Challinor (2009) climate change is likely to impact agricultural productivity and many wonder whether the earth will be able to produce enough food for our growing population in light of changing weather patterns. Without doubt, climate change is already increasing the risk of exposure to hunger, malnutrition and food insecurity among the world's poorest and most vulnerable people. Particularly in many of the poor, agriculture-based countries of sub-Saharan Africa with their low capacity to effectively cope, climate change is considered as posing the greatest threat to agriculture and food security in the 21st century (Nellemann et al., 2009; Shah, Fischer, & van

Velthuisen, 2008). To this extent it is suggestible to conclude sub-Saharan Africa is more exposed to the impacts of climate change than many other regions in the world.

The United Nations Framework Convention on Climate Change (UNFCCC) (2007) publication entitled “*Climate change: Impacts, Vulnerabilities and adaptation in developing countries*” described Africa as already a continent under pressure from climate stresses and highly vulnerable to the impacts of climate change, with many areas recognized as having climates that are among the most variable in the world on seasonal and decadal time scales. For example, estimates reported at the workshop indicate that one third of African people already live in drought-prone areas and 220 million are exposed to drought each year (UNFCCC, 2007).

Many factors contribute and compound the impacts of current climate variability in Africa and will have negative effects on the continent’s ability to cope with climate change. These include poverty, illiteracy and lack of skills, weak institutions, limited infrastructure, lack of technology and information, low levels of primary education and health care, poor access to resources, low management capabilities and armed conflicts. The overexploitation of land resources including forests, increases in population, desertification and land degradation pose additional threats (UNDP, 2006). Climate change is an added stress to already threatened habitats, ecosystems and species in Africa, and is likely to trigger species migration and lead to habitat reduction. Up to 50 per cent of Africa’s total biodiversity is at risk due to reduced habitat and other human-induced pressures (Boko et al., 2007).

The challenge of climate change adaptation is real; as such there is the urgent need to manage forest resources rationally, to strike a better balance between economic development and resource protection. Fresh studies on the effects of climate change on agriculture predict that, without proper mitigation and adaptation policies, sub-Saharan African countries will suffer the most in the form of increased malnutrition, unemployment and reduced export earnings. This article, therefore, will review the extent of the deteriorating state of food availability including financial factors; along with a special analysis of the impacts of climate change on agriculture.

### **Understanding the Issues**

This section presents a discourse on the nature and dimension of the three pronged crises i.e. economic, food and climate change in relation to sub-Saharan Africa (SSA).

#### ***Climate Change and Sub Saharan Africa***

Climate change is a key development issue (Gössling, Hall, & Scott, 2009; IPCC, 2007a, 2007d; Kok, Metz, Verhagen, & van Rooijen, 2008) as well as being one of most challenging problems facing the world in the 21<sup>st</sup> century (O'Brien & Leichenko, 2000). As noted by Thornton et al. (2008) the world’s climate is changing at rates that are projected to be unprecedented in recent human history. It is estimated that if the emission of greenhouse gas (GHGs) is not curtailed, the earth’s temperature will rise between 1 and 4 degrees centigrade over the course of the 21<sup>st</sup> century (IPCC, 2007c: 30). Without doubt, these changes will evidently have enormous and multiple implications for humankind (Shardul Agrawala & Crick, 2009).

As a result it is now almost universally recognized as one of the gravest threats to life and well-being on this planet. For example, the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (2001) indicated that the global average surface temperature increased by about 0.6°C during the 20th century. The recent Fourth Assessment Report (IPCC, 2007a) also attributed most of the observed increase in the globally averaged temperature since the mid-20th century to increase in anthropogenic greenhouse gas concentrations.

