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THE CLIMATE CHANGE MENACE, FOOD SECURITY, LIVELIHOODS AND SOCIAL SAFETY IN NORTHERN GHANA

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ABSTRACT

Since 2007, Northern Ghana has continuously experienced the double tragedy of droughts and floods which are manifestations of climate change. How these climate change manifestations are affecting livelihoods and social organisations of affected people and communities, especially the poor and vulnerable in Northern Ghana remains largely underestimated. This paper examines how climate change affects household food security, livelihoods and social safety in Northern Ghana. The paper conceptualises the transmission mechanisms of the effects of climate change on rural livelihoods. Observations and a desk review were the main methods employed. The main conclusion drawn is that, climate change is being felt in almost all parts of the world, particularly in the developing world including Ghana. Climate change makes affected communities and people vulnerable to food and nutrition insecurity and reduces social safety. It challenges the resilience of the poor and vulnerable across Ghana, especially those in the Northern part of the country where poverty is endemic to cope with emergencies triggered by natural and related disasters. To mitigate the effects of the climate change menace on the livelihoods of the poor and vulnerable, the development and implementation of a holistic climate change adaptation framework across the country and Northern Ghana in particular is recommended. Concerted efforts must be made to ensure that such a framework is socially acceptable, environmentally sustainable, economically viable, gender sensitive and politically stable.

Keywords: Climate Change, Food Security, Livelihoods, Northern Ghana, Social Safety.

INTRODUCTION

Climate Change may be defined as the gradual change in the weather pattern of the world over a long period of time mainly as a result of human activities with respect to the environment. It is the regional or global-scale changes in historical climate patterns arising from natural and/or man-made causes and resulting in intermittent but increasingly frequent extreme impacts. Climate change has become topical because of its effects on human lives and the future of the world. In particular, it affects food security, livelihoods and social safety very adversely and in so

many ways. Food security has been understood by many as the availability of food in the world marketplace (FANTA., 2003). However, global food availability does not translate into household food security. This is because food in the world market may not be affordable to the poor and vulnerable, especially those in developing countries. On the other hand, Devereux and Maxwell (2001) defined food security as the success of local livelihoods to guarantee access to sufficient food at the household level. According to Food and Agricultural Organisation. (2006) however, food security is defined as a situation when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food, enabling them to meet their dietary needs and food preferences for an active and healthy life.

There are different facets of food security. According to Food and Agricultural Organisation. (2008), there are four main facets of food security which are: food availability; food accessibility; food utilization; and food system stability or affordability. Interestingly, climate change affects all the four dimensions of food security. This means that, availability of food alone does not signify food security because it may not be accessible and affordable to all people and communities at all times. As such, attempts to address food security problems must be holistic. Thus designing programmes and projects to mitigate the adverse effects of climate change on each of the principal components of food and nutrition security is pivotal (Vogel and Smith, 2002; Clover, 2003).

The concept of livelihood has been extensively explained by the Department for International Development (DfID) of the United Kingdom and other institutions as well as individual researchers and development practitioners. Livelihood as observed by Carney *et al.* (2000) comprises of the capabilities, assets and activities required for a means of living. The Sustainable Livelihoods Framework (SLF) which was developed by Department for International Development (2001) defines livelihood as gains made by individuals or households and the various factors that affect the level, maintenance and enhancement of these gains. Individuals, households and communities therefore engage in a number of activities and strategies in order to earn a living. Prominent among these livelihood activities and strategies in rural areas is farming, which incidentally is the worse hurt by climate change. This assertion is consistent with the observations by the Intergovernmental Panel on Climate Change. (2007) that, agriculture is highly vulnerable to the increased frequency, severity and unpredictability of extreme weather-related events caused by climate change such as hurricanes, droughts, floods, and rising sea levels among others. The IPCC further observed that, on a global scale, various models predict a moderate impact in the next two decades indicating that, all regions will experience increased temperatures and changes in rainfall patterns that will affect agricultural production as well as food and nutrition security. However, opportunities may arise for producers in some countries as the 'carbon fertilization' effect takes hold and the expansion of potential agricultural cropland in temperate areas may produce an increase in the yields of some crops (ibid).

