RAINFALL, FOOD SECURITY AND HUMAN MOBILTY
CASE STUDY: GHANA

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″Where the Rain Falls″ Project
Case study: Ghana

Results from Nadowli District, Upper West Region

Authors: Christina Rademacher-Schulz and Edward Salifu Mahama

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Abbreviations and acronyms

CMS	*Centre of Migration Studies*
CBA	*Community-Based Adaptation*
CFSVA	*Comprehensive Food Security and Vulnerability Analysis*
EPA	*Environmental Protection Agency*
FAO	*Food and Agriculture Organization of the United Nations*
GIDA	*Ghana Irrigation Development Authority*
GDP	*Gross Domestic Product*
GSS	*Ghana Statistical Service*
IPCC	*Intergovernmental Panel on Climate Change*
ISSER	*The Institute of Statistical, Social, and Economic Research*
IOM	*International Organization for Migration*
LEAP	*Livelihood Empowerment against Poverty*
MoFA	*Ministry of Food and Agriculture*
NADMO	*National Disaster Management Organization*
NCAP	*Netherlands Climate Assistance Programme*
NGO	*Non-Governmental Organization*
PRA	*Participatory Research Approach*
RI	*Rainfall Index*
SADA	*Savannah Accelerated Development Authority*
SIDSEC	*Sustainable Integrated Development Services Centre (NGO)*
UDS	*University of Development Studies*
UNU	*United Nations University*
UNU-EHS	*United Nations University* *Institute for Environment and Human Security*
UNFCCC	*United Nations Framework Convention on Climate Change*
UWR	*Upper West Region*
WFP	*World Food Programme*
WVI	*World Vision International*

Executive summary

This report presents the findings from the Ghana case study of the "Where the Rain Falls: climate change, food security, social inequality and human mobility" project. This research project looks at the linkages between changing rainfall patterns, food security and human mobility in eight developing countries. The central question this study seeks to answer is: "Under what circumstances do households use migration as a risk management strategy in relation to increasing rainfall variability and food insecurity?" A mixed-method approach was used in this research, consisting of a household survey, participatory research approaches (PRA), expert interviews and the analysis of meteorological and crop production data. The research in Ghana took place in four communities of the Nadowli District (Takpo area) of the Upper West Region. The research area is located close to the border of Burkina Faso in the north-western part of the country, a region characterized by high incidences of poverty, a high rainfall variability including droughts and floods, as well as one wet (April/May to September/October) and one dry season (rest of the year). Rain-fed subsistence agriculture and livestock rearing are the main economic activities of the population, as the district offers little other employment opportunities and the degree of economic diversification is very low. The main staple food crops are millet, maize, sorghum and yam. Farmers increasingly plant groundnuts because selling this cash crop enables them to buy food from local markets to support their families. As farmers in this district have no access to irrigation facilities, their agricultural production is entirely dependent on rainfall.

The following changes in rainfall patterns over the past 20 to 30 years have been observed in the research villages: an increase in heavy rainfall causing floods; a delay of the rainy season (from April to May); and an increase of the occurence of dry spells associated with higher temperatures. Results from the household survey document that 92 per cent of the participants perceived changes in rainfall patterns over the period, with 87.3 per cent of interviewees perceiving more droughts over the past 10 to 30 years, 44.3 per cent reporting increased flooding, 35.8 per cent more heavy rains and 64.8 per cent more extreme weather events. In general, villagers report that the climate has become less predictable. These perceptions are also largely supported by local meteorological data and expert opinion, which confirm that average temperatures are increasing and that both longer dry spells and heavy rainfall events are increasing in frequency during the planting season. The evidence regarding a delayed onset of the rainy season is more ambiguous. Using meteorological data from different weather stations in northern Ghana, a delay in the onset of the wet season by more than two weeks was calculated for the period between 1961 and 2001 (Laux, 2009). For the nearest weather station in Wa, no delay could be detected though using the same approach.

The majority of the household respondents in the research site (98 per cent) mentioned that changing rainfall patterns have a negative effect on crop production and in turn worsen the economic situation of the household. Dry spells and heavy rainfall events during critical stages in the planting season can negatively affect crop production, leading to reduced yields or harvest losses, and ultimately resulting in food shortages. Negative effects on food crop production, in turn, lead to rising food prices. Thirty-seven per cent of the surveyed households reported rising food prices, which reduced the accessibility of food for their families. Seventy-five per cent of the respondents of the survey did not have enough food to cover household needs during the lean season (May to August), and 69 per cent of them did not have enough money to buy food during the same period. According to 37 per cent of the respondents, animal production declined as well, thereby reducing the "safety valve" of being able to sell livestock in times of crisis.

The dry season is the time where people engage in trade activities, food processing and seasonal migration. The lack of alternative *in situ* livelihood opportunities for poor households in these villages, coupled with the high dependence on rainfall, make these villages highly vulnerable to climate change. In coping with food insecurity, caused to a large extent by rainfall variability, respondents of the survey mentioned the following coping and/or adaptation strategies, ranked by importance: sale of assets (29 per cent); reduction of food consumption (21 per cent); diversification of household income (14 per cent), which is mainly migration; and modification of crop production (11 per cent).

Migration is an integral part of the local economy and an important livelihood strategy for the residents of the research villages. Due to social and cultural norms in the research site, male migration is more common than female migration. Nevertheless, the number of female migrants has increased since the 1980s and women currently account for 31 per cent of all migrants. Fifty-three per cent of the migrants are married and 40 per cent are single, and the average age at first migration is 23. Migration is mainly undertaken for economic reasons (83 per cent), and only 9 per cent are educational migrants. Results from the household survey show that 39 per cent are seasonal migrants, followed by 36 per cent permanent migrants, with temporal migrants making up the remaining 25 per cent. The PRA findings confirm that seasonal migration is the dominant migration type. Interactions in focus group discussions on mobility and seasonal calendars indicated that migrants usually move during the dry season and normally return to assist their households with farm work when the agricultural season at home starts. Migration during times of crisis can also take place during the rainy season.

The main destinations for migration are the Brong Ahafo Region (38 per cent) and Ashanti Region (39 per cent), followed by the Northern Region (10 per cent). The reason why people leave for Brong Ahafo (middle belt) is that it has two rainy seasons, two cropping seasons and more fertile lands than the northern part of Ghana. The main economic activities of the migrants in their new destinations are farming (52 per cent) and mining (14 per cent). Gold mining areas across the country attract young seasonal migrants who hope to make a fortune in a short period of time. Seasonal migrants usually work as farm labourers, whereas long-term migrants usually try to establish their own farms.

The household survey results showed that the most important reasons for migration by order of importance are: the decline in crop production for own consumption; shifts in the rainy season; unemployment; longer drought periods followed by unreliable harvest; and increase in drought frequency. Household members are mainly migrating for economic and food security reasons, which are directly linked to climatic and environmental factors by virtue of people's dependence on rain-fed agriculture. Suffering from a low degree of economic diversification in the area of origin, migration to other parts of the country is a common means to diversify household income and receive remittances.

Better off households show a more diversified livelihood portfolio, have more active working members engaged in (seasonal) migration, and in turn are much less vulnerable to the negative impacts of rainfall changes. Less wealthy households tend to engage in migration to improve their livelihoods if they can afford the costs involved in migration. The more vulnerable a household, the less its members can engage in seasonal migration. Female-headed households are more vulnerable than male-headed households, face a higher degree of food insecurity, have fewer members of working age, possess less land and engage slightly less in migration than male-headed households. Survey analysis has shown for the situation in 2011 that the higher the food insecurity of the household, the higher the propensity to migrate seasonally, in these cases during the rainy season, which is contrary to the normal migration pattern.

Section 1: Introduction

As climate change and climate variability have assumed importance in the global development agenda, their relationship with food (in)security and migration has also become an important issue. In particular, environmental changes and migration have formed a relatively new area of research in recent times. As observed by Akabzaa et al.: "There is a growing consensus in migration studies literature that migration is a complex phenomenon, rarely explained by one single factor and the diversity of thematic areas of study is well appreciated, yet the specific relationship between global environmental changes and migration is a relatively more recent area of study" (2010: 5). This is true in the case of Ghana.

In the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) Working Group II (WG2), the projected impact of climate change on the African continent reads as follows:

"Agricultural production, including access to food, in many African countries and regions is projected to be severely compromised by climate variability and change. The area suitable for agriculture, the length of growing seasons and yield potential, particularly along the margins of semi-arid and arid areas, are expected to decrease. This would further adversely affect food security and exacerbate malnutrition in the continent. In some countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020"

(IPCC AR4 WG2, 2007: 13).

The major projected impacts on agriculture in Africa are further specified:

- increased frequency of warm spells or heat waves with resulting reduced yields in warmer regions due to heat stress;
- increased frequency of heavy precipitation events with resulting damage to crops, soil erosion and the inability to cultivate land due to waterlogging of soils;
- increased frequency of droughts with resulting land degradation, lower yields/crop damage and failure, increased livestock deaths, increased risk of wildfire (IPCC WG2, 2007: 18)[1].

The "Where the Rain Falls: climate change, food security, social inequality and human mobility" project was developed to further empirically explore the linkages not only between climate change and food security, but also between climate change and migration in different parts of the world. The goal of this research is to help inform stakeholders on these challenges, and in doing so, find effective means of addressing the relationships that exist between these variables. Among the eight case studies in Africa, Latin America and Asia, Ghana was chosen as one of the countries. The project is financed by the AXA Group and the John D. and Catherine T. MacArthur Foundation and is implemented by UNU-EHS and CARE International.

The project aims to explore and better conceptualize the links between climate change – as rainfall variability – livelihood or food security, and migration[2]. For the Ghana case study, a region where crops are cultivated under rain-fed conditions was chosen; accounting for the fact that 82 per cent of croplands worldwide are cultivated under rain-fed conditions and in sub-Saharan Africa the figure is higher, at 95 per cent (Laux, 2010).

Given the dominance of rain-fed subsistence agriculture in this area, a stable food security strongly depends on reliable rainfall. Our interest is therefore to better understand under which conditions migration is a normal income strategy for households and is thus a way of adapting to climatic and other environmental changes, or rainfall variability, and under which conditions it is rather used as a risk management or coping strategy in times of crisis. The overall aim is thus to better understand how local farmers experience climatic trends in rainfall variability and how they have adapted their livelihood strategies, among them migration.

Hence, local perceptions of rainfall have changed for a period from the 1980s until today and the observed impacts on local livelihoods (see conceptual framework, Figure 1) are in the core of analysis. Food security is captured by looking at the availability of food (mainly through subsistence farming) and the access to food, bearing in mind not only accessibility to local and regional markets, but also the impact of food prices.

Research revealed several coping and adaptation strategies by the studied communities. One of the major coping and adaptation strategies is certainly migration. An assessment of the complex drivers of migration captures the importance given to natural or environmental factors, economic or food security-related factors and social or personal factors by the research participants.

The study takes into account existing social and gender inequalities by looking at the situation of female- and male-headed households as well as asset-poor and asset-rich households.

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1 Recent research on the impact of climate change on agricultural productivity under rain-fed conditions in sub-Saharan Africa (Laux et al., 2010) has demonstrated that the direct fertilization effect of the expected CO2 alteration is likely to outweigh the negative effects of precipitation and temperature change contrary to the projected impacts mentioned in the IPCC. In addition, planting date adaptations were considered, resulting in expected yield increases for groundnuts and maize in Cameroon (Laux et al., 2010: 1ff.).

2 This study does not consider other important aspects such as land use change or land cover change.

Moreover, local perceptions and observations are compared to secondary data, i.e. tested against rainfall records or crop production data, wherever applicable.

In the conceptual framework for the Ghana case study (see Figure 1), the variables of particular interest, namely food security and migration as well as coping/adaptation strategies, are part of the overall livelihood (security) approach, shown greyed out. The livelihood security may be additionally determined by other factors, such as economic or political developments or conflicts. However, this study focuses on the most relevant aspects for the study of the interaction of rainfall, food security and migration, and conceptual extensions were disregarded.

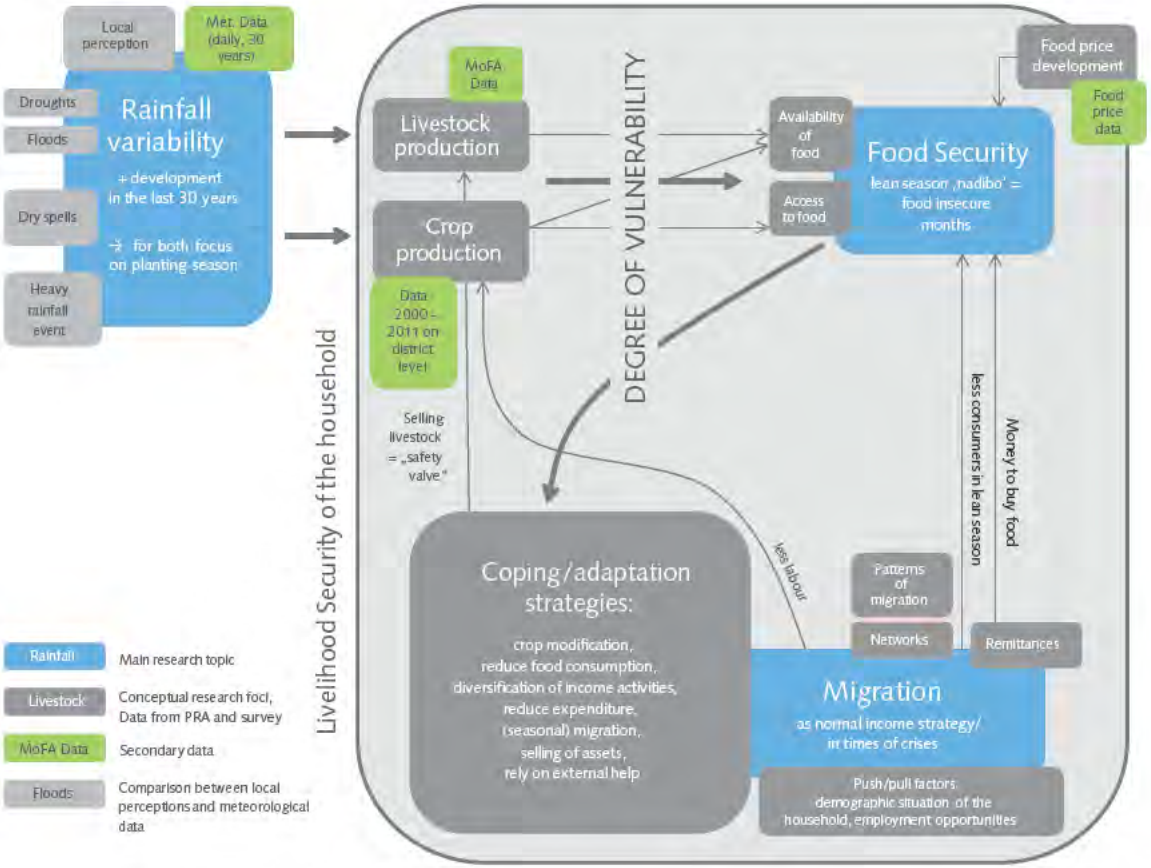


Figure 1: Conceptual framework for the Ghana case study. Source: Rademacher-Schulz and Rossow (2012).

In the framework, a barrier or threshold called "degree of vulnerability" is built in. It indicates that food security is to a certain extent dependent on the vulnerability of the household (here specifically the degree of economic diversification) and that the number of available coping or adaptation strategies for a household is determined by its degree of vulnerability (such as financial means, number of members of working age, etc.).

The conceptual framework illustrates the complex interrelations and interdependencies between the variables.

This report is the outcome of the Ghana case study, which was conducted in four communities of the Nadowli District in the Upper West Region of Ghana. This district was selected for several reasons: A mode of production based primarily on rain-fed subsistence farming, few irrigation facilities, a high occurrence of poverty, an occurrence of weather extremes, such as droughts, the presence of CARE projects in the district, and some logistical reasons (see Section 4).

This report consists of 10 sections. The first section gives a general overview of Ghana and the organization of the report. The second section is a review of the relevant literature on the topic. The third looks at the methods employed, while the fourth presents an introduction to the case study area. Sections 5–7 look at the research outcomes in the three thematic areas of the research, namely rainfall variability, livelihood and food security, and human mobility patterns. Research outcomes are pesented in the eighth section, and the summary and concluding remarks are presented in the ninth. The final section presents reflections and draws policy implications for the study.

1.1 Ghana

Ghana is located in West Africa and covers an area of 238,539 km^2. It shares borders with three African French-speaking countries: the Republic of Togo to the east; Burkina Faso to the north-west; and Ivory Coast to the west. To the south is the Gulf of Guinea.

Ghana gained independence in 1957 and became a republic in 1960 under the first Prime Minister, Dr. Osagyefo Kwame Nkrumah. Like many African countries, Ghana went through different military regimes and stabilized in 2000. In line with its decentralization policy, local governments were established in 1998 and charged with the implementation of national policies on governance, health, agriculture and education. In recent times, Ghana is often cited as one of the leading democratic countries of the African continent (Sambah, 2011).

Ghana has an estimated population of 24,223,431 (Ghana Statistical Service, 2012). Of this, 11,801,661 are males and 12,421,770 are females, with an annual intercensal growth rate of 2.4 (Ghana Statistical Service, 2012). The Ghanaian economy is largely agrarian. Agriculture accounts for 75 per cent of the foreign exchange earnings and contributes 37 per cent to the gross domestic product (GDP) (Armah et al., 2011). The major occupation of the majority of people is agro-based, mainly subsistence agriculture. Ghana also produces cocoa, timber, gold and other mineral resources and, in more recent times, oil. These products and remittances from migration (USD 114 million in 2009 according to the International Organization for Migration (IOM)) constitute the main source of Ghana's foreign exchange earnings.

Ghana exhibits a north-south divide in terms of economy and prosperity that dates back to colonial times. In colonial times, northern Ghana was treated as a labour reserve for the benefit of the economy in the south, where migrants from the north found work in mines, agriculture and industry. "The Northern Territories were deemed by the colonial regime to have little direct economic value, hence in the 1920s Governor Guggisberg designated the territories as a labour reserve for the supply of cheap labour for

the mines and general labour in the cities in the South" (Guggisberg, 1920, cited in Anarfi, 1982: 14; Schraven, 2010: 64). In addition, differences such as the lower rainfall in the north, the savannah vegetation and the remoteness of parts of the north strengthened this divide. After colonialism, the new rulers did not manage to change this established pattern. Northern Ghana is made up of three administrative regions. They are the Northern, Upper East and Upper West regions, which are the savannah zones of the country. There are two major seasons in the country, the rainy and the dry season. In southern Ghana, there are two rainy seasons, a major and minor one, separated by a dry season. Thus, most places have two cropping seasons. Annual rainfall ranges from about 1,100 mm in the North to about 2,100 mm in the south-east. Northern Ghana has a relatively shorter rainy season of about six months and, therefore, it has only one cropping season. In Wa, the capital of the Upper West Region (UWR), the dry season is very hot, with a mean temperature of 27 °C in December and of 31 °C in March (Weather Station Wa, Upper West Region).

Ghana is divided into 10 administrative regions. The "Where the Rain Falls Project" was carried out in Nadowli District in the UWR (see Figure 2).

The UWR was carved out of a bigger region, the Upper Region, which was made up of the current Upper East and Upper West Regions in 1983. It covers an area of approximately 18,478 km², which represents 12 per cent of the total area of Ghana. The region shares boundaries with Upper East region to the east, the Northern Region to the south, Burkina Faso to the north and west, and Ivory Coast to the south-west. The 2010 Provisional Population and Housing Census results show that the total population of the UWR is 677,763. Among them, 333,355 are males and 344,408 are females, with an estimated annual growth rate of 1.5 per cent. The sex ratio for the UWR is low, similar to the national one. For every 100 females, there are 97 males (Provisional Population Census Results, 2010). Population density is 37 inhabitants per km².

Ethnically, the UWR is diverse. The main ethnic groups of the region are Dagaaba, Wala and Sisala. However, several other Ghanaian ethnic groups live in bigger towns with the local population (Awedoba, 2005). In contrast, the smaller communities are generally made up of only one ethnic group. The different ethnic groups speak their own language and have different cultural practices. The people of the UWR, like other regions of the country, follow three major religions, namely Christianity, Islam and African traditional religion.

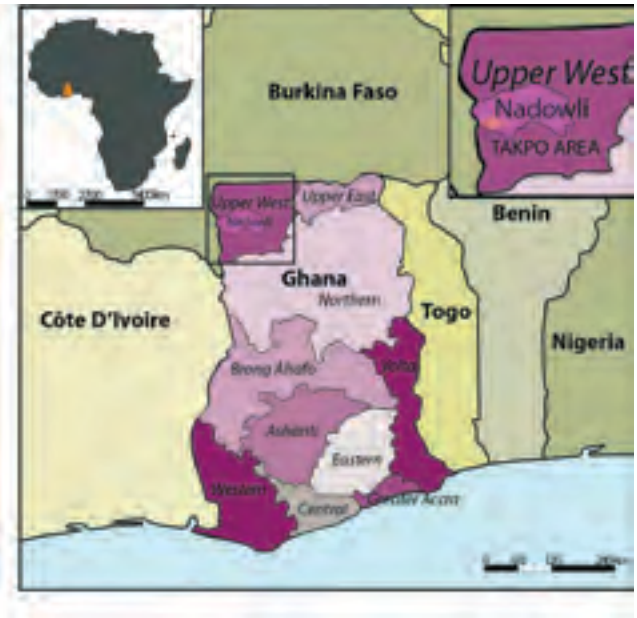


Figure 2: Map of Ghana, showing the Upper West Region and the study area in Nadowli District (small map top right). Source: Design by Rossow (2012), adapted from Volta Basin Authority (VBA) Geoportal.

Section 2: Literature review

This section gives a brief review of the literature in respect to the three thematic areas of the study, namely climate change or rainfall variability, food insecurity, migration and the interrelations between these variables. General findings on the topic will be presented in general for West Africa, Ghana and northern Ghana in particular.

2.1 Climate change and food insecurity in Ghana

The issues of climate change and food insecurity have become topical around the globe. The agricultural sector is known to be highly vulnerable to climate change, especially where farming relies heavily on rain (IPCC AR4 WG2, 2007). African countries are particularly vulnerable to climate change because, in addition to their dependence on rain-fed agriculture, they experience high levels of poverty, low levels of human and physical capital and poor infrastructure (Africa Partnership Forum, 2007; Laux et al., 2010).

The concept of food security has been explained by Holben (2004) as having access to enough food, including the ready availability of nutritionally adequate, safe foods for an active, healthy life and the ability to acquire these foods in socially acceptable ways. When individuals and families have limited access to food or if their ability to obtain food is limited or uncertain, then they are food insecure.

Bickel et al. (2000) define food security as access by all people at all times to enough food for an active, healthy life. Households are food secure when they have year-round access to the amount and variety of safe food for their members to lead active and healthy lives. "At the household level, food security refers to the ability of the household to secure, either from its own production or through purchases, adequate food for meeting the dietary needs of all members of the household" (Ewumbu, 2011: 14–15).

A World Food Programme (WFP) report from 2009 on food security and vulnerability in Ghana uses the following definition of food (in)security which was defined at the World Food Summit in 1996: "All people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (WFP, 2009). The report argues that "food security is highly complex in that it is determined by a range of inter-related agro-environmental, socioeconomic, and biological factors, all of which have to be addressed to conclude whether food security exists or not" (WFP, 2009: 19). Put simply, the report highlights the importance of three factors: food availability, food access and food utilization (see Section 6 for research results regarding food availability and access).

Although there have been considerable improvements in the food security situation in Ghana, agricultural production and productivity remain inadequate and, as a result, Ghana continues to struggle to improve its food security (United Nations Development Programme [UNDP], Ghana Human Development Report, 2007). A combination of factors such as inappropriate policies, lack of technological change and poor basic infrastructure, have led to a reduction in farmers' incentives to invest and produce and ultimately have slowed the growth of agriculture in the country. Moreover, a surplus of agricultural products in rural

areas is occurring at the same time as food scarcities happen in urban areas, a situation that can be linked directly to the (inadequate and at times even impassable) road links between rural and urban areas. Additionally, due to the poor traditional post-harvest management of food crops, 20–30 per cent of the production is lost. Losses of this scale lead to a food price increase, which in turn restricts access to food for households (UNDP Ghana Human Development Report, 2007).

As both staple and cash crop agriculture are almost entirely rain-fed, rainfall variability during the growing season leads to fluctuating food production from year to year. Therefore, rainfall significantly impacts both the national as well as the household annual food output (UNDP Ghana Human Development Report, 2007).

Food security is a complex phenomenon and difficult to measure. The WFP uses a number of proxy indicators such as diet diversity and diet frequency, wealth (index), coping strategies, market dependency, education, health, anthropometry, food and non-food expenditures, and livelihood strategies, in order to identify the people most vulnerable to food insecurity in Ghana. In addition, underlying factors that should be considered include: macro-level factors such as high food prices, the global financial crisis and natural hazards; and household level factors such as lack of education, high dependency on agricultural livelihood activities as primary income source, lack of access to markets and poverty (WFP Comprehensive Food Security and Vulnerability Analysis (CFSVA), 2009).

One of the main conclusions of the report is that, based solely on the basis of households' food consumption, the CFSVA found 5 per cent of the population (1.2 million people) to have very limited access to sufficient and nutritious food and are defined as food insecure. They are concentrated in the poorest regions of the country "which are also the areas most prone to adverse weather conditions, such as floods and droughts, and that have been disproportionately affected by last year's soaring food prices" (WFP CFSVA, 2009: 13f.). At a regional level, 34 per cent of the population in the UWR is food insecure, followed by 15 per cent in Upper East and 10 per cent in the Northern Region. This means that approximately 453,000 people are food insecure in northern Ghana.

Throughout the country, an additional two million people are vulnerable to becoming food insecure. This means that they were not food insecure in November 2008 when the cited survey was conducted, but their food consumption patterns were "barely acceptable and are likely to deteriorate during the lean season (March to September), when food prices generally increase or following a natural or man-made shock" (WFP CFSVA, 2009: 13f.). In the three northern Ghanaian regions, 507,000 people were found to be vulnerable to becoming food insecure in the future.

A study of the food security situation in northern Ghana by Quaye (2008) revealed that even though farmers purposely cultivated for household consumption and sold surplus harvest, the interviewed households suffered from food shortage as their staple foods lasted on average for seven months only. Months of inadequate household food provisioning was defined as the time between stock completion and the next harvest. In highly subsistence-oriented areas where production is primarily for home consumption and farmers purchase little from market, this is a normal measure of food insecurity (Quaye, 2008: 339). This study uses Quaye's approach to investigate food insecurity.