Today, there is a growing consensus that anthropogenic gas emissions have contributed to a change in the climate, and that such trends will continue into the future unless dramatic mitigation measures are put in place (Houghton et al., 1996). Anthropogenic climate change has gradually emerged

since the industrial revolution, especially since the 1950s, due to the availability of cheap fossil fuels such as coal, oil and natural gas, and the dramatic increase in its consumption (IPCC, 2007c). The panel also concluded that climate change is already manifesting with results that are multifaceted and will be dramatic unless immediate mitigating actions are taken (IPCC, 2007c). The IPCC climate model projections from 2001 suggest an increase in global average surface temperature of between 1.4 and 5.8°C from the present to 2100, the range depending largely on the scale of fossil-fuel burning between now and then and on the different models used (Houghton et al., 1996; O'Brien & Leichenko, 2000; Thornton et al., 2008). Recent modelling work indicates that the temperature increases by 2100 may be larger than those estimated in 2001 (Stainforth et al., 2005; Thornton et al., 2008).

Presenting a social dimension to the global climate change discourse, UNDP (2008) predicted that the impacts of climate change could, by 2080, push another 600 million people into malnutrition and increase the number of people facing water scarcity by 1.8 billion. Also, climate change, will pose the greatest threat to agriculture and food security in the 21st century, particularly in many of the poor, agriculture-based countries of the south (for example, sub-Saharan Africa countries) because of their low capacity to effectively cope with the problem (Nellemann et al., 2009; Shah et al., 2008).

Parry, Evans, Rosegrant and Wheeler (2009) in World Food Programme Report entitled "*Fighting Hunger Worldwide*" predicted that by 2050, the number of people at risk of hunger as a result of climate change is expected to increase by 10 to 20 percent more than would be expected without climate change; and the number of malnourished children is expected to increase by 24 million that is, 21 percent more than without climate change (Parry et al., 2009). Impacts of climate change in sub-Saharan Africa are increasingly common, especially in decreased river flows, the spread of vector-borne diseases and decreased crop yields. Climate change is already a reality in sub-Saharan Africa, with prolonged and intensified droughts in eastern Africa; unprecedented floods in western Africa; depletion of rain forests in equatorial Africa; and an increase in ocean acidity around Africa's southern coast (Besada & Sewankambo, 2009; Lisk, 2009). Vastly altered weather patterns and climate extremes threaten agricultural production and food security, health, water and energy security, which in turn undermine Africa's ability to grow and develop (Lisk, 2009). Agriculture, which provides a livelihood for about three-quarters of Africa's population, is mainly rain-fed.

Many of Africa's major economic sectors (e.g. agriculture, forestry, fisheries, tourism, construction, etc.) are sensitive in various ways to weather and climate conditions and large portions of the continent's population are involved, to varying degrees, in subsistence livelihoods making them highly vulnerable to climate and other environmental changes. The climate community has long articulated the max 2° target (namely an average temperature increase of no more than 2 degree Celsius over pre-industrial levels) as the safe threshold beyond which irreversible, costly and even catastrophic change becomes likely (Vohland, Lucht, & Lotze-Campen, 2007). This temperature target implies stabilizing carbon concentration at 450 parts per million CO<sub>2e</sub>, which in turn means drastic reductions in global carbon emissions.

### ***African Economic Crises***

The sub-Saharan African economy enjoyed robust boost and growth during the last ten years (that is, between 2000 and 2010). During the period, private capital inflows took off, driven by a number of domestic and external factors that contributed towards enhancing the region's attractiveness for foreign investors in search of high yields (Macias & Massa, 2009). The decade also saw net foreign direct investment (FDI) inflows grew progressively from \$13 billion in 2004 to about \$33 billion in 2007; portfolio equity reaching a value of \$15 billion in 2006; bonds flows rapidly increased, by \$7.13 billion from 2006 to 2007; and international banking activity all expanded significantly (Macias & Massa, 2009).

However, the global financial and economic crisis has had significant adverse effect on the region's economies, thereby reducing economic growth for the region in 2009 by about 4 percentage

points compared to the annual average growth rate for the period 2000 - 2007. Although not immune to the secondary effects of the global financial crisis (Macias & Massa, 2009), this significant fluctuations in economic growth in Africa, was exacerbated of sub Saharan countries' dependence on primary commodity exports with volatile prices, instability of both private and official capital flows, and vulnerability to climate change (UNCTAD, 2010).

