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Climate Change and Food Security: An overview about the issue

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1. Introduction

This paper seeks to discuss the main issues in climate change discourse emphasising on how they implicate agriculture and food security in Africa. It shows how the main economic activities are affected by climate change as well as discusses the concept of food security and its four pillars.

2. What is Climate Change?

The Intergovernmental Panel on Climate Change (IPCC)[1], and the United Nations Framework Convention on Climate Change (UNFCC) refer to *Climate Change* as any change in climate over time whether due to natural variability or as a result of human activity, which alters the composition of the global atmosphere. Thus, climate change can be defined as the slow change in the composition of the global atmosphere, which is caused directly and indirectly by various human activities in addition to natural climate variability over time. Climate is the long-term average of individual weather situations, taken over sufficiently long periods of time. Whereas weather impacts our daily lives, climate influences our decisions about where to live, where, what and how to grow food, which consequently have direct influences on how communities and economies develop and thrive. Changes in climate are associated with more fundamental changes to the global climate system, involving interactions and feedbacks between the atmosphere, the oceans, land and ice surfaces and all living things in these spaces. Climate change can be described as a complex biophysical process influenced by interaction of gases at the earth's atmosphere to cause land and sea temperature rise. Climate change can therefore also be defined as any long-term and significant change in the expected patterns of a specific region's average weather for an appropriately significant period of time.

The phenomenon of climate change is global but its impacts are varied and mainly detrimental to the largely tropical arid and semi-arid areas as in sub-Sahara Africa that is most vulnerable, with negative developmental consequences for the continent and its people. This is because about 70% of the people of Africa live in rural areas and mostly depend largely on agriculture and natural resource based activities for their livelihoods. These livelihood options are dependent on climate-sensitive factors making the people vulnerable. Already, population increase is putting pressures on food production and climate change adds further stress because food production is highly dependent on the environment. Therefore for Africa that is more dependent on climate-sensitive resources, change in climate is the occurrence that negatively impacts on its natural ecological systems to retard capacity for human development and food security. Adequate food production on the continent will ensure enhanced livelihood and nutrition security to achieve sustainable development and general welfare of the people. Climate change is thus a development issue and not only an environmental concern for Africa.

3. Climate change importance in development and food security

Over the years, policy to support climate change adaption and mitigation has been viewed in different context. In the 1970s and 1980s, climate change was seen more as an environmental issue, in the 1990s the focus was on power production and transport, and later in the early 2000s, the focus shifted to economic and energy issues. In more recent times, climate change phenomenon is regarded as a major threat to human security and attention is focus on the different aspects. The focus on various aspects of human security is as a result of competition for limited scarce natural resources, especially arable land

[1] Intergovernmental Panel on Climate Change - IPCC (2001)

and water, in the face of increasing population mainly in dry sub-Sahara Africa. Sub-Sahara Africa is mainly hot and dry and depends on surface water and ground water for freshwater supplies. The arid and semi-arid areas are also particularly vulnerable to the stress imposed by climate change on fresh water, as the rainfall and river water availability are just distributed over a limited period of time in the course of a year. With more than 50 shared basins on the continent there is a potential for conflict over water resources. Many of the major water basins (example Rivers Nile and Congo) in Africa pass through more than two countries with different interests for the riparian countries. For example, riparian countries of Volta and Niger Basins depend on the water bodies for food, water and transport, and additionally, in the case of Ghana, for hydro-electric power. Water demand is increasing in most places but with climate variability and change there is less water available through reduced rainfall patterns and reduction in water quantity which is eventually leading to diminished quality due to competing needs and causes. The coastal and marine resources are affected with implication for the coastal areas and the fishing communities. Rising temperatures and changes in rainfall patterns have direct effects on agricultural productivity, in addition to indirect effects through changes in water availability for irrigation. Again, temperature rise will lead to greater loss through evaporation placing additional stress on water resources regardless of changes in rainfall and affecting agricultural productivity and human security. The icecap on Mount Kilimanjaro has been disappearing due to climate change with serious implications for the rivers that depend on ice melt for their flow. Likewise several rivers and reservoirs are already drying out especially in the dry period due to similar changes such as Ruwenzori in Uganda and Mount Kenya. These chain reactions in water stress conditions have implication for food and nutrition security, health, water and sanitation, biodiversity needed for enhanced production and incomes. Climate associated water diseases and pests for humans like malaria and its vectors are likely to spread beyond it current locations. Changes in rainfall will affect the potential spread, and the presence and absence of vector-and water-borne pathogens[2]. Climate change causes floods and droughts as witnessed in parts of Africa have health implications. Rift valley fever which afflicts both human and livestock is related to heavy rainfall, and so are cholera bacteria. Increased temperature and related heat and drought are known to negatively affect animals and plant health and production. These developments can reduce agricultural labour potential of humans needed to support and manage farms, and cost of food production will also increase, and translate into higher food prices which in turn is likely to impact on food security leading to under-nutrition on the continent.