Though early model projections about world food demand and supplies into the twenty-first century generally show that global food supplies will match or exceed global food demand for at least the next two to three decades (Devereux and Edwards, 2004), the reality on the ground shows otherwise. One shortcoming of these models is that, the scales of the models are very coarse and conceal regional disparities that are a major concern for already food-insecure regions (Stephen and Downing, 2001). Another shortcoming is that, the models pay little or no attention to climate change which is a major threat to food security in many regions of the developing world, which are largely dependent on rain-fed and labour-intensive agricultural production (Döös and Shaw, 1999; Parry *et al*., 1999; Intergovernmental Panel on Climate Change., 2001; Parry *et al*., 2004).

Drawing mainly from the Intergovernmental Panel on Climate Change (IPCC) reports (e.g., Intergovernmental Panel on Climate Change. (2007) and the Food and Agriculture Organization (FAO) study on climate change and food security Food and Agricultural Organisation. (2008), there are indications that, the tropical regions will be the most negatively affected by climate change. The FAO and IPCC studies predicted these outcomes by showing how temperatures are rising and precipitation patterns are changing, generating higher rainfall levels. According to the FAO and IPCC studies, rising sea levels will affect the livelihoods of the large percentage of populations that live in coastal areas. As a consequence, what appears clear is that, due to climate change, all the dimensions of food security may be at great risk in both temperate and tropical regions.

The impacts of climate change on food availability, accessibility, utilisation and stability will ultimately be experienced differently, depending on location. For example, moderate warming (increases of 1 to 3 ºC) is expected to benefit crop and pasture yields in temperate regions, while in tropical and seasonally dry regions such as Africa, it is likely to have negative impacts, particularly for cereal crops. Warming of more than 3 ºC is expected to have negative effects on production in all regions (Intergovernmental Panel on Climate Change., 2007). The supply of meat and other livestock products will be influenced by crop production trends, as feed crops account for roughly 25 percent of the world's cropland (Food and Agricultural Organisation., 2008). This paper seeks to discuss the effects of climate change on food and nutrition security, livelihoods generally and social safety in Northern Ghana. The rest of the paper is organized into eight sections. The impact of climate change on food availability is discussed in the next section. Following that is a discussion on the impact of climate change on food accessibility. This is followed by a discussion on the impact of climate change on food utilization. The impact of climate change on food stability is discussed in the proceeding section. Following this is a discussion of the effects of climate change on food and nutrition security in Northern Ghana. This is followed by a conceptualization of the effects of climate change on food security and livelihoods in Northern Ghana. Next to this is a discussion of the mitigation and adaption strategies to

climate change in Northern Ghana. The last section presents the conclusion and recommendations for policy.

Impact of Climate Change on Food Availability

Food availability in the context of this paper refers to the existence of food stocks for consumption. Agricultural production, food availability and food security in many African countries and regions are likely to be severely compromised by climate change (Intergovernmental Panel on Climate Change., 2007). According to the Food and Agricultural Organisation. (2006), most African countries are net food importers, with between 25 percent and 50 percent of food consumed in sub-Saharan Africa being imported. Africa's cereal import bill, for example, was estimated at about US$22 billion in 2008 and about US$10 billion in Sub-Saharan Africa in 2008, representing a 30 percent and 35 percent increase over the 2007 levels respectively (Kamara *et al*., 2009). The consensus of scientific opinion is that, countries in the temperate, high-, and mid-latitude regions are generally likely to enjoy increased agricultural production, whereas countries in tropical and subtropical regions are likely to suffer agricultural losses as a result of climate change which will most likely impact negatively on food availability in coming decades (Arnell *et al*., 2002; Devereux and Edwards, 2004). It should be noted that, the favourable assessment for temperate and high latitude regions is based primarily on analyses of changes in mean temperature and rainfall, with relatively little analysis done to take account of changes in variability and extremes.

Impact of climate change on crop production and food availability should be a priority area for governments around the world if food self-sufficiency and security are to be achieved (Bryant *et al*., 2000; Smit *et al*., 2000). This is because climate change directly affects agricultural production and food availability. This is primarily due to the fact that agriculture is inherently sensitive to climate conditions and is one of the most vulnerable sectors to the risks and impacts of global climate change (Parry *et al*., 1999). Increasing population pressures interacting with declining rainfall and reduced pasture has already begun to impact the livestock sector and food availability negatively. Rangeland condition is directly affected by the climate and, in turn, directly affects the quality and quantity of small and large stock and associated livelihood activities. In Northern Ghana, food availability is affected through reduced production due to crop losses from floods and droughts as well as crop and livestock diseases triggered by climate change.