The northern regions of Ghana, especially the Upper East regions and UWRs, for the past 30 years have experienced high climate variability resulting in floods, droughts, bushfires, high winds and rain storms. Specific examples include the floods of 2007 and 2008, and long droughts in the late 1970s and early 1980s known as the Great Sahelian Droughts. While the floods destroyed farmlands, markets, schools and rendered many people

homeless, the droughts caused food insecurity and the dwindling resources and incomes. Those mostly affected are women, children, farmers, pastoralists and traders because these groups of people are not salaried workers and depend on the natural environment. Besides the insufficiency of food for the family, women are affected because they could not harvest wild fruits from economic trees such as Shea. In addition, since pastoralists depend entirely on natural vegetation to feed their animals, when droughts occur, there is neither enough grass nor water for the animals. The result is disease and death of the animals (CARE GWI report, 2010). The traders referred to here are petty traders who are mainly traders of agricultural products and in similar ways affected. Finally, for children, disasters often mean that they are unable to continue with their education immediately.

The road network in these regions is bad, and floods have rendered them even worse. As a result, many socio-economic activities have often come to a halt. There are frequent outbreaks of diseases due to these climatic changes, thus affecting the livelihood activities of people (Nadowli District Profile, 2010b). The National Disaster Management Organization (NADMO), the government organization that is mandated to support and intervene in times of such disasters, adds that floods, which have become an annual upheaval, result in the loss of lives and the destruction of properties and acres of cultivated farm fields (www.ghananewsagency.org).

2.2 Gendered division of labour, land tenure and food security in northern Ghana

A CARE report regarding gender analysis states that women produce 70 per cent of Ghana's food crops and up to 90 per cent of these women are involved in marketing and processing domains (Iddrisu, 2010). According to the gendered division of labour, men are responsible for growing staple foods like maize, millet, sorghum and yam. They specifically engage in clearing the land, plowing and fertilizer application. Women, men and children engage in planting and weeding. Women are also responsible for harvesting, growing vegetables, fetching wood and water, preparing food, food processing activities and childcare. Besides this, they engage in petty trading and processing of products like shea butter. Despite women's important contributions to food production, they are not considered to be farmers. They are rather considered responsible for providing "soup ingredients" (vegetables, spices, salt, etc.) only, while men are considered farmers being directly responsible for staple food production (Pickbourn, 2011; Abdul-Korah, 2004). Despite women's contributions, they face unequal access to resources such as land, labour, credit, extension services and markets (Iddrisu, 2010).

In northern Ghana, land ownership rights are held by the community as a whole and use rights are granted by the *Tendaana*, the earth priest of the community, to individual family lineages. Women do not hold any rights to the land, but gain access from the household head. If a household has enough land, married women may be given access to small plots by their husbands to cultivate vegetables and other food crops for the household's consumption (Pickbourn, 2011). Thus, access to land depends on women's marital status and her husband's good will. In case of a divorce, separation or death of the husband, the woman returns to her family of origin and is dependent on the good will of her male family members and on the availability of farm land (Iddrisu, 2010).

Dugbazah summarizes that women in rural Ghana are the main socio-economic backbone of the economy. Despite their contribution, gender imbalance continues with regards to the division of labour and access to resources, which compel women to take greater responsibilities and heavier workloads than men (Dugbazah, 2007).

Women´s and men´s economic roles within the household differ according to seniority and marital status (for further details see Pickbourn, 2011). The household head is reponsible for provding

shelter and staple foods for three meals per day. However, based on a study by Al-Hassan and Poulton (2009), Pickbourn described that household heads increasingly provide food for the evening meal only. Consequently, married women with children are expected to provide food for the family for the other meals. Gender ideology assigns women the responsibility to ensure that their children have enough food and do not starve. Married women with children are also often responsible for children's clothing, educational expenses and other needs (Pickbourn, 2011).

Changes in rainfall often lead to reduced harvest of staple foods, thus contributing to food insecurity. When men are not able to meet their food supply obligations, women are primarily responsible for making up for the household's food shortages. In order to meet all above-mentioned obligations, married women with children engage in several economic activities that are mostly low-return, small-scale production activities, such as Pito brewing, a sorghum beer, or Shea processing. In times of crisis, women's income earning activities are crucial for the household's well-being. Men and women do not pool their income, thus granting women full control over their cash income (Pickbourn, 2011).

Negative impacts of climate change are expected to further complicate women's economic activities as they are highly dependent on food crop production and harvesting wild fruits and berries to gain surplus income.

2.3 Climate change research in Ghana

Ghana is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC). After its ratification in 1995, the implementation of different climate change projects was co-funded by the government with technical and financial support from bilateral and multi-lateral agencies (cf. UNDP, 2008). One of them was the Netherlands Climate Assistance Programme (NCAP).

Through the support of NCAP (1996–2005), studies have been conducted in Ghana on the impacts of climate change on human health, fisheries, agriculture, land management, water resources, women's vulnerability and the linkages between the Ghana Poverty Reduction Strategy and climate change. In all these studies, climate change assessment addressed a set of interactions between humans and natural systems. Rising temperatures and the increased rainfall variability pose serious threats to the livelihoods of the people since the majority depends solely on rain-fed agriculture (Environment Protection Agency [EPA], 2008).

Brown and Crawford cite findings of the Ghanaian Environmental Protection Agency projecting temperature increases and reductions in rainfall over the coming decades:

"Historical data across the country from the year 1960 to 2000 shows a progressive and discernible rise in temperature and a concomitant decrease in rainfall in all agro-ecological zones in the country. Based on this data it's estimated that temperature will continue to rise by on average about 0.6 °C, 2.0 °C, and 3.9 °C by the year 2020, 2050 and 2080 respectively. Rainfall is also predicted to decrease on average by 2.8 per cent, 10.9 per cent and 18.6 per cent by 2020, 2050 and 2080 respectively in all agro-ecological zones"

(EPA, 2007: 7–8, cited in Brown and Crawford, 2008: 23).

Black et al. highlight the impacts of climate change with reference to the Ghanaian Environmental Protection Agency's projections on water resources resulting in a reduction in river flows and reduced groundwater availability. Without specifications of the magnitude they argue that agricultural yields will be negatively affected as well, especially in the central and northern part of the country (2008).

Research on climate change, particularly in the northern parts of Ghana, was partly carried out in the framework of interdis-

ciplinary research projects like the Impact of Climate Change on Drylands Project (1997–2004) or the Glowa Volta Project (2000–2009). Laube summarizes the findings of climate change research from the Glowa Volta Project in Northern Ghana and Southern Burkina Faso as follows:

"Regional climate change models predict a moderate increase in precipitation throughout the region, but with considerable local variation (Jung et al. 2007, Paeth and Hense, 2004). Furthermore, the onset of the rainy season has shifted from April to May and dry spells during the rainy seasons have increased (Laux et al. 2008). According to regional climate change projections developed from the results of global climate change models, this trend will become more pronounced, and climatic patterns more unpredictable and erratic than they were previously. This increases the probability of the occurrence of extreme events such as floods and droughts, and thus the danger of more harvest and food insecurity"

(Van de Giesen et al., 2010 in: Laube et al., 2012: 754).

It becomes evident from the cited studies that besides an undoubted increase in temperature, the findings on future seasonal rainfall differ between the research teams. This can be explained with different approaches (extrapolation of historical trend versus downscaling of global climate models). There seems to be agreement on more pronounced climate variability (extremes, dry spells and heavy rains causing droughts and floods) which worsen the situation of agriculture and livelihood conditions of the population.

Results from a recent study on food security and climate change in drought-sensitive Savannah zones in Ghana (Armah et al., 2011) point to projected drier climate conditions due to decreases in rainfall and increases in temperature for Guinea and Savannah agro-ecological zones of Northern Ghana that may further decrease suitable croplands for cultivation. The authors' assessment is that climate change, land degradation and desertification will reduce fertile land areas, which in turn will have significant consequences for food security. Their appraisal of the current situation reads as follows:

"The slow growth of agriculture in Ghana is attributed to a combination of factors, including inappropriate policies, lack of technological change, and poor basic infrastructure. Ghana faces challenges of making substantial progress in food security because average yields have remained stagnant over the years. With changing climate, substantial increases in crop yields are needed for food security in Ghana" (Armah et al., 2011: 301).

According to Armah et al., adaptation is necessay to ensure food security in the country. They warn that crop mangement "may be inadequte for the new climatic conditions"(Armah et al., 2011: 301f.).

Research by van der Geest (2011) concentrated on migration, environment and development in the UWR, and took into account data on rainfall, vegetation cover and population, as well as migration for the whole country. Van der Geest's findings suggest that environmental factors play an important role in causing migration from northern Ghana to Ghana's middle belt: farmers seasonally and permanently migrate to southern Ghana because of more favourable farming areas. Access to resources and a low rural population density in the middle belt turned out to be an even more important pull factor than vegetation cover.

2.4 Migration in Ghana

The nature of Ghanaian migration experiences is complex and dynamic. Ghana has a long history of internal and international migration. In colonial times, migration was mainly internal. The development of gold mines and cocoa farms within Ghana attracted many migrants. Migrant workers were actively recruited by the colonial authorities, resulting in an acceleration of labour

recruitment into the Northern Territories (Agyei and Ofosu-Mensah, 2009). The recruitment of unskilled workers from the north was very successful due to severe famines that occurred in the early 1920s in many parts of the West African Savannah and an influenza epidemic in 1918–1919 in the Northern Territories. Labour migration was seen by the population in the north as a coping strategy to earn extra income (Lentz, 2006). Apart from mining, the seasonal cultivation of cocoa in the southern forest zone attracted migrants from the north as it was done during the Savannah dry season. Thus, it did not overlap with farming activities in the north (Anarfi et al., 2003). The developments in the 1920s and 1930s can be considered as the beginning of the seasonal north-south migration that can still be observed today (Schraven, 2010). The colonial administration made only sporadic attempts to further develop agriculture in northern Ghana. During the first decades of colonial rule, the development progress in the north was very small while labour migration to the south grew massively. Progress in the north was primarily dependent on developments in the economy and the infrastructure in the south and linked to labour migration and wages that northern migrants remitted home to improve the livelihoods of their families (Schraven, 2010).

After independence in 1957, Ghana's first president Kwame Nkrumah aimed at transforming the Ghanaian economy to overcome the state's high dependence on agricultural products, timber and minerals. Farmer cooperations and state-owned agricultural enterprises were established to achieve this aim. Another goal was to reduce the development gap between the north and south which was not realized partly due to the fact that the political era of Nkrumah was overthrown by a military coup in 1966.

Until the 1960s, the high poverty rates and the poor performance of the agricultural production in the North made labour migration even more important – instead of decreasing it as intended by Nkrumah's development agenda. An additional factor was certainly that travelling to the South now was easier, faster and more secure than in the past. The reasons for that were essential improvements of the road network, which were undertaken in accordance to Nkrumah's development policy (Schraven, 2010).

"In the 1970s and 1980s, a series of socio-economic and political disruptions led to mass emigration to other African countries and the rest of the world. This process led to the creation of diasporas which in turn impacted current migration patterns (Awumbila et al., 2008). Since the last two decades, new migration dynamics brought increasing complexity in internal as well as international movement patterns, "thus making Ghana to simultaneously experience internal migration, immigration, transit migration and emigration both within and outside Africa"

(Awumbila et al., 2008: 2).

Seasonal and, to a lesser extent, long-term migration patterns were always used by the local population as a valuable coping strategy, especially in times of droughts, poor harvests, food shortages or epidemics. Mensah-Bonsu (2003) stresses the fact that migration was also used as an adaptation strategy in response to high population pressure on the natural resources. Schraven emphasizes the food-saving aspect of seasonal migration, being sometimes more important than the income-generating aspect (2010).

According to Black et al. (2008), migration is fueled by infertile soils and lack of local services in Ghana's North. Kwankye in turn stresses the natural resource distribution as a major reason for migration:

"Migration flows have largely been in response to the spatial pattern of natural resource distribution across the three ecological zones, namely the coastal belt, forest middle belt and the northern savannah. There has, consequently, been a north-south pattern of internal migration flow in the country with regions that are less-endowed with natural resources becoming the main sources of

migrants while those with rich natural resources have become the main destination centres for many internal migrants"

(Kwankye, 2009: 1).

Traditionally, migration involved unmarried young males travelling mainly seasonally, less often permanently, to agricultural areas and mining communities in the south (Agyei and Ofosu-Mansah, 2009). Female migration happened in the context of marriage or family "reunification" when wives joined their husbands or relatives.

Recent studies reveal a changing trend: young female migrants now form the majority of internal migrants from northern Ghana to urban centres in the south. These migrants mostly work as head porters ("kayayei") at market centres and lorry stations (Anarfi et al., 2003). Many female migrants nowadays are autonomous migrants who have made their own decisions and moved even if there were no family members at the destination. The main incentive for many of them is to earn money to purchase items for marriage (Abdul-Korah, 2011). These migrants see migration as a means of socio-economic enhancement (Kwankye et al., 2009).

Currently, both male and female adults (except the elderly) are involved in migration. Children, male and female adults are all involved. According to Kwankye et al. (2009), migrants to the south encounter a lot of difficulties, yet many of these people prefer being in the south because they are able to make a living for themselves and remit food and money for the upkeep of their families.

Agriculture provides employment and livelihood for the majority of the population in rural areas in Ghana. Therefore, after the rainy season in the north, there is "automatic unemployment" for most of the labour force; thus younger generations move to the south to either continue to farm or go into the mines or work for cocoa farmers. Though such opportunities may seem quite rewarding, this type of migration also has negative implications. Some people return to their communities economically better off while others return with diseases or even die as a result. *"The success of migrants in accumulating capital and skills is necessary but not a sufficient condition for them to invest productively in their places of origin. Rural-urban migration has positive and negative effects on both the migrant and members of his household"* (Ewumbu, 2011: 13-14; van der Geest, 2010).

Kwankye et al. (2009) state that skilled migrants with a relatively high level of education migrate preferably to the national and regional capitals, whereas the less educated migrants move to the mining and farming areas instead.

Migration processes are not only shaped by economic and environmental factors, but also by cultural values and norms. Hahn and Klute (2007) developed the "culture of migration" concept, which focuses on the perception and meanings of migration for the migrants themselves as well as their families and communities of origin with its specific economic and non-economic motivations. The authors view the culture of migration as an open process in which migration is seen as an outcome of a discursive and highly interactive process between different actors involved. In this concept, changes in the migrants' identities leading to cultural transformations in the home society are considered.

A recent study by Akabzaa et al. (2010) claims that environmental change also accounts for migration in Ghana, although more studies have been skewed towards remittances, brain drain, return migrants, rural-urban movement and their developmental impacts. The authors point to the fact that limitations on the linkages between enviromental problems and migration is due to the absence of long-term empirical data on migration patterns in response to environmental problems. Despite the paucity of data, a recent study by van der Geest et al. (2010) made the link between district-level migration rates and environmental scarcity

and change for three principle migration flows in Ghana. They found that environmental push and pull played an important role in two out of three of these migration systems (north-south migration and cocoa frontier settlement).

2.5 Migration status by region

The table below shows migration status for all regions in Ghana. Overall, 33 per cent are return migrants, while 19 per cent were in-migrants. Among the regions, Greater Accra had the largest proportion of in-migrants with approximately four in every ten residents being in-migrants. In contrast, the level of in-migration was generally low for many regions, particularly in the Upper East (6.7 per cent) and Upper West (6.1 per cent). On the other hand, return migrants exceeded 40 per cent of the population in the Western Region (46.4 per cent), Volta (43.8 per cent) and Eastern Region (41.5 per cent). The proportions of non-migrants exceeded 50 per cent in Brong Ahafo (52.8 per cent) and Northern Region (58.5 per cent) and 65 per cent in Upper East and Upper West (UNDP Human Report, 2007).

Out-migration from the district of origin was unfortunately not captured in the Ghana Living Standard Survey (GLSS). Van der Geest estimated out-migration from the northern part of Ghana, defining migrants as persons who are born in the north and are living in the south of the country at the time of the survey. According to the 2000 census, the out-migration rate for the UWR was 26.9 per cent (Van der Geest, 2011).

The map in Figure 3 clearly depicts a north-south migration pattern. Each of the dots in the map represents 500 migrants. In the north, the white dots represent the number of out-migrants per district. The black dots symbolize the destination areas of northern migrants in the south. The map also illustrates differences within the same region – in the UWR, out-migration is higher in the north-western part (Lawra/Nandom) than in the central-southern part, such as Nadowli (van der Geest, 2011).

Region	In-migrants	Return migrants	Non-migrants
Western	7.4	46.4	46.2
Central	22.7	37.2	40.0
Greater Accra	38.7	15.7	45.6
Volta	7.9	43.8	48.4
Eastern	20.2	41.5	38.3
Ashanti	25.9	28.0	46.2
Brong Ahafo	9.7	37.5	52.8
Northern	11.3	30.2	58.5
Upper East	6.7	23.6	69.6
Upper West	6.1	28.7	65.2
Average	15.7	33.3	51.1

Table 1: Migration Status by region in Ghana (per cent). Source: Ghana Statistical Service: Ghana Living Standard Survey (2008: 50). Adapted from: UNDP Human Report (2007).

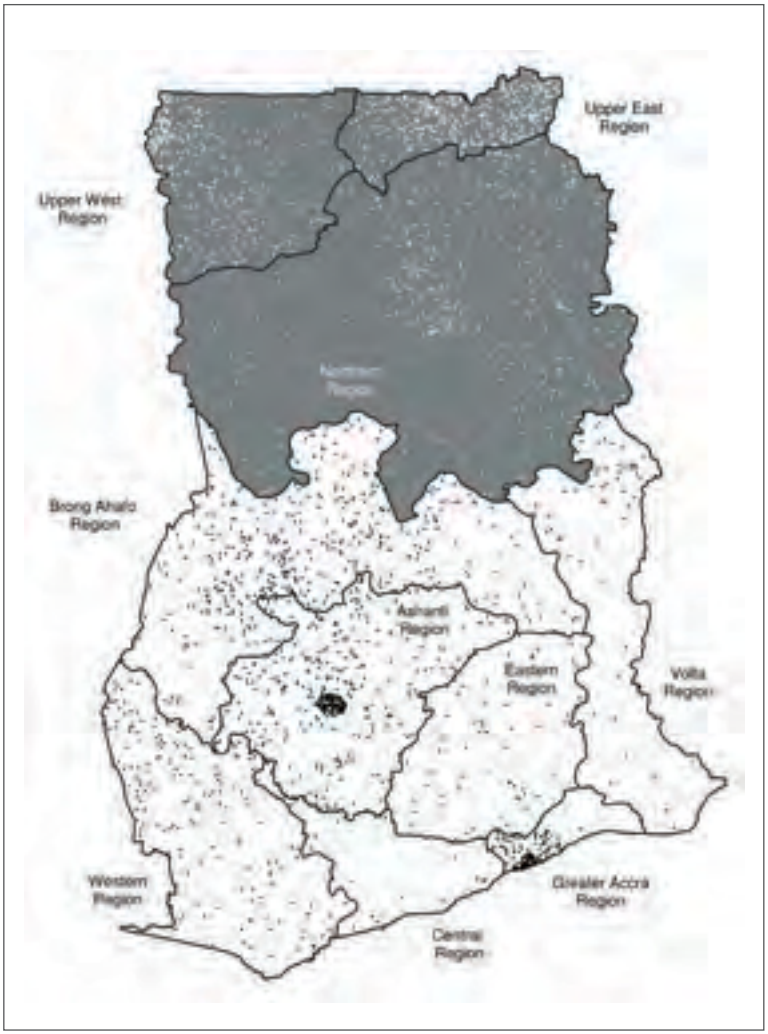


Figure 3: Map of North-South migration in Ghana (2000). Source: Van der Geest (2011: 77). Based on census data (2000) and estimated from Ghana Statistical Service (2005).

2.6 Migration in the Nadowli District

Migration in the northern part of Ghana is not a new phenomenon. It has been practiced both through force as well as by the willingness of people (Abdul-Korah, 2008). During the colonial era, people from the north were forced down south to work in the mines and on cocoa farms. As a result, the north served as the labour pool for the south. However, after the colonial era, migration still continued, this time more on a voluntary basis. The Daagaba were no exception. In his study among the Daagaba of the Nadowli district, Abdul-Korah wites that "while their predecessors were forced to migrate to the south by harsh colonial policies, the Dagaaba men who migrated between 1936 (before independence) and 1957 (independence) did so willingly in the absence of force or coercion" (Abdul-Korah, 2008: 2). According to him, men travelled for two reasons: first, to see the world and gain experience, and secondly, to satisfy their taste for European goods like bicycles, towels, hats, etc. Migration of Dagaaba men was an adventure. This is expressed in part of the title of his article "Ka bie ba yor" which is an incomplete saying among Dagaaba which means "if a child does not travel", it will not gain experience (our completion of the saying). This saying also hints that migration was part of a young man's initiation into manhood. Abdul-Korah argues further that, towards the 1950s, there was a shift of reasons for migration from "travel and see" to economic factors and the need for personal assets. Other reasons included domestic disputes and witchcraft accusation.

2.7 Causes of migration

There are several reasons which account for internal and international migration. Some of these include: the lack of social amenities and employment in the rural communities, unavailability of fertile lands for farming, long dry seasons and the lack of good education (Kwankye et al., 2009). Ominda (1981) lists a number of reasons including the attraction of the areas migrants go to, and the ease of means through which these movements take place. There are also environmental pressures, such as soil depletion, erratic rainfall, drought, floods, as well as other natural disasters. For some people, environmental reasons are the main push factors. According to van der Geest (2011), who carried out a study of northern migrant farmers in the Brong Ahafo Region, the majority of interviewees, in response to the question of why they migrated, mentioned environmental reasons such as scarcity of fertile land, low crop yields and/or food insecurity. Others said it was because of poverty in the north. A few of them also mentioned non-environmental reasons like family conflicts, witchcraft, lack of non-farm income opportunities, and the desire to be free and independent. Very few of the respondents, however, mentioned rainfall variability and climate change.

When household members are confronted with food insecurity, they look elsewhere for a solution and tend to engage in migration as a solution. People from the poorest regions of the country (the three northern regions) migrate to southern Ghana. The northern regions suffer from food insecurity regularly, especially during the wet season prior to harvest, while many households face food shortages. Luginaah et al. (2009) wrote in a study of migrants in Techiman in the Brong Ahafo Region of Ghana that permanent migration from the UWR to the more fertile lands of the Brong Ahafo Region increased where migrants are able to access farmland through different leasehold arrangements. Findings of this study suggest that UWR migrants view their growing settlement in the Brong Ahafo Region to be a long-term phenomenon, and that many of these migrants have no intention of returning to their villages of origin in the UWR due to the poor soils in UWR as compared to the fertile lands in the Brong Ahafo Region. Lugnaah et al. (2009) asserted that the main reason for these migrants to leave their places of origin is to accumulate more food for their families back home in the UWR. They send back food and money as a way of helping relatives to cope with food insecurity (van der Geest, 2011).

Poverty is often cited as a cause of migration in Ghana (Anarfi et al., 2003). What is sometimes missing in the literature is that, though agreeing that migration can result from poverty, it is not always the poorest and most destitute that migrate. Poverty as a cause of migration operates under a selective principle: the poorest are often unable to afford the costs associated with migration. In addition, Awumbila and Ardayfio-Schandorf (2008) argue that poverty may also be a result of migration. In families and communities where husbands and the active youth populations have migrated, poverty among children, wives, elderly people and other dependents may have worsened (Awumbila et al., 2008).

2.8 Poverty in Northern Ghana

According to the United Nations Development Programme (UNDP) Ghana Human Development Report (2007), 28.5 per cent of the Ghanaian population are reported to live in poverty and 18.2 per cent in extreme poverty.

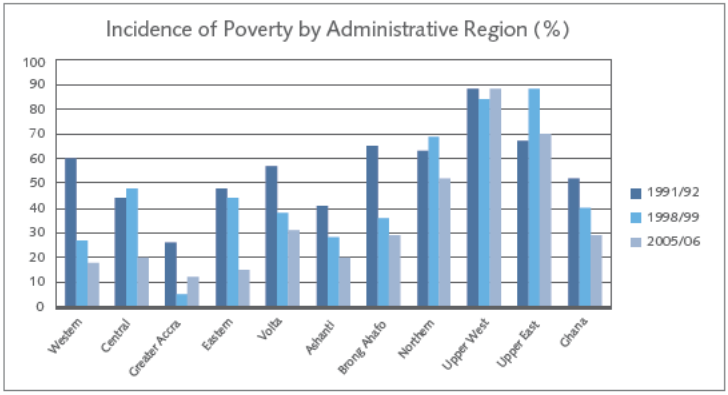


Figure 4: Poverty incidence by administrative region. Source: Adapted from Ghana Human Development Report (2007).

Despite the fact that poverty in Ghana has dropped from 51 per cent in 1991 to 28.5 per cent in 2005/2006, reporting progress at national level does not reveal existing regional discrepancies. The UWR is the poorest part of the country, followed by the Upper East and Northern Region (see Figure 4).

Pickbourn argues that poverty actually increased in the Northern and Upper East Region during the 1990s, whereas in the UWR the high levels of poverty were relatively stable. By 2005/06, the poverty rate in the three northern regions was 62.7 per cent compared to 19.7 per cent in the south of the country. Pickbourn concludes:

"Together, the three regions in the north account for just under 22 percent of the population, but close to 50 percent of the country's poor, and 80 percent of the extremely poor, i.e. those living below the lower poverty line"[3]

(GSS, 2000b; GSS, 2007 in Pickbourn, 2011: 46).

Results from the Ghana Living Standard Survey 5 on per capita income and expenditure reveal striking regional differences. The three northern regions have the lowest per capita income and expenditure levels in the country. The per capita income in Greater Accra Region is more than four times the per capita income in Upper West and East Regions and is almost double the per capita income for the Northern Region. Per capita income in the UWR is approximately one-fourth compared to the national level (the mean annual per capita income at the national level was approximately 400 Ghana Cedis which was equivalent of approximately €166 in November 2005). The per capita expenditure in UWR is

3 Households in the Ghana Living Standard Survey were ranked into quintiles on the basis of total expenditure per capita. Households having an expenditure falling below 50 per cent of average household expenditure were defined as extreme poor.

less than one-third of the national level (being approximately 620 Ghana Cedis which was the equivalent of approximately €257 in November 2005).

Poverty trends differ among the various economic sectors, with the informal sector and agriculture being the worst affected. Farming households were singled out to be the poorest among all other economic activities, with almost half of them (46 per cent) falling below the poverty line (UNDP report, 2007). According to the UNDP report, the poverty line incorporates both essential food and non-food consumption: individuals consuming at levels below this line can be considered unable to purchase enough food to meet their nutritional requirements.

In comparison with the rest of the country, the degree of poverty and underdevelopment in rural Northern Ghana is profound. It is apparent in the very poor health infrastructure, in infrastructure in general, sanitation, electrification and access to water as well as housing and in school infrastructure, leading to high illiteracy rates.