As observed by UNCTAD (2010), the economic fluctuations and reductions in growth rates has reversed the progress in economic performance made by the region since 2000 (see table 1).

Variable	2000–2007 (annual average)	2008	2009
Real growth rate (%)	5.6	5.18	1.69
Inflation (%)	8.3	10.25	9.05
External debt (% of GDP)	46.2	22.37	25.37

**Table 1: Africa's Recent Economic Performance**

*Source: World Economic Outlook database, International Monetary Fund (IMF), October 2009*

Consequent upon this decline in sub-Saharan African economies, Kaberuka (2009) noted that the crisis has increased Africa's financing needs which is estimated in the region would need \$50 billion to achieve pre-crisis growth rates and \$117 billion to attain the 7 per cent average growth rate required to meet the Millennium Development Goals (MDGs). Despite the long history of regional integration in Africa, intraregional trade and investment has remained very low. It is estimated that intra-African trade accounts for about 9 per cent of Africa's trade while intra-African foreign direct investment (FDI) represents about 13 per cent of inward FDI to Africa (UNCTAD, 2009, 2010). Analysis of the crisis also shed light on the need for African countries to have policy space to respond to adverse shocks.

In particular, it has shown that an active fiscal policy is necessary to cushion the effects of shocks on output. Even though the current global meltdown exacerbated African economic crisis, it is instructive to note that the impact of local problems such as lack of institutions of accountability as well as lack of access to credit have shown pointers to the crisis. In addition is the absence of policy spaces to absolve and respond to adverse effects of shock. The current crisis has also exposed the limitations of this approach to macroeconomic policy and renewed interest in the use of fiscal and monetary policies for economic stabilization. It has also raised questions about the role of capital account liberalization in developing countries.

### ***African Food Crises***

Food and agriculture is at the heart of humanity's civilization and its celebration is common across many sub-Saharan African religions and cultures due to its importance in our continuity (Shah 2010). However, the trend has been substituted with inadequacy, want, hunger and many nutritional health issues following the weather-related food crises of the last the 20 years across Sub-Saharan Africa. Although the sub-Saharan Africa contributes the lowest level of Carbon emissions in the world, the impacts of climate change is unexpectedly severe in relation to agriculture, drought, and desertification due the effects of climate change and the frequency and intensity of extreme weather conditions.

Despite a decades-long effort to reduce hunger, trends show an overall increase in the number of undernourished people in sub-Saharan Africa. In 1990-1992 169 million people were considered undernourished, and that number jumped to 212 million in the 2003-2005 period (Biavaschi, 2008). The sub-Saharan African food crises attained severity with the region according to Biavaschi (2008) moving from having one fifth of the world's hungry in 1990-1992 to having one quarter of the world's hungry in 2003-2005 (Food and Agriculture Organization of the United Nations (FAO), 2008).

Oniang'o (2009) traced food insecurity and hunger in sub-Saharan Africa to the beginning in the mid 1980's, when it was recognized as a cyclical issue that could be predicted as coming approximately every five years, particularly in East Africa. In addition, the region contains arid and semi-arid areas, some of which can go for as long as four years without a drop of rain. Historically, food insecurity and hunger have gone hand in hand with conflict, to the extent that it is difficult to determine the cause-effect relationship of the two with any degree of certainty. Furthermore, although the concept of climate change though fairly recent, have affected populations in East Africa for generations, with devastating impacts seen in the arid and semi-arid areas (Oniang'o, 2009).

Also, tracing the cause of the food crises in sub-Saharan Africa, Holt-Giménez (2008 cited in Vivas, 2010) submitted that the economic "development" policies driven by the countries of the North from the 1960s onwards (that is, the Green Revolution, structural adjustment programmes, regional free trade treaties, the World Trade Organization and agricultural subsidies in the North) contributed to the destruction of food systems in sub-Saharan Africa (Vivas, 2010). Besides short-term causative elements, Vivas (2010) argued further that there are underlying reasons that explain the current deep food crisis. She cited the neoliberal policies such as trade liberalisation at all costs, payment of the foreign debt for the countries of the sub-Saharan Africa, privatization of public services and goods which was applied indiscriminately in the course of the last thirty years as well as a model of agriculture and food at the service of a capitalist logic as being responsible for the current food crises (Vivas, 2010). All these put together was exacerbated by the incidence of global climate change, which also is the consequence of uncontrolled environmental degradation from the industrialized countries of the North.