IFPRI[3] analysis suggests that real agricultural prices will likely increase between now and 2050, the result of growing incomes and population as well as the negative productivity effects of climate change. The high physical sensitivity of the African region to climate change has resulted in increased average temperatures and rainfall variability, both of which have severely impacted on food production, water resources, biodiversity, and human and livestock populations. The importance of climate change interface with development in Africa is its varying effects on humans and their livelihoods. This is due to the continent's vulnerability not only on environmental problems in ecological terms but also as social predicament, lack of infrastructural and policy framework to tackle the problem. Climate change is inhibiting food insecurity and negatively affecting the well-being of people and economic growth in Africa.The combined effects of these are widespread starvation and under-nutrition that lead to child mortality. In the process, millions of people especially the rural folks are forced to abandon their homes in search of food for themselves and their animals. Women and girls are most adversely affected due to their role in food production and preparation, family care and upkeep, and fetching of water and fuel

[2] IPCC 2001

[3] 2010 International Food Policy Research Institute: Food security, farming, and climate change to 2050 : scenarios, results, policyoptions / Gerald C. Nelson ... [et al.].

wood. Much time and funds are also wasted in search of suitable places for farming which then affect the cost of production. Stressful conditions like drought forces people to migrate with their animals in search of pasture and water.

Migration of environmentally displaced people forces them to other places which also causes conflicts and increases security dilemmas, underscoring the urgent need to assess the implications of climate change on human security. These human security concerns include effects on food, livelihood and nutrition security. Other factors, that contribute to making climate change seen as a human security threats are: water scarcity, health and diseases, erosion of coastal lines, migration and its effect on population distribution, which create tensions and conflicts. Again, hike in food prices, with likely consequent food riots, will result in political unrest and lead to probable forceful change in governments in some countries causing more threats to human security. Tensions and conflicts are built between the migrants and inhabitants as they compete for space and use of scarce natural resources for food for themselves and their animals.

4. Various causes of climate change and importance of it effects

There are two mains causes of climate change. Both natural and human activities are known to change earth's climate. Many studies and observations proved that before the industrialisation era, human activities were at a very minimal level to cause climatic changes, and changes in climate resulted entirely from natural processes and forces such as changes in earth's orbit, changes in solar activity, volcanic eruptions that causes climate variations. Climate like any natural process is expected to be changed over time. These changes occur both naturally, as integral parts of how the climate systems function, as well as in response to additional influences due to human activity. After industrialization era, human activities are increasingly accounting for about 80% of climate change and it is mainly due to burning of fossil fuels for industries and transport, and deforestation for agriculture purposes, urbanization, or infrastructural development. These have increased heat trapping greenhouse gases (GHG) in the atmosphere causing warming of earth's atmosphere, land, and oceans. The warming produces dramatic changes in climatic conditions with numerous risks such as more severe extreme events, heat waves, droughts, precipitation events as floods, increased health risks, rising sea levels, and other negative impacts. These greenhouse gases (water vapour, carbon dioxide, nitrous oxide and methane) slow or prevent the loss of heat from the earth causing it to become warmer. Other GHGs like ozone, fluorocarbons (also known as F-gases) contribute to trapping or retaining of heat in the earth. The heating or cooling of earth's surface cause changes in GHG concentration. The impacts and risks associated with climate change are expected to increase with time, causing increasingly more stress on human populations, environment and economies.