Section 3: Methodology

This chapter presents a brief description of the research objectives and the methods used for this study. It also explains the sampling procedure for both the communities and households. The methodology applied was based on a mix of qualitative and quantitative methods selected by UNU-EHS and CARE International with regard to the aim of the project and the applicability in eight different countries. These included a combination of participatory and non-participatory methods. Different research instruments such as a household questionnaire, PRAs and expert interviews were used to gather primary data (for further details, see Rademacher-Schulz et al., 2012). Secondary data was collected mainly through the review of literature from books, journals and the internet. Rainfall data were gathered from the Synoptic Weather Station in Wa, and agricultural data from the Wa regional office of the Ministry of Agriculture.

3.1 Objectives of study

The "Rainfalls" project seeks to achieve the following specific objectives:

1. Conceptualize the relationship between changing weather patterns (specifically rainfall and shifting seasons), food insecurity, social inequalities (especially regarding gender) and different forms of human mobility.

2. Assess the potential for changing weather patterns to become a major driver of human migration and displacement in coming decades (from the present to 2030 or 2040).

3. Enable a range of stakeholders to influence policies, plans and practical interventions in processes such as the UNFCCC climate talks, the work of United Nations humanitarian and development organizations and specific committees such as the Economic and Financial Committee of the United Nations General Assembly, and regional discussions about human mobility.

The overall goal of this study is to describe the current situation of climate/rain variability, food insecurity and migration in the Nadowli District of the UWR in Ghana and better understand the relationships among the above-mentioned variables. The focus of this study lies on migration as a potential coping strategy used in times of crisis, such as food shortages, and as a mode of adaptation to climate change in general. The central question is under what circumstances migration is used as a risk management strategy of households in relation to rainfall variability and food insecurity. This case study provides evidence about the current relationships and interrelations between rainfall variability, food and livelihood security, and human mobility in Nadowli District. To achieve the above objectives, rainfall patterns for the last 30 years, trends of food production and consumption and migration patterns have been analysed.

3.2 Selection of the study area

Before research started, CARE and UNU-EHS agreed to work in the Nadowli District of the UWR for several reasons: it was known that people's livelihood largely depended on agriculture;

rainfall was reported to be variable; the region suffered from several droughts and floods in the past; migration has been a common phenomenon; and poverty levels have remained high. In addition, Nadowli is considered as a purely rural district in UWR compared to all other districts having bigger towns and thus being more urbanized. Another reason was the existence of only a few irrigation facilities in Nadowli District. More practical criteria included CARE Ghana's presence in the Nadowli District's running programmes as well as travel distances. Within the Nadowli District, Takpo was selected as the main base camp. Even though Takpo is the biggest of the communities selected, there were no accommodation possibilities, so the team spent the nights in Wa, the regional capital of the UWR, 25 km away. Takpo with its 332 households is the centre of the area and has a health care centre as well as primary and junior high schools[4].

CARE Ghana had worked in two of the three satellite communities (Zupiri and Mantari) before. These smaller communities were selected because of their geographical proximity to the Black Volta River, having fishing as an economic activity. It was only found out later that both communities were engaging much more in subsistence agriculture and livestock rearing than in fishing, thus minimizing the differences in the economic portfolio between the selected communities. Inhabitants of Mantari suffered from water problems before CARE Ghana engaged in building a borehole and water pump for the community. Nanville, the second biggest community, was chosen because of its importance as a regional market place. The market taking place every six days attracts people from the whole region as well as traders from neighbouring Burkina Faso.

All four communities were within a 15 km radius of each other thus allowing for minimal differences in the agro-ecological setting and livelihood activities. The communities were inhabited by one ethnic group and thus were relatively homogenous.

As a consequence, research results vary very little from community to community, which is a clear limitation of the study. More information about the Nadowli District and the research sites is presented in Section 4.

3.3 Methods applied

The mixed methods approach of qualitative and quantitative research tools will be briefly outlined here (further information can be found in Rademacher-Schulz et al., 2012).

3.3.1 Household questionnaire

The household questionnaire was administered with male and female respondents who were the heads of households. The respondents from each community were chosen using a simple random sampling technique calculated for each community. Questions were organized in four key sections: a) climate change/rainfall variability; b) livelihood and food security; c) migration; and d) the interplay of rainfall variability, food security and migration and the consequencies of their interplay. Data collection was preceded by a pre-testing of the questionnaire and training for both a national senior researcher and junior researchers to understand and familiarize themselves with the objectives and instruments of the research. During the training, the results of the pre-testing were discussed and challenges addressed. A total of 158 questionnaires were administered successfully.

3.3.2 Participatory Research Approaches

The PRAs were used to complement the information obtained from the household survey, as local participants in the sessions were asked open questions that allowed them to give more details. The groups for the sessions were also chosen randomly

4 In July 2012, Takpo was connected to the national electricity network.

with the help of the contact person at the base camp. The PRA sessions lasted between one and a half to two hours. The main objective of this tool was to get a better understanding of the local realities from the people themselves since they know and understand their locality and environment best. During the PRA sessions, local people were invited to discover and talk about different aspects of their lives in relation to the themes. All PRA sessions were done with mixed-sex groups. Results from pre-testing indicated that mixed PRA groups worked very well and that women adequately expressed their perspectives and perceptions in front of men. In addition, local women preferred having mixed PRA sessions. The mixed PRA sessions indeed were fruitful – sometimes, women and men defended their respective positions in lively discussions, and it took time for them to agree on a common viewpoint. In the beginning, it was planned to have at least some sex-segregated PRA sessions (i.e., mobility maps), but unfortunately this could not be realized due to time constraints.

The group size of PRA sessions varied, ranging from eight to as many as 28 participants. A maximum of eight was originally agreed upon as a reasonable group size by the research team, but this did not work out in most cases. In some communities, it was challenging because it was difficult to stop undesignated people from coming as observers, who in the end became active participants. In order not to appear rude and to show that everybody's view was important, the teams allowed more than eight in a group. In spite of the high numbers, the groups were easy to facilitate, resulting in successful PRAs. Specific PRA tools used included: transect walks; resource mapping; livelihood risk ranking; trends analysis; seasonal calendar; Venn diagrams; mobility mapping; impact diagram; and ranking of coping strategies. It should be added that not all methods were used in all communities due to time constraints (see Annex III).

Focus group discussions with youths and young adults were used to get supplementary information on the questions that were asked during the household survey on youths. Being the future of the communities, these focus group discussions were enquiries into the perceptions and understanding of the youth about livelihood conditions in the home communities, migration and their future plans.

3.3.3 Expert interviews

Expert interviews were held at the national, regional, district and local levels with experts in the three thematic areas of climate variability, livelihoods/food security and migration. In the case of local interviewees such as the teachers, chiefs and returned migrants, these experts had experienced these impacts in their work places and also at their homes. Interviewees were also staff from non-governmental organizations (NGOs), local government offices, the Ministry of Food and Agriculture (MoFA), the University of Development Studies (UDS), WFP, the Environmental Protection Agency (EPA), the Centre of Migration Studies, the Institute of Statistical, Social, and Economic Research (ISSER) and the Regional Institute for Population Studies of the University of Ghana. Altogether, 16 people were interviewed (see Annex II).

3.4 Limitations and challenges of the study

In spite of background information provided by CARE Ghana and the presence of an international researcher from UNU-EHS, the research team was confronted with a number of limitations. First of all, the time for the entire research was short, given the fact that a mix of socio-empirical methods had to be applied.

The selected communities and local authorities were not previously informed about the "Rainfalls" research and household data were not available for sampling. The team needed to introduce the project and organize facilitators to help with practical issues related to research. It was very helpful however, that CARE was well known to the population and thus enjoyed a good reputation.

Another limitation was the unavailability of statistical data at community and district levels. Due to time limitations, there was no time to visit institutions to gather secondary data; and authorities at the District level could not provide us with migration data.

Rainfalls research was conducted in a very limited geographical area, being representative for the Nadowli District only. In order to better understand the relation between rainfall variability, livelihood, food security and migration in Ghana, similar studies in other parts of northern Ghana are necessary.

Another challenge was the length of the questionaire, which lasted between one and 1.5 hours. As a result, fatigue set in for many of the respondents. The researchers had to use encouraging words as a way of maintaining the interest of the respondents. A motivation package made of cups and soap was provided by CARE as an appreciatiation for their time. This was very helpful.

The timing of research, which started in the last quarter of October, coincided with the harvest period that is in general a very busy time for men and women. Women in particular were very busy with harvesting groundnuts, and thus were reluctant to spend many hours in PRA sessions or other research activities.

All junior research team members originated from the region and were from the dominant ethnic group. On the one hand, they were very familiar with people´s situations in rural areas and spoke the local language; conversely, participants anticipating their descent and familiarity with the situation were sometimes reluctant to provide detailed information, as they expected the junior research members to already have an understanding of their situation. These problems were overcome by explaining to the respondents that the research team wanted to learn from them and get to know their specific perspectives and perceptions.

The household survey instrument includes a household definition stressing that household members are generally but not necessarily relatives, normally live under the same roof, eat together and pool their resources including absent members who have not established their own family with wife and children yet (de Haas, 2003). For the Ghana case study, this definition turned out to be a limitation. Several generations and households often live together in one compound, making it difficult to determine household membership. In some areas extended families were predominant, while in others smaller family units are the norm, especially among Catholic Dagaaba. Here, the norm was a nuclear household consisting of a man, his wife and their unmarried children living together and forming a nuclear household. They farm together, have one granary and cook and eat together (van der Geest, 2004). In the research area, people were predominantly Christian and tried to establish their own household soon after marriage. Within the definition by de Haas, extended households were rarely captured as well as whole compounds with differently composed household member units. This was assessed as a serious limitation by the research team. We often interviewed relatively young household heads, sometimes without any migration experience partly due to the early stage of the household life cycle. Households at this stage with young children are less likely to practice migration (only if they were forced to do so in times of crisis), whereas households with older children and a higher number of adult household members had a higher incentive to migrate.

A challenge posed by the use of the EpiData entry mask, a mask specifically programmed to enter survey data, was the limited amount of time to get familiar with the new tool. Being familiar with the Statistical Package for the Social Sciences (SPSS), the team would have preferred to directly enter data into SPSS.

Section 4:
Introduction to the case study area

This chapter provides background information on the UWR and specifically on the Nadowli District in which the research sites are located in Takpo area. Demographic information will be given, followed by economic aspects and vegetation and climate information. Then, information on the household structure will be presented. The last section deals specifically with the research communities in Takpo area where demographic information is given followed by some background characteristics of the 158 surveyed households.

The Nadowli District, which is centrally located in the UWR, covers a total land area of 2,742.50 km². The district was restructured in July 2012, being reduced in size due to the creation of a new district in the northern part of the old district. As our analysis is based on the situation in 2011 with the old district boundaries, they are depicted in the map (see Figure 7).

With regards to the four research communities, Takpo and Nanville are situated along a feeder road to the regional capital Wa. From Takpo, another feeder road leads to Nadowli. Mantari and Zupiri, on the contrary, can only be reached via small earth roads. The small earth road ends in Zupiri, which is located at approximately two km distance of the border to Burkina Faso.

4.1 Nadowli District demographics

In 2010, the Nadowli District had a total population of 96,400 according to the Population and Housing Census. Between 1984 and 2000, the annual growth rate was at 1.5 per cent, whereas it was at 1.6 per cent between 2000 and 2010 (see Figure 5).

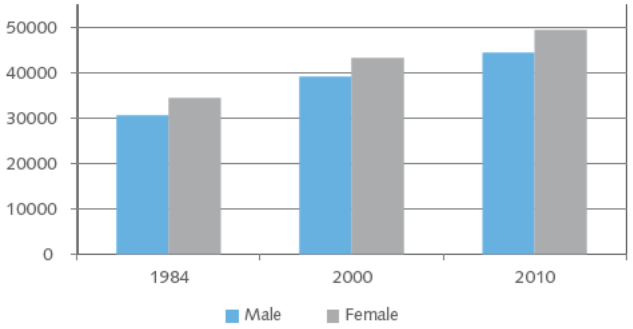


Figure 5: Population growth and trends, Nadowli District. Sources: Population and Housing Census (2000, 2010).

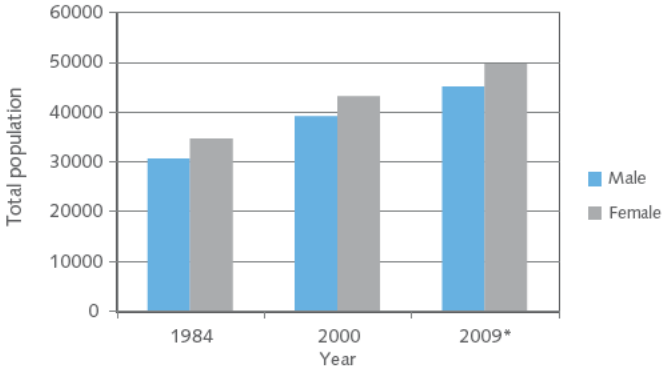


*Figure 6: Sex distribution of Nadowli District 2000–2009. Source: Population and Housing Census (2000) and * District Assembly Projections (2006 and 2009).*

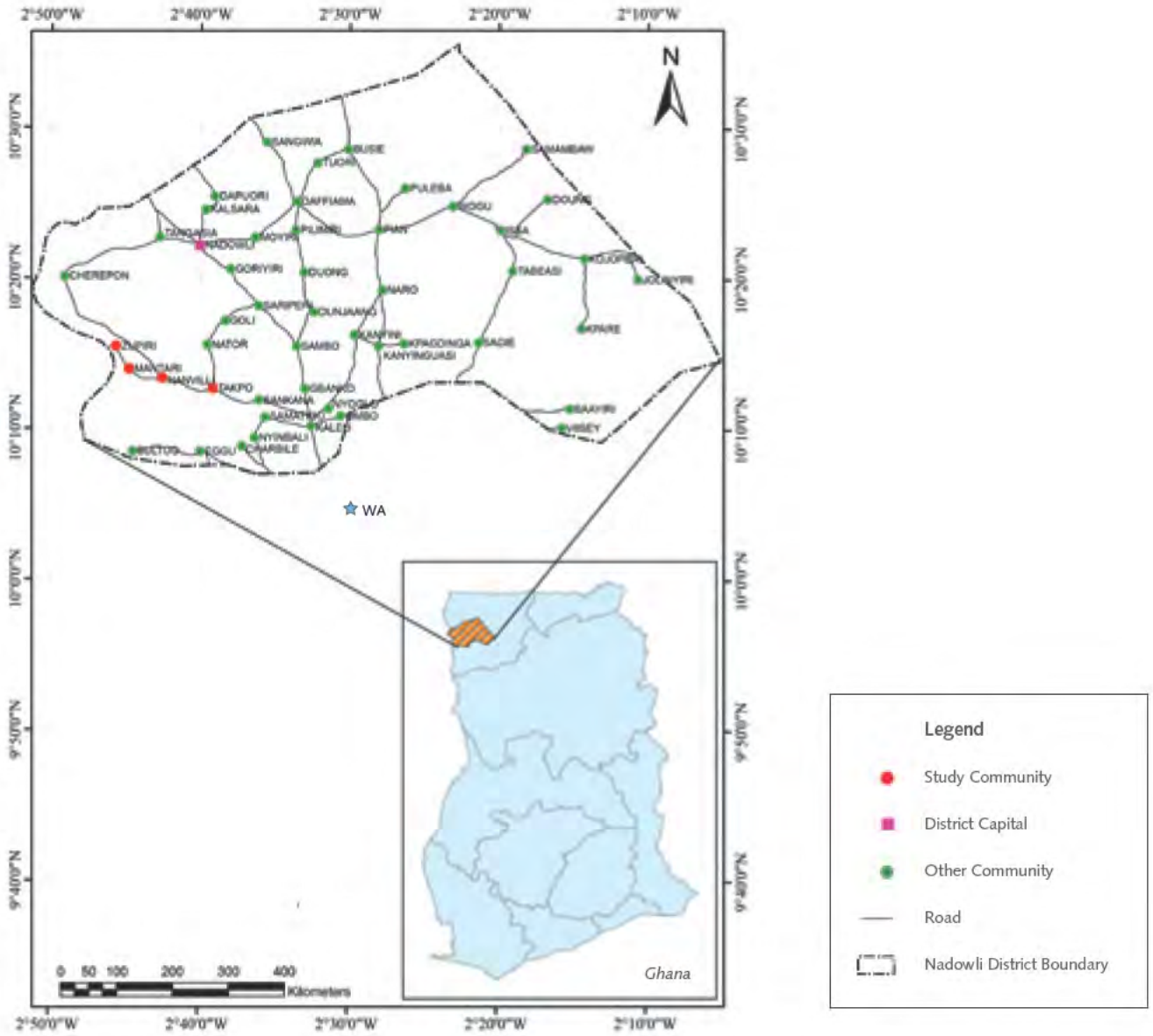


Figure 7: Map of the Nadowli District with the four research communities in Takpo area (District boundaries in 2011). Source: Department of Environment and Resource Studies, University for Development Studies, Wa, Ghana (2012).

The distribution according to age groups throughout the years is 45 per cent of the population aged between 0 and 14 years, 49 per cent of the economically active population and 6 per cent elderly people. The literacy rate in the district is as follows: 69.5 per cent of men and 83.3 per cent of women are illiterate (Ghana Statistical Service, 2005).

4.2 Economic activities of the district

Like in the rest of the UWR, the economy in the Nadowli District is mainly based on subsistence agriculture. According to the Nadowli District Plan (2010a), about 85 per cent of the active population is engaged in this sector, while commerce/service and industry account for 14 per cent and 1 per cent of the population, respectively. The plan also indicates that food crop production in this sector largely remains subsistence with low output levels (see Section 6.1). There are no large plantation holdings in the district. The major food crops are millet, sorghum (guinea corn), maize, cowpea and yam, while cash crops include groundnuts, soybeans, cassava, tiger nuts and chili pepper.

The Nadowli District Development Plan states that about 75 per cent of farmers use traditional methods of farming (cutlass and hoe) and are highly dependent on rainfall for crop production. Only 25 per cent of farmers make use of tractor services, animal drawn implements and irrigation. The district development planner's conclusion is that "these methods of farming do not only lead to the depletion of the soils, but also result in low yield which is responsible for the low income and hence low standard of living, as well as food insecurity in the District" (Nadowli District Development Plan, 2010: 27). Peasants farm plots both far away from the communities and around their houses, these are so-called bush and compound farms. The vast majority of farmers practice mixed/intercropping.

4.3 Vegetation, soil and climate

The district lies within the tropical continental or Guinea Savannah woodland characterized by shrubs and grassland with scattered medium sized trees. The main economic trees found in the district are Shea, Baobab, Mango and Dawadawa (African locust bean)[5] and Teak; all of which except for the Mango tree are resistant to both fire and drought. The Mango, although not resistant to fire is resistant to drought like the other economic trees. These trees are a major source of income for households as women produce different products from them for household consumption as well as for sale. These economic trees provide a potential for the establishment of processing industries to increase employment opportunities for the people. For example, the bulk of Shea butter produced in the country comes from northern Ghana and the establishment of Shea butter processing industries would be very beneficial to the people of the north as well as the country as a whole.

The soil types are laterite, sandy and sandy loam (savannah ochrosols). The Nadowli District Profile's statement about soil quality reads as follows: "They are generally poor in organic matter and nutrients as a result of the absence of serious vegetative cover due to bush burning, overgrazing, over cultivation and protracted erosion" (Nadowli District Profile, 2010b: 20). This assessment coincides with findings from the Duadzes study on land use and land cover changes in the UWR (2004), which states that soils in the Savannah ecosystem are in general of low fertility. Soils under closed and open woodland are of higher quality than soils under cultivated area. Duadze explains this particular low

5 Shea butter and Dawadawa are food ingredients obtained from these corresponding economic trees. These ingredients are the main source of oil and protein for many households in the community. The butter also has some medicinal values and is also used for cosmetics. During the period of food shortage, the women rely on these products as source of income and food to maintain their households.

fertility under farmland by human-induced land degradation due to poor soil management practices leading to increased run-off, soil erosion and "soil mining". The latter refers to "the removal and storage of mineral nutrients by crops in the harvestable parts" (Duadze, 2004: 172f.). Many farmers are not able to use fertilizers to balance the losses in nutrients.

The annual rainfall is confined to six months, starting from May to October and in some cases lasting until the end of October, and is unevenly distributed. Mean annual rainfall is about 1,100 mm and peaking around August (see Section 5.1). From October to March, there is little or no rain, and this long dry season is accompanied by the dry north-eastern Harmattan winds (Nadowli District Mid Term Development Plan 2010a). The district has a mean annual temperature of 32 °C, and a mean monthly temperature ranging from 36 °C in March to 27 °C in August (see Section 5.5). In addition, high temperatures, dry conditions and Harmattan winds encourage bush fires.

4.4 Household structure

Households in the Nadowli District as in other parts of northern Ghana are based on male-headed units of extended families. This means that the most senior male acts as the family head. He has control over other members of the household including their labour (Abdul-Korah, 2004). He also has control over the most important resource, land. The perception is that men fought for the land and should have the right to own and use it. Within the household, there is a division of labour based on sex and age. For instance, while men are responsible for clearing the land and generally taking care of the farm, women are responsible for sowing and harvesting, cooking and child care (see Section 2.2; Pickbourn, 2011).

Within Dagaaba society a trend towards nuclear families is perceived. Van der Geest explains: "There seems to be a trend away from large three-to-four-generation households. Although these generations often still live together in the same compound, brothers, fathers, cousins and uncles increasingly separate their farms and granaries" (2004: 103).

Power is ascribed to men, and the allocation of resources, status and duties between men and women is determined by factors such as descent, succession and paternity. Access to land is therefore mediated by men, who tend to control the decision-making powers of the allocation of resources within the household. In spite of recognizing the role women play in farming, women do not have direct access to land but can be given family land to do their independent farming (Adeetuk, 1995 cited in Abdul-Korah, 2004). Women's access to land was and still is linked to their status as married women. According to a study from MoFA on gender and agricultural development (2001), women in the three northern regions held only two per cent of land (having a social organization based on patrilineal descent), while women in Brong Ahafo (having a social organization based on matrilineal descent) held up to 50 per cent of land (MoFA, 2007 in: Iddrisu, 2010: 12). Land accessed by female farmers is usually smaller and of poor soil quality.

Social organization in Northern Ghana is thus based on patrilineal descent. Gender relations are never static and women, being in a subordinate position, always found ways to challenge and change their position within the family and their communities. During the colonial and post-colonial period, gender relations changed (Abdul-Korah, 2011) and are still changing. One major factor of this is the increasing amount of female migration since the 1980s.

4.5 Background characteristics of survey respondents

The population of the research communities is shown in Table 2 according to the Population and Housing Census in 2000.

A minimum of 150 households were to be interviewed, as was decided by UNU-EHS/CARE. For the selection of the households within the communities, a simple random technique was used under the premise that the population of the study area was homogeneous. This was based on the experience of CARE's work in the area. For the selection, Microsoft Excel was used for the randomization process. The details of the populations and selected households are presented in Table 3.

Table 4 presents some key characteristics of the surveyed households for each community. In our study area, 88 per cent of the households were male-headed and the average household size was seven persons. Survey results showed that 42 per cent of the interviewed households live as nuclear families, comprising parents and their children. These findings coincide with the indicated trend by van der Geest (see Section 4.4). One of the reasons for this high percentage of nuclear families may be that the vast majority of people in the study area were Christian. Furthermore, family type and dependency ratios have implications for the migration behaviour of household members.

The average education level of household members older than 14 years was four years, thus completing primary school. Seventy-seven per cent of the interviewed households had members with migration experience. The majority of households had medium- and large-sized land plots, with an average farm land holding of 8.2 ha.

Name of community	Population of males	Population of females	Total population
Mantari	79	73	152
Nanville	510	643	1153
Takpo	1159	1229	2388
Zupiri	78	98	176

Table 2: Population of selected research communities. Source: Population and Housing Census (2000).

Name of community	Total number of households	Number of households selected
Mantari	24	9
Nanville	190	52
Takpo	332	88
Zupiri	34	9
Total	580	158

Table 3: Selected households and household sizes. Source: Household survey (2011).

Key characteristics of surveyed households	Mantari	Takpo	Zupiri	Nanville	Total
Households interviewed	9	88	9	52	158
Female-headed households	2	14	0	3	19
Female interviewees	3	17	1	11	32
Average age of the interviewees	43	47	41	51	48
Household size (average)	6	7	8	7	7
Average years of schooling of household head	1	2	2	4	3
Average years of schooling of household members aged 14+	2	4	3	5	4
Household income*:					
Below average (<106 GH Cedis)	2	19	2	7	30
Above average (>106 GH Cedis)	0	5	0	8	13
	2	24	2	15	43
Land Category**:					
Number of landless households	1	7	0	2	10
Number of land-scarce households (0.1-1.0 acre)	0	5	0	1	6
Medium land (<5 acres)	4	25	3	20	52
Large land (>5.01 acres)	4	41	5	19	69
Average farm land holding (acres)	6.1	9.5	5.5	6.9	8.2
Households with migrants	7	64	8	42	121

** The mean annual income per capita in Ghana is 397 GH Cedis/cap/annum or 33.1 GH Cedis/cap/month (USD 246 per year; ≈ USD 20 per month). The UWR is the poorest part of the country, which is reflected in the mean annual income per capita being 106 GH Cedis/cap/annum or 8.8 GH Cedis/cap/month (USD 66 per year; USD 5.4 per month). Source: Ghana Living Standard Survey 5 (2008). According to GLSS 5, households falling under 50 per cent of the national average are classified as 'extremely poor'. Comparing the Ghanaian poverty line with the international poverty level being at USD 1/cap/day one can conclude that all households in our study area are considerably below the international poverty line. Still, information given here on poverty depending on information of household income should be looked at with caution. Most interviewees did not want to answer this question. Those who answered often did not give monthly sums, but roughly distinguished between household income in the dry and wet season. Nevertheless, findings from the GLSS 5 coincide with our survey data.*

***21 households did not specify their land size or category.*

Table 4: Key characteristics of surveyed households.
Source: Household survey (2011).

Section 5:
Climate variability

This section starts with analysing annual rainfall and its seasonal shifts. Then perceptions of rainfall variability and temperature by local people are presented, followed by a comparison between these perceptions and meteorological data. Section 5 concludes with the impacts of changing rainfall patterns on livelihood.

5.1 Annual rainfall

The climate in the UWR is marked by a wet and a dry season. According to the data of the synoptic weather station in Wa, the period between 1953 and 2011 was characterized by a mean annual rainfall of 1,036 mm and high inter-annual variability (see Figure 8). The annual minimum was 500 mm in 1986, compared to a maximum of 1,550 mm in 1963, which is known by people of the entire region as a flood year. The five-year running mean of the annual sums shows the alternation of drier and more humid periods. Most striking is the drought period during the 1980s (Dietz et al., 2004). At the end of the 1980s, rainfall amounts increased again. During the last decade, moderately drier and humid years alternated, reaching a maximum in 2008 (1,300 mm), causing severe floods. A clear trend, however, in annual rainfall sums is missing (Dietz et al., 2004). A brief summary of the debate about the recovery of rainfall or the "greening" of the Sahel can be found in West et al. (2008).