According to the United Nations (UN) Africa's food security situation is particularly worrisome, with 21 countries currently facing food insecurity (UN, 2009 cited in (Kabasa & Sage, 2009)). More than 300 million Africans are chronically hungry - nearly a third of the continent's population (UN, 2009 cited in Kabasa & Sage, 2009) and of this number, at least 235 million are in sub-Saharan Africa (FAO, 2008 cited in Kabasa & Sage, 2009), making it the region on the planet with the highest proportion of chronically hungry people (Kabasa & Sage, 2009). This appears a tragedy for a region of the world where agriculture is by far the dominant economic activity. The Food and Agricultural Organisation estimate shows the sector employs about 62% of the population in the region (excluding South Africa) and generates 27% of the GDP of these countries (FAO, 2006; Jones, undated). Without doubt as posited by Thornton et al. (2008), climate change is likely to have major impacts on poor livestock keepers and on the ecosystems goods and services on which they depend. These impacts will include changes in the productivity of rain fed crops and forage, reduced water availability and more widespread water shortages, and changing severity and distribution of significant crop, livestock and human diseases. As a result, major changes can be anticipated in livestock systems, related to livestock species mixes, crops grown and feed resources and feeding strategies. These changes will occur over the same period during which Africa's population is projected to grow from 0.9 billion people in 2005 to nearly 2 billion by 2050 (United Nations Population Division (UNPD), 2007)

According to Jones (undated), sub-Saharan Africa (SSA) bears the gloomiest food security and other human welfare indicators. He adds further that, SSA is the only region of the world where per capita food production has been declining for the past three decades; cereal yields in the region are a quarter of the global average (Jones, undated) while food emergencies continue especially in this region of Africa.

### **Pathways Linking Climate Change, African food and Economic Crises**

Scholes & Biggs (2004) refer to sub-Saharan Africa as the food crisis epicentre of the world, and conclude that projected climate change during the first half of the 21st century will make this situation worse. Climate change will add to the burdens of those who are already poor and vulnerable (Thornton et al., 2008). At the same time, agriculture in sub-Saharan Africa will continue to play a crucial role through its direct and indirect impacts on poverty, as well as in providing an indispensable platform for wider

economic growth that reduces poverty far beyond the rural and agricultural sectors (Department for International Development (DFID), 2005; Thornton et al., 2008).

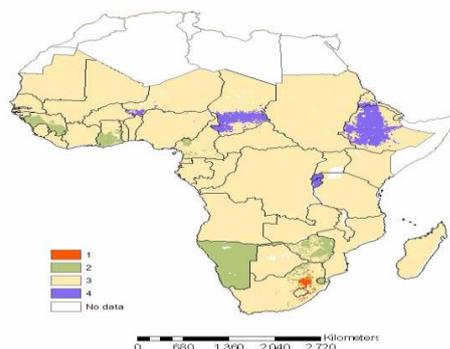


Figure 2: Country-by-systems, showing quartiles of the vulnerability indicator derived through Principal Components Analysis (PCA) (quartile 1, 'less vulnerable' – quartile 4, 'more vulnerable') (from Thornton et al., 2006a)

The indicative results of this analysis show that many vulnerable regions are likely to be adversely affected. For instance, progressive climate change will reduce land for habitation, as some regions experience desertification and others permanent flooding from rising sea levels (DCDC, 2007; Horizon, 2009). Regional weather patterns will be subject to change, with increased frequency and intensity of extreme weather events, such as heat waves, droughts, storms and floods (DCDC, 2007; OECD, 2003; The Millennium Project, 2008). As climate change and socio-economic factors shift the balance between Climate change, as clearly pointed out in the IPCC 4th Assessment Report, is already today impacting on the lives of poor communities. The most vulnerable are most hardly hit, and expected to bare the largest burden of a climate crisis they have not caused.