The primary GHG that contribute to heating of earth is carbon dioxide, which naturally comes from volcanic eruptions, plants and animals including human respiration and ocean atmosphere exchanges. Human activities that contribute to production of carbon dioxide are mainly in burning of fossil fuel and actions that cause changes in land use as a result of development to secure basic and social amenities. The increase in GHG concentration in the atmosphere is the direct result of our productive, economic and social activities of which agriculture is a major contributor. These changes result in increased temperatures and rainfall variability, both of which severely impact on food production, water resources, biodiversity, and human and animal populations. Agricultural production that most rural communities in Africa and the continent as a whole depend on for its survival is highly sensitive to

changes in these variables that constitute climate change. An IPCC report[4] revealed that the impact of increased temperature and reduced precipitation in some parts of the region resulting from climate change could lead to overall reduction in agricultural productivity and yields, threatening food security and heightening the risk of hunger. This is confirmed in the fourth assessment[5] report that indicates that Africa will experience reduced water availability affecting up to 250 million people by the year 2020, reduced areas suitable for agriculture and reduced yields for rain-fed agriculture, and fisheries resources which will all combine to affect food supply.

Changes in the climate are natural, but human activity has quickened transformational process and accelerated natural climate change with dire consequences for the poor and the marginalized who are most affected and faced with severe environmental, social, political and economic outcome. According to the IPCC third assessment report, climate change is already happening, and will increase even if global greenhouse gas emissions are curtailed significantly in the short to medium term. The IPCC Fourth Assessment report also concluded that observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases. The evidences from these reports imply that climate change and its impacts are real and increasing intensity and frequency to affect all spheres of social fabric and its development. This information, coupled with Africa's vulnerability to climate change and the importance and sensitivity of the agricultural sector to food, livelihood and nutrition security, should be a major concern for the continent. Both natural and human activities interact to produce agricultural effect on climate change and vice versa.

5. Climate change and agriculture

Agriculture is the cultivation of all forms of plants, animals, and other life forms and products for food/feed, fibre, energy and other purposes in order to satisfy man's needs, sustain and enhance human life. Nearly 70% of people in developing countries, live in rural areas, where agriculture is the largest supporter of livelihoods[6], and Africa is no exception. Climatic variables like temperature, radiation, precipitation, humidity, etc have direct impact on the productivity of agriculture, forestry, and fishery systems. Climatic and atmospheric conditions determine vegetative growth and animal production and their development implying agricultural production needs optimum climatic conditions to achieve its potential output. Even though agricultural productivity is projected to decrease for small temperature increases of about 1-2° C in Africa, at the global level, changes in cool regions has the potential for increased food production with rises in local average temperature over a range of 1-3° C. This means in cool regions, moderate warming will be beneficial to plants (such as cereals and pasture yields) but slight warming in seasonal dry and tropical regions will decrease the crop yield. Climate change however, exerts multiple stresses on biophysical as well as social environments that underpin agricultural production, thus thwarting the efforts of farmers and causing a threat to food and livelihood security. Agriculture is not only a victim but also a cause of climate change. It releases and absorbs greenhouse gases but the balance shows how agriculture is contributing to mitigate or increase climate change. Agriculture's CO_2 release and uptake are about balanced.

[4] The Third Assessment Report of the IPCC (2001)
[5] The fourth Assessment Report of the IPCC (2007)
[6] IPCC, 2007

Agriculture contributes to global climate change by releasing carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), the three gases presently causing the most greenhouse warming. Agriculture as a cause of climate change includes and starts with land clearance in new areas. Other causes in the agricultural development include but not limited to land preparation- land clearing and burning, deforestation, changes in land use, energy use and agricultural mechanization processes, husbandry practices of plants and livestock, plants and animals respiration, ocean atmosphere exchanges, natural wetlands use for rice and other production systems, agro-chemical use like fertilization, pesticide and herbicide use, and water use (irrigation, livestock watering, aquaculture).