Impact of Climate Change on Food Accessibility

Household food access is the ability to acquire sufficient quality and quantities of food to meet all household members' nutritional requirements. Individuals have sufficient access to food when they have adequate incomes or other resources to purchase levels of appropriate foods needed to maintain consumption of an adequate diet/nutrition level (United States Agency for International Development., 1992). This means that, access to food is determined by physical and financial

resources, as well as by social, cultural and political factors. In essence, food access depends on the ability of households to obtain food from purchases, production, stocks, or through food transfers from relatives, members of the community, the government, or donors. Intra-household distribution of these resources is an important determinant of food and nutrition security for all household members. Food access is also influenced by the aggregate availability of food in the market, market prices, productive inputs, and credit (Food and Agricultural Organisation . 2000). Poor market infrastructure and an unfavourable policy environment may lead to high and variable prices for food and inputs, further undermining agricultural productivity, food supplies, and derived incomes.

One of the major factors affecting food accessibility is also transportation, in that, after food is produced, it needs to be moved from the point of production to the point of consumption. This often depends on transport systems. In many developing countries, food accessibility is negatively influenced by inefficient and ineffective transport systems which retard the delivery of food items from producers to consumers. This in most cases creates artificial food shortages thereby pushing prices of food items up and making food inaccessible to the poor and vulnerable. The fact that climate change is expected to place a strain on transport systems (Intergovernmental Panel on Climate Change., 2001) will further worsen the situation in less developed areas particularly Northern Ghana. This is consistent with the findings of Perry and Symons (1994) that, increased heat stress as a result of climate change may reduce the life of roads. They further observed that, climate change may increase the frequency and severity of windstorms which impact negatively on transit at air and sea port terminals as well as damaging infrastructure which may create delays in food transports thereby creating food accessibility problems. Another concern is the fact that, people move to marginal lands to produce during harsh climatic conditions such as droughts. Unfortunately, most marginal lands, especially in Northern Ghana do not have access roads and transport systems which make transportation of food items produced in such marginal areas to consumption centres a huge challenge with serious consequences on food accessibility.

Further, food accessibility depends both on market and non-market distribution mechanisms and is at the mercy of climate change. The capacity of individuals and households to buy food may be significantly reduced as income for farmers in developing countries depends mostly on the capacity to sell surplus production. The fact that climate change affects the availability of certain food products will also change the prices households can charge. Particularly, small scale farmers who are often not protected by social safety nets such as insurance schemes may suffer from changes in market prices. Too low market prices will make farmers generate low incomes; if too high, farmers may not be able to sell their products (either because there are no buyers or because they themselves are not able to buy other food and so keep the surplus for their own consumption) all of which affect the accessibility of food.

Impact of Climate Change on Food Utilization

Adequate food utilisation is realized when proper food processing, storage and utilisation techniques are employed, adequate knowledge of nutrition and child care techniques exist and are applied, and adequate health and sanitation services exist (United States Agency for International Development., 1992). Simply put, food utility involves how food is used. This can include how often meals are eaten and of what they consist. Constraints to food utilization include loss of nutrients during food processing, inadequate sanitation, improper care and storage, and cultural practices that negatively impact consumption of nutritious foods for certain family members. In many areas of Northern Ghana where food is produced and consumed locally, food utility changes with seasonal variation and food availability changes throughout the year. The harvests of most households in Northern Ghana do not last them more than three months. This is exacerbated by the fact that, the area is characterised by mono-modal rainfall patterns lasting a maximum of four months. The hunger season is the time before the planted crops are ready to be eaten which can last for more than 6 months (generally from March – August). Food utility at this period is normally at its lowest. Similarly, at harvest time, there might be festivals and a lot of food consumed and food utility may be at its highest at this time. If there has been a drought and food availability is low, the range of food available often decreases, and so the meal frequency can decrease and the balance of nutrients can be inadequate. This can lead to malnutrition in children.

Climate change therefore has an impact on food utility indirectly. This is because, in recent times, most crops in the area are harvested at a time that the rains continue to fall. The phenomenon of recording rains after harvest has been attributed to climate change because it used not to be the case in the past. Hot dry days enable households to process crops and vegetables by drying them for use later in the year. Besides, seasonal crop production makes households face fluctuations in cash and in-kind income, both within a single year and from year to year. Agricultural households in the area therefore face seasonal fluctuations in income related to crop cycles. The year-to-year fluctuations in income results from varying agro-climatic conditions and climate variability attributable to climate change.

