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Literature Review on the Impact of Climate Change on Economic Development in Northern Ghana

(PART 1)

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Abbreviations

GAMA	Greater Accra Metropolitan Area
GCM	General Circulation Model
ITCZ	Inter-Tropical Convergence Zone
USAID	United States Agency for International Development

1 Introduction

The purpose of this study is to identity existing evidence on risks and opportunities associated with climate change as regards economic development, and in particular agricultural development, in North of Ghana; in order to inform wider strategy for work in the North, and feed into early thinking on the approach to climate and environment programming.

It is important to highlight that the amount of evidence regarding the impact of climate change specifically on north Ghana is very limited. The documents listed on Annex A could not always provide information specific to the northern regions. Most of the content of the policy literature provided mainly address the condition of the entire Ghana rather than northern Ghana that is supposed to be studied. Thus, a great deal of supplementary information was found from USDA Forest Service (2011) which gives a comprehensive answer to most of the questions being asked. As some of the documents on Annex A may not be applicable to Part 1, they have not been included on the reference list.

Methodology

The approach taken by this literature review includes conducting a comprehensive and relevant search of content in the documents listed on Annex A of the Terms of Reference. The literature review covers government reports, discussion papers, and research papers by multilaterals on Ghana and on agriculture and climate change; some of which are considered to be useful to respond to the query.

This report presents the key findings to be structured as follows:

Section 2 will provide a background on the climatic variability and its effect on economic growth in North Ghana.

Section 3 will address each sub-question in the order of (i) providing a brief overview on the issue I question; (ii) describing the known current and future impact of climate change; and (iii) in some sub-sections highlighting the ways forward to address the problem.

Section 4 will conclude the report with a response summary.

2 Climate overview in Northern Ghana

Northern Ghana (or northern savanna zones) comprises three administrative regions, namely Northern, Upper West and Upper East. With the highest poverty levels in the country, it is also where temperatures are hottest, rainfall is low and there is only one rainy season. The climate of the entire country is dominated by the interaction between the Inter-Tropical Convergence Zone (ITCZ)[1] and the West Africa Monsoon, which gives rise to alternate wet and dry seasons. (USDA Forest Service, 2011)

The intense heat in this part of the country comes from the so-called “Harmattan” winds blowing in from Saharan Desert. Available temperature data indicates that North of Ghana will become a hotter region. The increase in heat and the number of hot days and hot nights has been the most extreme between 1961 and 2003, and the trend will continue in the years ahead. Some scenarios of General Circulation Models

[1] The ITCZ, also known as the Equatorial Convergence Zone or Inter-Tropical Front, is a region of calm winds separating the north-easterly and south-easterly trade winds. The location of the ITCZ annually moves, reaching its northernmost extent during the northern hemisphere summer and its southernmost extent during the northern hemisphere winter. (USDA Forest Service, 2011)

(GCMs) have shown that Northern Savanna is expected to witness the widest range (maximum-minimum) of temperature variability (around 5.7°C). Under one of the climate scenarios, according to the World Bank, temperatures in the three northern regions will rise by 2.1-2.4°C by 2050. (DARA, 2012) (World Bank, 2010a)

GCMs agree in general that mean temperature will increase in northern regions, however, little agreement exists on future precipitation amounts or seasonality, which renders identification of long-term trends difficult. Some GCMs project decreased precipitation in the three northern regions whereas others project increases. As reproduction of a number of key features of the atmospheric circulation patterns over West Africa, projects of rainfall pattern by climate models are varied and uncertain. (USDA Forest Service, 2011)

Climate change is likely to have a major impact on Ghanaian economy. Under all four GCM scenarios (Global Dry, Global Wet, Ghana Dry and Ghana Wet), Northern Savanna is the slowest-growing rural region. For instance, historical year-to-year variability of GDP growth rates is remarkable in North Savanna where income can fall by more than 10% in bad years but can also rise by almost 20% in good years. The region is projected to experience the largest percentage-point decline in mean GDP growth under all GCM scenarios primarily due to flooding, droughts, desertification and shortened farming seasons. (World Bank, 2010a)

As a result, the northern region of Ghana is believed to be the most vulnerable to climate change, with negative implications for agriculture (the country's core economic sector), water resources, commodity value chains, poverty and various social dynamics, including conflict risk and land tenure. These will, in turn, lead to significant decrease in economic productivity and hence, the income of the region's population.

3 Impact of climate change

This report will summarise the known impact of current climate variability and projected climate change on the following interlocking issues:

a. Current cropping systems and practice;

b. Water resources: rainfall patterns and groundwater;

c. Value chains and market demand;

d. Poverty and vulnerability; and

e. Social dynamics.