Forest loss and degradation through agriculture contribute to climate change. Forests are useful ecosystems that are essential for water catchment and carbon sinks, in addition to providing food, pasture for animal use, among others. Deforestation for agricultural purposes, slash-and burn agriculture, and the conversion of virgin habitats into agricultural areas are further exacerbating the climate change situation. Forests are presently under threats from demand for firewood and charcoal as energy sources, and from the trade of forest products such as timber, nuts, fruit to meet food and livelihood security options. Conversion of land uses and changes in land use patterns for agriculture purposes contribute to climate change by affecting especially temperature and precipitation change.

variables are temperature and precipitation. The IPCC third assessment report disclosed that impact of increased temperature and reduced precipitation resulting from climate change could lead to overall reduction in agricultural productivity and yields, including rangeland and livestock production, threatening food security and heightening the risk of famine. Already, many scientists and farmers are already experiencing the impacts of climate change on agricultural production in various part of the continent in their research results or on their farms respectively. The impact of climate change on food crops and forests will have a huge effect on the socio-economic pattern of many countries. In addition to increasing risk of poor yields or crop failure, more investments are made in time, energy and resources and increasing hardship for farmers. Many countries economy relies heavily on rain-fed agriculture and tourism as the main economic stay of Africa. For example agricultural export commodities like cocoa from West Africa, coffee and tea from Eastern Africa and timber from Central Africa are the major foreign export earners. Declines in subsistent food crops production has already been reported for sorghum in Sudan, Ethiopia Eritrea and Zambia; maize in Ghana; Millet in Sudan; and groundnuts in Gambia[8]. This has seen sub-Sahara Africa having a worsening in abject poverty[9]. Climate change has affected the cropping system; these include changing planting dates, planting in new locations, intercropping, and diversifying crops. Climate change in the arid northern sub-region of the continent is expected to enhance desertification and bring a gradual decrease in forest cover[10]. Increasingly variable growing season conditions examples shifts in start of rainy seasons, length and quality of rains, etc, are disrupting subsistence agricultural production leading to famine and severe loss of livelihoods in many semi-arid regions of Africa like the Sahel of West Africa and Sudan of East Africa.

In summary, climate change may affect the agriculture sector in the following ways:

- Reduction in crop yields and agriculture productivity: There is growing evidence that in the tropical arid and semi-arid areas, where crops have reached their maximum tolerance, crop yields are likely to decrease due to an increase in the temperature. The reduction holds or forest and its products (like wild foods), and rangeland. Arable land suitable for agricultural production and soil fertility will decline in quality. Other agriculture sectors like fisheries and poultry are all sensitive to climate. Production processes for food, feed, fibre, beverages, energy, industrial crops, livestock, poultry, fish or forest will be impacted.
- Higher cost on food distribution: Higher temperatures from climate change will increase the need for refrigeration in the food distribution network. The transport system could suffer extra cost because of destroyed roads and bridges, railway lines, waterways, affected harbours due to sea level rise, and disrupted air transport due to increased precipitation or bad weather.
- Increased incidence of pest attacks: An increase in temperature is also likely to be conducive for a proliferation of pests that are detrimental to crop and livestock production.
- Limit the availability of water: It is expected that the availability of water in most parts of Africa would decrease as a result of climate change. Particularly, there will be a severe down trend in the rainfall in Southern African, Sahel and Horn of Africa countries and in the dry areas of countries around Mediterranean Sea. When water bodies recede, there would be a decline in water availability for irrigation purposes, and reduction fish production. When large water bodies recede, whole economies suffer. Examples: Egypt and Kenya are reliant on the Nile for irrigation; Guinea, Mali, Niger and Nigeria depend on the river Niger, for food, water and

[8] UNEP/GRIDA rendal Maps and Graphics Library, 2006
[9] African Security Review 2003
[10] FAO (1999)

transport, and Ghana on Volta River for same. Women's work load will increase and livelihood reduce

