

# The Implications of Climate Change on Food Security and Rural Livelihoods: Experiences from Northern Ghana

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## Abstract

Climate change has become a developmental issue across the world. This paper examines the implication of climate change on food security and rural livelihoods in northern Ghana. It focuses on the effect of climate change on the principal coordinates of food security and livelihoods of households in northern Ghana. Participant observations and key informant interviews were the main data collection methods employed. The main finding is that communities that hitherto never experienced floods and droughts are now faced with the realities of these natural phenomena and these are adversely affecting food security and household livelihoods. It is recommended that government and its development partners need to adopt a holistic approach to mitigate the negative impacts of climate change in northern Ghana if the MDGs are to be achieved.

**Key Words:** Climate Change, Food Security, Livelihoods, Northern Ghana, Social Safety

## 1. Introduction

Climate Change 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, Devereaux and Maxwell (2001) defined food security as the success of local livelihoods to guarantee access to sufficient food at the household level. According to FAO (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 FAO (2008a) 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 on the other hand 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 DfID (2001) defines livelihood as gains made by individuals or households and the various factors that affect the level, maintenance and enhancement of these gains. Akudugu (2011) defines livelihoods as the ability of individuals and households to take care of their health, educational, food, social and cultural needs and to make savings for future use. 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 made by the Intergovernmental Panel on Climate Change (IPCC, 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 of climate change 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 models projections about world food demand and supplies into the twenty-first century generally showed that global food supplies will match or exceed global food demands for at least within 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 (Parry *et al.*, 1999, 2004; Döös and Shaw, 1999; IPCC, 2001a). Drawing mainly from the Intergovernmental Panel on Climate Change (IPCC) reports (e.g., IPCC, 2007) and the Food and Agriculture Organization (FAO) study on climate change and food security (FAO, 2008a), 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 and livelihoods 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°C) 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°C is expected to have negative effects on production in all regions (IPCC, 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 (FAO, 2008a).

This paper seeks to examine the implications of climate change on food security, and rural livelihoods generally in northern Ghana. The choice of northern Ghana is against the backdrop that it is the most vulnerable part of the country with regards to these factors. The rest of the paper is organized into four main sections. A review of the empirical literature is presented in section 2. The materials and methods are presented in section 3. Section 4 presents the results and discussion. Section 5 presents the conclusion and policy implications of climate on food security and livelihoods of farm households in northern Ghana.

## 2. Literature Review

Food and nutrition insecurity according to Devereux and Maxwell (2001) 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 are closely linked to the general problem of livelihoods. 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). The Third Assessment Report of the

Intergovernmental Panel on Climate Change (IPCC, 2001b) projects that, areas that are currently dry might experience an average increased dryness with global warming. Although the issue of food security is directly linked to climate change (Winters *et al.*, 1999; Reilly, 1995), 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).

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; Smith *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.

Agricultural production, food availability and food security in many African countries and regions are likely to be severely compromised by climate change (IPCC, 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.

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 (USAID, 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 (FAO, 2000).

One of the major factors affecting food availability 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 (IPCC, 2001a) will further worsen the situation in less developed countries. 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 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.

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. Adequate food utilization 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 (USAID, 1992). Climate change therefore has an impact on food utility indirectly.

From the foregoing, climate change ultimately influences household food security and livelihoods. It affects food availability, accessibility, utilisation and stability and livelihoods in general. Low household income as a consequence of climate change impact on output translates into the inability of households to diversify their diets, generating situations of chronic malnutrition and poor livelihoods. It also leads to deterioration in food quality due to increased temperatures and lack of refrigeration equipment and water scarcity generating health hazards and poor living conditions especially among poor and vulnerable households who depend on agriculture for their survival.