The resultant effect of this is the infliction of a three pronged crises of climate, food, and economic on sub-Saharan African countries. The economic crisis being a direct consequence of the other two is largely manifested because of the largely agrarian nature of many Sub-Saharan African economies. In the same context, the financial and food crises are the result of the same policies of deregulation and have supplemented each other. This consequence of food shortage crises and climate change-induced drought with these deteriorating economies may mean that food supply for large percentages of African 550 million populations will be in peril. According to Thornton et al (2008) Sub-Saharan Africa is home to 300 million of the of the planet's 1.3 billion poor people with about 60 per cent whose livelihood is heavily dependent on livestock for survival (Thomas & Rangnekar, 2004; Thornton et al., 2002).

As noted by Tubiello et al (2008) climate changes projected for future decades will modify and may often limit the direct CO<sup>2</sup> effects on crop and pasture plant species. For instance, high temperature during the critical flowering period of a crop may lower otherwise positive CO<sup>2</sup> effects on yield by reducing grain number, size, and quality. In addition, climate change is likely to impact agricultural productivity, and thereby raising doubt about the earth's capability to produce enough food for the growing population in light of changing weather patterns. In both popular and academic writing, this concern is often described as "climate change threatening food security" and arguments often are based on computer models that link climate change scenarios with agricultural productivity models (Evan et al., 2009). It has been projected that Sub-Saharan Africa will be most adversely affected by climate change: up to 250 million people are expected to be affected by water stress, and food production will be severely compromised if no strategy of adaptation is adopted.

Pathways to malnutrition consist in a higher frequency of droughts and water scarcity, diminishing dietary diversity, reducing food consumption and leading to water contamination and higher exposure to infectious diseases as well as population displacement associated with impoverishment and changes in consumption habits (Deligia, 2010). According to Schmidhuber and Tubiello (2007), climate change affects food production directly through changes in agro-ecological conditions and indirectly by affecting growth and distribution of incomes, and thus demand for agricultural produce. The extreme variations in weather conditions, with the increasing frequency and severity of extreme events will lead to greater fluctuation in crop yields and local food supplies can adversely affect the stability of food supplies and food security (Ludi, 2009; Tubiello et al., 2008). Climatic fluctuations will be most pronounced in semi-arid and sub-humid regions and are likely to reduce crop yields and livestock numbers and productivity as well as access to food. Moreover, climate change is likely to further shift the regional focus of food insecurity to sub-Saharan Africa (Easterling et al., 2007). Easterling et al (2007) adds that by 2080, about 75% of all people at risk of hunger are estimated to live in this region [Sub-Saharan Africa]. The effects of climate mitigation measures are likely to remain relatively small in the early decades; significant benefits of mitigation to the agricultural sector may be realised only in the second half of this century, i.e., once the positive CO<sub>2</sub> effects on crop yields level off and global mean temperature increases become significantly less than in non-mitigated scenarios.

Furthermore within the projected timeline of 2080, sub-Saharan Africa may also account for 40-50% of all undernourished people, compared with about 24% today (F. Fischer, 2000; G. Fischer, Shah, Tubiello, & vanVelthuizen, 2005; G. Fischer, Shah, & van Velthuizen, 2002; Parry, 2004a; Parry et al., 2009) with some estimates are as high as 70-75% under the assumptions of slower economic growth (Easterling et al., 2007; G. Fischer et al., 2002; Parry, 2004a). Specific impacts must be examined within the context of whole sets of confounding impacts at regional to local scales (Adger, Huq, Brown, Conway, & Hulme, 2003). These impacts of climate change upon these systems according to Easterling et al (2007) will include, the direct impacts of changes in temperature, CO<sub>2</sub> and precipitation on yields of specific food and cash crops, productivity of livestock and fisheries systems, and animal health.

