

Article

Impact of Floods on Livelihoods and Vulnerability of Natural Resource Dependent Communities in Northern Ghana

Frederick A. Armah ^{1,*}, David O. Yawson ², Genesis T. Yengoh ³, Justice O. Odoi ⁴ and Ernest K. A. Afrifa ¹

¹ Department of Environmental Science, School of Biological Sciences, University of Cape Coast, Cape Coast, Ghana; E-Mail: e_afrifa@yahoo.co.uk

² School of Agriculture, University of Cape Coast, Cape Coast, Ghana; E-Mail: oskidoo@yahoo.com

³ Lund University Centre for Sustainability Studies, P.O. Box 170, SE-22100, Lund, Sweden; E-Mail: Yengoh.Genesis@lucsus.lu.se

⁴ Ghana Nature Today, A 25 Standard Estates, Sakumono, P.O. Box OS 1455, Osu, Accra, Ghana; E-Mail: justice20gh@yahoo.com

* Author to whom correspondence should be addressed; E-Mail: atoarmah@yahoo.com; Tel.: +233-24-9483014; Fax: +233-42-32709.

Received: 15 January 2010; in revised form: 8 March 2010 / Accepted: 30 March 2010 /

Published: 7 April 2010

Abstract: Sub-Sahara Africa is considered to be most vulnerable to climate variability including flooding. The frequency and severity of floods in Northern Ghana over the last decade has increased considerably. Through qualitative modelling the paper explores the impact of floods on natural resource dependent communities in Northern Ghana. Simplified causal loop diagrams are used to conceptualise flood-induced coping strategies in the study area. The results indicate that some characteristics of the socio-cultural environment appear to mitigate risk and reduce vulnerability. In this context, the role of social networks in enhancing livelihood security is essential. The paper concludes that both in case of seasonal variations in agricultural output and floods, individuals that have effectively diversified their livelihoods, both occupationally and geographically, are less sensitive than individuals who mainly achieve entitlement to food via crop cultivation. However, diversification in this case, is effective only in the short term.

Keywords: floods; vulnerability; environment; communities; livelihoods; Northern Ghana

1. Introduction

Agriculture remains one of the most vulnerable sectors to climate change in Africa in terms of declines in agricultural production and uncertain climate that significantly affects food security [1]. Yet, agriculture is an important source of livelihoods. An average of 70% of the population lives by farming; 40% of all exports earnings come from agriculture, and about one-third of the national income in Africa is generated by agriculture [1,2]. The poorest members of society in African countries are those most dependent on rain-fed subsistence agriculture for food, jobs and income, and hence the most vulnerable to changes in climate [2].

During the months of August and early September 2007, heavy rainfall led to severe flooding in Northern Ghana resulting in the loss of lives, displacement of vulnerable persons and the destruction of key infrastructure, food stocks and livestock throughout the region. The floods coincided with the most critical time of the year, the lean (minor) farming season when Ghanaian families faced food insecurity.

This paper focuses on the Northern Region of Ghana, where excessive rainfall coupled with the spillage of excess water upstream from the Bagre Reservoir in Burkina Faso resulted in extensive floods in many districts of the region. Apart from the death toll of 20, the floods caused severe damage including the loss of livestock, the destruction of farmlands, houses, bridges, schools and health facilities, as well as damage to the water supply, irrigation systems, food storage and processing facilities. Floods are a common feature in Ghana hence certain community coping mechanisms are in place. However, it was the combination of cumulative events (the prolonged dry spell, abnormal torrential rains and the spillage of the Bagre Dam in Burkina Faso) that caused the humanitarian situation in Northern Ghana. Coping mechanisms were overwhelmed and an already very vulnerable population was severely affected because of the timing and scale of the floods.

The Government of Ghana and its development partners provided some of the much needed life saving assistance to affected populations in the most devastated areas. However, most of the affected areas were socio-economically vulnerable prior to the floods. The floods therefore triggered a rapid deterioration of existing vulnerabilities. In the aftermath of flooding, many of the flooded areas were inaccessible due to breakdown of key infrastructure, including bridges and roads. Initial assessments of the Ministry of Food and Agriculture (MoFA) estimate that 70,500 hectares was affected [3], resulting in an estimated production loss of 144,000 Metric Tonnes (MTs) of food crops (including maize, sorghum, millet, ground nuts, yam, cassava and rice). Not all food commodities were readily available at all markets, due to flooded roads and submerged bridges. An estimated 50,000 people in Northern Ghana were expected to remain vulnerable to food insecurity and at risk of malnutrition for at least 15 months beyond the early harvest in October 2008 [3].