### **3. The Methodology**

Only qualitative data were gathered for this study. The main data collection methods were participant observation and key informant interviews. As people who were born, bred, live and work in the study area, the participant observation afforded the researchers the opportunity to bring on board their experiences in climate change and its manifestations in the area into the study. Observations made by the researchers on rainfall, temperature, crop yields and livelihood patterns in general constituted a great source of information on the issues being studied. On the other hand, the key informant interviews conducted in a face to face setting enabled the researchers to seek new insights, ask relevant questions, and assess the phenomena of climate change manifestations and their impacts on food security and rural livelihoods. Individuals deemed to be knowledgeable in the issues being studied constituted the key informants.

The choice of key informant interviews over other qualitative data collection techniques is because of the fact that it provides the necessary platform for the researchers to elicit in-depth views from a wide range of people including professionals, community leaders and residents who have first-hand information or knowledge on how climate change is affecting food security and other livelihood outcomes in the sampled communities. Fifty (50) key informants across northern Ghana were interviewed. The data were transcribed and analysed using Microsoft Excel 2007 by sorting for patterns and filtering.

## **4. The Results and Discussion**

### ***4.1 Impact of Climate Change on Food Security in Northern Ghana***

The study results revealed that climate change and its manifestations are rife across northern Ghana. Communities which hitherto never experienced the double tragedy of drought and floods within and between seasons are now experiencing it. The direct impact of climate change on agriculture is making most households who depend on it for their livelihoods food insecure. This is because of the fact that agriculture is vulnerable to external shocks including economic crises, and food price increases and emergencies such as droughts, floods, pests and diseases outbreaks. Food security 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 availability, accessibility and stability of food supplies is affected by the changing patterns in crops cycles impacted by climate change.

It was found that food insecurity at the household level triggered by climate change negatively impacts on general livelihoods and thus has the potential to put families permanently poor or trapped in the poverty cycle. This is because of the fact that climate change causes crop yields in the study area to decline as a

result of erratic rainfall patterns. As farmers get less harvest, food availability in the area is seriously affected as there is little or no surplus to sell. As a consequence, those who do not produce crops either have to buy food at high costs or starve and this definitely lead to food insecurity. In the view of most of the research participants, food insecurity is bad because it affects sustainable livelihood development as farm households divert resources to consumption instead of investments in production activities. For example, resources that might have been used to support education of children, healthcare of household members, income generation and employment among others, get reallocated to ensure that basic household food needs are met. There was a consensus among the research participants that capacity of farm households to sustainably guarantee food security is challenged by climate change as climate change affects their decisions as producers and consumers. This finding is consistent with the observation made by McConnell and Moran (2000) 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.

The research participants were of the opinion that food insecurity has become a “normal” phenomenon in northern Ghana under climate change. This they said is because of the fact that for decades, the issue of a “hunger period”, usually from April to June/July which has recent times been extended because of climate change to cover March to August seems to have been regarded as usual. That is partly because the people of northern Ghana almost solely depend on climate for survival and therefore unfavourable climate directly affects their very existence. A change in climate results in 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 insecurity, now seems to be the norm because food security or insecurity is more of a routine household phenomenon. For most households in northern Ghana, the attainment of food security has been a mirage and climate change has exacerbated the situation.

There was also a consensus among the research participants that climate change is real and is adversely affecting the ability of the people, especially farmers to feed themselves, families and urban populations most of who are not into agricultural production. Research participants observed that over the years, the study area has and continues to experience increasing length and severity of the dry season. 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 insecurity. One of the worse consequences of climate change according to the research participants was recorded in 2007 when delayed rains in the area were followed by heavy rains resulting in farmers planting the same crop fields several times during the season. Many farmers ran out of seed to plant. The extensive flooding destroyed farms, livestock and poultry. The resultant effect was serious food insecurity in almost all farming households in northern Ghana, particularly the Upper East and Upper West Regions. According to the research participants, some families have not yet recovered from that because they lost everything that they worked for over decades to accumulate. Remnants of the droughts and floods continue to be conspicuous as broken houses, collapsed bridges and other damaged infrastructure remain visible in the area.