Corbera, Conway, Goulden, & Vincent (2006) further added that these will include both impacts of changing means and increased frequency of extreme events, with the latter being more important in the medium-term (to 2025). Positive and negative impacts on different crops may occur in the same farming system. Agrawala et al (2003) suggest that impacts on maize, the main food crop, will be strongly negative for the Tanzanian smallholder, while impacts on coffee and cotton, significant cash crops, may be positive (Easterling et al., 2007). Establishing a connection between climate change, economic and food crises in Africa, Vivas (2010) blamed the current model of agricultural production and industrial ranching as contributory to deepening the global ecological crisis with a direct impact on the generation of climate change. As the Stern report (2006) states, agro-industry is one of the main sources of the generation of greenhouse gases, ahead even of energy and transport. ... if we take the impact of deforestation (which generates 18% of greenhouse gases) and the impact of the current agricultural and livestock model (which causes 14% of these gases), both concepts together are responsible for 32% of greenhouse gases. A figure that can be attributed certainly to the model of intensive and industrial agriculture which is primarily responsible for climate change globally, ahead of the energy (24%) and transport (14%) sectors (cited in Vivas, 2010).

The financial and food crises are the result of the same policies of deregulation and have supplemented each other. With the crisis of high risk mortgages in 2007 investors began to seek safer places to invest, like agricultural products and oil (Vivas, 2010). This led to the increase in the prices of food and agricultural supplies, contributing to the situation of food crisis and pushing 2008 prices upward (Holt-Giménez, 2008 cited in Vivas, 2010).

Despite the fact that the financial and economic crisis has led to a decrease in speculation in raw materials and resulted in a reduction in their prices, this has not had a direct impact on the final cost of

food. According to Holt-Giménez (2008 cited in Vivas, 2010) the economic crisis has exacerbated the food crisis, because governments and international institutions claim that there can be no more economic resources to alleviate the situation of famine and the price of food in supermarkets has not fallen, although they promote the sale of low-cost products through various mechanisms. To this Biavaschi (2008) pointed out that an examination of both global and local policies that have influenced food security, as well as details of the current situation, helps to identify some of the causes of the discrepancies in who tends to go hungry in sub-Saharan Africa. She adds further that to diminish these discrepancies and reduce hunger for all, failed policies of the past need to be replaced with innovative policies and programs that acknowledge gender inequalities (Biavaschi, 2008).

In considering the linkages between climate change and socioeconomic conditions, Parry and Carter (1998, p. 24) note that "... the effect of any climate change in the future will be influenced by concurrent economic and social conditions and the extent to which these create a resiliency or vulnerability to impact from climate change". Regardless of which economic scenario is used, one obvious fact is that the combination of climate change, food and economic crises is having varying consequences on sub-Saharan African region.

### ***Africa's Disequilibrium in Tackling Climate Change Impact***

The negative impact of climate change on economic growth and sustainable development in Africa, is limiting the ability of African countries to cope with climate change (Lisk, 2009). Considering that most of the poor in sub-Saharan Africa depend on natural resources and rain-fed agriculture for their livelihoods, and they are least able to cope with the shocks of climate change-induced droughts, floods, soil erosion, food and economic crises (Lisk, 2009). The spectacle of the crises in the region can be categorised as follows; there are prolonged and intensified droughts in eastern Africa; unprecedented floods in western Africa; depletion of rain forests in equatorial Africa; and an increase in ocean acidity around Africa's southern coast (Besada & Sewankambo, 2009; Lisk, 2009). Put together, the vastly altered weather patterns and climate extremes threaten agricultural production and food security, health, water and energy security, which in turn undermine sub-Saharan Africa's ability to grow and engage in economic development (Lisk, 2009).