3.1 Current cropping systems and practice

Rural economy in north Ghana is predominantly dependent on agriculture as it significantly contributes to people's income, employment, food security and export earnings. However, it will suffer from serious economic consequences from climate change projected across Ghana's four agro-ecological zones: coastal, forest, north savanna and south savanna. Relative to the baseline projection for mid-21st century, along with climate change, agricultural GDP of the entire country is estimated to decline by 3% to 8% under different scenarios. (World Bank, 2010a)

A huge diversity of cropping systems is seen in Ghana. This reflects vibrant adaptations to increasing population pressure, land insecurity, climate variability and new trading opportunities or markets. Rice and maize and soya are main crops in Northern Ghana. Most smallholder famers combine strategies to meet food security and cash flow needs. Farming systems may combine sedentary and shifting cropping systems as well as intercropping and rotational cropping. (USDA Forest Service, 2011)

Cereal-based systems, often combining two or more crops in a field, prevail over traditional cropping systems in semi-arid West Africa, including the northern savanna zones in Ghana. Intercropping minimises risk of crop failure from drought or flooding and spreads the need for labour over a longer period. With the risk spread over two crops, a smallholder can take advantage of a long growing season during a year of above-average precipitation. Table 1 outlines some cropping systems commonly seen in Northern Ghana.

Table 1 Cropping systems in Ghana

Cropping system	Ecological Zone	Crops	Disadvantages	Advantages
Shifting Cultivation/Bush Fallow/Grass Fallow (clear vegetation, burn; fallow period to restore soil fertility)	Dominant farming system throughout Ghana	Depends on zone	Soil exposed to erosion; fire alters microbial communities and can reduce long-term soil quality; nitrogen is volatilized; deforestation; escaped agricultural fires degrade the rural landscape	Long fallow can restore soil physical and chemical conditions; correct mixture of crops (for example, cereals, and legumes) can augment soil fertility, promote water retention, and prevent flooding. Within a field during the cropping period, farmer may rotate crops (shallow vs.

Cropping system	Ecological Zone	Crops	Disadvantages	Advantages
				deep rooted, nutrient demand)
Compound (farms are cultivated within close vicinity of villages and commonly combined with animal husbandry; includes upland and lowland bush fallow and sometimes fadama)	Northern savanna zones	Cashew and cassava intercrops and food crops such as yam, maize and cassava. tomato, okro, pepper and garden eggs	Soil erosion, leaching and eutrophication are prevalent in this zone	Permanent agriculture with soil fertility often maintained in the compound fields
Irrigated, Floodplain, Fadama (swamp rice cultivation, irrigated farming, naturally moist valleys and depressions; fadama is a Hausa word for irrigable land)	Northern savanna zones	Rice, dry season vegetables	Deforestation of riparian or gallery forests	

(USDA Forest Service, 2011)

In fact, households in Northern Savanna Zones are showing changes in their cropping practice by cultivating larger farms through agricultural extensification as a form of livelihood insurance. Dry-season gardening with small irrigation systems (hand-dug wells and river pumps) was increasing. Women were also taking on more agricultural tasks, rather than remaining limited to sowing and harvesting as in the past. New crop varieties were being used with shorter gestation periods and higher market value, as well as hardy crops. Fertilizer use had increased. Off-farm activities — such as charcoal and fuel-wood harvesting, as well as increased shea and dawadawa harvesting and processing — had increased. Outmigration was being undertaken, and diversification into livestock rearing also was present. (World Bank, 2010a)

Maize, grown across Northern Ghana, is the most important food crop for smallholders to meet nutrition and cash needs. Low soil organic matter and limited availability of plant nutrients, particularly phosphorus and nitrogen, are major bottlenecks to agricultural productivity in Ghana, which is further hampered in the northern savanna zones by substantial topsoil losses through wind and water erosion. (USDA Forest Service, 2011)

For example, a clear erosion of agricultural system in Bolgatanga area was noticeable. Local experts reported that key causes of such erosion have been the expansion of the hot dry season – traditionally from November to April – and the contraction of the traditional rainy season – April through October. Even though farming is done in both seasons, the rainy season is the lifeblood of the harvest. In dry season, it is only possible to grow crops where there is irrigation; whilst in wet season, large part of the land is suitable for cultivation. In consequence, the shortening of farming season does weaken overall agricultural potential. Rains that reportedly once started in April are now not starting until May, which will be detailed in 3.2.1. (DARA, 2012)