The research participants also indicated that 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 security is increased pests and diseases attacks on food crops and animals thereby reducing food availability. The research participants further noted that locust attacks have been serious problems in neighbouring Burkina Faso and Togo with widespread crop failures and food insecurity. All these they noted have to do with rainfall because when there is drought, disease causing organisms are able to breed thereby causing more disease outbreaks. They observed that though the timely interventions by the Ghana Ministry of Food and Agriculture and several civil society organizations have over the years averted potential pest attacks in northern Ghana, some areas still continue to battle with the incidence of pests and diseases leading to crop and livestock losses.

The research participants further revealed that climate change has over time reduced the ability of farm households to earn income through their inability to produce cash crops. This has also greatly reduced their ability to undertake food marketing activities as a result of limited surpluses to sell. Also, as a result of

climate change and low agricultural production, high prices in all goods and services are being experienced. That goes to further increase food insecurity, especially for the poor and vulnerable which includes the majority of northern Ghanaian rural dwellers. Another major climate change effect that came up in the study is that it impacts greatly on water resources in northern Ghana. Rivers, dams, streams and groundwater sources are under pressure. Climate change has resulted in the drying up of many streams and rivers. Several small dams constructed for animal watering and small scale irrigation either dry up or become very inadequate before rains set in. The implication of such situations on food security in northern Ghana is obvious. Many farmers are virtually unemployed during the long dry season. This severely affects dry season food production leading to widespread poverty and food insecurity. Climate change also affects adversely the quality of food produced and thus has significant adverse effects on human nutrition in northern Ghana. The research participants noted that high levels of carbon dioxide 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 bedeviled with bad micronutrient malnutrition (“hidden hunger”).

From the foregoing, it is clear that people in northern Ghana agree that climate change is real and its manifestations are being felt across the area and beyond. It affects food availability, accessibility, utilization and stability. Poor households in rural areas who depend largely on agriculture for their livelihoods are the worse hurt by climate change.

#### ***4.2 Impact of Climate Change on Rural Livelihoods***

The study results showed that climate change affects the different types of “capital” assets (natural, physical, financial, human and social capitals) upon which farm households draw to build their livelihoods. Some of the direct impacts according to the research participants are caused by floods which cause destructions of life and property and these ultimately affects livelihood development negatively. 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 capitals become very vulnerable. With respect to physical capital, that is, various types of infrastructures, the reduction in rainfall does not only adversely affect water levels in dams and rivers for irrigation but also hydro electricity generation. The research participants observed that Ghana experienced the problem of low levels of water in the hydro-dam 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 Volta Lake) according to the research participants resulted in suspension or slow down of rural electrification and that was a significant physical capital reduction, especially for northern Ghana which negatively affected livelihood development as some essential services could not be provided when they were most needed due to power outages.

It was argued by the research participants that climate change has and will continue to impact negatively on potable water supply in northern Ghana. To buttress their arguments, they stated that recharge of groundwater sources for potable water are being overstretched. 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 the country 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 entitlements 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 rural areas 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 and thus climate change according to the research participants is having a heavy burden on rural livelihoods in northern Ghana.

It was also found that 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. The research participants also noted that 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. They lamented that climate change will ultimately increase the stress on resources which will negatively impact on social safety. According to them, 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 practised anymore because of climate change and this greatly affects social safety.

It was also revealed that women who play critical roles as food producers, caregivers, and home keepers among others are stressed under climate change. The research participants stated that access to resources such as land, water, trees and others by women is getting more and more difficult under climate change. As potable water become scarce, women who are responsible for providing water for household use in the area now have to walk for longer distances to be able to secure water. Those women who are unable to do this may have problems with their husbands which can lead to divorces among others. 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 seriously affecting in terms of social safety, according to the research participants is conflict as the relationship between food crop farmers and pastoralists, the Fulani herdsmen continues to become unfriendly. As land and grazing areas as well as water sources for livestock become more and more scarce as a result of climate change, there is increased competition between crop farmers and animal herders and that easily leads to conflicts.