1.1. Aims and Objectives

This paper assesses the coping strategies and vulnerability of two agriculture-dependent communities in the aftermath of the floods. Vulnerability will be considered in this study because it takes into account complex ecological, socio-cultural, and economic-political dimensions of context-specific social phenomena such as livelihoods [4].

1.2. Some Terminologies

- *Vulnerability* is the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt [5]. Vulnerability consistently focuses on socio-ecological systems. The concept of a social-ecological system reflects the idea that human action and social structures are integral to nature and hence any distinction between social and natural systems is arbitrary. It is the multi-level interactions between system components (livelihoods, social structures and agricultural policy) that determine system vulnerability. In all formulations, the key parameters of vulnerability are the stress to which a system is exposed, its sensitivity, and its adaptive capacity. Algebraically, we could define vulnerability to be a function of the character, magnitude, and rate of climate variation:

$$\text{Vulnerability} = \frac{\text{sensitivity to stress} \times \text{probability of exposure to stress}}{\text{State relative to threshold}}$$

Or

$$\text{Vulnerability} = \text{Exposure} + \text{susceptibility} - \text{resilience}$$

- The IPCC report of 2001 defines *sensitivity* as ‘the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of flooding)
- *Adaptive capacity* is the ability to plan, prepare for and implement adaptation measures. Factors that determine adaptive capacity of human systems include economic wealth, technology and infrastructure, information, knowledge and skills, institutions, equity and social capital. Adaptive capacity cannot be measured. Adaptive capacity is often represented by social capital and other assets [6].
- *Coping strategies* refer to people’s agency, ingenuity and abilities to help one another individually and collectively from time to time in order to meet their hierarchical needs [7]. They grow out of a recognition of the risk of an event occurring and of established patterns of response. They seek not just survival, but also the maintenance of other human needs such as the receiving of respect, dignity and the maintenance of family, household and community cohesion.
- *Social capital* refers to connections within and between social networks as well as connections among individuals. It is usually meant to boost the adaptive capacity of individuals and communities. A social network is a social structure made of nodes (which are generally individuals or organizations) that are tied by one or more specific types of interdependency, such as values, visions, ideas, financial exchange, friendship, sexual relationships, kinship, dislike, conflict or trade. Nodes are the individual actors within the networks, and ties are the relationships between the actors.
- *Entitlement* is a term for the access that people have to food from the sale of their labour, their own food producing activity, or via social networks, or some political claim on state resources including moral claims on international food aid [7].

- *Livelihoods* comprise the assets (natural, physical, human, financial and social capital), the activities, and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household [8].