The rainfall index (RI) in Figure 9 provides information about the difference of each year's rainfall sum compared to the mean annual rainfall for the whole period (1953–2010). In relation to the annual mean of 1,038mm (RI=0), an RI of 0.2 indicates a 20 per cent "positive" deviation, whereas -0.2 indicates a 20 per cent "negative" deviation in rainfall for the respective year.

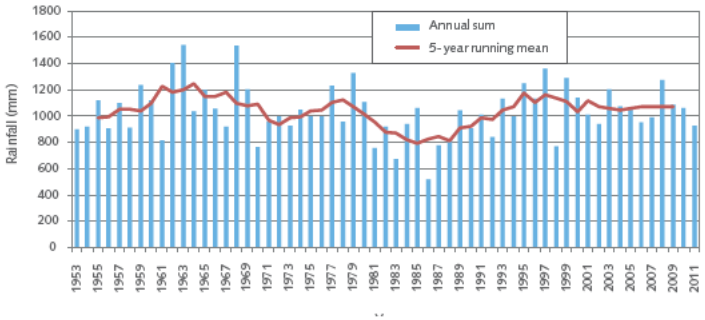


Figure 8: Annual sums and five-year running mean from 1953–2011. Source: Synoptic Weather Station Wa, Upper West Region (2011).

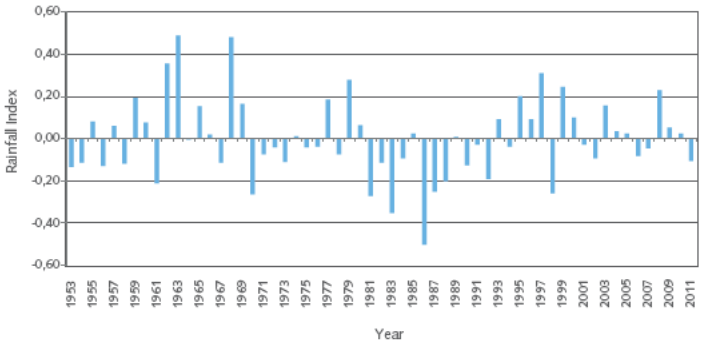


Figure 9: Rainfall index (1953–2011). Source: Synoptic Weather Station Wa, Upper West Region (2011).

From Figure 8 it becomes clear that in some "unusual" years a 40 per cent deviation was recorded in Wa. The years 2008–2011 have been above average with a significantly wetter year in 2008. The knowledge about intra-seasonal rainfall characteristics, such as onset and cessation of the wet season, dry spell and heavy rain probabilities during growing season are much more important for agricultural production than the annual rainfall amounts alone (Dietz et al., 2004, see Section 6).

5.2 Seasonal shifts of rainfall

Figure 10 shows the mean monthly rainfall for the years 1953–2011. Starting in March, the monthly rainfall amounts increase, peak in August and decline in October. The rainy season – explained as Monsoonal rains by Dietz et al. (2004) – is concentrated in the period from April to October, reaching peak levels in August and September. During this time, rainfall intensity can be very high, with rainstorms causing floods and soil erosion.

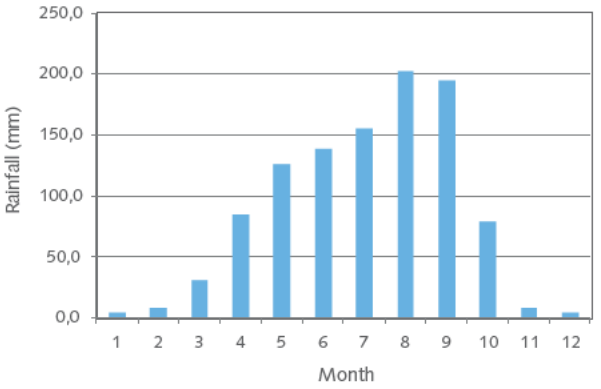


Figure 10: Mean distribution of monthly rainfall throughout the years 1953–2011. Source: Synoptic Weather Station Wa, Upper West Region (2011).

The variability of monthly rainfall is a measure to elucidate inter-annual differences in monthly precipitation amounts during a period of time e.g., several years. For the Wa station all months with substantial rainfall (April–October) were analysed for the decades separately, starting with 1981–1990 to check for trends in the last 30 years. From Figure 11 it can be seen that between April and September the rainfall variability generally is below 50 per cent.

During the last three decades the mean rainfall amount in April, May and August increased, whereas in June, July and October no clear trend is detectable. The three lines show rainfall variability for each month with substantial rainfall (April to October) within a decade.

Rainfall variability decreased during the first months of the rainy season (April/May) in all three decades. From June to August the range of rainfall variability increased and reached its biggest range in August. In September, variability and its range are comparable to June. At the end of the rainy season rainfall amounts decrease significantly which generally correlates with increasing variability starting with October. It is noticeable that in the 1980s the month of June showed the lowest variability, whereas in the 1990s it was reached in July and in the 2000s not before August.

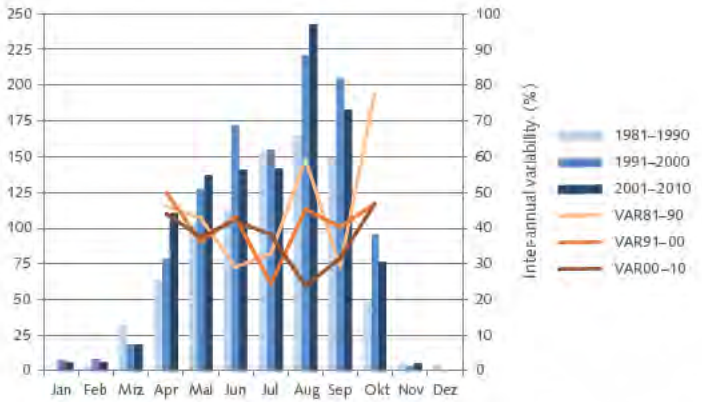
For farmers, a low variability is better suited for planting crops, but other factors need to be considered as well, such as temperature, the growth period of plants and the end of the rainy season. In years where the start of the rainy season is late, farmers need to decide which crops can still be grown before the planting season ends.

A shift in the onset of the rainy season was reported by farmers from April to May. The determination of the onset of the rainy season is of prime importance for sowing and planting (Laux, 2009). Since single rains and intermediate dry periods of several days or weeks do not provide the soil moisture necessary for growing crops, a quick look at the first rainfall to some extent is

not sufficient. Based on existing agro-meteorological definitions and criteria for sufficient rainfall, Laux et al. developed an approach for the determination of the onset of the "wet season"[6] and applied it to meteorological stations of the Volta basin (Laux et al., 2008; Laux et al., 2009, Laux, 2009), and coupled this approach with a crop model in order to derive crop and location specific planting rules, and thus, planting dates at the end (Laux et al., 2010). For the northern part of Ghana (six stations grouped based on statistical criteria, 1961– 2001), Laux found a mean shift of 0.42 days/year at a 99 per cent level of significance. This means that between 1961 and 2001 the mean onset of the wet season was delayed by more than two weeks (Laux, 2009).

For the current study in north-western Ghana, the approach of Laux et al. (2008, 2009) has been applied to the daily rainfall data of station Wa (1961–2010). Compared to the results for the Northern Ghana region, this single station exhibits no clear trend in the onset of the wet season (see Figure 12). What can be stated from Figure 11 is that at Wa station, there is a lower variability in the onset of rains during the 1960s and 1970s, followed by a more pronounced fluctuation beginning in the 1980s. For the last five years the onset was delayed compared to the five years before (2001–2005) but except for the late start in 2007 the onset was in the normal range that could be observed during the last 50 years.

The mean onset of the period that matches the agro-meteorological criteria to be called "wet season" was 10 June (day of the year 161). In 90 per cent of the analysed data the onset began between 21 April and 5 August (days of the year 111 and 217). As described above, the term "wet season" differs from the more commonly used "rainy season".



*Note: Variability was calculated as "STANDARD DEVIATION / AVERAGE * 100%" for months with substantial rainfall (April-October).*

Figure 11: Monthly rainfall (mm) and inter-annual variability (per cent) during the last three decades for the Wa station, Upper West Region (1981–2010). Source: Synoptic Weather Station Wa, Upper West Region (2011).

6 Laux defined the onset to be the first date in the year, for which the following three constraints are valid simultaneously:

1) A total of at least 25 mm of rainfall are observed within a five-day period
2) The starting day and at least two other days in this five-day period are wet (at least 0.1 mm of rainfall recorded)
3) No dry period of seven or more consecutive days is occurring in the following 30 days. This constraint is marking the false start criterion (Laux 2009: 56).

This should be considered while interpreting Figure 12. A late – sometimes extremely late – start does not mean that there was no rain before; instead, it indicates in the respective year conditions for an early start of rain-fed agriculture were unfavourable.

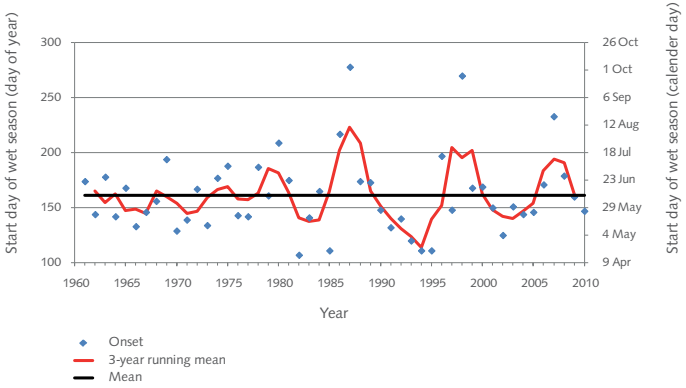


Figure 12: Onset of the wet season for the Wa station, Upper West Region (1961–2010). Source: Synoptic Weather Station Wa. The onset was calculated by Laux based on agro-meteorological criteria (Laux et al. 2008; Laux 2009).

5.3 Perceptions of rainfall variability and temperature

Research also focused on the participants' perceptions of the changing local climate and the resulting implications for people's livelihoods. Results from PRA sessions and from the household survey show that their main perceptions of the changes in rainfall include:

- the rainy season starts later (shift from April to May);
- the rainy season is shorter and contains more and longer periods of dry spells;
- extreme weather events increased (storms, floods, droughts);
- the climate has become less predictable.

Results from the household survey document that 92 per cent of the participants perceived changes in the rainfall pattern over the period. Only 1.3 per cent of them did not observe any changes. The rest of the participants could not answer this question because of their prolonged absence from the region mainly due to migration. Details on the results are found in Tables 5 and 6:

Eighty-seven per cent of the respondents perceived more droughts or dry spells during the rainy season. Sixty-five per cent observed more extreme weather events, but perceptions on flood and heavy rainfall are not that unambiguous. Of the respondents, 41.6 per cent perceived less heavy rainfall events whereas 35.8 per cent perceived an increase.

A more pronounced picture is given in Table 6, differentiating the nature of climatic changes.

According to most respondents, dry spells increased and lasted longer, whereas the rainy season was shorter than in the past. In addition, 42 participants perceived more rain at unexpected times of the year, especially during the planting season. Unfortunately, perceptions about the start of the rainy season were not included in the household survey. Information on the onset of rainfall was captured in PRA sessions and expert interviews. Results from the survey do not reveal a correlation between the perception of rainfall changes and the age of the household head.

Climatic changes	More drought/ dry spells?	%	More flood?	%	More heavy rain?	%	More extreme weather events?	%
Yes, a lot more	20	36.4	11	36.4	6	11.3	14	27.5
Yes, more	28	50.9	12	50.9	13	24.5	19	37.3
Same as before	7	12.7	11	12.7	12	22.6	15	29.4
No, less than before		0.0	5	0.0	22	41.6	3	5.9
Did not exist at all		0.0	13	0.0		0.0	1	2.0
Total	55		52		53		51	

Table 5: Perception of climatic changes over the last 10–30 years. Source: Household survey (2011).

During these discussions, people claimed to have observed changes in the timing, amount and intensity of rainfall over the years. A participant in the PRA impact diagram session in Nanville said: "Rainfall now is unpredictable, it stops when it is needed and it rains when it is not needed." People complained that at critical stages of the crop cycle, there was either no rain or too much rain, thus negatively affecting plant growth and crop yields. Respondents also claimed that the onset of the rainy season has shifted from April to May. During a seasonal calendar PRA session, one respondent in Nanville explained: "We are now struggling. Many years ago, things were better. We knew when the rains would start and end but now nobody knows. It keeps changing." Similarly, in another PRA session in Takpo, a person said: "Now nobody understands God. Things don't happen as they used to."

Rainfall change	Yes
Longer rainy season	3
Shorter rainy season	84
More rain at unexpected times	42
Longer dry spells	92
Shorter dry spells	29
More dry spells	77
Total	327

Table 6: Perception of rainfall changes over the last 10–30 years. Source: Household survey (2011).

A 71-year-old man from Nanville said: "Rainfall was very favourable in the last 10–20 years compared to today. One could cultivate small parcels of land and harvest a lot. Today, the rainfall is very unpredictable; we would rather farm larger land sizes and harvest little."

Others report heavy storms proceeding rainfall that in some cases lead to the destruction of fields, crops and houses. More heavy rain is reported to cause water runoff rather than being absorbed by the soil, thus causing erosion.

Similar to the responses during the household survey and the PRA sessions, all expert interviewees agreed that there have been significant changes observed in the country as a whole and in particular in the northern region. They specifically pointed to changes regarding the onset of the rainy season, its intensity and length. According to the Regional Agricultural Extension Officer in Wa, the rainy season used to begin in April and would continue until September. Nowadays, he claims that the rainy season starts in May and continues until September/October, with a few rains in December before the dry season takes over completely. Currently, it would be very difficult to predict the onset of the rainy season as well as its end. These changes directly affect the start of the planting season and the agricultural cycle. Some farmers sow early, others sow late, and, depending on the pattern and a number of other factors such as soil fertility and sunshine, yields can be "good" or "bad". Another strategy farmers are applying is spreading risks of crop failure by spreading out the timing of sowing on different fields (van der Geest, 2004).

5.4 Comparison of people's perceptions and meteorological data

Some of the people's perceptions regarding rainfall variability during the last 10 to 30 years can be compared to meteorological data from Wa climate station. Annual amounts of rainfall during the last 60 years (see Figure 8) do not indicate a clear trend either to increase or to decrease, but a more variable climate in general with alterations between more humid and drier periods. Figure 11 clearly depicts this variability. During the last decade, the floods of 2008 are outstanding. People's perceptions of changes in the amount of heavy rainfall events are split: 33 per cent observed an increase, whereas 49 per cent perceived a decrease, and 19 per cent did not perceive any changes. Further analysis on heavy rainfall events will be presented in Section 6.

Monthly rainfall data for the last 60 years (see Figure 12) does not support an increase in variability – no clear trend towards a higher or lower variability can be detected. These findings can be in part explained with results from Simelton et al.'s study on African farmer's perceptions of erratic rainfall:

"Perceptions of rainfall can be confounded with impacts on yields, changes in the agricultural system that have made the crops or the farming system more sensitive to rainfall changes, or combinations of both. Impacts on yields may be indirectly associated with, or aggraved by, adverse climatic conditions, such as pests, delayed planting, or totally unrelated to climatic conditions, such as access to farm inputs"

(Simelton et al., 2011: 22).

A maize farmer will perceive climatic events different than a millet farmer or a pastoralist. As mentioned in the quotation, perceptions may be confounded by the impacts of rainfall as well as the fact the people may remember more recent and extreme weather events better than past events. People unconsciously tend to romanticize the past. In addition, external non-climatic factors should be taken into consideration, such as structural adjustment programmes, national agricultural and food security policies and living standards that may affect the farmers' access to subsidies and inputs resulting in more unstable yields (Simelton et al., 2011). Given these constraints, it is still important to investigate farmer's perceptions of change, since their actions are based on how they perceive changes. Meteorological data alone cannot explain people's behaviour.

Another perceived major change was the delay in the onset of the rainy season, which has been analysed for station Wa. Looking at this climate station alone, no clear trend could be detected, thus contradicting local perceptions. Results from the Glowa Volta project for northern Ghana, on the contrary, show a delay of more than two weeks between 1961 and 2001 (Laux, 2009). The local perception might be influenced by the situation of the last five years marked by a delay in the onset of the wet season compared to the situation five years prior. In general, perceptions cannot simply be judged as "wrong" as they are social constructs as rightly pointed out by Meze-Hausken (2004).

Thus, perceptions may show a statistically low correlation with the underlying meteorological conditions. Social constructions are shaped by cultural models, experience and knowledge (Eguavoen, 2012).

Table 7 provides a summary of the local perceptions with regard to climate variability and contrasts them with biophysical observations. They coincide with results from recent studies on perceptions of climate change from Burkina Faso showing a larger inter-annual variation in the rainy season and a greater inter-annual rainfall variability (such as Nielsen and Reenberg, 2009; Nielsen and Vigh, 2012; West et al., 2008) and results from the Glowa Volta project in the Upper East Region of Ghana (such as Laube, 2011; Laux et al., 2008).

In Central Burkina Faso, a study by West et al. (2008) revealed that farmers observed a long-term decrease in rainfall and an increase in rainfall variability. The distribution of rainfall during the rainy season is of particular importance to farmers, especially the number of "big rains" (or heavy rainfall events), the frequency of dry spells and the duration of rainfall events – they form key criteria used by farmers to evaluate the nature of the season. Farmers formulate their expectations for the harvest based on observed rainfall patterns and the performance of crops during the planting period. The authors lacked daily rainfall data to compare local perceptions about the distribution of rainfall in the planting season with the meteorological records, but could prove some perceptions with the help of monthly and annual rainfall data. In our study of the Nadowli district, having daily rainfall data for Wa climate station from 1981 to 2010 allowed us to analyse the distribution of rainfall during the rainy season (results of this analysis can be found in Section 6.1).

Nielsen and Reenberg (2010) investigated the perceptions of climate change in a village in northern Burkina Faso and created human-environmental timelines between 1950 and 2008,

	Peoples' perceptions	Bio-physical observations
Quantity of rainfall	More rain at unexpected times	Ambigious/no clear trend
Onset of the rainy season	Later start (shift from April to May)	Delay of >14 days (1961–2010, Laux) for Northern Ghana, not for Wa climate station
Intraseasonal rainfalls characteristics	• Shorter rainy season • Increase in dry spells	• Confirmed • Slight increase in dry spells during planting season (comparison 1990s and 2000s)
Occurence of extreme weather events		
• Heavy rainfall/floods	• Floods: ambigious • Heavy rainfall: increase	• Heavy rainfall: increase of events >50 and 100 mm this and last decade
• Droughts/dry spells	• Droughts: increase	• Slight increase dry spells during planting season
• Wind/storms	• Storms: increase	• No data
Temperature	• hotter weather nowadays	Rise in mean annual temparature confirmed

Table 7: Comparison of local perceptions and biophysical observations. Source: Survey, PRA sessions, expert interviews, climate data; Laux (2009); Jung and Kunstmann (2007); van de Giessen et al. (2010).

looking at climatic and non-climatic drivers of change, natural resources and agriculture as well as livelihood diversification. They show that the importance of migration, small-scale commerce, vegetable gardening, development projects and livestock rearing has co-evolved with a diminishing importance of rain-fed cereal production. Nowadays, the villagers depend only to a small extent on cereal agriculture for their food supply. The authors conclude that changes in livelihood can be best understood by looking at the co-evolution of different driving factors over time. These findings contrast with our study, as in Takpo area there are hardly any other employment opportunities apart from agriculture and livestock rearing and no means of irrigation.

Barbier et al. (2009) in their study on farmer's adaptation strategies in Northern Burkina Faso emphasized that farmers were mostly interested in particular characteristics of the rainy season, but less in total rainfall amounts or trends. The interviewed farmers stressed the importance of rainfall on crop and animal production and were able to easily rank the impact of different aspects of the rainy season (occurrence of dry spells, intensity, duration and regularity) on specific crop yields. It was more difficult for them to explain their adaptation strategies as they thought that nothing much could be done to mitigate risks. Changes in farming practices were not attributed as adapting to climate change. Their adaptation strategies are consistent with findings from this study, as they contain animal sale, food reduction, diversification, crop modification and migration (Barbier et al. 2009: 798, see Section 8.2). In contrast to this study, farmers increasingly use dry season irrigation as an alternative to migration which is in line with Schraven's study on irrigation and migration in the Upper East Region of Ghana (Schraven, 2010).

5.5 Perceptions of temperature change

In relation to temperatures, respondents said that there is much more heat than before. Although they were unable to provide exact temperatures, some of the interviewees also mentioned that temperatures were very high. March used to be the hottest month in northern Ghana, but now it is difficult to say so. From February, they claimed, it begins to get very hot.

Figure 13 shows the mean distribution of monthly temperatures for the last four decades. The hottest months of the year are February to April with mean average temperatures of more than 30 °C.

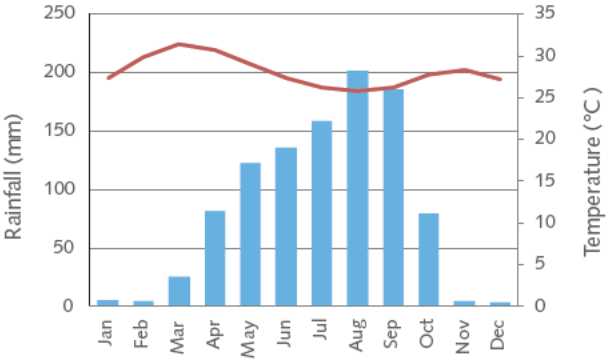


Figure 13: Mean monthly rainfall and temperature for Wa station (1970–2010). Source: Synoptic Weather Station Wa, Upper West Region (2011).

Temperature data from Wa climate station confirms the respondents' perception of an increase in mean temperatures during the last four decades. The mean annual temperature shows a trend of +1.6 °C between 1970 and 2010 (see Figure 14). Temperature rise obviously has an impact on agriculture, leading to higher evapotranspiration, reduced soil moisture, etc.

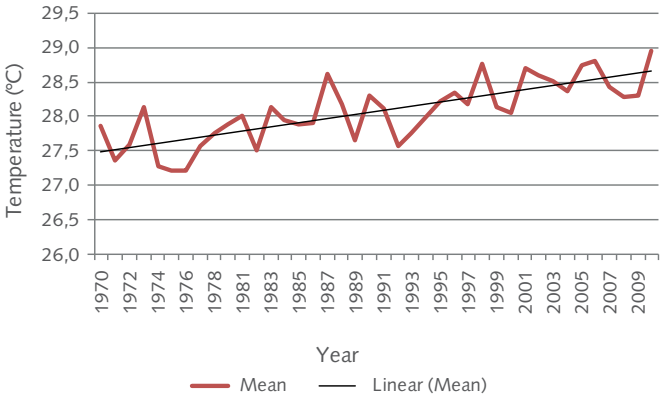


Figure 14: Mean annual temperatures and linear trend from 1970–2010. Source: Synoptic Weather Station Wa, Upper West Region (2011).

5.6 Impact of changing rainfall patterns on livelihood

This research also focused on the effects of perceived changes in rainfall patterns on the livelihood of local people, being primarily subsistence farmers. Linkages between climate change and livelihood were explored, tackling economic activities in general, as well as food production and water availability.

Table 8 illustrates the effects of rainfall variability on food production, the general economic situation of households and water availability.

The majority of respondents (92 per cent) indicated that changing rainfall patterns have a big effect on food production, their main economic activity. Linked to this, 89 per cent of respondents reported that climatic changes negatively affected the economic situation of households in general. Survey analysis does not reveal a correlation between the perceptions of the effects of rainfall changes on the economic situation of the household and the age of the household head.

Respondents of the survey did not perceive a direct linkage between changing rainfall patterns and water availability for the household (63 per cent), since all households fetch water for domestic consumption from boreholes. They acknowledged a strong linkage when it comes to drinking water for their animals, as they drink from the ponds and other bodies of water nearby. Tables 9 and 10 illustrate in detail the effects of changes in rainfall on the economic situation of the household and its food production. Ninety-two per cent of the respondents reported a decline in crop yields, negatively affecting the economic situation of the household (see Table 8). Animal production declined as well (37 per cent), thus reducing the "safety valve" in times of crisis when people sell livestock in order to buy food from the market. This decline in crop production affected food prices. According to participants, food prices rise every year (37 per cent) and make it difficult for them to buy food to feed their families. In terms of food production, 98 per cent of the respondents reported a decline in crop production (see Table 9). All other effects are minor.

Those respondents who have current migrants in their household said that changing rainfall patterns also affected remittances negatively. Many migrants seasonally worked as farmers in other regions, and they perceived changes in rainfall in their destination areas as well.

Eighty-five per cent of the respondents claimed that, during the last 5 to 10 years, they were unable to cater for the food needs of their families throughout the year, and the situation according to them seems to be "getting worse". Results from different PRA sessions affirm these impacts. In Nanville, participants (including a teacher who mainly drew the diagram and the chief of the community) created an impact diagram session of climatic

Changing rainfall affects ...	food production	%	household economy	%	water availability of household	%
Yes, a lot	144	91.1	141	89.2	21	13.3
Yes, but only little	10	6.3	11	7.0	34	21.5
No, it does not affect us	2	1.3	5	3.1	99	62.7
Not applicable	2	1.3	1	0.7	4	2.5
Total	158	100	158	100	158	100

Table 8: Rainfall variability affects food production, household economy and water availability. Source: Household survey (2011).

changes on their livelihood, differentiating between direct and indirect effects. The creation of the diagram was preceded by discussions on the current situation of the climate. It centred on shifting rainfall patterns (see Figure 15).

This PRA session particularly tackled all three major variables in the "Rainfalls" project research and illustrated their relations and interconnectedness according to local people's perception. In particular, respondents reported three direct impacts of rainfall variability. The direct impacts were seen to be the direct visible/observable outcomes of heavy storms (being part of rainfall variability), namely the destruction of crops, economic trees and houses. Indirect observable impacts resulted from the destruction of crops, economic trees and houses. They included a lower household income, poor housing/living conditions, food shortages or hunger, diseases and migration of household members. Similar results were reported by Tschakert and Sagoe (2009) using mental models in Ghana. The indirect impacts of storms/rainfall variability were not further sub-divided by the PRA participants.

First, poor crop yields were seen as one major direct impact of rainfall variability (onset of rainy season, dry spells, floods, storms), while indirect impacts included food shortages, hunger, disease and finally, migration.

Secondly, the damage or destruction of fruit trees like Shea or Dawadawa was perceived to be a direct impact of storms. Lower or no yields from economic trees resulted as indirect impacts in a lower household income, food shortages, eventually hunger, and finally migration.