- Exacerbation of drought periods: An increase in temperature and low precipitation as a result in change of climate throughout the continent are predicted to cause recurrent droughts in most of the region. Frequent droughts lead to outmigration of natural resources dependents
- Reduction in soil fertility. An increase in temperature is likely to reduce soil moisture, moisture storage capacity and the quality of the soil, which are vital nutrient for agricultural crops.
- Low livestock productivity and high production cost: Climate change will affect livestock productivity directly by influencing the balance between heat dissipation and heat production and indirectly through its effect on the availability of feed and fodder. For optimum performance, the livestock may even need air conditions. Higher feed prices caused by climate change will result in higher meat prices. Heat stress and drought are likely to have a negative impact on animal health, production of dairy products, meat and reproduction and in turn could impact on food security leading to protein deficiency and under-nutrition.
- Availability of human resource: Climate change is likely to cause the manifestation of vector and vector born diseases, where an increase in temperature and humidity will create ideal conditions for malaria, sleeping sickness and other infectious diseases that will directly affect the availability of human resources for the agriculture sector.
- Low health profile of population: increased incidence of malaria, sleeping sickness, outbreak of cholera etc. Malaria has spread into the malaria-free areas of Rwanda, Burundi, Kenya, and Ethiopia already. Rift valley fever which afflicts people and livestock is associated with rainfall events and likely to increase with climate change. Availability of farm labour is expected to decrease when many people are affected with illness
- Outmigration and low availability of labour for agriculture: The poor performance of the agricultural sector and exacerbated by climate change is causing migration of able body out of rural areas
- Tensions/ conflict and displaced people: The consequences of climate induced changes on agriculture and natural resources will lead to movement of people and livestock in search of water, food/feed and create competition over scarce resources which is likely to generate into social unrest in host countries. Example is the movement of Fulani herdsmen and their cattle from the Sahel region of West Africa to farming communities in the south e.g Ghana, all in an effort to meet food security needs.

These changes in agricultural production will impact on food security in these ways: food production will affect food supply differently even within Africa; all forms of agricultural production will affect livelihoods and ability to access food. The differential access has implication for the poor and marginalized households with inference for nutrition of its members. The development of other food systems like processing, distribution, acquisition, preparation & consumption may also suffer.

6. Gender considerations

Climate affects everyone but rural African women in dry tropics are distressed more. Feeding and caring for the household is usually the responsibility of women. Men and women till the land, but comparatively women have smaller parcels and consequently lower produce. With less rain and higher

temperatures leading to soil deterioration, which results in low agricultural yields, it means more work and time for yet less food. Women are less likely to enjoy the same level of access to agricultural information and other inputs as men which has implications for agricultural productivity. Insecurity of tenure for women results in lower investment, and with potential environmental degradation; it compromises future production potential and increases food insecurity. Lower production reduces women's potential income, and the availability of food for house-hold consumption resulting in under-nutrition. Provision of water is usually the woman's job, and with less water available for domestic and farm work, it translates to more work for women who have to travel for long distances. Women collect the fuel for cooking. Less rain causes slower regeneration and therefore more work finding fuel wood. Increased incidence of diseases and less food caused by climate change, where children are particularly susceptible, women as care providers are burdened with extra duty for medical care.

7. What is food security?

Food security is a multi-dimensional concept, and a developmental issue. Food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (adopted at the 1996 World Food Summit). The pillars of food security are: availability, access, utilization and stability.

Physical **AVAILABILITY** of food covers domestic production, the country's stock, flow of food aid and trade which could include imports and exchanges. With environmental degradation as a consequent of climate change resulting in reduced arable land suitable for agricultural production and low soil fertility, depletion of water bodies and less precipitation, high incidence of pests attacks and diseases that affect crops and livestock, decreased animal productivity from high temperatures and negative impacts on labour available to work, food availability is decreasing in Africa. Climate change is also exacerbating desertification on the continent and decreasing arable land for food production. Fishery production is likely to be affected through changes in water availability and salinity of water bodies and so are other animal sources like poultry production because they are affected by temperature change. Climate change cause shifts in growing seasons, lower agricultural yields as a result of variability in rainfall and higher temperature patterns and reduce local food availability. With decrease production at the continental level, Africa will be dependent of food imports and aid.