It is more difficult for farmers to produce crops in dry season, if only because of the extreme levels of heat stress as they toil in the fields. Moreover, periods of drought are now very severe, since the heat is so much more intense, and crop productivity suffers whenever the heat is not offset by generous and evenly spread rainfall, reported to be rarely the case anymore. (DARA, 2012)

To cope with declining yields, farmers have begun to take measures, such as selling their livestock. The decline in livestock has also decreased the availability of local manure and therefore fertilizer, forcing farmers to rely more heavily on imported chemical fertilizers, the price of which has been escalating in recent years, together with the increase in gasoline prices. Finally, the chemical fertilizers available were

said to be less effective for water retention than organic alternatives, so of declining utility as heat and water pressure grew. (DARA, 2012)

The findings here have shown that climate change, which believably is giving rise to a hotter and drier north Ghana, had already brought moderate impact to Ghanaians' cropping systems and practice as household-level measures are being taken to minimise the erosion of the productivity on their farmlands.

3.2 Water resources

3.2.1 Rainfall patterns

Despite GCMs agreeing in general that mean temperature will increase, little agreement exists on future precipitation amounts or seasonality, which renders the identification of long-term precipitation trends difficult. Some GCMs project decreased precipitation in the three northern regions whereas others project increases. As reproduction of a number of key features of the atmospheric circulation patterns over West Africa, projections of rainfall pattern by climate models are varied and uncertain. (World Bank, 2010a) (World Bank, 2010b) (World Bank, 2010c)

A recent example is a 2011 climate change assessment commissioned by USAID. Reportedly, *Tamale* (Guinea Savanna Zone) meteorological station forecast changes in precipitation ranging from -36% to +32% in wet season rainfall. The variability among the model's precipitation changes is not very different from the inter-annual variability the region currently experienced. The Northern Region where Tamale is situated is the southern-most region in Ghana that shows a consistent trend towards decreased rainfall. *Walembelle* (northern Guinea Savanna Zone) predicted changes in precipitation ranging from -25% to +24% in wet season rainfall. *Bawku* (Sudan Savanna Zone) also gave similarly inconclusive results as its forecast ranges from -28% to +30% in wet season rainfall. (USDA Forest Service, 2011)

Meanwhile, according to the models adopted in the World Bank's report on economics of adaptation to climate change in 2010, the forecast for precipitation indicates a cyclical pattern over the period 2010-50 for all Ghanaian regions, with high rainfall levels followed by a drought every decade. The northern savanna region is expected to be relatively dry. In contrast, the World Bank also quoted Owusu and Waylen's 2009 study of rainfall patterns in Ghana which shows that the reductions of mean annual rainfall between 1981 and 2000 in the transitional and savanna zones, which occupy the northern half of Ghana, are minimal compared to the forest and coastal zones. Some northern savannas and river towns are even predicted to be flood-prone areas where the incidence of floods is especially high. (World Bank, 2010a) Table 2 shows a general predicted decline in rainfall for different ecological regions.

Table 2 Scenarios of mean annual change in rainfall for Ghanaian ecological zones (%)

Year	*Sudan Savanna*	*Guinea Savanna*	*Transitional*	*Deciduous rainforest*	*Rainforest*	*Coastal Savanna*
2020	-1.1	-1.9	-2.2	-2.8	-3.1	-3.1
2050	-6.7	-7.8	-8.8	-10.9	-12.1	-12.3
2080	-12.8	-12.8	-14.6	-18.6	-20.2	-20.5

(UNEP/UNDP, 2009)

According to Owusu and Waylen, reductions in rainfall in the forest zones are reported to be about 20%, which is even higher than the 10% reduction in the Transition and Savanna to the north. (UNEP/UNDP, 2009) Therefore, available data for past and projections of future rainfall patterns by climate models are diverse and uncertain.

The actual experience of dwellers in the north interviewed by USDA Forest Service has reported delays in rainy season onset, heavier rains later in the rainy season, and increased flooding that causes crop

damage. A majority of interviewees have congruent observations that rainfall has decreased and temperatures increased over the last couple of decades. (USDA Forest Service, 2011)

Rainfall in Ghana is in any event still below the 1960 baseline, which is not keeping pace with the agreed increase of in temperature and so the evaporation rate of water for the region is increasing. (DARA, 2012) With regard to changes in surface water runoff in Northern Ghana, Black Volta basin will experience reductions in runoff under both Wet and Dry scenarios. The Oti basin will experience a small increase in runoff in the Wet scenario and 29% reduction in the Dry scenario. The fluctuations in stream flows and runoffs, particularly in the Volta River, increase the risk of floods and/or droughts in urban and rural areas. Given that Ghana has very little control over the upper streams of rivers across its borders in Burkina Faso and Togo, there is a need for sub-regional cooperation in the management of water resources. (World Bank, 2010a)

Given the virtually contradictory sets of data recorded at different meteorological stations and by different research teams for similar periods of time, the existing evidence with regard to the specific impact of climate change on north Ghana's rainfall pattern and its future trend is inconclusive.