In summary, food utilization is mainly affected by the effects of climate change on availability and accessibility. Low household income as a consequence of climate change, impact on output and translates into the inability of households to diversify their diets, generating situations of chronic malnutrition. It also leads to deterioration in food quality due to increased temperatures and lack of refrigeration equipment and water scarcity, generating health hazards in most parts of Northern Ghana.

Impact of Climate Change on Food Stability

Agriculture is vulnerable to external shocks (economic crises, food price increases, etc) and emergencies (droughts, floods, pests and diseases outbreaks, etc.). The stability of food availability

is hampered by the lack of adequate social safety nets and disaster management programmes. Established social safety nets and disaster management institutions could help in mitigating shortfalls of food supplies in times of emergencies, particularly for the vulnerable rural poor population who make up a large percentage of the population of Ghana as a whole and Northern Ghana in particular.

Food stability is more difficult to achieve in Northern Ghana under climate change regimes as vulnerability to drought and floods continue to bring chronic or periodic food and nutrition insecurity. Guaranteeing the stability of food supplies is affected by the changing patterns in crops cycles impacted by climate change (changes in temperatures and rainfalls). Policies to adapt to and mitigate the effects of climate change are essential to prevent disastrous effects on food and nutrition security and the livelihoods of the rural poor and vulnerable in Northern Ghana. Efforts in this direction need to be intensified at both the national and regional levels. The importance of integrating climate change policies into national development strategies is a must if food stability is to be achieved in Northern Ghana and Ghana as a whole.

Effects of Climate Change on Food and Nutrition Security in Northern Ghana

Although there is research on the impact of climate change on food production, there is limited understanding of how climate change currently impacts food systems and associated livelihoods (Downing, 2002; Ziervogel and Calder, 2003; Akudugu *et al*., 2012). Although the issue of food and nutrition security is directly linked to climate change (Reilly, 1995; Winters *et al*., 1999; Akudugu *et al*., 2012), it must be noted that climate is not the single determinant of yields, nor is the physical environment the only decisive factor in shaping food security (Parry *et al*., 2004). The multidimensional nature of food and nutrition insecurity remains a key concern affecting the livelihoods of marginal groups and communities. Therefore, understanding the impacts of climate change as well as the possible effects on food and nutrition security in particular, and livelihoods in general is critical if the drive towards attainment of the Millennium Development Goals (MDGs), especially halving extreme poverty and hunger and malnutrition among others in Northern Ghana are to be realised. This is particularly important because food and nutrition insecurity at the household level negatively impacts on general livelihoods. The danger of food and nutrition insecurity on sustainable livelihood development is the issue of diversion of resources. For example, resources that might have been used to support the development of livelihoods such as education, health care, income generation and employment among others, get reallocated to ensure that basic food needs are met (Akudugu *et al*., 2012). This is further supported by an earlier research by McConnell and Moran (2000) who noted that the acquisition of food for marginal groups often entails a delicate balance of producing food for the household under stressed conditions at the same time drawing on social and economic resources to access available food. This is particularly so in Northern Ghana where food and nutrition insecurity seems to have become a "normal" phenomenon.

For decades, the issue of a "hunger period", usually from April to June/July which has in recent times been extended to cover March to August seems to have been regarded as usual. That is partly because the people of Northern Ghana have been almost solely dependent on climate for survival. Unfavourable climate directly affects their very existence. A change in the climate is a change in their fortunes. To the people of Northern Ghana and many other places, climate change issues are not academic discussion issues, they are real practical concerns that must be urgently tackled. Climate uncertainty in Northern Ghana, just as food and nutrition insecurity, now seems to be the norm. Nobody can predict the climate these days. As such, food and nutrition security or insecurity is more of a household phenomenon than a national or global one. For most households in Northern Ghana, the attainment of food and nutrition security has been a mirage and climate change has exacerbated the situation.