In effect, changes in climate 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 lost 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 rural livelihoods.

### **5. Conclusion and Policy Implications**

From the study results, it is obvious that climate change is being felt in almost all parts of northern Ghana where a large majority of the people depend solely on climate and natural resources for their survival. It affects food security and rural livelihoods adversely. Climate change is therefore a worrying trend and something has to be done urgently and effectively to mitigate its negative effects. The less confidence the people have on climate for survival, the more they will depend on available natural resources such as the forests and other unsustainable and destructive systems. Obviously, that will cause greater climate uncertainties and the problem will continue to worsen. The generality of the people must understand the causes, the effects and possible and alternative solutions to the problem. Climate change discussions have to be undertaken in the village squares if we are to start trying to solve the problem. However, those who would lead those discussions must understand the issues very well and do not confuse the people. Specifically, the following are relevant for policy:

1. The poor and vulnerable, especially those in northern Ghana are heterogeneous in terms of their natural, social, financial, physical, and human capital asset endowments. This means that they are affected differently by climate change. There is therefore the need to identify the different categories of the poor and vulnerable for proper targeting for climate change research and mitigation strategies.
2. Food security is contingent on food availability, accessibility, utilisation and stability all of which are affected by climate change. Strategies to overcome the adverse effects of climate change on food security must focus on these facets.
3. Farmers must be encouraged to adopt modern agricultural production and productivity enhancing technologies. To do this, government and its development partners must invest in agricultural modernisation including mechanisation and construction of irrigation facilities.

4. Rural-urban migration is exacerbating the negative impacts of climate change. Government and its development partners should formulate policies, programmes and projects that aim at creating off-farm employment opportunities for rural people so as to curtail the rural – urban drift.

## References

- Akudugu, M. A. (2011). Rural banks' financial capital and livelihoods development of women farmers in Ghana. *Journal of Enterprising Communities: People and Places in the Global Economy*, 5(4): 248-264.
- Arnell, N. W., Cannell, M. G. R., Hulme, M. Kovats, R. S., Michell, J. F. B., Nicholls, R. J., Parry, M., Livermore, M. J., and White, A. (2002). The consequences of CO<sub>2</sub> stabilisation for the impacts of climate change. *Climatic Change*, 53:413-446.
- Bryant, C.R., Smit, B., Brklacich, M., Johnston, T., Smithers, J., Chiotti, Q., and Singh, B. (2000). Adaptation in Canadian agriculture to climatic variability and change. *Climatic Change*, 45:181–201.
- Carney, D., Drinkwater, M., Rusinow, T., Neeffjes, K., Wanmali, S. and Singh, N. (2000). Livelihoods approaches compared: A brief comparison of the livelihoods approaches of the UK Department for International Development (DfID), London.
- Clover, J. (2003). Food security in sub-Saharan Africa. *African Security Review*, 12: 1–11.
- Department for International Development (2001). Sustainable Livelihoods Guidance Sheets, London, UK.
- Devereux, S., and Edwards, J. (2004). Climate change and food security, In: *Climate Change and Development*, Yamin, F. and Kenbar, M., Eds., *IDS Bulletin*, 35:22–30.
- Devereux, S., and Maxwell, S., Eds. (2001). *Food security in sub-Saharan Africa*. London, UK: Intermediate Technology Development Group Publishing.
- Döös, B. R. and Shaw, R. (1999). Can we predict the future food production? A sensitivity analysis, *Global Environmental Change*, 9:261–283.
- Downing, T. E. (2002). Linking sustainable livelihoods and global climate change in vulnerable food systems. *Die Erde*, 133:363–378.
- FANTA. (2003). Food and Nutrition Technical Assistance Project (FANTA) and Food Aid Management (FAM). *Food Access Indicator Review*, Washington, D.C.: Food and Nutrition Technical Assistance, Academy for Educational Development.
- Food and Agriculture Organisation. (2000). Guidelines for national FIVIMS: Background and principles. Rome.
- \_\_\_\_\_. (2006). 'Food security'. FAO Policy brief Number 2, June. Rome.
- \_\_\_\_\_. (2008a). Challenges for Sustainable Land Management (SLM) for Food Security in Africa. 25<sup>th</sup> Regional Conference for Africa, Nairobi Kenya, Information Paper 5:15.
- Intergovernmental Panel on Climate Change (IPCC). (2001a). Climate Change 2001. Synthesis Report. Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press: Cambridge.
- \_\_\_\_\_. (2001b). Climate change 2001: Impacts, adaptation and vulnerability. IPCC Working Group II, Third Assessment Report. McCarthy, J. J., O. F. Canziani, N. A. Leary, D. J. Dokken, and K. S. White, Eds.. Cambridge, UK: Cambridge University Press.
- \_\_\_\_\_. (2007). Fourth assessment report: Climate change 2007.  
<[http://www.wmo.int/pages/partners/ipcc/index\\_en.html](http://www.wmo.int/pages/partners/ipcc/index_en.html)>.
- Kamara, A. B., Mafusire, A., Castel, V., Kurzweil, M., Vencatachellum, D., and Pla, L. (2009). Soaring food prices and Africa's vulnerability and responses: an update. Working Papers Series No. 97, African Development Bank, Tunis, Tunisia. p.36.
- McConnell, W. J., and Moran, E. F., (2000). Meeting in the Middle: The Challenge of Meso-Level Integration. LUCC Report Series No. 5. International Workshop on the Harmonization of Land Use and Land Cover Classification. Ispra, Italy, 17-20 October, 2000. Bloomington: Indiana University. pp.62.
- Parry, M., Rosenzweig, C., Iglesias, A., Fisher, G., and Livermore, M. (1999). Climate change and world