3.2.2 Groundwater

Owing to projected decrease of precipitation under some climate scenarios, groundwater resources are limited in Northern Ghana. This is attributable to the lack of geological porosity, low direct recharge via precipitation, variable but generally low borehole yields, and low hydraulic transmissivity (horizontal flow of aquifers). These indeed characterise the White and Black Volta River and Oti River basins, Sudan and Guinea Savanna Zones to the north. (USDA Forest Service, 2011)

The main hard adaptation option identified was expansion of wells to the rural areas and harvesting rainwater to help recharge groundwater, which was assigned a high priority. Soft options seen as high priority included optimal use of water to reduce wastage, more efficient use of water, and recycling of wastewater to reduce demand for freshwater. Other soft options identified as medium or low priority included afforestation and alternative uses of wastewater. (World Bank, 2010a)

The development of groundwater resources are directly related to that of rainfall patterns. Inconclusiveness of the impact of climate change on rainfall pattern should extend itself to that on groundwater level, although the Dry scenario is elicited here.

3.3 Value chains and market demand

North Ghana's economy is highly dependent on agricultural production, as are livelihood – especially rural livelihoods in northern regions where more than 90% of the population depends primarily on agriculture-related work. A reliable value chain that connects farmers with agricultural services and local purchasers (to bring these suppliers close to the demand side) through hard and soft infrastructures is of critical importance.

3.3.1 Local value chains

Cash crop production is an important climate change adaptation strategy for farming households in northern Ghana. Nevertheless, road infrastructure (hard) and access to markets (soft) are relatively poor in the north. Increasing temperatures and decreasing rainfall will also undermine the economic effectiveness of existing infrastructures. (World Bank, 2010b) (USDA Forest Service, 2011)

Cities in Ghana need new and stronger infrastructure that can withstand the impact of climate change. New roads with better drainage systems can help prolong the roads' life and improve municipal water management. On road maintenance, in particular, timely routine and period maintenance is deemed to be of high importance. There is a need for a review of overall road design criteria, including materials and design standards for construction of bridges, culverts, and drains. For example, measures proposed for road maintenance to cope with temperature increase included development of new, heat-resistant paving materials, as well as binding coarse material to suppress dust levels. New ports should also be built with climate change adaptation in mind. (UNEP/UNDP, 2009) (World Bank, 2010a)

Apart from hard infrastructure, investments in improving access to markets (soft infrastructure) would improve market conditions and hence, the value chains. There is also a need for policies promoting stable and favourable crop prices such as better access to credit which will facilitate farmers to invest in cash crop production. (USDA Forest Service, 2011)

3.3.2 Market demand

With domino effect, negative impact of climate change on key economic sectors will extend to market demand (household consumption), if there are no adaptation measures in place. The consumption of both rural and urban households will be adversely affected. Compared to urban residents, rural residents are more reliant on agriculture for their income, but urban households' real consumption also suffers from climate-change-induced rises in food prices, resulting in falling market demand. The simulation analysis quoted by the World Bank (2010b) suggests that real household consumption is expected to drop by 5-10% by 2050. Rural households are likely to suffer greater reductions, primarily because of lower agricultural yields. This will lead to migration within the country as people seek better land. (World Bank, 2010a) (World Bank, 2010b)

It is acknowledged that the role of hard and soft infrastructure in securing a value chain and supporting sustainable demand in the market is significant. Thus, the impact of climate change on value chain and market demand is not certain as their functionality needs to depend on the climate-resilience of hard infrastructure and the climate-compatibility of soft infrastructure.

3.4 Poverty and vulnerability

The past/current data and future climate projections across the north seem to have demonstrated a relationship between, climate (change) and poverty/vulnerability levels.

Assessment of social vulnerability to climate change in Northern Ghana

USDA Forest Service (2011) reports the results of the assessment of social vulnerability to climate change they conducted on a district level in Ghana. A vulnerability index was used and the assessment based on 11 socio-economic indicators: Ability to survive, agricultural employment, dependent population, distance from drinking water, distance from food market, female-headed households, illiteracy, malnourished children, poverty perception, road accessibility, and unimproved drinking water source.