According to Jones (undated) African agriculture faces numerous challenges that diminish its capacity to catalyze economic growth. Examples of these problems include: low internal effective demand due to poverty; unfavourable external markets due to subsidised farm products of industrialized countries; climatic risks; poor rural infrastructure which increases transaction costs and reduces competitiveness of products; institutional weaknesses for service provision to the agricultural value chain from pre-production to consumption; and weak policy and regulatory mechanisms (Inter Academy Council, 2004; Jones, undated).

In addition to above, Devereux (2009) argued that the prevailing structural conditions are actually more responsible for the persistence of famines or food security crises in sub-Saharan Africa this century than the actual shocks that trigger them.

It has been predicted that the sub-Saharan Africa's population is likely to grow by 81 percent by 2035, 15 percent of which is likely to be under-nourished (DCDC, 2007). The implication of this is that agriculture unarguably the mainstay of the people within the sub-Saharan Africa will experience significant challenges in the 21st century, largely due to the need to increase global food supply under the declining availability of soil and water resources and increasing threats from climate change (Tubiello et al., 2008). Environmental degradation and external economic shocks pose challenges for achieving food security in Africa. For example, land degradation is reducing Africa's agricultural GDP by 5 percent per year (Food and Agriculture Organization (FAO), FAO, 2009). The limited diversification of agriculture-based economies also makes these economies structurally vulnerable to external food price and commodity shocks. This was clearly illustrated during the 2007-2008 food price spikes, which caused

severe macroeconomic imbalances in many food importing countries, directly impacting on balance of payments and fiscal priorities, and triggering food related riots and political/social instability in several countries (Conceição & Mendoza, 2009).

According Holtz and UNCCD (2009) the situation is particularly harsh in Africa, where more than 50 per cent of Africa's poorest people are concentrated on 'low potential' lands that are prone to degradation. More than two-thirds of the African continent is made up of drylands (43 per cent drylands in addition to 27 per cent classified as desert) and more than 325 million people are adapting to the uncertainties of climate change and rainfall (Holtz & UNCCD, 2009). A recent UNCCD publication (UNCCD, 2009) entitled "Benefits of sustainable land management" rightly underlines that investment in rural areas and SLM is a local concern, a national interest and a global obligation (Holtz & UNCCD, 2009).

Recent assessments place Africa as a priority for climate adaptation assistance due to the high number of least developed countries, fragile resources, sub-Saharan Africa's large share of the world's drylands, highly variable climates and relatively weak institutions for managing the multiple stresses related to climate change vulnerability (Smith, undated). The changes in annual rainfall over Africa present a more varied picture. West Africa and much of central Africa has experienced a marked decline in annual precipitation, southern Africa shows no clear long-term trend, while east Africa shows patterns of increasing rainfall over the northern sector and declining amounts over the southern sector. There has been an increase in the number of droughts, and in southern Africa the number of extreme rainfall events has increased, leading to severe flooding. Projections of anthropogenic climate change in Africa are still largely based on results from global circulation models, as there have been few studies using regional models or empirical downscaling experiments.

Empirical downscaling is a statistical technique to produce station level projections of climate change from global climate models. Model projections for temperature are better than those for precipitation, as many models find it hard to accurately capture aspects of sub-Saharan African climatology that affect rainfall, such as dust aerosol concentrations, sea-surface temperature anomalies, the role of vegetation and land-use change, deforestation in the equatorial region, and soil moisture in southern Africa. Other associated problems include: repeated sub-division of land into units which lack the capacity to support agricultural-based livelihoods 'tragedy of the commons': over-grazed, and inadequately managed, communally-owned land, deforestation and soil erosion, resulting from excessive use of forest resources erratic rainfall, which further constrains agriculture's ability to provide adequate livelihoods unreliable and ineffective farmer-support services: extension, marketing, credit and institutional policies widespread food insecurity (Horizon, 2009).