- food security: A new assessment, *Global Environmental Change*, 9:S51–S67.
- Parry, M.L., Rosenzweig, C., Iglesias, A., Livermore, M., and Fischer, G. (2004). Effects of climate change on global food production under SRES emissions and socioeconomic scenarios. *Global Environmental Change*, 14:53–67.
- Perry, A.H., and Symons, L. J. (1994). The wind hazard in the British Isles and its effects on transportation, *Journal of Trans-boundary Geography*, 2:122–130.
- Reilly, J. (1995). Climate change and global agriculture: Recent findings and issues, *American Journal of Agricultural Economics*, 77:727–733.
- Smit, B., Harvey, E., and Smithers, C. (2000). How is climate change relevant to farmers? In: *Climate Change Communication: Proceedings of an international conference*. D. Scott, B. Jones, J. Audrey, R. Gibson, P. Key, L. Mortsch and K. Warriner, Eds., , Kitchener-Waterloo, Canada: F3.18–F3.25.
- Stephen, L., and Downing, T. E. (2001). Getting the scale right: A comparison of analytical methods for vulnerability assessment and household-level targeting. *Disasters*, 25.2:113–135.
- United States Agency for International Development. (1992). Policy Determination 19: Definition of Food Security. Washington, D.C.: United States Agency for International Development.
- Vogel, C. and Smith, J. (2002). The politics of scarcity: conceptualizing the current food security crisis in southern Africa, *South African Journal of Sciences*, 98:315–317.
- Winters, P., Murgai, R., de Janvry, A., Sadoulet, E., and Frisvold, G. (1999). Climate change and agriculture: Effects on developing countries. In: *Global environmental change and agriculture*, Frisvold, G. and B. Kuhn, Eds. Cheltenham, UK: Edward Elgar Publishers.
- Ziervogel, G. and Calder, R. (2003). Climate variability and rural livelihoods: Assessing the impact of seasonal climate forecasts, 35:403–417.

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