Economic and physical **ACCESS** to food means being in employment with stable livelihoods, and having the financial resources to access food. In rural communities, common community resources like forest for collection of wild foods and community support networks are essential means to access food. Market factors and the prices of food as well as one's purchasing power is important to enable one access food. Wild food available in forest that the poor rural community depends on is under threat from climate induced changes and therefore less food for the poor and vulnerable. Climate change has important implications for food distribution as it affects accessibility due to destruction of road, bridges and other infrastructure, and influences the functioning of markets and other social and economic institutions. Extreme weather events affect local production and therefore local income and accessibility to food. Access to food is affected by climate change due to the disruption or loss of livelihoods and price volatility of staples and animal protein source.

Food consumption and **UTILIZATION** in the body depends on one's physiological needs, health status, and availability of access to clean water, sanitation, hygienic conditions and health care. Consuming sufficient protein and energy (food quantity), and micro-nutrients for a balanced and nutritious diet (food quality, diet diversification) to attain better nutritional status. Climate change might affect utilization through incomes and consumption behavior. Drop in income is likely to cause the development and use of different coping strategies like reduction in both quantity and quality food through less consumption of protein source, fruits and vegetables. Climate induced changes affect food diversity, causes increase in vector diseases of humans, and pests of livestock and crops and therefore affect food utilization patterns. The diversity of diet is important with consumption of a range of food sources (fresh fruits and vegetables, and protein sources -plant, animal or fish-based) and staples for energy to attain healthy life style.

STABILITY of all the other three dimensions above should be stable over time and not be affected negatively by natural, social, economic or political factors such as risk of adverse effects and sudden shocks caused by economic, climatic change or cyclical events. Instability from climate change can arise because of increased variability in production induced by climate change. Extreme events, including excessive high temperature at crucial periods in agricultural growth, droughts and floods, are a particular threat to stability of food access and utilization. Factors that contribute to food insecurity are expected to become more frequent as a consequence of climate change leading to frequent temporary food shortages and stresses on available resources' causing political unrests. Climate induced movement of herdsmen and their animals into new locations in search of food and feed often cause conflicts. Conflicts around scarce resources like water and land, and migration as a result of drought could become more frequent and intensify due to climate change and could have an escalating effect on food security and under-nutrition.

Vulnerability of food and nutrition security to climate change is a function of all the driving factors mentioned above. Climate change is impacting negatively on Africa's food security situation and increasing vulnerability as a result of: deforestation and loss of forest quality in all sub-regional levels; coastal erosions in West, Central and East Africa; and sea level rise in West and Central Africa. Individuals with high risk of food insecurity are also largely found in rural areas where food production normally takes place so their livelihoods are directly affected by local effects of climate change. The food security threat posed by climate change is great for Africa, where agricultural yields have been declining steadily, with population growth and high demand for food, water and forage the likelihood of risk of hunger and under-nutrition is high.

8. Vulnerability

Africa accounts for only 3.6%[11] of global CO_2 emissions (the main sources are power generation from coal in South Africa, and gas flaring in the Niger) and the continent's forests are shrinking at an alarming rate[12], and accordingly its carbon absorption is decreasing – a disastrous development for both Africa and the global climate. Africa's CO_2 emission is very small compared to other regions but the continent is at greater risk of negative impacts of extreme weather conditions, due to peculiar vulnerabilities. Two-

[11] UN Statistics Common Database 2006
[12] FAO 2007

thirds of the surface area is dry land or desert – these areas are the arid and semi-arid areas of West Africa Sahelian land, East Africa Sudan and Southern Africa. There is a dependency of economic activities on climate-sensitive sectors like rain-fed agriculture, fishery, mining, oil & gas, forestry, tourism, etc. Rain-fed agriculture supports the economy; with agriculture accounting for about 70% employment, 30% to GDP, 50% export. The agricultural sector is also a safety net for the rural poor. Increased frequency and intensity of extreme weather conditions leading to drought and floods in many parts, such as the countries around the Rift Valley, plains of Mozambique, Senegal and the Gambia make the people more vulnerable. Other factors accounting for the vulnerability of African countries are:

- Disappearing water bodies, as a result of many factors like pollution, population pressure, evaporation due to deforestation and high temperatures, and inadequate rainfall or variability in precipitation as a result of climate variability and change.
- Rising sea levels affecting the fish numbers and eroding the coastal areas and displacing coastal communities
- Energy use – land grabbing, and biofuel production could have negative consequences for food security if not well managed and displace rural communities of their land and incomes. In some areas it has generated into conflicts.
- Poor economic and social infrastructure;
- poverty (low per capita GDP, life expectancy; and high infant mortality, hunger, illiteracy rate) Africa also has higher number of Least Developed Countries
- Increasing disaster risk of climate change in a number of sectors that provide livelihoods to the people
- Conflicts caused by climate, social, economic and political unrest
- Existing stresses on health and well being (e.g., HIV/AIDS, illiteracy)
- Migration (youth) and rapid urbanisation: rapid migration to cities without jobs and facilities to cater for the large numbers
- Weak institutional & low adaptive capacity (weak institutional framework: policy development & its implementation, leadership and management, limited human, technological and financial capacities)

All the above factors are very crucial to the very survival of the continent and its people and their social and economic development, including the realization of the MDGs.

Climate change will affect everyone but the most hit will be small-scale farmers, forest dependent people and fishers, that is those who depend largely on natural resources for their very existence and livelihoods. This is because climate change affects the suitability of diverse crops, animals and pasture, and impact on the productivity and health of land, forest and water bodies. The impact is also likely to affect incidence of pests and diseases, biodiversity and ecosystems.

Many studies[13] have also confirmed that Africa, particularly the arid and semi-arid regions are the most vulnerable areas to climate variability and change because of multiple stresses and low adaptive capacity. This vulnerability is due to several factors such as over-exploitation of natural resources, widespread poverty, poor infrastructure, high illiteracy rates, conflicts, and dependence of a large share of its economies on climate-sensitive sectors mainly rain-fed agriculture. These climate-sensitive natural

[13] IPCC WGII, 2007

resources based activities and agriculture production contributes to the vulnerability of the people. These factors, coupled with limited institutional and technological capabilities, have contributed to the region's predicament. This situation is worsened by low adaptive capacity, poor governance, limited infrastructural and economic development.

The vulnerable sectors are all agriculture based livelihood systems like:

- Crop failure & low yields
- Loss of livestock & fish stock
- Increasing water scarcities
- Destruction of productive assets
- Pastoralist systems
- Inland & coastal fishing
- Aquaculture communities
- Forest –based systems
- Rural communities esp in coastal, flood plains, dry land etc
- Deterioration in nutritional status for women of reproductive age, children, elderly, ill & socially disabled people

Individuals, organizations and institutions are developing adaptation measures to manage risks of climate change and these are:

- Climate smart agricultural production
- Diversification of livelihoods/ alternatives
- Decentralisation of local governance of resources
- Alternative eco-friendly energy uses
- Infrastructural development
- Climate information
- Early warning systems
- Insurance schemes

Policy suggestions

- Research & dissemination of crop varieties adapted to local areas
- Effective use of genetic materials
- Indigenous knowledge use/ gender considerations
- Promotion of agro-forestry & integrated farming systems
- Improved infrastructure: small scale irrigation & water harvesting techniques, storage etc
- Improve soil and water management

- Adaptation to farming systems & livelihood strategies.

9. Conclusions

Climate change has far reaching effects for agriculture and other economic activities which ensure the availability and accessibility of food. The more climate sensitive economic activities are also direct sources of livelihood especially for the poor. Developing a food security strategy that enhances availability through various climate smart agricultural responses and enhanced and diversified livelihood sources are necessary paths for development. Taking due congnisance of the needs of the vulnerable may be an effective guiding principle in strategy development.