The third direct impact of rainfall variability that participants mentioned was the destruction of buildings, i.e., due to floods. Indirect impacts could be loss of life, but more often included

Effect on economic situation of household	Count	%
Lower crop yields	146	92.4
Increasing food price	59	37.3
Less livestock production	58	36.7
Others	3	1.9
Substitute market products	2	1.3

Effects on food production	Count	%
Decline of crop production	154	97.5
Increase in crop production	0	0.0
Decline of fodder production	4	2.5
Increase in fodder production	5	3.2
Decline of pasture plants	1	0.6
Increase in pasture plants	1	0.6
Shortage of water for animals	6	3.8
More water for animals	1	0.6
Less fish production	2	1.3
More fish production	0	0.0
Others	1	0.6

Tables 9/10: Effects of changing rainfall on economic situation of the household and its food production (n=158).
Source: Household survey (2011).

Impact of rainfall variability and storms on local livelihood
Perceptions of PRA participants in Nanville

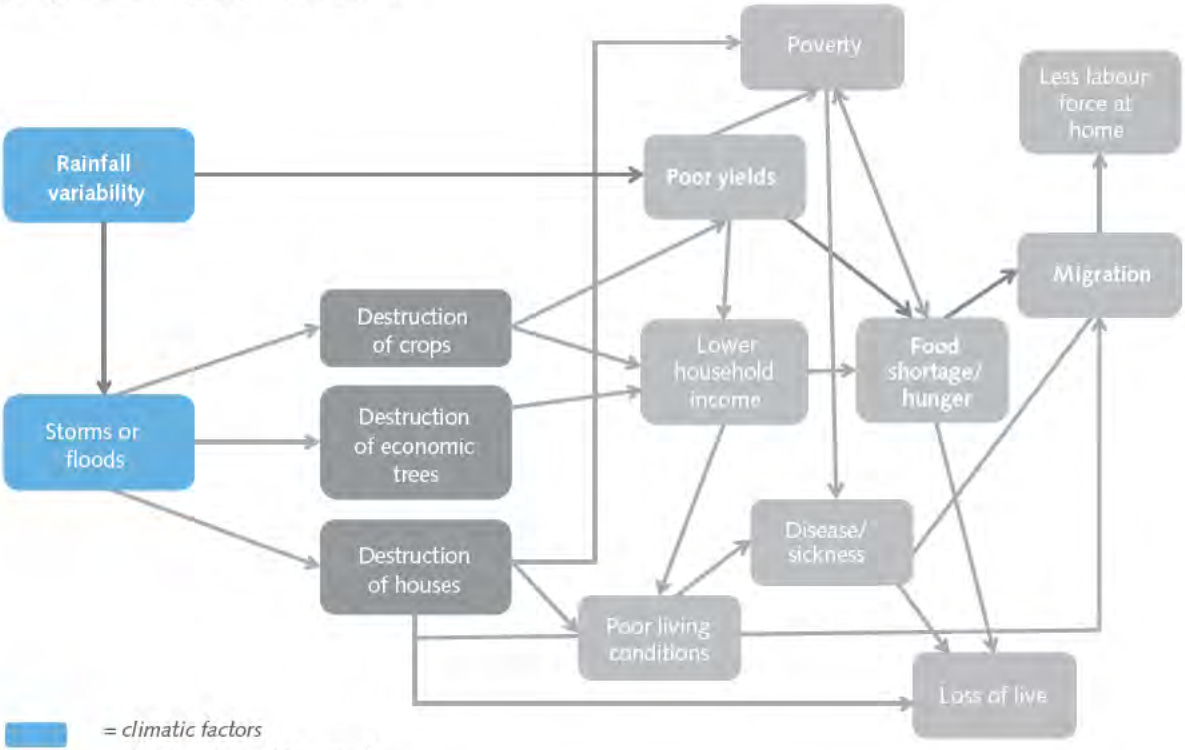


Figure 15: Impact diagram in Nanville (scheme).
Source: PRA session (2011). Design by Rademacher-Schulz and Rossow.

the temporary reconstruction of demolished houses using little financial resources. This in turn resulted in poor living conditions for inhabitants, and thus frequently caused health problems.

Migration was mentioned as an indirect impact, mainly resulting from food shortages or hunger, but also being linked to poor living/housing conditions and poverty. A negative impact was mentioned as the drain of active labour force, especially the young ones being away, and a stagnating community development. Taking into consideration the dangers to which migrants might be exposed at the destination, the indirect impacts can be death or migrants coming home with illnesses.

The impact diagram exercise shows how participants of the study understand causal relations and the impact of rainfall variability on their livelihood. Their view of connections and relations resembles in many aspects our scientific understanding. This is an interesting finding, as participants did not mention cultural or religious reasons and consequences at all, as demonstrated by Eguavoen (2012). PRA sessions aim at reaching a consensus among the participants to represent people's perception. If the results and the depiction of causal relations was influenced by the fact that the community chief was present and by the fact that the diagram was drawn by a teacher remains unclear.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Section 6:
Livelihood and food security

Section 6 presents the main sources of livelihood of households in the study area (agricultural and livestock production) and changes over time. An emphasis is placed on the impact of rainfall on crop harvests for famers, as it is the basis on which farmers decide to begin the planting season. The distribution of rainfall during the planting season is analysed in detail to assess the potential impact on crop production. Following this, agricultural production and market price development are explored. Background information on food insecurity in the study area and local challenges to food security are also analysed. The section concludes with presenting challenges in the agricultural sector.

Information presented in this section has been derived from own data (survey and PRA sessions), secondary data and statistical data (specifically agricultural and rainfall data).

6.1 Sources of livelihood

Households in the Nadowli District are highly dependent on subsistence agriculture. As mentioned before, approximately 85 per cent of the population is employed in agriculture, with the majority of farmers relying on traditional methods for crop cultivation. Since the district lies in the Guinea Savannah zone, the majority of the year is dry, with only one main rainy season from May to September. Due to the low level of development of irrigated agriculture in the district, dry season farming is limited. Close to Takpo area, near Sankana, a dam has been developed for irrigation purposes, but in the research communities there is no irrigation agriculture.

Though not on commercial basis, irrigation facilities (small dams, dugouts and boreholes) exist in some parts of the UWR, mainly supported by NGOs such as Plan Ghana and the Global Water Initiative. Plan Ghana has irrigation projects in the Sissala West and East districts. Farmers and dam users of these districts in the UWR have recently been introduced to drip irrigation technology to help improve their livelihood. The drip irrigation technology incorporates a pipe system to ensure water gets to the roots of plants in a piece of land for gardening during the dry season. The Global Water Initiative also has some irrigation projects with some villages around Nadowli and Lawra. While men use this facility for the cultivation of rice and staple food crops, such as millet and sorghum, maize, groundnuts, as well as some tree crops, such as Mango and Cashew, women use it for vegetable cultivation and sometimes rice cultivation. Dry season irrigated production is used to supplement basic foodstuffs with small amounts of vegetables and fruit tree production. Irrigators use water to produce additional crops for the lean season between April and June/July, the end of the dry season and early wet season before rain-fed crops can be harvested. The irrigation facility does not only provide food for the people but also some financial gains when farmers sell surplus production. In a study in the Upper East Region, Schraven focused on people using shallow groundwater irrigation in the dry season to plant tomatoes, which turned out to be a quite successful adaptive strategy as it enabled farm households to improve their living standard. As this form of irrigation is realized by the supply of knowledge, land and labour within kin groups and is not cost intensive, it has become an alternative to migration (Schraven, 2010; see Section 6).

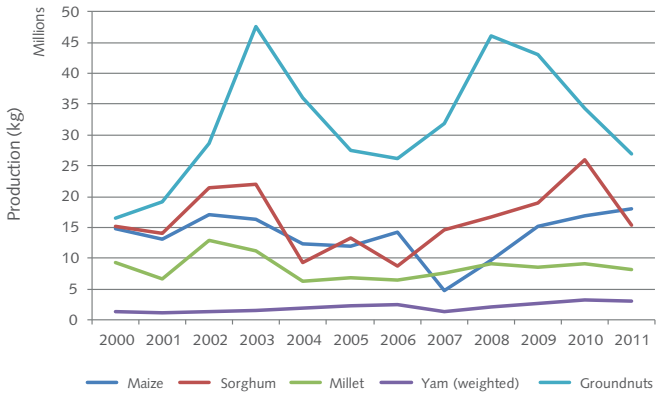
Although government programmes to develop small dams and dugouts (shallow ponds) have been in existence in the UWR for up to 20 years, the Ghana Irrigation Development Authority (GIDA) databases show only 83 have been constructed, and most of these do not have any surface irrigation system. With the exception of eight small dams in Sissala West district, and up to 10 others scattered throughout the Region, small reservoirs serve as groundwater recharge systems, a water source for manual irrigation, and cattle watering points rather than a reliable source of gravity irrigation (Inkoom, 2011).

From both household surveys and PRA sessions, farmers said their success or failure in crop production depended heavily on the onset of rain each year and whether there will be dry spells or not. A good onset with minimal dry spells according to them will bring good crop yields. This finding is in line with van der Geest (2004). A farmer's cropping strategy is heavily based on the onset of the rains each year and is often a gamble to predict whether the year will be dry or wet. In the case that the farmer predicts incorrectly, crop harvests will fail in that year. In reality, however, farmers spread the risks (West et al., 2007; van der Geest, 2004).

Agricultural production at district and regional level

This study investigates perceptions about crop yields, self-sufficiency and food security throughout the year, rather than surveying agricultural production and the complex factors encompassing food security. Results from PRA sessions and interviews show that farmers complain about insufficient crop yields to secure the household throughout the year. They indicated that they typically face food shortages during the wet season prior to the next harvest. These local concerns will be compared with agricultural production data published by the MoFA.

Figure 16 illustrates the total production values for staple crops (maize, millet, yam, sorghum) and groundnuts in the Nadowli District between 1999 and 2011.



** Yam production is expressed in grain equivalents (output divided by 3.5, based on FAO nutritive factors, FAO 2010. In: van der Geest, 2011: 153)*

Figure 16: Production of major crops in Nadowli District, 1999–2011 (in kg). Source: MoFA (2010).

Total production values (in kg) depict fluctuation for all four staple crops below 25 million kg throughout these 10 years, while production of groundnuts fluctuated significantly over this period with an overall positive trend. The production of the staple foods millet, maize and sorghum does not show a clear trend, whereas yam production increased with the exception of the year 2007. The good production data for groundnuts, sorghum and maize in 2003 and 2008 can be linked to the positive rainfall anomalies depicted in Figure 9. It becomes clear that farmers in the Nadowli district are producing significantly more cash crops in 2011 than in 2000. The most important incentive for this production increase is getting cash to buy food, which is why respondents made a conscious effort to increase production by increasing acreages. Farmers also stated that the chances of succeeding in

groundnut production are higher than with other crops. Production increase could also be partially explained by crop rotation. Crop rotation is quite a common practice among farmers in the region to minimize the extractive effects of any particular crop on soil nutrients while gaining from the additive effect of other crops. In this case, groundnuts (a leguminous crop) are sometimes planted after some years of planting maize so as to benefit from their nitrogen fixing. The crop production data for groundnuts in 2010 and 2011, however, show a significant decrease. This decrease can be attributed to the negative rainfall anomaly in 2011, shown in Figure 9. During field research, farmers were especially complaining about the bad groundnut harvest due to unfavourable climatic conditions.

Figure 17 provides an overview of production in Nadowli and the entire UWR between 2000 and 2009. The comparison between production trends of aggregated major food crops (maize, millet, sorghum, yam and groundnuts) reveals that Nadowli district produces more on aggregate than the whole UWR on average. These data coincide with results from an interview with a regional extension officer from MoFA who described the Nadowli District as a district with very good farming lands "that could be considered as the food basket of the Upper West Region. It is less densely populated than other districts and does better in terms of crop yields".

Although generally the Nadowli district benefits from a relatively low population per hectare, one reason for the inter-annual fluctuation in crop production may be attributed to annual rainfall conditions (see Figure 18). Given these favourable conditions in comparison to other districts of the UWR, farmers in the research area still complain of being food insecure during certain months each year (Quaye, 2008).

Figure 18 shows the monthly rainfall figures for 2000 to 2009 against production, acreage and yield for five crops (maize, millet, sorghum, yams and groundnuts). These indices were calculated

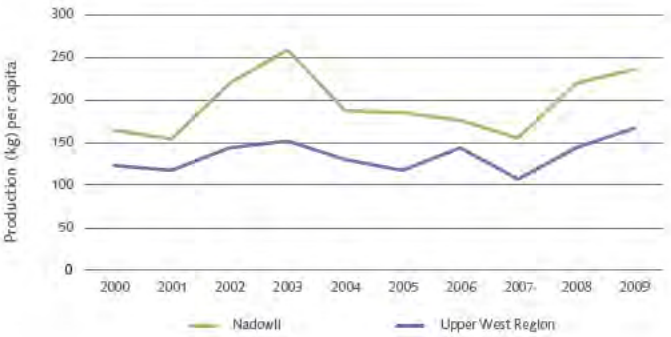


Figure 17: Production of major crops in Nadowli and the whole Upper West Region 2000–2009 (in kg). Source: MoFA (2010).

Figure 18: Annual rainfall and production, acreage and yields for five crops in Nadowli 2000–2009. Sources: MoFA (2010); Wa station data from Meteorological service of Ghana (2011).

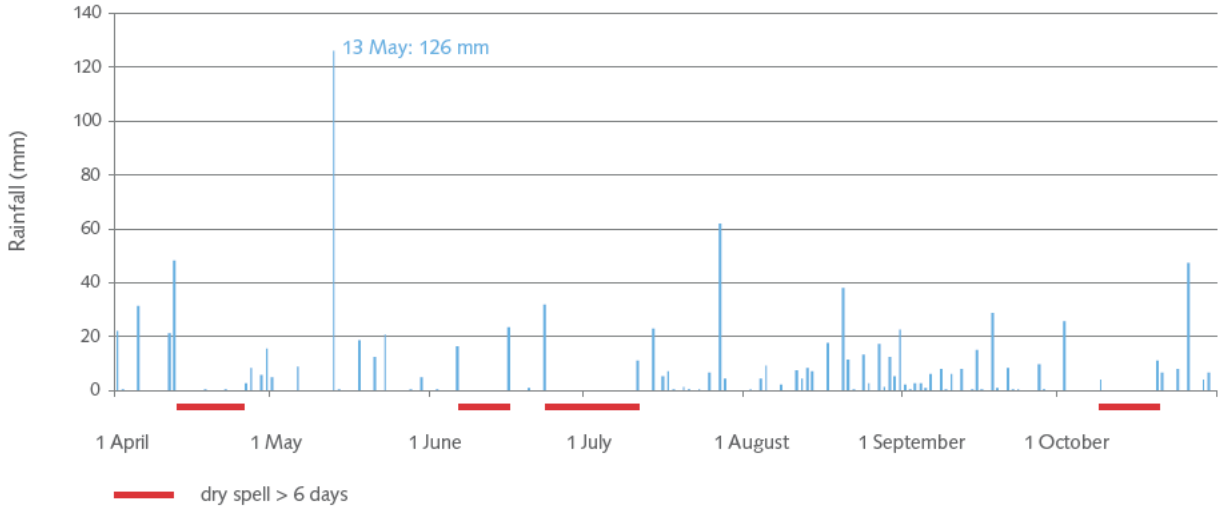


Figure 19: Monthly distribution of rainfall in the planting season, April–October 2007. Source: Synoptic Weather Station Wa, Upper West Region (2011).

using yearly averages for all five crops, acreage and production data then expressed as a percentage of the 10-year average. There is a positive correlation between production, acreage and yield and the average annual rainfall during the rainy season. It is important not to base yearly harvest predictions on crop yield figures alone because: "In the case of a total failure for a certain crop, yields may not show a sharp decline because yield data are measured in plots that are harvested" (van der Geest, 2004: 74). Similar to his analysis of the UWR, it is found that in the Nadowli District higher rainfall does correlate to greater harvests. In a comparison of acreage and yields, it becomes clear that from 2004 onwards the crop yield index is higher than the acreage index. One possible explanation for this positive development (with the exception of 2007) may be that agricultural programmes run by MoFA and NGOs resulted in an increase in crop yields. Information given by a regional extension officer from MoFA reveals that farmers in the area learned to practice "tie ridging" of their fields to better keep moisture in the plots. Cowpeas were also introduced to supplement the traditional beans, as well as improved and early maturing varieties of food crops.

Rainfall distribution during planting season

The availability of daily rainfall data for Wa station from 1981 to 2011 allows us to analyse the distribution of rainfall during the planting season in terms of intensity, duration, dry spells and heavy rainfall events. Looking more closely at the decline in crop yields in 2007, one may attribute the timing of rains to disrupting the planting season for major crops.

The monthly distribution of rainfall (see Figure 19) reveals that there were four instances of rain at the beginning of April (more than 20 mm) and one significant peak of high rainfall occurring in mid-May (126 mm). Following this, the region experienced little rainfall in the summer months with June receiving only two instances of rainfall (23 mm, 16 June and 32 mm, 23 June 2007) after or before two prolonged dry spells between 7 and 15 June and between 24 June and 10 July. Here, a dry spell is characterized by more than six consecutive days without rain with a threshold of 1 mm for a rainy day (Laux, 2009). Laux (2009) studied the probabilities of dry spells in the whole Volta region and presented results for Bole[7] using rainfall data from 1961 to 1999. He concludes:

"The minimum dry spell probabilities hold a regional maximum in northwest Ghana and southwest Burkina Faso (~30%). In these regions, dry spells occur more likely within the following 30 days, so that there is an enhanced risk of crop failure"

(Laux, 2009: 77).

In July and August, only two rainfall events above 20 mm in each month were recorded (on 27 July 82 mm and on 20 August 38 mm). The annual sum for rainfall in 2007 was 991 mm, which is below the long-term annual mean of 1038 mm. More important for farmers, however, is the distribution of rainfall within each of the planting months of the year. We lack information about the actual timing of farmers to start planting, but comparing rainfall data with production outcomes, the year 2007 was an unfavourable year for agriculture both in East and West Africa. Dry spells followed by heavy rainfall led to food shortages in 2007 and consequently to price increases (Laux, 2009). When discussing crop production, it is crucial to analyse the rainfall amounts and rainfall distribution around timing of planting. Looking at annual rainfall sums, 2007 may not have appeared that different for crop harvesting than 2006, but it was due to dry spells and heavy rainfall events at crucial times of the plant cycle. The yield drop in 2007 can certainly not exclusively be explained by the dry spells that occurred during the planting season. Different plants have different water needs during their growing stages and water availability is not the only factor that should be considered. Further research is required to clarify these relationships.

An analysis of daily rainfall data for the last 30 years with regards to dry spells (see Figure 20) shows a high dry spell occurrence in the 1980s during the Sahelian droughts (with the exception of 1982). The 1990s display fewer dry spells in general and a high variability. In the last decade, a relatively high occurrence of dry spells can be found, which is higher than in the 1990s, but not as high as during the drought period. Comparing the last two decades, the farmers' perception of an increase in dry spells during the planting season can be verified with rainfall data using the approach by Laux. A dry spell is defined as a period of more than six consecutive days with a threshold of 1 mm for a rainy day (Laux, 2009).

Study participants reported an increase in heavy rainfall events compared to the past. An analysis of heavy rainfall events during the planting season (Figure 21) does reveal low amounts of rainfall and only few heavy rainfall events in the 1980s during the Sahelian droughts. The 1990s show a recovery with an increase in rainfall events above 20, 50 and 100 mm with a peak in 1997. The last decade does show a similar development in rainfall above 20 mm, but also an increase in rainfall above 50 mm. This supports the observation of farmers of an increase in heavy rains. Extreme events with rainfall above 100 mm are very rare, but occurred twice within the last two decades.

7 Apart from the two climate stations at Ejura and Bole, this pattern approximately reflects a north-south distribution, which follows the movement of the Intertropical Convergence Zone (Laux 2009: 77).

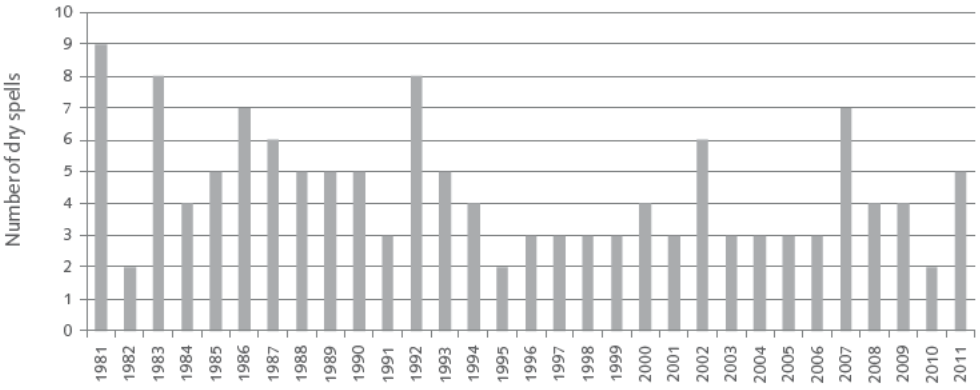


Figure 20: Number of dry spells in planting season (April–October) 1981–2011. Source: Synoptic Weather Station Wa, Upper West Region (2011).

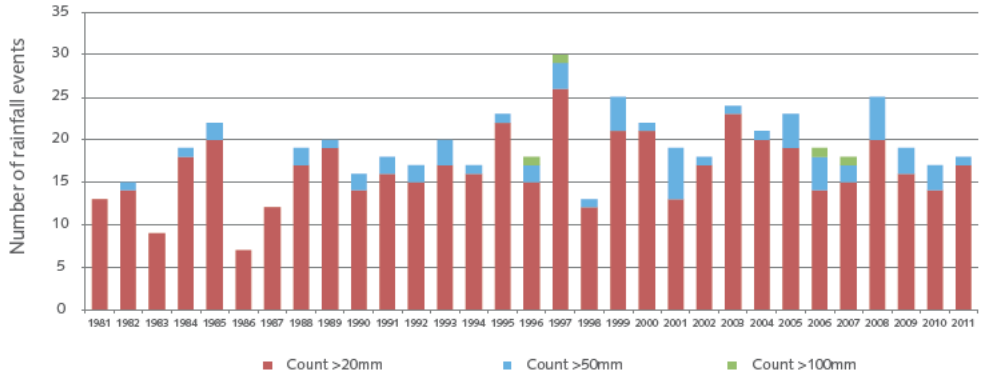


Figure 21: Number of heavy rainfall events in planting season (April–October) 1981–2011. Source: Synoptic Weather Station Wa, Upper West Region (2011).

Food prices development

Most households in the study area try to harvest enough food from their own farm to secure the household's food needs throughout the year. In the past, many households ran out of food stock during the wet season prior to harvest and were forced to buy grains from markets. Participants of the study were complaining about high food prices especially during the lean season, which makes it difficult for them to buy food from the market. A comparison with market price data from Wa market for the years 2005 to 2009 reveals price increases of the staple foods maize, millet and sorghum during the lean season between May and July. Unfortunately, market price data from regional or local markets such as Nadowli or Takpo are not available. Available data for Bussie market for the years 2007 to 2009 north of the research area are patchy and do not provide information for all major staple and cash crops.

Prices for maize (see Figure 22) between 2005 and 2009 show a similar trend with a decline in April and peak in August. Since the UWR has one harvest per year, the decline in April may be attributed to imported maize stocks from southern Ghana since farmers there are able to plant twice a year. With respect to the peak in August, higher prices are to be expected since farmers in the north and south have not yet harvested (apart from early maturing maize). Thus, the stock of maize is relatively low, driving up prices.

Millet (see Figure 23) and sorghum (not displayed here, but showing a similar pattern) are not produced in southern Ghana as is the case with maize, which is why prices mainly follow the seasonal calendar of the north, with early harvests beginning in October and November. These findings coincide with farmer's observations of price increases, especially during the lean season when they run out of food stocks and go to the local markets to buy grains.

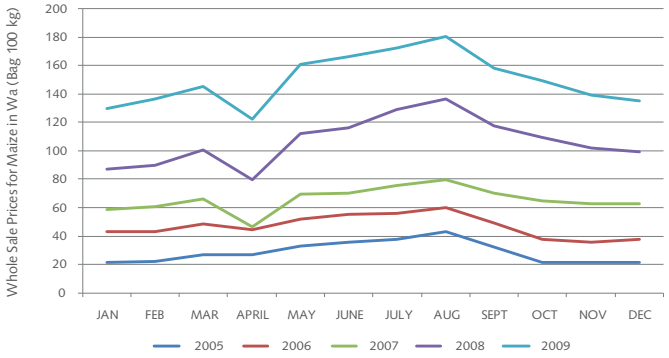


Figure 22: Price development for maize, Wa market, 2005–2009. Source: MoFA price data (in Ghana Cedis) (2011).

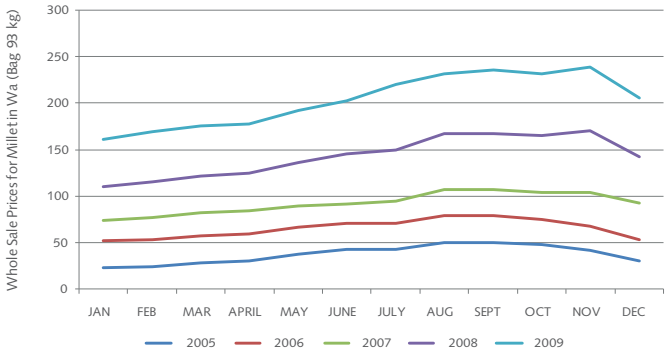


Figure 23: Price development for millet, Wa market, 2005–2009. Source: MoFA price data (in Ghana Cedis) (2011).

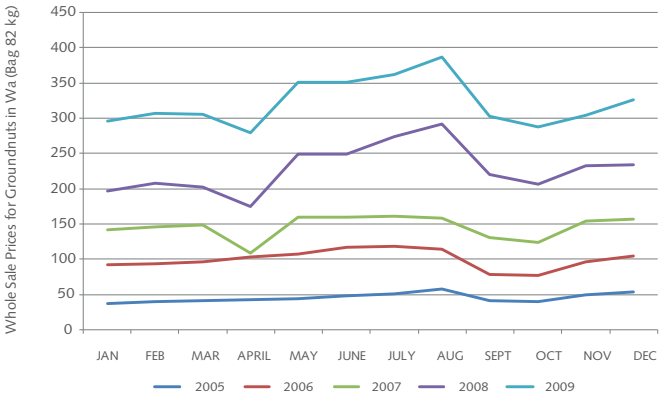


Figure 24: Price development for groundnuts, Wa market, 2005–2009. Source: MoFA price data (in Ghana Cedis) (2011).