The climate has no doubt been changing in various dimensions over time globally and the effects, mainly negative have been numerous. In Northern Ghana, it has been observed that, the dry season is increasing in length and becoming more severe. Temperatures are increasing and everyone, including farmers and rural dwellers, are conscious of this fact. Rainfall has become increasingly erratic resulting in frequent droughts and floods within the same seasons. The effect of all these is increase in food and nutrition insecurity. In 2007 in particular, delayed rains in Northern Ghana were followed by heavy rains resulting in farmers planting the same crop fields several times during the season. Many farmers ran short of seed to plant. There was also extensive flooding that destroyed farms, livestock and poultry. The resultant effect was serious food and nutrition insecurity in almost all farming households in Northern Ghana, particularly the Upper East and Upper West Regions and in other regions of the country in general in 2007 and after (see Akudugu *et al*., 2012).

Warmer and more frequent hot days and nights are now common in the area. These are usually associated with increases in the occurrence of pests and diseases. Thus another climate change induced effect on food and nutrition security is increased pests and diseases attacks on food crops and animals. Locust attacks have been serious problems in some African countries. Timely interventions by the Ghana Ministry of Food and Agriculture and several civil society organizations averted potential pest attacks in Northern Ghana in the past years. Even though food production is important for food and nutrition security particularly in Northern Ghana, there are other important determinants such as money poverty. Climate change has over time reduced the ability of rural people in particular to earn income through their inability to produce cash crops and their greatly reduced ability to undertake food marketing activities. This is because there are limited surpluses to sell. Also, as a result of climate change and low agricultural production, high prices in all goods and services are expected. That goes to further increase food and nutrition insecurity, especially for the poor and vulnerable which includes the majority of

Northern Ghanaian rural dwellers. Another major climate change effect that affects food and nutrition security adversely in Northern Ghana is its impact on water resources. Rivers, dams, streams and groundwater sources are under pressure. Climate change has resulted in the drying up of many streams and rivers. Several small scale dams constructed for animal watering and small scale irrigation also either dry up or become very inadequate before rains set in. The implication of such situations on food and nutrition security in Northern Ghana is obvious. Many farmers are virtually unemployed during the dry season. This severely affects dry season food production leading to widespread poverty and food and nutrition insecurity.

Climate change also affects adversely the quality of food produced and thus has significant adverse effects on human nutrition in Northern Ghana. High levels of carbon dioxide affect the nutritional value of food crops. It is believed that, since 1960, atmospheric nitrogen as a result of greenhouse emissions has increased by 20 percent and that has the effect of reducing protein in cereals. Rising levels of carbon dioxide is said to reduce water flow through crops and thus affect the uptake of micronutrients such as iron, zinc, sulphur and magnesium from the soil. That is a major drawback in an already bad micronutrient malnutrition ("hidden hunger") situation, as we have in Northern Ghana. We are particularly concerned with micronutrient malnutrition because of its implications for human development which is the key to other aspects of development.

Increasing bushfires is another indirect effect of climate change on food and nutrition security in Northern Ghana. The higher temperatures and the high velocity winds make bush fires very destructive to the environment. In Northern Ghana, many semi-wild fruit trees such as shea, dawadawa, the berries (*sisibi*, *aara*, *kaya*, *etc)*, which are major sources of micronutrients are constantly being destroyed by climate change enhanced bushfires leading to dangerous levels of micronutrient deficiencies in the area as already alluded to.