The negative impact of climate change on economic growth and sustainable development is also limiting the ability of sub-Saharan Africa countries to cope with climate change (Lisk, 2009). Most of the poor in sub-Saharan Africa depend on natural resources and rain-fed agriculture for their livelihoods, and they are least able to cope with the shocks of climate change-induced droughts, floods, soil erosion and other natural disasters (Lisk, 2009). Africa's food security situation is particularly worrisome. Of the 36 countries worldwide currently facing food insecurity, 21 are African (UN, 2009 cited in (Kabasa & Sage, 2009)). More than 300 million Africans are chronically hungry - nearly a third of the continent's population (UN, 2009 cited in Kabasa & Sage, 2009). Of this number, at least 235 million are in sub-Saharan Africa (FAO, 2008 cited in Kabasa & Sage, 2009), making it the region on the planet with the highest proportion of chronically hungry people (Kabasa & Sage, 2009).

As such, it is widely accepted that policy measures should incorporate the "ecological and social truth" into economic activities by internalizing unwanted environmental, health and distributional impacts. However, economic instruments suffer from some major shortcomings in regard to the agenda of sustainable development (Vohland et al., 2007). First, economic instruments are often found to be in conflict with the goal of equity. This is clearly visible in the controversy over climate change. Vohland et

al. (2007) argued that most economic instruments (and indeed the current trends towards higher oil prices) are highly regressive in nature and subversive of the development and poverty. Estimates of the extent to which poverty falls as agricultural productivity rises are generally high. For example, Thirtle et al. (2003) estimate that a 1 % increase in crop yields reduces the number of poor people by 0.72 percent in Africa (approximately 2 million people). Their estimates reveal that the impact on poverty reduction due to increases in crop yield is greatest in Africa. Analysis by Sachs (2005) shows positive correlation between cereal yields in poor countries and average yearly growth of GDP per capita from 1980 to 2000. It would explain why some people remain food-insecure more or less permanently and why some may manage to become permanently food-secure. This understanding is crucial to determining when and what types of responses are required.

### **Conclusions: Interconnectivities between dimensions**

An analysis of the impact of climate change scenarios on sub Saharan Africa show a projection of 10 million (26 percent) increase in the number of malnourished children in 2050 compared with a no-climate-change scenario (Parry et al., 2009). Globally, climate change is projected to increase the number of malnourished children by 24 million (21 percent) in 2050 compared with the no-climate-change case. These analyses indicate that the impact of climate change on hunger will be more profound where social inequality in development is maintained. They also reaffirm the conclusion that sub-Saharan Africa is the most at risk from climate change: about 65 percent of the global total increase in climate related hunger is projected to occur in the continent.

Many of sub-Saharan African farmers may be categorised as are small farmers who are at the edge of survival or they are land-less people seeking to sell their labour. They depend on agriculture for their earnings, either directly, as producers or hired workers, or indirectly in sectors which derive their existence from farming (International Fund for Agricultural Development (IFAD), 2002). There are two indicators of financial capital. One is the share of total GDP that is associated with agriculture. According to Thornton et al. (2008) economies with a higher dependence on agriculture are hypothesized to be less diverse and thus more susceptible to climatic events and changes. The second relates to global interconnectivity, and is the trade balance in terms of all goods and services exported and imported, expressed as a percentage of GDP. Economies with a higher dependence on imports are hypothesized to be more vulnerable to climate change and variability.

It must therefore be given priority at the local level to increase income, improve food security and contribute to poverty reduction; and at the national and global levels to help alleviate hunger and malnutrition, reduce poverty, protect the world's climate, safeguard natural resources and ecosystem services and, in many cases, to preserve cultural heritage (Holtz & UNCCD, 2009; UNCCD, 2009). Policy change will be crucial to make effectual improvements to the current status quo. To begin to improve the food security in sub-Saharan Africa there is a need for policies that encourage self-sufficiency and local control. The trend toward cash crops has made poor African countries vulnerable to fluctuating world markets and unable to provide enough food to support themselves; the dangers of this approach have become abundantly apparent in the last two years. As climate change continues to change weather patterns and soil conditions, creating new challenges to farmers, it is imperative that local governments have control over finding solutions that address their unique needs. The future of food-security in Africa will depend on identifying and encouraging successful programs, such as micro-lending, and developing new creative solutions that will address unique challenges that will continue to arise.

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