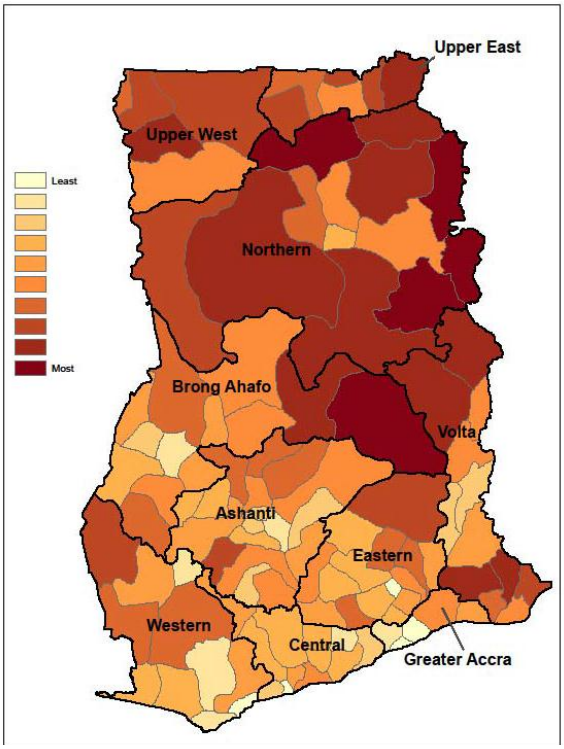

Figure 1 Social vulnerability to climate change in Ghana, by district (Based on the 110 district boundaries in place prior to 2006) (USDA Forest Service, 2011)

The data indicates that Northern Ghana (composed of the Upper East, Upper West and Northern administrative regions) have the highest overall social vulnerability to climate change (as shown in **Error! Reference source not found.**). Urban districts are less vulnerable than rural districts. The Upper East, Upper West, and Northern regions also have a much higher incidence of poverty than other regions of Ghana and doubled (Upper East, Upper West) or tripled (Northern) in population density between 1960 and 2000. These three regions lie in the Sudan and Guinea Savanna ecological zones. These data indicate that Ghana's three northern regions deserve attention for investments that support climate change adaptation. A district-level approach to identifying the areas in greatest need of support for climate change adaptation will help to better target resources than a regional-scale approach. (USDA Forest Service, 2011)

Factors leading to this correlation

The extent of climate change-induced poverty or vulnerability to climate change per se is not uniform for every community but differs according to (physical and economic) geographical, socio-economical (e.g. sectors) and demographical factors (e.g. social groups: migrant status, gender). (World Bank, 2010c)

Geographically, in northern Ghana, for example, social vulnerabilities were extreme: no running water or sanitation facilities of any kind in many households, less than 50% of households with electricity or lighting, no cooling units or fans almost anywhere, too few mosquito nets, very few vehicles and no insurance for houses damaged by flooding and wind or for crops destroyed in drought or floods. (DARA, 2012) These manifestations of social vulnerabilities are set to worsen under the threat of climate change that could lead to a hotter and drier northern region.

Social differentiation and access to resources, as enabled by both formal and informal institutions, explain the differential adaptations people face in their communities. For instance, the nature of the inheritance system, governance systems, and land tenure relations are important. The main categories of vulnerable groups include widows, disabled, aged, children, youths, divorced women and, particularly, the poor. (World Bank, 2010c)

Poverty in northern regions

As regards poverty, over the past two decades, rural areas in the Guinea and Sudan (rural) savanna ecological zones in northern Ghana have consistently exhibited the highest incidence of poverty in the country (Table 3). The most recent data (2005-06) show that poverty incidence in the rural savanna is more than double that of any other ecological zone; 60.1% of all households were living below the poverty line. At the scale of administrative regions, the Upper West Region has the highest poverty, with 88% of households living below the national poverty line in 2005-06 – three times the national average (Table 4). It was closely followed by Upper East, at 70%. The Northern Region exhibits the next highest poverty incidence in Ghana, at 52%. Although overall poverty in Ghana has steadily declined since the early 1990s, this was not the case in the Upper West or Upper East Regions. (World Bank, 2010c) (USDA Forest Service, 2011)

Table 3 Incidence of poverty (percentage) by ecological zone (USDA Forest Service, 2011)

Ecological Zone	1991/92	1998/99	2005/06
Accra (GAMA)	23.1	4.4	10.6
Urban Coastal	28.3	31.0	5.5
Urban Forest	25.8	18.2	6.9
Urban Savanna	37.8	43.0	27.6
Rural Coastal	52.5	45.6	24.0
Rural Savanna	73.0	70.0	60.1
Urban	*27.7*	*19.4*	*10.8*
Rural	*63.6*	*49.5*	*39.2*