Groundnuts are sowed between April and May and harvested between October and November (see Figure 24). An explanation for the upward price trend between October and December may be that farmers try to store the nuts after harvest and keep them as long as possible to realize higher prices. Two explanations may explain the price decline in April: One possible reason is oversupply; the other may be pest infection due to inadequate storing facilities, which lowers the quality and subsequently the price.

Al-Hassan and Poulton claim that farmers continue growing staple crops for fear that prices of these crops will be unaffordable in a "bad" year (2009: 3). Their strategy is crop diversification and the production of staple and cash crops. Looking at price development of maize and millet, crop diversification is a necessary strategy for farmers to secure the households' food consumption.

Livestock rearing in Nadowli District and research communities

Apart from crop cultivation, livestock rearing is the second most important pillar of the local economy. Livestock census data from Nadowli District between 2008 and 2010 show a general increase in livestock production. Sheep and goats are the most important ruminants for farmers.

According to the Nadowli District Development Plan (2010), the vast grazing lands in the district allow most households to engage in livestock production.

Livestock census figures from the district (see Table 11) show that livestock production between 2008 and 2010 increased for sheep, goats and cattle, while there was almost no increase in pig production. The most significant increase is in poultry production due to vaccination campaigns. Apart from poultry, sheep and goats are the most important ruminants owned by famers in the Nadowli District. According to Nadowli District Development Plan, the district has not been able to optimize livestock production "though there exist great opportunities for increasing production" (2010: 30).

	Livestock				
	Cattle	Sheep	Goats	Pigs	Poultry
2008	4,157	8,217	8,935	9,871	18,015
2009	5,357	9,457	9,943	9,967	22,234
2010	5,987	9,909	10,009	10,087	43,987

Table 11: Livestock census figures in Nadowli District, 2008–2010. Source: District Agricultural Development Unit, Nadowli (2010). (http://mofa.gov.gh/site/?page_id=1677).

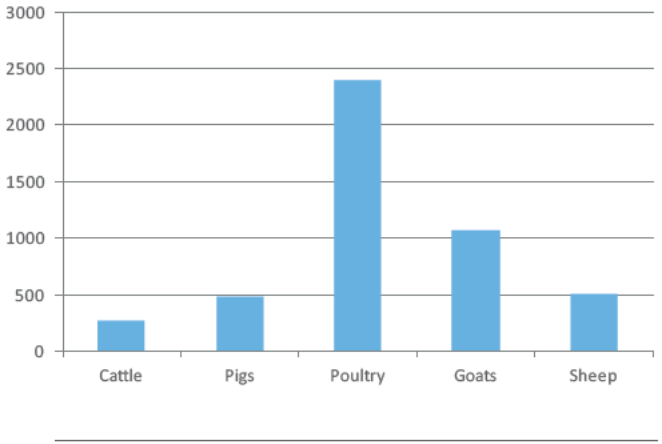


Figure 25: Livestock production in four research communities in Nadowli District, 2011. Source: Household survey (2011).

The situation in the four research communities shows a similar pattern. Figure 25 shows that the surveyed households in Takpo, Nanville, Zupiri and Mantari own poultry, goats and sheep, which is consistent with the information provided in the PRA sessions and interviews. Again, goats and sheep are the most important small ruminants. Only 17 households (6.3 per cent) out of the 158 surveyed households owned cattle despite the fact that cattle are an item for the bride wealth. Five of these 17 households own more than 20 animals, which suggests that these households are relatively wealthy.

Livestock possession serves as a "safety valve" or buffer against crop failure or climatic stress in general. When food production falls under subsistence level, one of the most common strategies of households is selling livestock to be able in turn to buy food from the market. Schraven stresses that the possession of livestock is not only perceived as an insurance investment and an ex ante coping strategy in times of a sudden need, but is also used for important social events, like funerals (2010). According to van der Geest (2004), people sell chicken and guinea-fowl throughout the year, but the sale of small ruminants and pigs has two peaks: first, around Christmas time when demand and prices are high, and second, in or prior to the farming season. With regards to the second peak, farmers either need to sell ruminants to bridge food shortages or to finance farm inputs.

Changes in income sources in research communities

Given this background information on agricultural production and livestock possession, results from the household survey (see Table 12) show changes in the two primary sources of income today as compared to 10 years ago. Farming as the primary income source increased slightly, while livestock as the second most important income source remained nearly "unchanged". Results from the PRA sessions show that people nowadays have fewer cattle due to cattle theft.

Small-scale Pito brewing and selling by women increased slightly, followed by petty trading which is also primarily a female economic activity. Respondents of the survey were also asked to give information about their tertiary activity, but most interviewees said that they only had two main income pillars: nearly 80 per cent of respondents did not reply when asked about their third most important economic activity. Those who did reply mentioned petty trading, charcoal processing, Pito brewing and fishing. Interestingly, only a small minority of household heads considered remittances from migration as principal income sources. One possible explanation for this was that migration is seasonal and remittance flows are relatively low. Participants of PRA sessions mentioned that most migrants remit in kind (mostly bags of maize or millet, but also assets) and not in cash (see Section 7).

Findings show that most households rely on two major income sources and that diversification is minimal. There are few changes between the past and present situation. Many of the small-scale, low return activities are performed by women. The high dependence on rainfall renders most households highly vulnerable to the environmental conditions in which they live. Food insecurity in "bad years" is one of the consequences.

N=158	Primary activity today (%)	Primary activity 10 years ago (%)	Secondary activity today (%)	Secondary activity 10 years ago (%)
Farming	90.5	82.9	5.1	5.1
Livestock rearing	-	-	40.5	41.1
Pito brewing (local drink)	-	-	12.7	10.1
Petty trading	0.6	-	9.5	6.3
Teaching	2.5	3.2	1.3	0.6
Handicrafts	0.6	0.6	3.2	1.9
Charcoal processing and sale	1.3	-	0.6	-
Food/fruit/crop processing and sale	0.6	0.6	1.9	1.9
Fishing	-	-	1.3	1.3
Migration	-	0.6	1.3	-
Mining	-	0.6	0.6	0.6
No response	3.2	9.5	22.2	31.0

Table 12: Changes in principal income sources at household level. Source: Household survey (2011).

Problems of the agricultural sector

Apart from the high dependence on rainfall, the Nadowli District Development Plan states that the district suffers from the following general problems in the agricultural sector:

- poor storage facilities;
- erratic/unreliable rainfall;
- inadequate credit facilities;
- poor farming technology;
- inadequate access to extension service;
- inadequate irrigation facilities;
- infertile soils;
- poor road network from producing areas to marketing centres.

Besides environmental problems regarding soil and rainfall, farmers who apply traditional farming techniques and traditional storage facilities have inadequate access to credit and extensions services, and suffer from a poor road network to marketing centres (Nadowli District Development Plan, 2010a). This in turn may contribute to food insecurity.

6.2 Food insecurity in the study area

The state of food security in the communities was examined using responses from the household questionnaire, PRAs, expert interviews and youth focus group discussions. The authors investigated consumption patterns of the population, food insecure months and coping strategies only. Yet, still the findings coincide in many aspects with the literature.

Findings from the household survey revealed that 79 per cent of the respondents produce food for their own consumption, while 20 per cent produced for own consumption and for sale. Cash crops cultivated by locals in the study area included groundnuts, rice, beans and yam. Rarely did farmers sell maize or millet because they were the staples of the people's diet. As one farmer in Takpo put it: *"If you sell your maize or millet, you will surely buy it again – perhaps sell at a lower price and later buy it at a higher price. Therefore, it is better not to sell."*

Most commonly, if people sold staple foods, it was due to the fact that they needed to pay off debts or for other purposes as stated below. As many as 34 per cent of the respondents said they hardly ever sold their food production. Similarly, 54 per cent said they only sell a small part. Seven per cent of respondents said they sold about half, while 5.6 per cent of them said they sold three quarters of their food production. Those who sold parts of their food production said they sold it during harvesting, when it is cheap just to get money to cater for immediate needs such as school fees or money to travel. Although they knew it would be better to sell it later, they were not able to keep it because of the competing problems and poverty. Even when people do not sell, they may still buy food. One of the respondents summarized the situation, saying "some years are good and others are bad". As many as 21 per cent of respondents said they buy about 75 per cent of their food needs. Thirty-four per cent said they buy about half of their food needs, and 23 per cent buy about a quarter of their food needs from the market. These findings correspond to assessments of experts who say that livelihoods are threatened. This implies that these communities, in spite of their conscious efforts to keep their production for their families, are still threatened by food insecurity. This also had implications on the number of meals per day.

Respondents said that many adults do not have three meals a day, especially during the lean season. According to them, they sacrifice their share for children to have three meals. Even with just two meals a day, a respondent in Nanville said one of the meals could be Pito, which is a sorghum beer. In effect, some adults may only eat once a day. The frequency of meals depends on the time of the year. March/April to August/September are the most difficult months because most respondents said they neither have much of their farm production left nor enough money to buy food. As a strategy, they

reduce quantities in order to manage for the year. Regarding food shortage in the last 5 to 10 years, a 45-year-old household head from Nanville had this to say:

"We have experienced food shortage every year by June. This has mainly been due to poor harvest arising from unfavourable rainfall. By June each year, our food stock runs out and we have no money to buy any foodstuff. The household relies on the sale of livestock and Shea butter to get a little money to buy food. We, the adults, are also compelled to reduce the amount of food we take daily. During this period we are lucky to have wild fruits such as yellow berry and Shea fruits."

This, according to some respondents, could go on until August when early maize and groundnuts are being harvested.

During PRA sessions the local people enumerated not only climate-related factors as causes of their food insecurity situation but also non-climatic related ones. These were: poor soils, continuous use of the same land poverty, bad roads, unemployment, lack of equipment (such as tractors), traditional farming methods/lack of modern farming techniques, cultivation of traditional crops, poor health of their animals as well as thieves.

The seasonal calendar of Takpo (see Table 13) is consistent with findings from the household survey, clearly depicting the lean food insecure season.

As can be seen in the seasonal calendar, the people are engaged in different activities all year round. However, all the activities can be classified as food-related, social or economic. In particular, farming was mentioned as the main livelihood activity. Farming in this area, and for many parts in northern Ghana, starts around December with land preparation for crops such as yam and takes off fully by May/June for most crops. These include millet, maize and sorghum. Usually, by this time, the rainy season has begun. Rice, which needs more water, is grown either in June or July, when valleys and low lands are expected to be very wet. Although respondents mentioned these specific periods for the different crops, they also indicated that the times could vary depending on the year. In some years, the rains come early and are sufficient to begin farming early; in other years, rains may delay the planting season. During the dry season, most male farmers work in private basket weaving for their homes or in maintenance of silos to store their food crops. A few people were also involved in commercial basket weaving, and pottery was mentioned as another economic activity undertaken by women. They make large pots for storing water and smaller pots for storing and cooling for Pito, the local drink. For construction and pottery activities, the dry season is better as the respondents say there are no weather disruptions and pots will dry properly before firing them. The dry season is also the period for community events such as weddings.

Results from the survey show that households facing inadequate food supply also experience insufficient amounts of money, thus rendering them very vulnerable during certain months of the year (see Figure 27). At the peak of the rainy season, dry spells occur, sometimes very severe, withering young plants and food production. This period also happens to be the most difficult period for households as the majority run out of foodstuff. This period is referred to as *nadibo*, which means *"what shall we eat?"* During the lean season between May and August, 75 per cent of the respondents of the survey did not have enough food to meet their household food needs, and 69 per cent of them did not have enough money to buy food either. During the past 5 to 10 years, 85.4 per cent of respondents said they experienced food shortages and only 5.1 per cent said they did not. Some of those reporting that they did not experience food shortages were households that received remittances from other household members.

Table 13: Seasonal calendar of Takpo. Source: PRA session (2011). Design by Fielmua and Mwingyine, 2011.

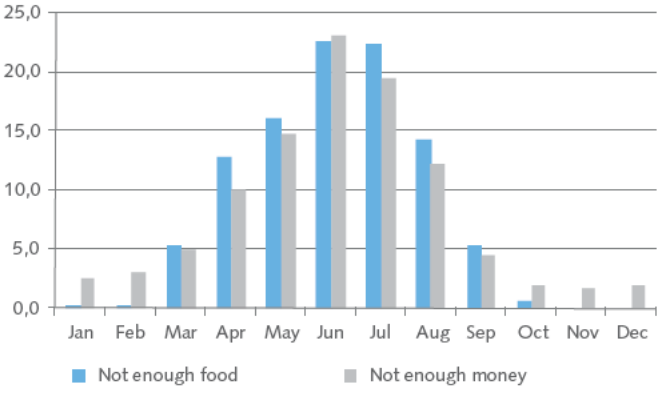


Figure 27: Food insecurity and lack of money during the year. Source: Household survey (2011).

Section 6.5 provides more insights into the coping and adaptation strategies of the population. One common statement when talking about food insecurity is given by a 71-year-old man from Nanville: "My children need to supplement household food needs by migrating to find money."

Challenges to food security

Although the district of Nadowli may comparatively be seen as food secure based on production and acreage figures, there may exist other challenges regarding food security in the district. As mentioned by Codjoe and Owusu in their study of the Afram plains in Ghana, "the challenges of food production, storage and distribution inherited from previous decades largely prevail in Ghana" (2011: 756). Inefficient storage methods and facilities place a heavy burden on households to provide sufficient quality and quantity of food during the lean seasons. In addition, from the household survey data gathered in the Afram plains, household concerns of food insecurity were focused on their inability to meet the nutritional requirements – an aspect not explored in this case study. However, participants of our study mentioned storage problems.

One of the problems farmers are facing is the marketing of their farm produce. Most farmers sell their produce at farm-gate prices because of difficult access to market centres and/or inaccessible farm tracks. This is especially the case in the rainy season when some of the feeder roads are flooded (Nadowli District Development Plan, 2010a) and remote communities like Zupiri are cut off from markets. According to the Nadowli District Development Plan (2010), 85 per cent of the products are sold within the settlements of production, usually at working site. This applies for farm produce and small-scale industrial products. The industrial sector in Nadowli is characterized by small-scale activities which use labour intensive production technology. Activities include basketry, cloth/smock weaving, blacksmithing, Pito brewing, pottery and Shea butter extraction. There are no factories or large agricultural plantations in the district. The majority of small-scale activities (74 per cent) are agro-based, such as milling, Pito brewery or Shea butter processing, or wood-based (11.5 per cent), such as carpentry, carving, weaving or charcoal production. As only 15 out of 154 communities in the district are currently connected to the national electricity grid, most households rely on firewood and charcoal for cooking.

6.3 Social inequalities in the research communities

According to local perceptions, the quality of one's house, formal employment, the possession of a motorbike, as well as livestock ownership are important indicators of the household's economic status. Owning cattle was a distinctive sign of wealth years ago, but since organized cattle theft is common in the region, people tend to have fewer or no cattle. Still, five households own large herds of cattle. A household's capability to be food secure throughout the whole year is also mentioned as a sign of well-

being. Last but not least, the educational level of the household head and the number of children enrolled in school are signs of a higher economic status.

Information on income given in the household survey is scanty and thus a categorization according to household income was not possible (see Table 4). The analysis of formal employment reveals a low level of employment in the formal sector: nine teachers, one Imam, two hairdressers and one dressmaker (probably formal employment), one butcher, one mason and three apprentices that may be formally employed later.

For the analysis of the situation of households in 2011, differentiated indicators according to the sex of the household head, livestock (based on the possession of cows, pigs, goats and sheep) and assets (based on the possession of motorcycles, bicycles, a tractor, water storage basins and mobile phones) were created. The quantity of each item/animal owned was multiplied with its virtual market price[8] and then aggregated. Livestock and asset indicator both form a wealth indicator.

This wealth indicator was plotted against female-headed (n=19) and male-headed (n=138) households. Female-headed households show a mean wealth score of 37.8 (with a standard deviation of 108), whereas male-headed households have a mean wealth score of 60.6 (with a standard deviation of 127). Household survey data analysis reveals that a rich household is characterized by a bigger number of members, especially in working age, a lower mean age, less food insecurity and vulnerability, a male household head and the use of good building materials for the house. Female-headed households show a higher incidence of food insecure months compared to male-headed households.

The bivariate analysis of food insecure months and wealth (being categorized in six percentile-based wealth groups, see Figure 27) shows the tendency that the richer the household, the less food insecure it is.

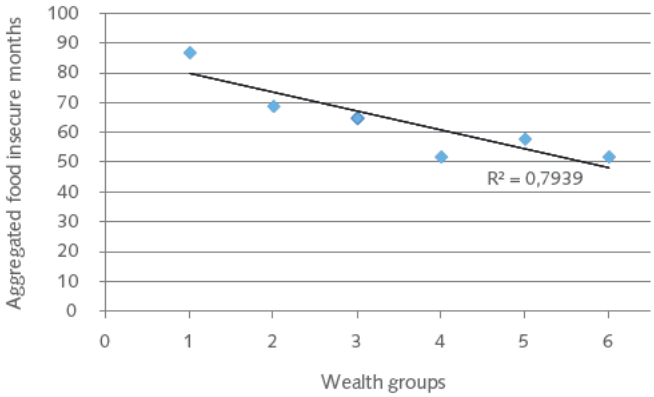


Figure 27: Aggregated food insecure months per wealth group. Source: Household survey (2011).

Further, the wealth indicator was plotted against land possession and sex of the household head. The result looks as follows: 21 per cent of all female-headed households own no land, whereas only 4.3 per cent of the male-headed households do not own any land. However, land possession is not the most important factor for economic status as in many other agrarian societies, since land ownership rights are held by the community and granted by the earth priest to individual families. Even if people are land-scarce or are not granted any land, they can easily farm on somebody else's land. The analysis revealed that the 10 landless households were better off than the 148 land possessing households. However, the reasons for that are manifold.

To summarize, survey data analysis for 2011 revealed that female-headed households are less wealthy, possess less land, have a higher dependency ratio and face higher food insecurity than male-headed households. With regards to the number of migrants, no correlation can be found with the sex of the household head.

8 Virtual prices were used from the Glowa Volta project assessment (Schraven, 2010).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Section 7:
Migration and human mobility patterns

As in the case of data for the first two thematic areas of the study, data on migration and human migration patterns were gathered using the household survey, expert interviews, PRAs and youth focus group discussions.

This chapter contains research results about migration indicators for each community and provides information about mobility patterns and destination areas. It then looks at the economic activities of migrants, their remittance behaviour and sheds light on how households use remittances.

7.1 Migration indicators, patterns and destinations in study area

From the 158 households surveyed, 121 had migration experience (77 per cent), comprising 257 migrants (see Table 14).

In 83 per cent of the households, migration took place due to economic reasons. Like other studies (van der Geest, 2008; Awumbila et al., 2010; Yaro, 2004; Ewumbu, 2011), this study reveals that economic factors are among the most important motives for influencing migration. Results from the household survey show that 75.3 per cent of the participants perceive migration as a normal income-generating strategy (multiple options were possible), whereas 36.1 per cent perceive and use it as a strategy only in times of crisis.

Twenty-five per cent of the respondents were classified as temporal migrants – they moved away for periods of more than six months up to two years, and 36 per cent were seen as permanent migrants who moved away from home for more than two years. Thirty-nine per cent migrated seasonally moving away from home for less than six months and thus form the biggest group of migrants (five per cent were not captured). These findings coincide with results from PRA sessions, clearly indicating a dominant seasonal rural-rural migration pattern. The analysis of survey data revealed that in 2011 seasonal migration was mostly done in the rainy season, contrary to the common pattern to migrate during the dry season (see Section 8.3).

Seventy-seven per cent of the respondents reported current migrants in their households and 32 per cent were returned migrants. With regards to the sex of migrants, 69 per cent of them were male and 31 per cent female. Taking into consideration that women in the region only started migration individually (independent from husbands or relatives) from the 1980s onwards, and that they faced more obstacles as female migration is negatively perceived by their communities, the percentage of female migrants should be seen as high.

The average age at first migration is 23. The migrants' level of education was comparable with the average years of schooling of household members older than 14 at the community level. In Zupiri, the educational level of migrants was better than the average. In addition, 40 per cent of the migrants were single and 53 per cent married.

Figure 28 illustrates the destinations of migrants from our study area. Of the migrants, 97.5 per cent moved to destinations within the country and the rest migrated internationally to Burkina Faso and Ivory Coast[9].

9 Considering international migration between Ghana and the neighbouring countries Burkina Faso and Ivory Coast, there is more immigration to Ghana than vice versa.

Indicators	Mantari	Takpo	Zupiri	Nanville	Total
Households interviewed	9	88	9	52	158
Households with migration experience	7	64	8	42	121
Total number of migrants	17	140	15	85	257
Economic migrants (count)	14	120	13	66	213
Educational migrants (count)	1	10	2	11	24
Sex of migrants					
- Male	12	95	13	58	178
- Female	5	45	2	27	79
Average age of migrants (first trip)	22	22	19	24	23
Education level of migrants (years of schooling)	2	4	5	5	4
Average years of schooling of household members aged 14+	2	4	3	5	4
Marital status of migrants					
- Single	8	48	10	37	103
- Married	8	79	4	44	135
- Other	1	13	1	4	19
Type of migration (based on 1st migration trip)					
- Seasonal	9	49	6	30	94
- Temporal (61) + permanent (88)	8	82	9	50	149
Migration status					
- Current	11	90	12	61	174
- Returned	6	50	3	24	83

Table 14: Migration indicators per village.
Source: Household survey (2011).

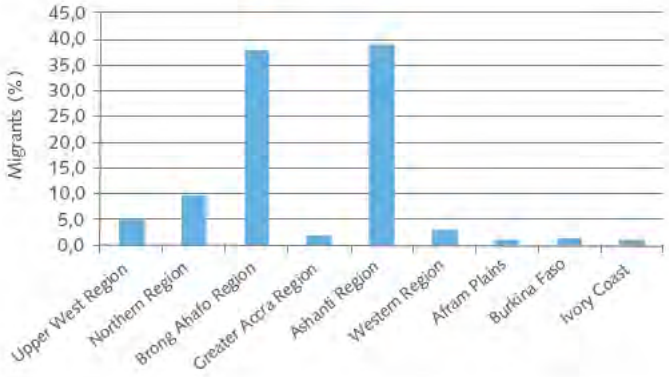


Figure 28: Migrant destinations (per cent) within Ghana and abroad (n=198). Source: Household survey (2011).

Within Ghana, the main destinations for migration included the Brong Ahafo Region (38 per cent) and Ashanti Region (39 per cent), followed by the Northern Region (10 per cent). Brong Ahafo lies in the middle belt, is sparsely populated, and has two rainy seasons and two cropping seasons, with more fertile lands than the northern part of the country. These factors make the Brong Ahafo Region very attractive for migrants from the North as agriculture is the mainstay of the region, too. By consequence, the region has become one of the main destination areas for Dagaaba migrants (van der Geest, 2011). Schraven (2010) emphasizes Brong Ahafo's role as a small bread basket for the whole country. The population of the Ashanti region south of Brong Ahafo is also primarily engaged in agriculture.

Migration in the study area is largely seasonal. Interaction at focus group discussions on mobility and seasonal calendars point out that many migrants move during the dry season and/or during periods of crisis and return to assist households with their farm work when the agricultural season starts. Mobility maps drawn during these sessions confirm that migrants from these communities move within the UWR, outside the region (specifically to Brong Ahafo and Ashanti regions) and, to a low extent, abroad. The mobility maps of Takpo and Nanville (see Figures 29 and 30) illustrate that farming and mining areas within Ghana are the main occupations for migrants in those regions. Farming is mainly concentrated in Brong Ahafo around Techiman, Kintampo and Atebubu, whereas mining sites are found in many southern parts of the country as well as in northern Ghana. While many of the migrants are involved in small-scale surface mining activities commonly referred to as "galamsey" in Tinga-Kwi, Dakupe and Klor around Buipe in the Northern Region or Tongo in Upper East Region, a few migrants are actually employed by mining companies in southern Ghana in places such as Obuasi and Konogo in the Ashanti region and Prestea in the Western region.

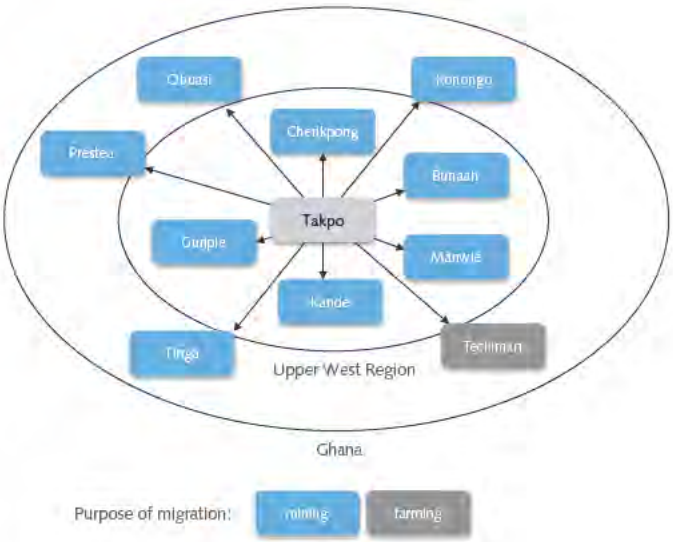


Figure 29: Mobility map of Takpo. Source: PRA session (2011).

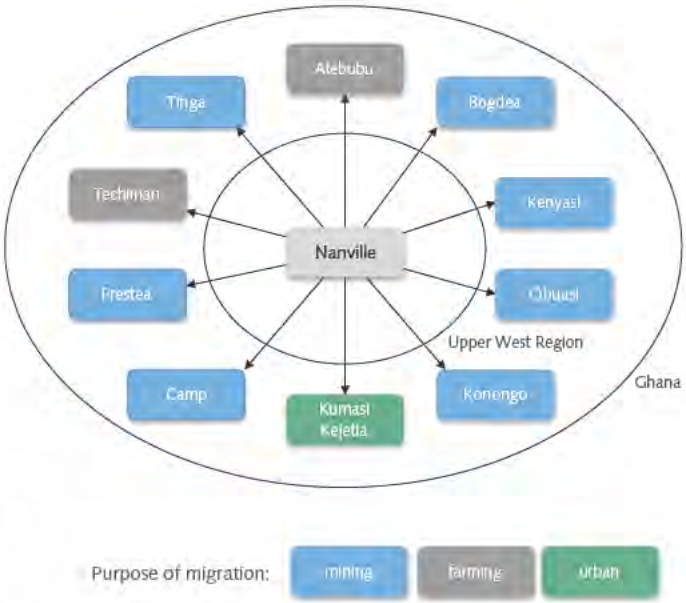


Figure 30: Mobility map of Nanville. Source: PRA session (2011).

7.2 Economic activities of migrants

Figure 31 illustrates the income activities of migrants during their first trip. It clearly shows that the main economic activities are farming (52 per cent) and mining (14 per cent). Seasonal migrants usually work as farm labourers, whereas more long-term migrants usually try to establish their own farm.