Conceptualisation of Climate Change on Livelihoods in Northern Ghana

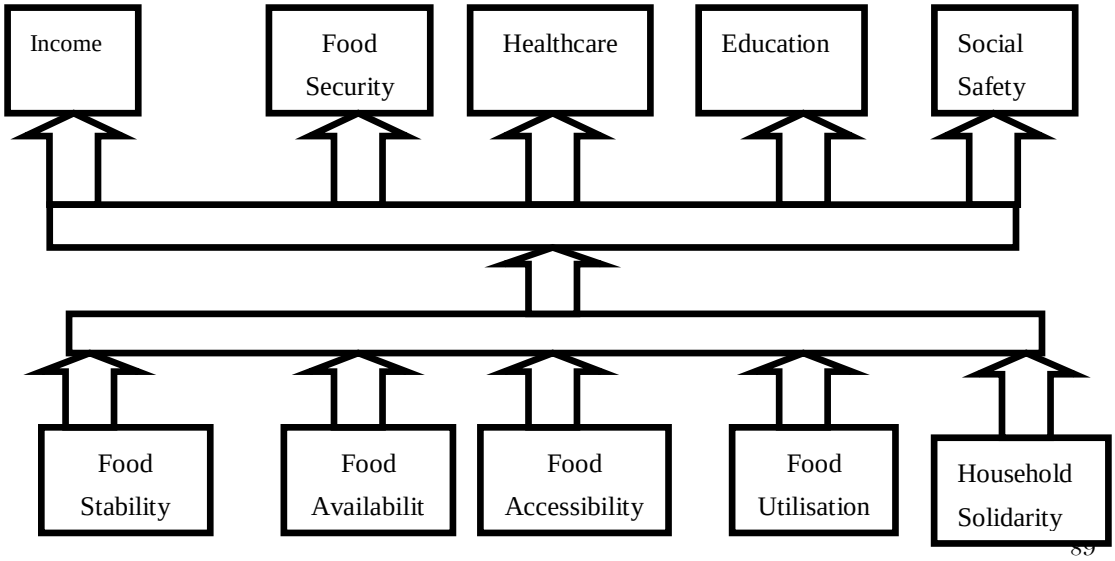
Devereux and Maxwell (2001) state that, food insecurity is no longer seen as a failure of agriculture to produce sufficient food at the national level but as a failure of livelihoods to guarantee access to sufficient food at the household level. That means the problems of food insecurity discussed above are closely linked to the general problem of livelihoods. With the livelihoods approach, how climate change affects the different types of "capital" resources available to households is the issue for discussion. The different capital resources are listed as natural, physical, financial, human and social capital assets (Department for International Development, 2001).

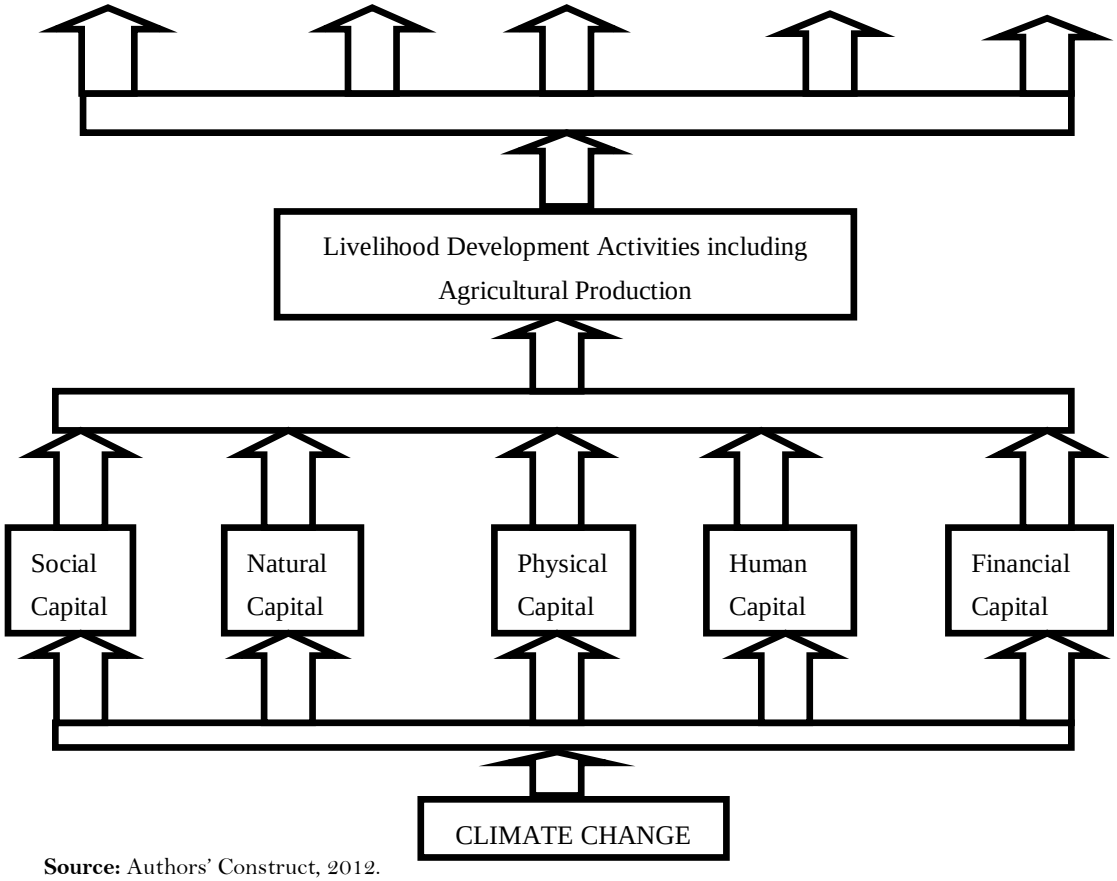
Climate change clearly reduces the natural capital of Northern Ghana. Degradation of arable lands for agricultural production through floods, destruction of trees and grasses through bushfires triggered by high temperatures which lead to destruction of wild life, and decreased