Source: Ghana Statistical Service, 2007

Table 4 Incidence of poverty (percentage) by administrative region (USDA Forest Service, 2011)

Administrative Region	1991/92	1998/99	2005/06
Western	60	27	18
Central	44	48	20
Greater Accra	26	5	12
Volta	57	38	31
Eastern	48	44	15
Ashanti	41	28	20
Brong-Ahafo	65	36	29
Northern	63	69	52
Upper East	67	88	70
Upper West	88	64	88
Ghana	*52*	*40*	*29*

Source: Ghana Statistical Service, 2007

The general decline in poverty in Ghana as a whole is attributable to the high growth rates of cocoa production in south-western regions with the implementation of Ghana Poverty Reduction Strategy. Nonetheless, this is not the case for northern Ghana where the majority of Ghana's poor live with a high dependence on agriculture. Region-specific climate change impacts are identified on following demographics:

3.4.1 Geography

Climate change is likely to affect poverty depending on the physical and economic geography:

Physical geography: Northern savanna regions are the poorest in Ghana compared to the transitional and forest regions. As droughts will be a major problem for the north, Northern Ghanaians' dependence on rainfall exposes farmers to climatic variability in the absence of intervention and conducive policy. The

changes in the climatic conditions in the past have already deepened rural vulnerability to poverty and enhanced the process of land degradation and desertification, which make investments in agriculture in these regions become risky and less profitable. Nelson and Agbey (2007) suggest that ecological zones with high rainfall and low temperatures had a lower poverty level than those with low rainfall and high temperatures, vice versa. (UNEP/UNDP, 2009) (World Bank, 2010c)

Economic geography: Such correlation has little explanatory value without considering the socio-economic, socio-political and historical factors, which account for plantations, mining and urban growth. Colonial and post-colonial policies have always followed the export-oriented path favouring plantation agriculture and mining. Food crops and livestock have been relegated to savanna zones, an ideal environment for production. This has led to preferential investment by capitalists in social services and economic infrastructure (including roads) in the south, which in turn, a paralysis of development or under-development in the north. Ghanaians living in northern savanna will suffer from even lower levels of climate change resilience and adaptive capacity than the rest of the country. (World Bank, 2010a) (World Bank, 2010c)

3.4.2 Livelihoods

The severity of climate change impacts are felt mostly by poorer groups who depend on natural resource-based activities and living in marginal environments along with natural resource depletion. In an agricultural society, the socio-economic groups affected most by climate change include small-scale food crop farmers, women small-scale farmers (to be discussed further under sub-section on gender), livestock operators, slum dwellers, and migrant farm workers in the north. These groups are vulnerable due mostly to institutional bottlenecks, legal frameworks, poor capacities and market imperfections. These non-climate drivers of vulnerability define the access patterns of different people in different places to productive resources which builds resilience and adaptive capacity. (UNEP/UNDP, 2009)

For example, climate change-induced environmental change inflicts harsh and extreme environmental conditions upon rural smallholder farmers, and therefore has direct implications for creating unsustainable livelihoods. Farmers have their investments washed down the drain by floods and droughts almost every second or third year, particularly in the northern savanna zone. (UNEP/UNDP, 2009)

Ordinarily, the popular adaptation strategies include livelihood diversification, adapting planting dates, and changes in crop varieties planted. Multiple livelihoods as an adaptation strategy are important in all the zones as a realistic adaptation strategy. The mix of coping and adaptation strategies is necessary for the survival of the poor. Coping strategies buy time for people to effectively plan the future based on the past and imagined scenarios of what trends will occur. (World Bank, 2010c)

The poorest are the most vulnerable because they usually have neither stored assets nor access to sophisticated technology to help them withstand times of stress. Interventions that reduce development gaps in particular geographic areas can be effective — for example, social protection and health, better education, and skills training. (UNEP/UNDP, 2009) (World Bank, 2010b)

There are critical pro-poor measures that need to be in place at the national level to ensure that adaptive strategies will be effective and will help the poorest and most vulnerable. These include the need for (a) stronger government commitment to redistributive policies; (b) clear and effective rule of law regarding natural resource ownership and exploitation; (c) shifts from the current open access approach to natural resource utilization to a user rights approach; and (d) more efficient and trans-parent use of resources. (World Bank, 2010c)

3.4.3 Gender

Vulnerability is higher among women, who have difficulty accessing land and securing livelihoods, than men due to inheritance rules and land tenure relations. The patriarchal system of Ghanaian society limits access patterns of women to productive resources and in some instances social justice.