The student population (9 per cent) is also included here, although students currently do not contribute to household income. They are included because many educational migrants reported that they seasonally migrate in order to finance their education. Discussions from PRA sessions indicate that farming is the respondents' main and "traditional" economic activity. However, in youth discussions the preference for mining was stressed by nearly all participants. We were told that many young women left on their own and went for "galamsey" even though female migration is negatively perceived by the communities.

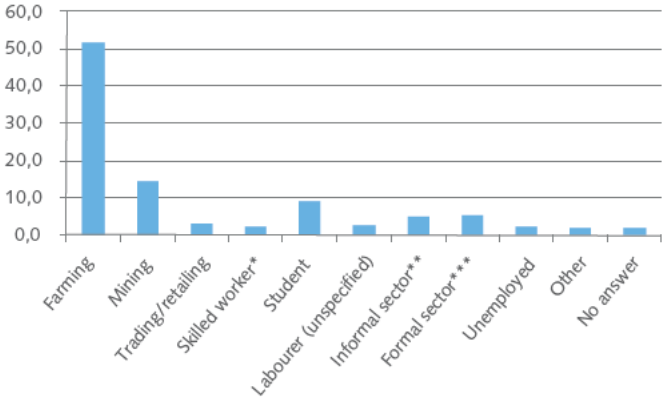
A comparison with respondents' economic activity before migration shows that 79 per cent of them had been working in agriculture (see Table 15). During their first migration, only 52 per cent kept working in the same sector while others chose new income generating activities such as mining. Those who had been students (13 per cent) kept on with their studies (9 per cent) while others probably finished their studies and found jobs.

During PRA sessions with young adults and students, differences in migration activities according to age were discussed. The younger generation favoured mining, whereas middle-aged migrants mainly continue working in agriculture. The young preferred mining because they hoped to make a fortune within a short period of time, despite the numerous risks in mining.

Remittances

Survey results reveal that households with migrants usually have between 1 and 5 family members in migration. In 2011, 110 persons were migrating and contributing to the household income (n=59), whereas in the past the number was higher (123, n=66). Only a minority of migrants were able to contribute to the household income on a regular basis, but the majority of migrants did remit occasionally. Material support in the form of food (bags of maize, yam or cassava) was nearly as important as occasional cash remittances.

Respondents of the survey were asked to assess the size of remittances compared to local monthly income (no details about the actual amount of remittances were given) (see figure 32). From



* *Skilled worker: Construction work, fitting, masonry, seamstress*

** *Domestic help, head porter, fruit and oil processing, Pito brewing*

*** *Civil servant, police man, teacher*

Figure 31: Economic activity during migration (first trip) (n=257). Source: Household survey (2011).

Economic activity (n=257)	Frequency	Percentage
Construction work	1	0.4
Farming	203	79.0
Student	33	12.8
Teaching	1	0.4
Unemployed	4	1.6
No answer	15	5.8
Total	257	100.0

Table 15: Economic activity before migration. Source: Household survey (2011).

those households (n=81) who replied, 47 per cent said remittances were small compared to monthly household income, 33 per cent judged them as intermediate, and only 11 per cent thought they were substantial.

The same households were asked to compare the size of remittances at present and in the past (5 to 10 years ago). Thirty-six per cent observed no increase or decrease compared to the current situation, whereas 35 per cent observed a slight in/decrease, the majority of them declared a decrease. Fourteen per cent of the household declared a substantial in/decrease, and again the majority of them observed a decrease (see Figure 32).

The vast majority of households use remittances for food consumption, followed by purchasing consumer goods, health care and education. Investments and repayment of debts ranked very low.

7.3 Evaluation of migration

Interactions in PRA sessions and interviews revealed the double-sided evaluation of migration in the communities. Participants stressed the risks and dangers involved in migration, such as the decrease in jobs particularly in the farming sector. Another problem often mentioned is labour exploitation – many migrants reported that they were not paid the full amount that was agreed upon earlier or even not paid at all.

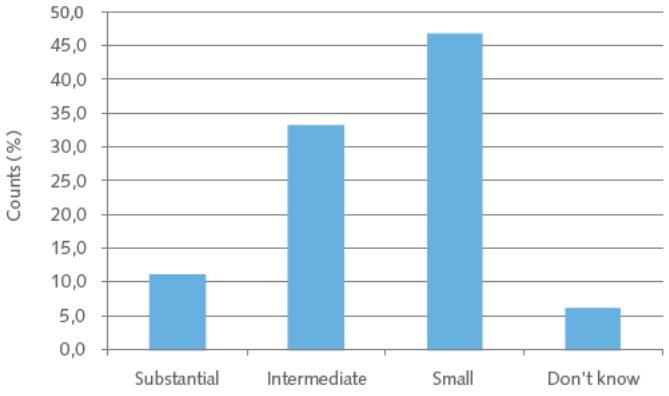


Figure 32: Size of remittances compared to local monthly income (n=81). Source: Household survey (2011).

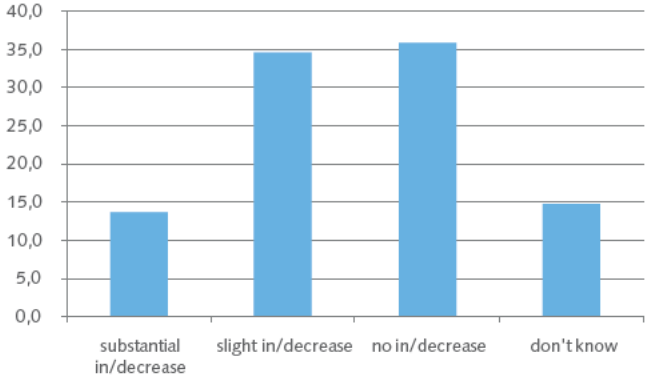


Figure 33: Change of remittances 5–10 years ago ... (n=81). Source: Household survey (2011).

Schraven (2010) stresses changes in the socio-cultural perception of seasonal migration. Formally, it was culturally highly appreciated as a means to gain outside knowledge and skills. Nowadays, when respondents are asked about the benefits of seasonal migration, none of the interviewed farmers in the Atankwidi catchment mentioned aspects like gaining experience or "knowledge import" related aspects (Schraven, 2010: 169). The same holds true for respondents in Takpo area: the reasons centre around the economic dimension of migration and the support of the household via remittances or bags of food. The change in emphasis may be linked to the fact that migrants have imported new knowledge and items from the South for decades. In addition, today's markets in the north show a variety of products that were formerly only found in the South (Schraven, 2010). During PRA sessions, the participants evaluated seasonal migration more positive than temporal or permanent migration. They favoured seasonal migration due to the fact that this type of migration is specifically dedicated to earning money in a short period of time to help the household.

Section 8:
Linking rainfall variability, food security and migration

This section analyses the research outcomes by focusing on the current and past relationships between climate, specifically changes in rainfall, food security, social inequalities and different forms of human mobility. Following the detailed examination of each variable in Sections 5–7 that already contained some analyses on the interplays, this section intends to further highlight these interrelations, and analyse how people react and cope with stress. One of the aims of this project is to identify the circumstances under which households use migration as a risk management strategy in relation to increasing rainfall variability and food insecurity.

Firstly, the impact of rainfall variability on food and livelihood security will be discussed. Secondly, coping strategies of the local population to changes in their local environment are analysed and in particular household strategies are looked at in a situation of food insecurity. Finally, the linkages between rainfall variability and migration are assessed.

8.1 Rainfall change and livelihood

Rainfall variability is experienced by the majority of people in the research communities. It has been demonstrated that many of the perceptions and observations of locals tally with rainfall and temperature data from meteorological stations. Table 7 summarizes the perceptions and biophysical observations (cf. Section 5.4). These findings are supported by the literature dealing with climate change and local perceptions from Ghana and Burkina Faso (Dietz et al., 2004; van der Geest, 2011; West et al., 2008; Nielsen and Reenberg, 2009).

Table 16 provides information on households being affected by natural hazards during the last 12 months before the study was conducted.

Households affected by natural hazards	Count
Flood	43
Heavy storms	67
Drought	71
Never by natural disasters	2
Others	15

Table 16: Households affected by natural hazards during the last year (n=158). Source: Household survey (2011).

44.9 per cent of the respondents mentioned droughts (specifically dry spells during the rainy season), followed by heavy (rainy) storms (42.4 per cent) and floods (27.2 per cent). In 2010, annual rainfall was slightly above the average (1036 mm), whereas in the year of study (2011) it was below average (928 mm). Figure 34 illustrates the distribution of rainfall in the rainy season 2010. It is noticeable that no rain fell in March, whereas in April rainfall was comparably high (186.9 mm). Rainfall in June was very low (48mm) compared to the long-term mean. Most rain was recorded in August (295 mm). Between April and October, 14 events with heavy rainfall (>20 mm) were listed, thus matching with local observations about heavy (rainy) storms and floods. In comparison to the long-term monthly mean (1953–2011), April and August showed significantly more rain in 2010 (216 per cent in April and 146 per cent in August of the long-term monthly mean), whereas rainfall in June reached only 35 per cent of the long-term monthly mean. This distribution of rainfall seemed to be unfavourable for some crops (see Section 5.2).

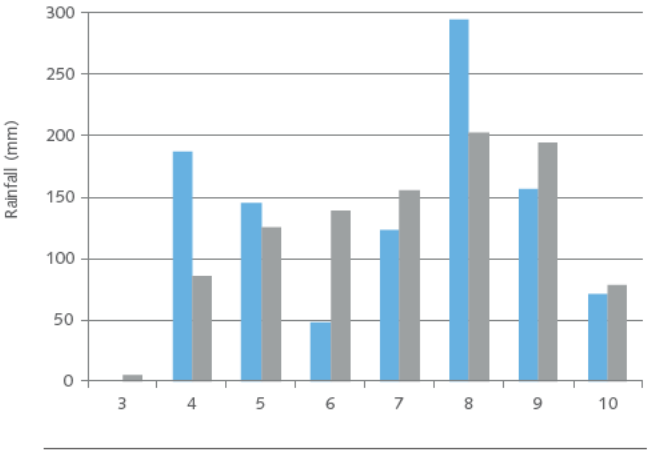


Figure 34: Distribution of rainfall in planting season (2010) Source: Synoptic Weather Station Wa, Upper West Region.

Hazard's impact on Livelihood	Count	%
Crops affected/destroyed	106	67.1
House or other property damaged	38	24.1
Loss of livelihood	2	1.3
Death of livestock	18	11.4

Table 17: Impacts of hazards on livelihood (n=158). Source: Household survey (2011).

The impact of the above-mentioned hazards was mainly in the domain of crop production (67 per cent) and damage to houses (see Table 17). Death of livestock was mentioned as the third most important impact. PRA participants also stressed the impact on vegetation cover, negatively affecting their livestock production. The negative impact of hazards on crop production can be partly confirmed by looking at crop production data from 2010: Sorghum and maize yielded well whereas groundnut production dropped. Obviously, crop yields are not only determined by climatic conditions such as rainfall variability, temperature and the like but also by soil fertility, farming methods and intensity, type and varieties of crops, farm inputs and others. However, unlike rain or other climatic factors, these factors may not vary as much as climatic conditions.

During PRA sessions, respondents stressed that changing rainfall patterns had both direct and indirect impacts on their food and livelihood. As direct, observable impacts of rainfall variability – in

Strategy and...		… their specific actions	
Modify crop production	10.9%	Plant other crops and early maturing varieties	54.3%
		Use of fertilizer	42.9%
Reduced food consumption	21.3%	Change diet	6.0%
		Reduce consumption	89.6%
		Send member somewhere	4.5%
Diversify activities to increased income	14.3%	Switch to alternative income	22.0%
		Increase household member contribution	5.1%
		Expand livelihood activities	71.2%
Selling of assets	28.7%	Sell agricultural products	22.3%
		Sell livestock	77.7%
Migration of household members	14.3%	Move seasonally	73.3%
		Move temporarily	14.7%
		Move to rural areas	10.7%
		Move to urban areas	1.3%
Reduce expenditure	1.9%	Reduce health expenditure	3.3%
		Reduce buying goods	93.3%
Rely on external help	8.1%	Borrow from family members	63.3%
		Borrow from friends/relatives	33.3%
		NGO Support	3.3%

Table 18: Coping strategies (n=258) and specific actions. Source: Household survey (2011).

the concrete example storms – destructions of crops, economic fruit trees and houses were mentioned. Resulting indirect impacts were poor crop yields, food shortages or hunger, the worsening of livelihood and housing conditions, poverty and migration (see Section 5.6). Migration was seen as a means to improve the living conditions of households, but also had negative consequences, such as less labour force to maintain agriculture and livestock rearing.

Comparing the past and present situation in terms of food production, many respondents said they had better harvests in the past. Statements like "Many years ago, things were better" or "Yesterday was better" were common.

The question is if memory of past harvests is reliable, given highly local rainfalls, different soil types and crops. The authors lack agricultural production data for the last 20 to 30 years, so no comparison can be drawn. The following statement should be read with caution as people have the tendency to unconsciously "romanticize the past":

"When I was a child in the early 1980s, we used to farm and harvest a lot. An acre of groundnut farm could yield 10 bags... This year I cultivated two acres of land and I harvested only two bags of groundnuts..."

The early 1980s was a time of severe crisis with droughts and famine. A possible explanation for this perception found in van der Geest's study (2004) is that as small children, they would not automatically notice that crop yields were poor as their mothers assured that children would have enough food to eat.

When asked what respondents thought was the cause of declining crop production nowadays, they attributed it first of all to the worsening of climatic conditions such as unreliable rainfall patterns and soil infertility. Soil fertility in the UWR indeed decreased according to Duadze (2004), especially on farm land. In addition, the respondents mentioned the continuous use of their agricultural plots, traditional farming methods and a lack of "modern" equipment, such as tractors. Climatic conditions are changing from year to year (see Section 5), and many perceptions of respondents tally with rainfall data.

8.2 Food insecurity and coping strategies

Enquiring about how people cope with insufficient food, respondents of the survey (see Table 18) mentioned five main strategies, namely: the sale of assets (29 per cent); reduction of food consumption (21 per cent); diversification of household income (14 per cent), migration (14 per cent); and modifications to crop production (11 per cent). The majority of households that are forced to sell assets sell livestock (78 per cent), which was stated as the main "safety valve". Diversification of income activities was specified by expanding livelihood activities which can be directly linked to migration. Seventy-three per cent of the respondents named seasonal migration as their main action. A reduction of expenditure and the reliance on external help ranked very low.

Finally, those who modify crop production plant other crops or early maturing varieties (54 per cent) and use fertilizer (43 per cent).

Diversifying income means that women play a crucial role in supplementing the family's budget with their small-scale processing and selling activities. During a PRA session on seasonal calendar a woman in Takpo said the following:

"This is the time the men respect us because they depend on us a lot. They are very sober and calm. They don't shout at us and listen to what we say, but when they harvest the food they are there again yelling at us and sometimes threatening to beat us."

Women and men are responsible for food supply, but the women's role is more visible and acknowledged in times of crisis. At this time of the year, they play an important role since their husbands or male relatives tend to rely on their financial support.

Other ways in which people cope with food insecurity include relying on less preferred and less expensive foods, borrowing food, relying on help from a friend or relative, limiting the portion size at mealtimes, restricting consumption by adults and reducing the number of meals eaten each day.

Interviews with experts revealed the same coping strategies that were captured in the survey. What they added to the responses of the household survey included: support from NGOs; the cultivation of cowpea as a supplement to the traditional beans; and farming along the riverbanks as an adaptation strategy. The cultivation of yam and rice in lowlands is getting more important for farmers due to declining soil fertility in upland farming areas (van der Geest, 2004). In addition, soil moisture in lowland areas is higher than in upland areas.

An interviewee from MoFA gives an example of cowpea that has been developed by Savannah Agricultural Research Institute (SARI), an agricultural research institute in northern Ghana, which matures early. In fact, the interviewee stated it has been described as "nwubi mong doo" (written the way it was said and not how it is written in Dagbani, a local language of the Northern Region) which literally means "eating without the husband". It is so fast even in its preparation that if a man fails to provide food for the family, the wife could easily feed her children and pretend she has not cooked because the husband will not come from work to find her cooking.

The findings on food insecurity and coping strategies are supported by Quaye (2008) for Ghana, by West et al. (2008), Nielsen and Reenberg (2009) and Nielsen and Vigh (2012) for Burkina Faso as well as Mertz et al. (2008) for the rural Sahel. However, in the studies on Burkina Faso (central and northern part of the country), the research communities had a wider range of coping and adaptation strategies than in our study. They became more independent from rain-fed subsistence agriculture by engaging to a bigger extent in off-farm activities (such as working in development projects).

8.3 Climate change and migration

For further investigation on the links between climate change, especially rainfall variability and migration, respondents of the survey were asked to assess the complex reasons behind the decision to migrate and rank them according to their importance. The reasons were grouped into social/personal, economic/food security, natural/environmental reasons, forming a list of 39 potential options. Table 19 shows the reasons for migration in descending order of importance.

The most common reasons for migration were:

1) decline in crop production for own consumption;
2) shifted seasonal rainfall;
3) unemployment; and
4) longer drought periods followed by unreliable harvest and increase in drought frequency.

The 10 most important factors centre exclusively on agriculture (plus livestock rearing) being directly linked to food security and climate/rainfall variability.

People's main economic activities showed a low degree of diversification thus rendering them highly vulnerable to climate/rainfall variability. Not surprisingly, respondents declared that they mainly migrated due to economic reasons (compare migration indicators in Table 14).

Reasons to migrate (n=104**)	Very Important	Important	Not Important	Score*
Decline in crop production for household consumption	60	37	7	157
Shifted seasonal rainfalls	45	48	10	138
Unemployment	36	59	9	131
Longer drought periods	30	58	15	118
Unreliable harvest	37	43	23	117
Increase in drought frequency	30	54	19	114
Poor soil quality	28	53	22	109
Decline in animal production for household consumption	38	32	34	108
Less crop production for sale	16	68	19	100
Increasing food prices in the market	23	53	28	99
Not satisfied with my livelihood	11	65	27	87
Less financial resources to buy food/staples	10	66	27	86
Heavy rainfall events	23	38	41	84
Less animal production for sale	14	54	33	82
Better job opportunities in the city	14	42	48	70
Storms	5	60	38	70
Floods	3	61	39	67
Water shortage	9	40	54	58
Insect plagues	5	38	59	48
No land available for farming	9	24	71	42
Poor water quality	2	30	71	34

Reasons	Very Important (frequency)	Important (frequency)	Not Important (frequency)	Score*
Insufficient health care services in the village	4	19	81	27
"Bright lights" of the city/the city attracts me	3	20	81	26
No school for my children available in the village	5	15	84	25
Family reasons (e.g., death of parent)	3	18	83	24
The living quality in the city is better		22	82	22
Work related to my skills is not available	3	16	84	22
I want to become independent from my family		21	83	21
Earthquake		21	82	21
My friends already live in the city	2	16	86	20
Mudflow		19	83	19
No relatives and friends in the village		17	87	17
I want to build up my own life in the city	1	15	88	17
Conflict over natural resources (please specify)	2	9	90	13
No land available for grazing	1	1	101	3
No permission available for fishing?	1	1	99	3
Decline in fish production for sale		3	99	3
Decline in fish production for household consumption		1	101	1
Overfishing			103	0

**Note: "Score" calculated as: (freq. "very important" * 2) + (freq. "important" * 1) **sometimes missing values (when not adding up to 104)*

Table 19: Reasons to migrate (in descending order of importance).
Source: Household survey (2011).

As an underlying cause, the majority of interviewees considered environmental factors which threatened their livelihood. A respondent from Takpo aptly described it: "If we had rains throughout the year, nobody would leave the village."

These findings coincide with findings from the Foresight report on migration and global environmental change (Foresight, 2011), which states that environmental factors tend to influence migration in an indirect way, mostly through economic drivers. The same report stresses that environmental change can affect household wealth and income which is likely to lead to an increase in short-term, rural-rural migration in dryland ecosystems, because households seek to diversify income and secure the livelihoods.

The most important factors displayed in Table 19 are illustrated in Figure 35. The predominance of economic/food security reasons caused by environmental factors becomes clear.

Migration in the past was described by some participants as a thing of pleasure and sight-seeing (in their words, "travel and see") and as Abdul-Korah (2004) put it "to see the world." However, according to our research, many of the respondents now migrate because they need to earn money to support their families.

Research on environmentally induced migration in Ghana (van der Geest, 2011; Schraven, 2010) highlighted the different push and pull factors of migration, among them prominently economic reasons due to livelihood or food insecurity. Small-scale irrigation for dry season tomato gardening as a local livelihood adaptation has become an alternative to seasonal migration in parts of the Upper East Region (Schraven, 2010). Further research in the UWR is needed to check if in areas of small-scale irrigation such as the Sissala District, this adaptation strategy does also serve as a valuable alternative to migration or not. In farming communities, the degree of economic diversification and dependence on rain-fed agriculture are therefore important factors shaping migration patterns.

In the aim to assess the use of migration as a risk management strategy of households in relation to rainfall variability and food security, the household survey data have been analysed. At first sight, the analysis does not show a correlation between seasonal or temporal migration patterns and risk management strategies of households. Households that were exposed to aggregated multiple stressors in 2010/2011 (such as lower income, inadequate food intake, exposure to natural disasters or animal disease), showed the tendency to send less members into seasonal migration. They did not or were not able to use migration as a risk management strategy.

However, a detailed examination taking into account the time of departure of migrants in 2011 reveals that there is a strong correlation between food insecurity (captured as the number of food insecure months) and what we call "rainy season migration" (between April and October). In the case of acute food insecurity at the end of the dry season/beginning of the rainy season, migrants are forced to leave in order to earn income to feed the family. Others who faced problems during the planting season and anticipated the expected harvest to be low moved later in the rainy season.

In this case, migration clearly is a risk management strategy. The analysis of rainfall distribution and crop production for 2011 shows that this year was characterized by a negative rainfall anomaly and by a significant drop in sorghum and groundnut production. Earning money from selling the cash crop groundnuts is crucial for farmers to ensure food security. When farmers expected the groundnuts harvest to be low, they decided for migration in the rainy season.

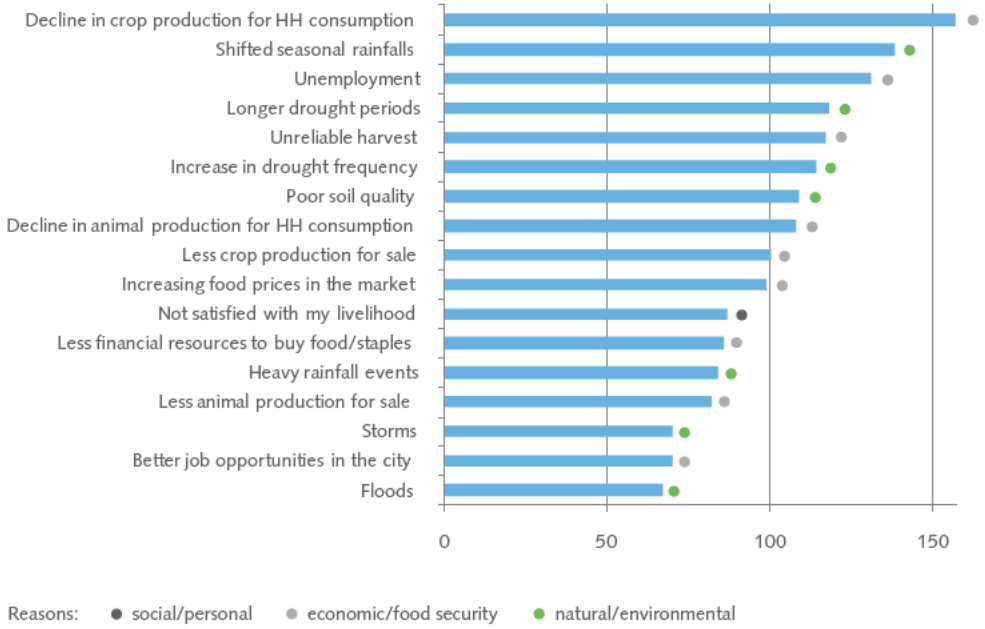


Figure 35: Most important reasons for migration in order of importance. Source: Household survey (2011).

Section 9: Summary and conclusion

Ghana is likely to experience greater rainfall variability and higher temperatures in the future than today according to projected climate change scenarios (IPCC, 2007). In all agro-ecological zones, temperature is expected to increase on the average by 0.25 °C from 2010 to 2020. With regards to rainfall, the situation is more complex, with projected decrease in most agro-ecological zones (including Guinea and Sudan Savannah zone) and an increase in rainfall in the Rain forest zone. The Sudan Savannah zone in parts of the Upper West and Upper East Region is predicted to be most affected by drier and warmer conditions (Armah et al., 2011).

The research in Nadowli District proved that negative effects of changing rainfall patterns on local livelihoods have been experienced and revealed several changes in rainfall patterns over the past 20 to 30 years: an increase in heavy rainfall causing floods, a delay of the rainy season, an increase of the occurance of dry spells and more heat. An analysis of rainfall data from Wa climate station based on a prior definition of heavy rainfall, dry spells and the start of the rainy season following the approach of Laux et al. (2009) does support local observations and perceptions: farmers in this study reported an increase of dry spells compared to the past which could be proved for the last decade with daily meteorological data. The same holds true for an increase in heavy rainfall events of more than 50 mm during the last decade. A delay of the onset of the rainy season could not be detected looking at Wa climate station, while it has been proved for the northern part of Ghana (Laux, 2009).

Dry spells and heavy rainfall events during the planting season negatively affected crop production which could be shown for 2007. In a rain-fed farming system, highly variable annual rainfall conditions influence agricultural productivity significantly, leading to potentally reduced yields or harvest losses, and more severely, to food shortages. During the dry season people primarily engage in trading, food processing and migration. Almost all households run out of food stocks during the lean season (with its peak between May and August) and are therefore forced to buy food from the local markets. To aggravate the situation, participants also complained that they were short of financial means to buy food, given the fact that food prices are generally high during that season.

People have developed several coping or adaptation strategies to deal with food insecurity, including: the sale of livestock ("the safety valve"); reduction of food consumption; seasonal migration; and modifications in crop production, namely planting other crops and early maturing varieties. Especially during the lean season, women play an important role in supporting food supply of the household by engaging in small-scale fruit and food processing. Their contribution was highly respected by family and community.

In times of crisis, when neither husband nor wife have enough means to provide for the family, men and sometimes even women with children are forced into seasonal migration. Migration in general is predominantly of seasonal rural-rural type. Male migration still is more common and better perceived by society than female migration. However, since the 1980s, the number of female migrants has increased – in the study area, 31 per cent of all migrants are women. Research revealed that migration is both an income strategy as well as a strategy for crisis. Results from the household survey show that 75 per cent of the participants perceive migration as a normal income-generating strategy, whereas 36 per cent perceive it as a strategy only in times of crisis (multiple answers possible).