biodiversity in terms of plants and animals are serious depletions of natural capital as a result of climate change. Rural people in particular whose livelihoods depend very much on these become very vulnerable. With respect to physical capital, that is, various types of infrastructures, the reduction in rainfall will not only adversely affect water levels in dams and rivers for irrigation but also hydro electricity generation. Ghana experienced the problem of low levels of water and its adverse effects on power generation in 2005/2006, only to experience too much rainfall and its own negative effects in 2007. The former (low water levels in the Volta Lake) resulted in suspension or slow down of rural electrification and that was a significant physical capital reduction, especially for Northern Ghana. Climate change has also and will continue to impact negatively on potable water supply especially in Northern Ghana. Groundwater resources for potable water are being overstretched already and groundwater recharge is declining in many parts of Northern Ghana. The negative effects of climate change in other areas also affect the country's ability to improve on the general infrastructure and especially, the already marginalized parts of Ghana that are usually the most affected.

The 2007 devastating floods mentioned earlier resulted in the destruction of houses and household assets, displacement of large groups of persons and indeed resulted in a humanitarian crisis in Northern Ghana. There was very significant erosion of the people's financial, human and social capital in various ways. This for sure, very adversely, affected their general ability to maintain livelihoods. The already narrow entitlement base of the people was greatly eroded during the floods. Houses had to be rebuilt and most assets acquired over several years could not be replaced. Despair could be seen in the people. The situation also resulted in increased migration of able bodied people from the area into towns and cities for menial jobs which led to increased unemployment in the towns and cities of Northern Ghana and obviously increased social problems.

Figure-1. Conceptualisation of impact of climate change on livelihoods





Source: Authors' Construct, 2012.

Climate change as well affects the social safety of people and communities. Traditional social safety nets get stressed in difficult times such as during floods and often lead to conflicts. A number of prevailing and potential conflicts in Northern Ghana can be traced to overstretched natural and other resources which make it difficult for social safety nets to be maintained. Climate change which ultimately increases the stress on resources thus negatively impact on social safety. People who once lived, worked and ate together are separated through migration and others as a result of climate change. Communal eating which fostered Northern Ghana's families and communities together is not extensively practiced anymore because of climate change and this greatly affects social safety. Women's contribution to the promotion of food and nutrition security as well as social safety in Northern Ghana in particular and Ghana as a whole cannot be overestimated. These can be seen in their roles as food producers, caregivers, and home keepers among others. However, their access to resources such as land, water, trees and others are continuously getting more and more difficult under climate change. Thus with climate change, societies are less socially secure and the most vulnerable persons such as women and children will bear most of the brunt. Also when disasters take place as a result of climate change, women and children suffer disproportionately because they tend to be unable to recover easily or even recover at all.

Another area that climate change is worsening social insecurity and conflict in Northern Ghana is the relationship between food crop farmers and pastoralists, the Fulani herdsmen. As land and grazing areas become less and less scarce as a result of climate change, there is increased competition between crop farmers and animal herders and that easily leads to conflicts. It must however, be stated that, it is not all the manifestations of climate change that are negative. Some significant positive effects of climate change have been identified. It is reported that, the Sahel of West Africa could benefit from rising temperatures as there is evidence of re-greening due to increasing rainfall in parts of the area. It is argued that, the desert-shrinking trend is supported by climate change models. In effect, changes in climate, be it positive or negative, lead to changes in the capital assets (i.e. natural capital such as land or soil fertility; social capital such as relationships among families and communities; physical capital such as crops, livestock and houses; financial capital such as loss of farm incomes and man-days; and human capital such as sicknesses and loss of lives) all of which greatly affect the pursuance of livelihood development activities and strategies including agricultural production. When these livelihood development activities and strategies such as agricultural production are affected, it directly affects availability, accessibility; utilisation and stability of food as well as solidarity amongst household and community members, and these in turn affect income levels, access to healthcare, access to education, social safety and food security (*see Figure 1)*.