In the Guinea savanna, women traditionally only assisted with farming rather than being considered farmers in their own right due to the taboo on women's ownership of land. Also, male siblings are given priority over their female counter-parts even in areas where some female ownership is allowed.

The emerging commodification of land tenure relations is a good sign for women, as they now participate on an equal basis as their male counterparts. But even in this case, years of subordination of women means that they cannot compete on the same level as men, who already have some access to social networks, assets, and financing.

In northern Ghana, there are more men in single-livelihood activities than women, who now also own small parcels of land for vegetable or groundnut cultivation in addition to natural-resource-based off-farm activities such as shea nut, dawadawa, and fuelwood gathering. (World Bank, 2010c)

Evidence available from different sources has presented consistently that current and projected future climate change in north Ghana have brought significant impact on the levels of poverty and vulnerability in the region. Impacts identified on different demographics based on geography, livelihoods and gender all identically point to a shift towards the downside of the development.

3.5 Social dynamics

Climate change in northern Ghana brings a series of impacts on the social dynamics in the region. Social dynamics studies the ability of a society to react to inner and outer changes and deal with its regulation mechanisms managing distribution of interests and related behaviour. In the case of north Ghana, climate change is bringing impact to vested interests and consequential behaviour, which explains the conflicts happening between social groups locally. Subsequent natural resource depletion and soil degradation leads to risk of social conflicts, which then motivate land tenure reforms, but poor reform plans can lead to another wave of conflicts between smallholder and commercial farming initiatives. It is likely that a vicious cycle has already been developed.

Conflict risk

The predicted climatic changes and socio-economic vulnerabilities in northern Ghana will have adverse effects on human well-being and rain-fed agricultural activities, food insecurity, and reduced water availability. In response to these climate changes, conflicts resulting from resource competition will occur as seen in, for instance, the delicate balance of rural communities being upset.

Since farmers now own less livestock, the relationship between farmers and nomadic people who settle in the less fertile surrounding areas has also been compromised. In the past, farmers would entrust the nomadic peoples from Burkina Faso (Fulani herdsmen) with their livestock in return for payment, either in-kind or in the form of farm produce. Thus, the nomadic people have also been deprived of a source of income and livelihood, and are now being reported to be engaging in a growing number of criminal acts, such as theft, violence, and other social problems, not to mention destroying and burning savanna vegetation. (DARA, 2012)

Continuously declining agricultural yields, depleting resources and rising conflict risk will push people to migrate in search of better land and environment. The migration and relocation of population will slow

economic growth and development. Migration will occur not only within the country, but also from countries to the north of Ghana that will also become hotter and drier. (UNEP/UNDP, 2009) (World Bank, 2010a)

Rapid increase of south-bound migrants ultimately leads to conflicts, which are due to resource scarcity and degradation, food insecurity and sanitation problems, transferred from northern regions to the southern urban areas where vulnerability to flooding, diseases, heat waves, poor water supply are worsened by poor urban planning and poor infrastructure provision. (UNEP/UNDP, 2009)

Planned land tenure reforms

To increase agricultural productivity and livelihoods' sustainability on drier lands, it necessitates improvements in the land tenure system. (World Bank, 2010a) North Ghana's economy is dependent on agricultural production, as are livelihood – especially rural livelihoods where over 90% of the population depends primarily on agricultural related work. Most of Ghana's agricultural production takes place on 1-2 ha plots of land. A pervasive sense of insecurity and a lack of transparency pervade the current customary land tenure system practiced over most of Ghana. Without secure access to land, farmers are less likely to invest in or develop long-term innovative agricultural systems. Nor are they likely to invest in new technologies. Rather, without secure access to land, farmers are more likely to try to maximize short-term profits, often at the expense of the land's long-term health. This is unsustainable in the long run. Without secure access to land, farmers also have difficulty accessing credit or connecting with investors, reducing overall production. Finding ways to secure land assess, provide credit at a local level, and strengthen local value chains (connecting farmers with local purchasers, etc.) could help farmers overcome these barriers.