Survey analysis for 2011 has shown that female-headed housholds face a higher food insecurity, are less wealthy, possess less land and have a higher dependency ratio compared to male-headed housholds. In terms of the number of migrants, no correlation was found between the sex of the household head and migration. Better off households, which are normally male-headed, have a more diversified livelihood portfolio, a higher number of members in working age, face less vulnerability, and use good building materials for the house (such as cement/bricks or corrugated zink roofs). As better off households tend to be bigger, having more members in working age, they tend to have more migrants compared to poorer households.

The main destination areas for male and female migrants were the Ghanaian middle belt (Brong Ahafo) and Southern Ghana (Ashanti), where the majority worked in agriculture, thus profiting from better agricultural opportunities such as two cropping seasons. In contrast, the younger generation preferred working in surface mining.

A complex interplay of different factors leads to the decision of a household to send one or more members into migration. The survey findings revealed that the main reasons for migration were environmental, food security and economic factors that were all closely entangled. The most important environmental factors mentioned were shifting seasonal rainfall and increasing frequency and length of droughts/dry spells. Their impact on food security was depicted as a decline in crop production and unreliable harvests rendering households vulnerable to food insecurity. The economic factors that were mentioned were unemployment and reduced financial means of the household. Survey analysis has shown that a high food insecurity does correlate with a specific form of seasonal migration, namely "rainy season migration".

The central question this study tried to answer was "under what circumstances do households use migration as a risk management strategy in relation to increasing rainfall variability and food

insecurity?" The overall conclusion is that Northern Ghana is extremely vulnerable to climate change. A strong link between rainfall variability and food security was demonstrated, as people were shown to be highly dependent on rain-fed agriculture to make a living and have few other economic options in the area of origin. However, other factors contribute to food insecurity as well, such as soil degradation, traditional farming methods and a lack of modern equipment, and poor crop storage methods among others. Apart from farming, their other local income-generating activities such as livestock rearing and processing of (wild) fruits such as Shea, Baobab, Dawadawa and Neem depend on favorable climatic conditions as well. One of the consequences, given the environmental conditions, is that most households are food insecure during some months of the year. However, people developed several coping or adaptation strategies to adapt to the resource-poor and risk-prone environment. If household members cannot provide enough food given the fact that most of the local coping strategies are in turn affected by climatic conditions, they engage in migration to gain income somewhere else. The study has proved that migration is a crucial strategy to diversify income and to spread risks. People migrate in times of crisis, but also in anticipation of coming lean seasons and unreliable harvests affecting food security. Through migration, people cater for the households' food needs in the beginning of the rainy season. When migrants come home, they either bring back bags of food or savings to buy food and other items needed in the household. In this way, they bridge the food gap during the lean season. The normal pattern for seasonal migration is reported to be during the dry season (van der Geest, 2011; Abdul-Korah, 2011). The study in Nadowli district revealed that in cases of acute food shortage and/or in anticipation of a bad harvest, migrants in 2011 left during the rainy season to gain income elsewhere. They engaged in farming and gold mining in other parts of the country. This pattern was not yet mentioned in the relevant literature.

Contrary to findings from UWR (Schraven, 2010), seasonal migration is perceived as being the most beneficial migation type due to the fact that it mainly contributes to food security at home (to a higher extent by bringing home staple crops and to a lower extent by revenues). To conclude, the most important driving forces for migration mentioned by participants of this study are environmental/climate-related resulting in food insecurity and reduced economic means of households.

Looking at the overall context, some other factors that were not fully captured in this study should again be brought into attention. In a north-south comparison, the agro-ecological conditions are generally unfavourable in the northern part of the country. However, low agricultural productivity and high rates of poverty and food insecurity do not result from the climatic conditions alone. Northern Ghana suffers from a long history of governmental neglect:

"A century of colonial and post-colonial government policies that structurally neglected the North and concentrated development efforts in the South has produced a widening gap in the livelihood opportunities of people in the North and the South"

(van der Geest, 2011: 208).

Some of the effects are a low degree of agricultural intensification, unfavourable market conditions combined with a bad infrastructure, i.e., to transport agricultural goods, little industry and jobs in the non-farm sector and an unfavourable educational and health infrastructure.

In this context, seasonal migration is used as a short-term strategy to cater for the household's food needs primarily, and only to a limited extent to invest into the modernization of the farming system. As such, the potential that migration theoretically has in developing agriculture as the livelihood basis of the population is not fully developed.

This study demonstrated that in research on environmentally induced migration, the variable food security is crucial in understanding changes in rainfall and human mobility, especially in farming communities that are oriented towards rain-fed subsistence agriculture. Referring to the conceptual framework, food security, being part of the wider livelihood security, is influenced by rainfall variability in farming communities. The degree of vulnerability of a household including its degree of economic diversification, especially off-farm activities and formal jobs, as well as the number of dependent members and members of working age, influences its food security situation and the number of available coping and adaptation strategies. More vulnerable households with a high dependency ratio and a low livelihood portfolio tend to have less options than better off households. The study has shown that most households face regular periods of food shortage. The higher the food insecurity of a household, the higher the propensity to migrate seasonally in times of crisis, which is usually during the lean, rainy season. In the case of rainy season migration, the household has a member less who could engage in agricultural labour. On the other hand, seasonal migration contributes to improving the food security situation of the household via remittances in kind or cash.

Section 10: Reflections for policymakers

This section begins with the perceptions and recommendations given by participants of this study. A brief overview over NGO activities in the research communities concerning the agricultural/ livelihood sector follows. Some policy recommendations from literature tackling the agricultural sector are pointed out. At last, policy recommendations developed by CARE Ghana staff are presented.

Research participants stressed their livelihood risks and gave several recommendations to improve local livelihoods during PRA sessions. Their expectations include:

- modernize farming since the use of old simple farm implements and traditional methods of farming does not support large-scale production. This implies:
  - improved seeds (high yielding varieties) and early maturing crops;
  - tractor services or animal traction in order to cultivate bigger fields; and
  - fertilizer provision.
- provision of dams for dry season gardening to ensure local farming throughout the year;
- improve animal husbandry (e.g., create shelter[10]; vaccination campaigns);

10 During the dry seasons animals are kept open range. Farmers complained that they sometimes destroy fields and that animals are exposed to risks (climate related risks, diseases, stealing, etc.).

- stopping bush fires as they destroy vegetation cover causing soil erosion, destroy farm crops, kill economic trees, endangering people and houses (in one of the four communities, bush burning is not practiced anymore);
- curtailing tree felling for firewood and charcoal production (practical solutions for other ways of cooking were not, presented, however);
- creating local employment opportunities in agriculture by establishing bigger modern farms;
- provision of micro-credit services to farmers to better access farm inputs.

Several local/national and international NGOs are currently working in the Nadowli District. The majority of them created programmes addressing farmers, such as the local NGOs "Sustainable Integrated Development Services Centre" (SIDSEC), World Vision International (WVI), Adventist Development Relief Service (ADRA), National Disaster Management Organization (NADMO) and last but not least CARE International.

Activities realized by NGOs in the agricultural/income generating sector include:

- training on appropriate farming and storage methods by extension agents in cooperation with NGOs:
  - planting crops in lines;
  - cultivation of soy beans and cowpeas, instead of maize and millet;
  - improved seeds (high yielding varieties) and early maturing crops; and
  - compost training/soil conservation techniques.
- realization of small-scale farming projects to improve farmer's income. Sometimes, parts of the harvest are sold to NGOs at a fair price and food crops used for school feeding projects in the same community;
- providing farmers with farm inputs (seeds and chemicals);
- training women how to better manage their income-generating activities and food production (i.e. Pito brewing, production of Shea butter, groundnut oil, Dawadawa products, beans cakes) and provide micro-credit with very low interest rates.

Participants of the PRA sessions acknowledged the involvement of NGOs and expressed their appreciation; still, they see the urgent need for more agriculture and livelihood-related projects reaching all famers, men and women. They perceive the need to intensify agriculture to achieve higher yields in their risk-prone environment.

Authors like Al-Hassan and Poulton, considering the current agricultural development in northern Ghana, call for an "enhanced agricultural policy" (2009: 9) combined with social grants. They conclude:

"However, as the GLSS surveys show, under current circumstances semi-subsistence agriculture is not a reliable way to exit poverty. For agriculture in northern Ghana to realize its poverty-reducing potential, an improved agricultural policy is also required. More investment is required in irrigation, rural roads, extension and veterinary services. A complementary policy to agriculturally-targeted social grants for the "poor" group would be the provision of animal traction hire services to LEAP[11]

11 The "Livelihood Empowerment against Poverty" (LEAP) Programme is a social cash transfer programme which provides cash and health insurance to extremely poor households across Ghana to alleviate short-term poverty and encourage long term human capital development. In the UWR, 10,178 households receive money from the LEAP Programme, among them 1,195 households in Nadowli District.

beneficiaries, something that could perhaps be piloted by an agricultural NGO. In the longer term, assistance towards the acquisition of cattle, training of oxen, subsidies or loans for ploughs would also be useful"

(Al-Hassan and Poulton, 2009: 9).

Policymakers can respond to climate change, food insecurity and migration through climate-sensitive development policies that build local resilience and adaptive capacity in order to reduce involuntary migration. Of importance in this context is the National Climate Change Adaptation Strategy (NCCAS). NCCAS is the culmination of views from experts, civil society groups, governmental organizations, the private sector and NGOs, both national and international, and some development partners.

NCCAS provides clearly defined mechanisms for building Ghana's capacity, in terms of the infrastructure and knowledge required, to deal with climate change impact and to reduce vulnerability in key sectors, ecosystems, districts and regions of the country. It will serve as a guide to the Government of Ghana in its commitment under the UNFCCC, according to which national governments are expected to take climate change issues into consideration in development planning.

The NCCAS is a blueprint for adjusting Ghana's economy to expected climatic stimuli and their effects. It makes projections for the period 2010 to 2020. Focused on the goal: "To enhance Ghana's current and future development by strengthening its adaptive capacity with regard to climate change impacts and building the resilience of the society and ecosystems", NCCAS has formulated some objectives and proposed some programmes to achieve them (EPA, 2011). These programmes are geared towards minimizing vulnerability and increasing resilience to climate change impacts for the poor and vulnerable and enhancing national capacity to adapt to climate change.

A crucial consideration in this document is to reduce maladaptation and to ensure the development of a more holistic and integrated national adaptation strategy. The preparation of NCCAS has been driven fundamentally by a participatory approach and first of all, impacts of climate change in Ghana are outlined, followed by strategies in these realms: livelihood, energy, agriculture, health, early warning, fisheries management, land use and water. All Ghana state levels are being incorporated in this holistic approach, just as a detailed concept of finance is provided (EPA, 2011).

Some other policy efforts have already been turned into projects. Worth mentioning is the Savannah Accelerated Development Authority (SADA) which has been established by the Mills-led government by an Act of Parliament (Act 805, 2010) to provide a framework for the comprehensive and long-term development of the Northern Savannah Ecological Zone. This zone comprises the three northern regions of Ghana, namely Upper East, Upper West and Northern regions, and stretches to include districts contiguous to the northern region that are located north of Brong-Ahafo and the Volta region. SADA constitutes Ghana's response to the effects of climate change associated with floods and drought. The Authority operates in a paradigm known as "Forested and Green North by 2030" for sustainable development, climate change reversal and improved livelihoods of the most vulnerable. Using the vision of a forested and Green North by 2030, this strategy is designed for small-holder families and poor farmers to develop a long-term stake in agriculture by intercropping with economic trees. Some of the relevant components of SADA include modernized agriculture, livelihood security, post-flood rehabilitation and water resources (Gariba, 2010).

It is expected that findings from this study would help in the development of more nuanced community centered adaptation programmes.

Some of the suggestions for policy considerations include:

Local/district/regional level

1. Development of community-based adaptation strategies (CBAs) that would respond to the specific needs and challenges of local people.

2. Development and extension of climate resilient crop varieties, such as early maturing, drought and flood resilient crops.

3. Adoption of conservation agricultural techniques (teaching farmers to do composting, contour bonding, zero tilage, etc.).

4. Include women in planning, development and implementation of adaptation strategies.

5. Conscious efforts must be made to increase women's access to fertile land for crop production since they are now seen to play a key role in household food security.

6. Conscious efforts at local/district level to conserve natural resources as well as a sustainable usage of natural resources for local needs.

7. The village savings and loans scheme promoted by CARE and other NGOs has proven to be one effective way of local mobilization of resources for livelihood activities.

National level (Government/SADA/NGO sector)

1. Develop livelihood diversification schemes for local vulnerable communities. This could be in the form of support to implement alternative livelihood activities such as bee farming, small ruminant raising, dry season gardening via small-scale irrigation projects using dug-outs and streams. Dry season gardening would also help farmers to cope with insufficient rainfall in the form of short-term intervention measures.

2. Incorporate both migration and climate change adaptation issues into national development plans. Policies should be developed and implemented that will ensure that District Assemblies incorporate climate adaptation strategies in their medium-term development plans.

3. Fast track the modernization of agriculture in the country, particularly in northern Ghana, by supporting farmers with farm inputs, tractors, etc.[12].

4. Invest in irrigated agriculture in the area to ensure all year round farming.

5. Improve infrastructure in the region to better access markets, schools and health care institutions.

6. Contextualize the knowledge of food insecurity and include CBA strategies in the national framework in order to create an equitable regional development policy that could make different communities resilient.

7. Institute programmes that would reward the communities that have initiated mitigation measures such as tree planting, wild fire management and minimizing indiscriminate tree felling.

International level

1. International organizations should financially support national and local evidence-based strategies to support such initiatives.

2. Finance more in-depth research about climate change, food security and migration in different districts of the country in order to develop further refined policy plans and NGO interventions.

12 It should be noted that there is inconsistency in some of the recommendations. The use of tractors is not in line with conservation agriculture. In consideration of the current situation of agriculture and food insecurity in northern Ghana and an expected increase in climate variability in the future, a careful decision should be taken by politicians.

Annex I:
National research team composition

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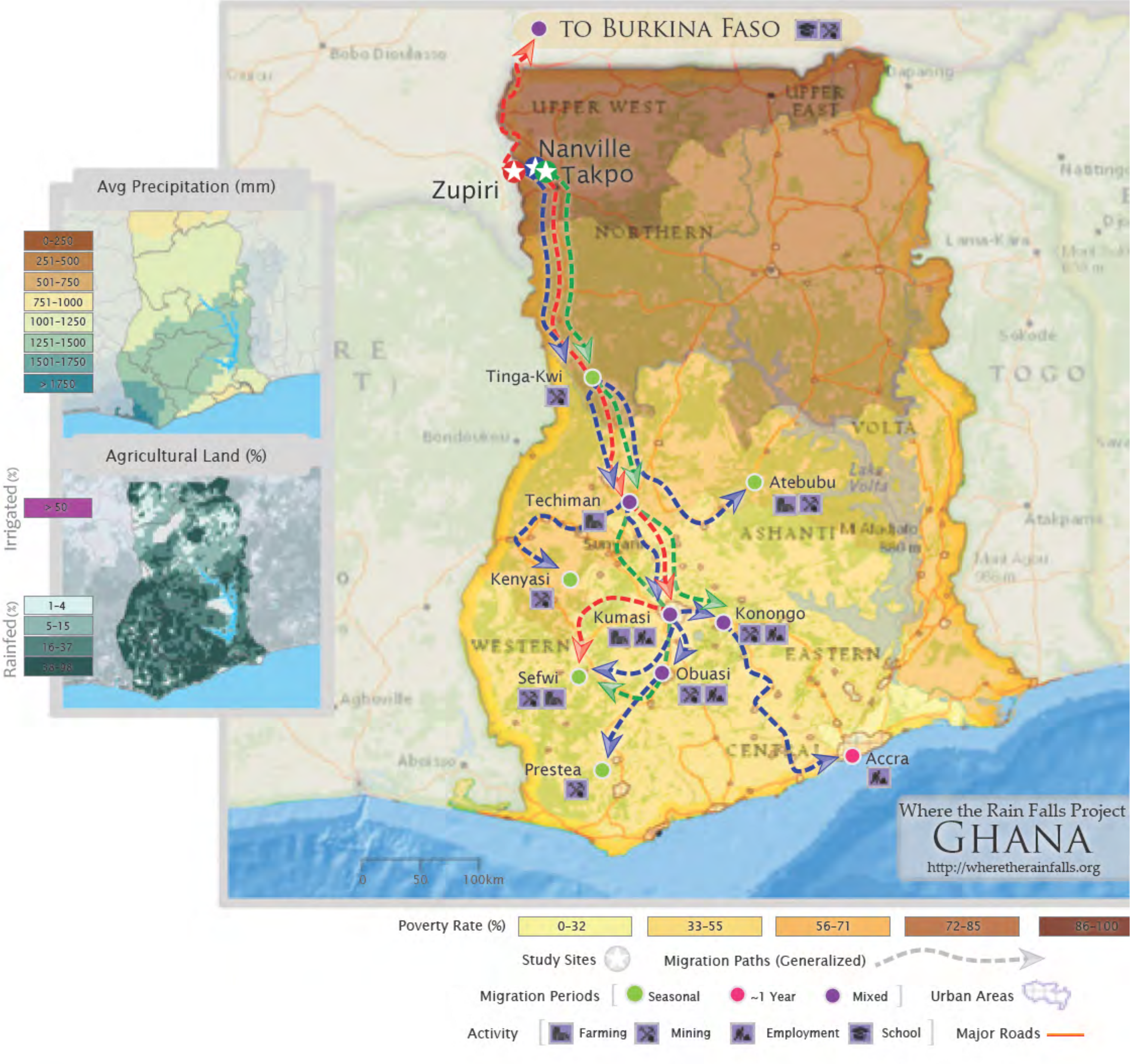
Ernest Bagson (UDS Wa)
Samuel Bonye (UDS Wa)
Albert Dakyie (translator)
Nicholas Fielmua (UDS Wa)
Darius Mwingyine (UDS Wa)
Ophelia Soliku (UDS Wa)

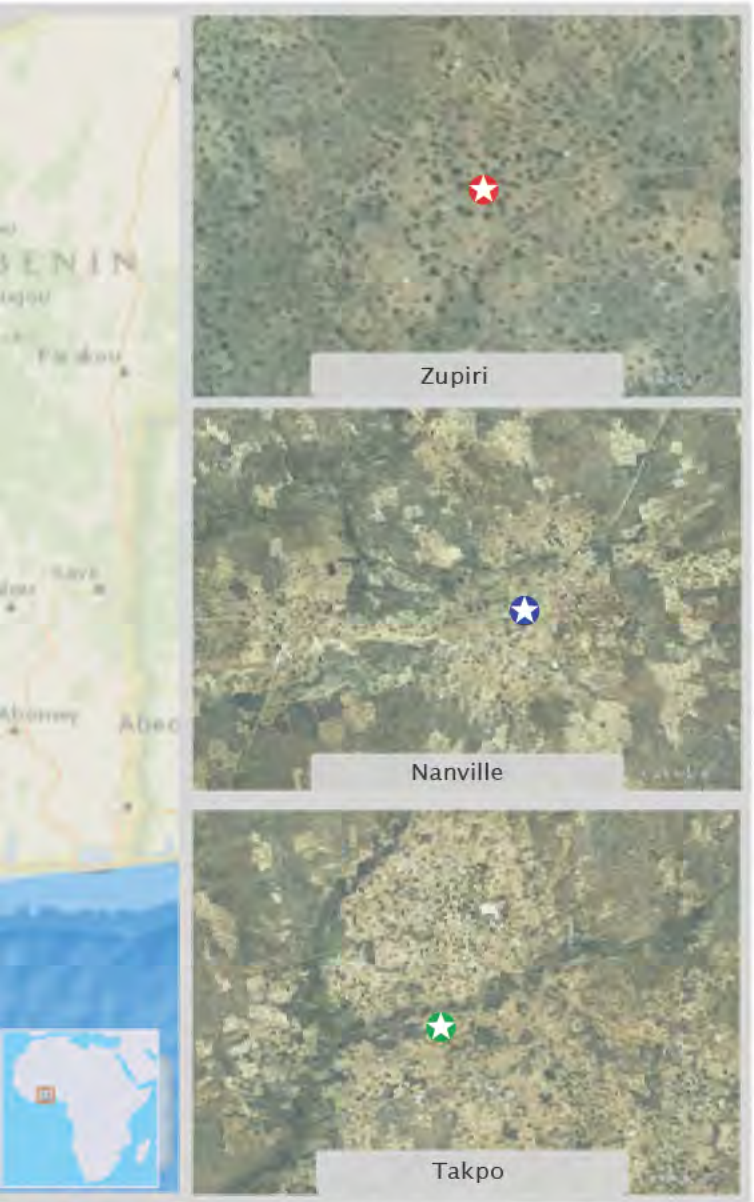
Annex II:
List of expert interviews

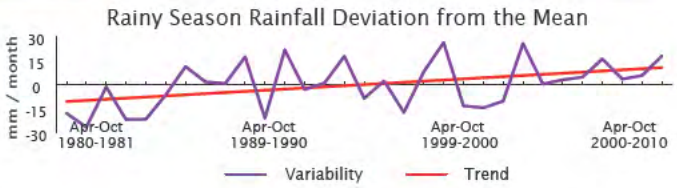
	Name	Institution/Position	Location/level	Date
1.	Mr. M. Mohammed	District Assembly Officer	Nadowli	31 October 2011
2.	Ms Rahmat Salih and Mr. B.Gilbert Michael Bayele	Social Welfare	Wa	2 November 2011
3.	Dr. Boye Bandie	Lecturer UDS Wa, SIDSEC	Wa	2 November 2011
4.	Mr. Otis Tibila	District Meteo Office	Wa	2 November 2011
5.	Mr. Abdul-Kerim Shehu and Mr. Sulemana Mohammed	World Food Programme	Wa	2 November 2011
6.	Mr. Edward Bayela	Retired teacher	Takpo	4 November 2011
7.	Chief Naa Widana II	Community Chief	Takpo	4 November 2011
8.	Mr. John Bosco and Dr. O. Kanton	Lecturers UDS Wa	Wa	4 November 2011
9.	Mr. M.Y. B. Suglo	Regional Ext. officer, MoFa	Wa	4 November 2011
10.	Mr. Ziemah Dapilaa	Secretary at Zupiri	Zupiri	5 November 2011
11.	Mr. David	WIDO	Kaleo	7 November 2011
12.	Mr. Abu Iddrisu	Regional EPA office	Tamale	10 November 2011
13.	Mr. Wuni Dasori	WFP	Tamale	14 November 2011
14.	Ms. Florence Kukura	Christian Mothers	Yendi	15 November 2011
15.	Prof. Mariama Awumbila and Mr. Longi	Center of Migration Studies	Accra	16 December 2011

Annex III: List of Participatory Research Approach sessions per community

Community	Target	Date of PRA session
Mantari	Transect Walk	21 October 2011
	Wealth/Resource Ranking	21 October 2011
	Livelihood Risk Ranking	21 October 2011
	Seasonal Calendar	21 October 2011
Takpo	Seasonal Calendar	27 October 2011
	Livelihood Risk Ranking	27 October 2011
	Mobility Map	27 October 2011
	Youth discussion – future strategies	28 October 2011
	Venn Diagram Food Security	28 October 2011
Zupiri	Transect walk & Resource Mapping	28 October 2011
	Livelihood Risk Ranking	28 October 2011
	Coping Strategies of Livelihood Risks	28 October 2011
Nanville	Mobility Map	28 October 2011
	Community Resource Mapping and Ranking	3 November 2011
	Livelihood Risk Ranking	3 November 2011
	Mobility Map	3 November 2011
	Impact Diagram	3 November 2011
	Youth discussion – future strategies	3 November 2011
	Venn Diagram on Food Security	3 November 2011


TO BURKINA FASO
UPPER WEST
UPPER EAST
Nanville
Takpo
Zupiri
NORTHERN
Tinga-Kwi
VOLTA
Techiman
Atebubu
ASHANTI
Kenyasi
Kumasi
Konongo
WESTERN
EASTERN
Sefwi
Obuasi
CENTRAL
Accra
Prestea
TOGO
Avg Precipitation (mm)
0-250
251-500
501-750
751-1000
1001-1250
1251-1500
1501-1750
> 1750
Agricultural Land (%)
Irrigated (%)
> 50
Rainfed (%)
1-4
5-15
16-37
38-98
0
50
100km
Where the Rain Falls Project
GHANA
http://wheretherainfalls.org
Poverty Rate (%)
0-32
33-55
56-71
72-85
86-100
Study Sites
Migration Paths (Generalized)
Migration Periods
Seasonal
~1 Year
Mixed
Urban Areas
Activity
Farming
Mining
Employment
School
Major Roads





Annex IV

This map was created by the Center for International Earth Science Information Network (CIESIN) at the Earth Institute of Columbia University. The main map shows the principal destinations and occupations of migrants from Takpo area, Nadowli District, based on PRA sessions. For comparison, Figure 29 presents results from the household survey for all four research communities. The main destinations are situated in the fertile Ghanaian middle belt. The colours in the main map depict poverty levels. The research area has the highest poverty levels in the country, and migrants mostly move to areas with low or very low poverty levels.

The graph in the lower-right corner shows that monthly rainfall deviation from the statistical mean during the rainy season (April–October) has slightly increased over the past three decades. The red line depicts a slightly positive trend. For comparison, the situation in UWR is depicted using annual rainfall sums and a five-year-running mean for Wa climate station (see Figure 8) for the last 60 years. Here, no clear trend is detectable. The graph in the top left corner shows that average precipitation is lowest in Northern Ghana. According to Wa climate station data, the region has an average annual precipitation of 1036 mm (see Figure 8).

Note: The maps (and associated rainfall variability graphs) produced for each case study report were developed using data sets from multiple sources. Each map provides the location of each research site along with contextual data on rainfall amounts and variability, poverty and agriculture. For a full list of sources please see chapter 9.2 of the Where the Rain Falls Global Policy Report (Warner et al., 2012).

Source: CIESIN (2012).

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WHERE the RAIN FALLS

The Where the Rain Falls Project investigates how changes in rainfall interact with societies. The project provides a more nuanced understanding of the links between changing rainfall patterns, food and livelihood security, as well as migration in eight case study countries:

Bangladesh: Kurigram District, Rangpur Division
Ghana: Nadowli District, Upper West Region
Guatemala: Cabricán Municipality, Quetzaltenango Department
India: Janjgir-Champa District, Chhattisgarh State
Peru: Huancayo District, Junín Region
Tanzania: Same District, Kilimanjaro Region
Thailand: Thung Hua Chang District, Northern Thailand
Viet Nam: Dong Thap Province, Thap Muoi District.

Changing weather patterns are already causing weather extremes, including droughts and flooding, leading to food insecurity and displacement of people. Research results will help climate change policy and its implementation with important practical aspects to tackle poverty, protecting the most vulnerable people.

The full project findings – a research protocol, eight case study reports and a synthesis report for policymakers – are available at *www.wheretherainfalls.org*.