Mitigation and Adaptation to Climate Change in Northern Ghana

Ghana does not currently have a problem with greenhouse gas emissions. That is not to suggest that, steps should not be taken to make sure manufacturing industries and other activities of people guard against the problem. With the petroleum industry coming on stream, Ghana should carefully avoid the mistakes of the developed countries with regards greenhouse emissions. Ghana should take steps to increase its carbon sinks capacity and that is where correct policies and actions can make Northern Ghana contribute significantly towards stemming the effects of climate change. The goal of the Savanna Accelerated Development Authority (SADA), of re-greening Northern Ghana is clearly aim at producing a large carbon sink capacity. Savannah woodlands, forests, rangelands and grasslands should be developed with a goal of targeting absorption of greenhouse gases from the atmosphere.

Many people in Northern Ghana have over the years been devising ways to cope with climate change. It is however, obvious that, the people have limited knowledge of what causes climate change and how it affects their food and livelihood security. There is the need therefore for a concerted and holistic approach to explain climate change and its effects to the people. With that, they will better appreciate the mitigation and adaptation approaches to address climate change.

Several activities of the Ministry of Food and Agriculture (MOFA) and agriculture-oriented civil society organizations such as the agricultural stations of the Association of Church Development

Projects (ACDEP) are in many respects addressing negative climate change effects. Sustainable land management (SLM) and afforestation programmes are good climate change mitigation and adaptation measures. SLM practices will particularly reduce the use of inorganic fertilizers. Other measures that need to be pursued with greater degree of seriousness include, rain water harvesting at the household levels, natural regeneration of tree and shrubs on farm and range lands as being experimented in the Talensi/Nabdam District by World Vision, use of solar and wind technologies, the practice of zero tillage, scientific control of animal grazing, development of biofuels, the adoption of drip irrigation systems which are very water-use efficient and several others. All these and other mitigation and adaptation measures have to be well developed with active participation by farmers and rural people.

CONCLUSIONS AND RECOMMENDATIONS

The main conclusion is that climate change is real and its manifestations are felt across the world. The negative consequences of climate change are severe among poor and vulnerable communities in developing countries, especially those in Sub-Saharan Africa including Ghana as a whole and Northern Ghana in particular where there is endemic poverty. There is no doubt that the main cause of climate change is "modernization and industrialization" and the rejection of simple sustainable production systems. Getting the developed world and the elite of the developing world to accept this simple fact is arduous task and that is what is making the global approach to mitigating the negative effects of climate change ineffective. To be able to tackle the negative consequences of climate change successfully, especially in Northern Ghana, the following recommendations are worth considering by policy makers and implementers:

First, the gap in information and knowledge transfer, particularly on climate change requires new enterprise-management-based approach of extension services. As such, there is the need for a complete overhaul of attitudes of the extension department of the Ghana's Ministry of Food and Agriculture (MOFA). Extension agents must be updated on service oriented role which the NGOs are now taking up.

Second, the poor and vulnerable majority of who are farmers must be encouraged to diversify their livelihood development strategies. To do this, government and its development partners must invest in setting up cottage industries and developing the agricultural value chain which has a great potential of providing off-farm employment opportunities in rural Ghana where majority of the poor and vulnerable live.

Third, the vegetative cover particularly trees play critical roles in dealing with climate change. To this end, the 'greening Northern Ghana' initiative by the Savannah Accelerated Development

Authority (SADA) setup by the Government of Ghana must be pursued vigorously devoid of political inclinations.

Fourth, policy makers and implementers must ensure that the development and implementation of all climate change policies, mitigation strategies and frameworks are socially acceptable, environmentally sustainable, economically viable, gender sensitive, politically stable and community specific. To do this, the bottom-up approach to policy formulations and implementations must be adopted.

Fifth, climate change interventionists must integrate indigenous knowledge systems in managing the adverse effects of climate change in formulating, implementing, monitoring and evaluating their interventions. This is important as it will make it possible for the combined strengths of indigenous and exogenous climate change knowledge systems to be maximised and their weaknesses to be minimised. Besides, in doing so, the interventions will be compatible to local norms, beliefs and values which is critical for community ownership of such interventions.

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