Women, migrants, and unconnected (socially) landless farmers are among the most vulnerable groups in Ghanaian society. Under normal circumstances these groups have difficulty accessing land and securing livelihoods. Land tenure reforms should not only focus on titling and registration but on ensuring that land is distributed equitably, affordably, and simply (meaning the process should be straightforward enough to be navigated by groups without much social or political capital.) Recent planned land tenure reforms are changing the nature of vulnerability among migrants and different ethnic groups in Ghana. (USDA Forest Service, 2011)

Migrants used to suffer discrimination and were more vulnerable than indigenes. However, with the commodification of farm land, migrants with sufficient financial resources and human capital are actually better off than their non-landowning indigene counterparts. Most landowners and chiefs charge as much as 40 ghc for leasing an acre of land. This is far above the ability of poor indigenes, especially women. Most migrants start by working as agricultural labourers; saving money enables them to rent their own lands. Also, the new system of "share-land-cropping" rather than the well-known sharecropping system, which used to disadvantage migrants, now enable them to own land over some years when tree crops reach maturity and they are given a third of the farm as compensation. Migration introduces the factor of ethnicity as migrants become minorities in the destination areas. However, ethnicity in itself does not pose new vulnerability challenges, except those presented by location. (World Bank, 2010c)

Smallholder versus commercial farming initiatives

Land tenure reforms would also be needed to facilitate commercial farming initiatives. Commercialised or mechanised farming could increase production and strengthen food security. However, it could also create joblessness and contribute to increased poverty if done without full consideration of potential socio-economic impacts. This is especially relevant given that most of the large-scale commercial agricultural operations likely will occur in portions of the country that are already marginalised. If reduced rainfall caused by climate change reduces the amount of arable land, increased competition for land will lead to even greater vulnerability of smallholders. Livestock rearing occurs primarily in the northern savanna zones, and could be a viable livelihood diversification strategy for farmers. However, grazing rights threaten

to pose increasing conflicts, particularly if land ownership and rights are unclear. (USDA Forest Service, 2011)

In northern Ghana, commercialisation of maize and rice production requires increased land security in order to motivate farmers to invest in technology and inputs. Commercialisation of maize production already has led to changes in the land tenure patterns and a tendency to preferentially allocate land to large-scale commercial farmers. Pressure on the available land resource has already intensified conflict in the northern savanna zone in a "vicious cycle". Evident are conflicts that have arisen between farmers and herdsmen on the alluvial plains; in other areas, land fallowed by one family has been reallocated to another family. Transforming rice cropping in the northern savanna zone would include concentrating access to land in the hands of wealthy producers, while smallholders would lose their use rights. (USDA Forest Service, 2011)

4 Conclusions

We have summarised the impact of current climate variability and projected climate change on the following issues in the context of Northern Ghana:

a. Current cropping systems and practice;

b. Water resources: rainfall patterns and groundwater;

c. Value chains and market demand;

d. Poverty and vulnerability; and

e. Social dynamics.

We found that the existing knowledge and evidence base as regards the impact of climate change specifically on north Ghana is limited. Currently, most of the analyses and researches done by governments, donors and multilateral organisations are country-specific rather than region-specific. The uniqueness of north Ghana in the context of climate change remains to be investigated. This report has, however, identified some known impact of climate change on the interlocking issues as requested.

Firstly, on current cropping systems and practice, the key findings have shown that a hotter and drier northern savanna zone had already brought moderate impact to Ghanaians' cropping systems and practice. Household-level measures such as agricultural extensification are being taken to minimise the loss of productivity against a shorter farming season.

Secondly, the impact of climate change on water resources (including rainfall patterns and groundwater levels) in northern Ghana is indeterminate. This is primarily because of the conflicting data recorded at different meteorological stations for different climate research projects. Both higher and lower levels of precipitation (and hence evaporation) have been projected under different scenarios.

Thirdly, the impact on value chains and market demand could be major or minor, depending on the climate-resilience of hard infrastructure (such as roads and port facilities) and the climate-compatibility of soft infrastructure (such as improving access to agricultural services or micro-credit). But it is more certain that market demand, driven by household consumption, will go downwards if there are no adaptation measures in place.

Fourthly, there is a correlation between climate and poverty/vulnerability levels. The drier the region, the more vulnerable the dweller will become to the threat of climate change. This can explain the high level of concentration of poor people in north Ghana. Impacts identified on different demographics based on geography, livelihoods and gender all identically point to a shift towards the downside of the development.

Finally, social dynamics, as regulation mechanisms managing interest distribution, have been a niche to examine the social dimension of climate change in north Ghana. Unfavourable climate being developed is exerting pressure on the available land resource, which has already intensified conflict in the northern savanna zone in a "vicious cycle". Conflicts have arisen between farmers and herdsmen in the north along with resource scarcity; between migrants and other inhabitants in the south with land tenure reform; and, between smallholder and commercial producers when cropping systems are to be transformed to boost productivity.

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