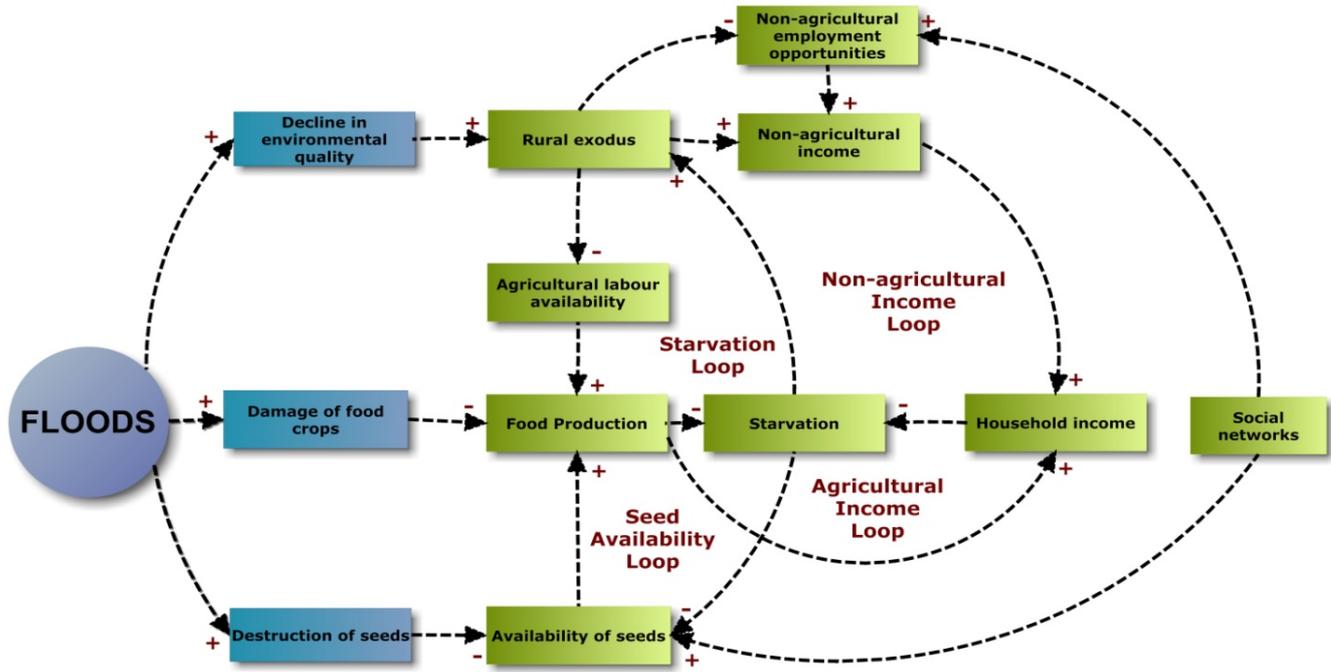
1.3. Conceptual Framework: General systems structure of the effects of floods on natural resource-dependent communities in northern Ghana

The effects of floods on natural resource-dependent communities in northern Ghana are complex but can be illustrated in a simplified structure such as in Figure 1. Being essentially agricultural producers, the main consequence of flooding has been the destruction of food crops on farms as well as seeds stores; eventually culminating in a decline in food production. A decline in food production can lead to starvation which may in some cases last for several months after each episode of floods. Starvation together with a decline in environmental quality resulting from flood related damage, fuels the desire for migrating out of these rural areas (see the starvation loop in Figure 1). The reduction in food production resulting from floods also means loss of income for many in these communities which further reduce their ability to purchase food and thereby contributes to increasing the problem of food shortages and starvation within households (agricultural income loop Figure 1). In these communities, non-agricultural income opportunities are few [11]. However social networks can enable residents to be informed of the existence of opportunities both within and without the communities. Non-agricultural income can contribute to increasing household income and thereby reduce starvation that may result from flooding (non-agricultural income loop, Figure 1).

Such destruction and physical loss is usually accompanied by generalized destitution and sense of grief among people who have lost loved ones. These together increase the desire of people to move out of these communities in search of safer and more stable means of livelihood (Figure 1). Sometimes, the risks prevailing in the destination of prospective migrants are higher yet, individuals still migrate. Some potential migrants are aware of the risks associated with migration while others are not aware [7]. In the *agricultural income loop*, increase in agricultural labour results in a corresponding increase in agricultural activities (productivity) which in turn amplifies food production. When food production increases the risk of starvation is minimized. Less starvation suggests that individuals become less susceptible to diseases and this makes more labour available for agriculture activities as observed in the *starvation loop*. More agriculture activities lead to a rise in food production which in turn enhances the likelihood of seed storage as seen in the *seed availability loop*. Food production and non-agriculture income feed into household income which in turn influences the means of livelihood for the two communities. When the means of livelihood in the community grinds down, it triggers exodus of community members into urban centres in search of new and better income opportunities; eventually this situation reduces the agricultural labour force. Onset of floods could lead to incidence of disease which potentially could lower labour available for non-agriculture activities and also reduce non-agriculture income that community members earn. Consequently, household income decreases. The destruction of crops by the floods makes it imperative for the community members to shift dependence on agriculture income to non-agriculture income or diversify their agricultural livelihoods. In the *non-agricultural income loop*, flood events simultaneously trigger reduction in food production (farms are destroyed and agriculture lands become inundated and unsuitable for cultivation for most of

the staple foods within the study area leading to reduction in household income) and outbreak of diseases such as cholera. It must be emphasized that existing bad sanitation practices within the communities also feed into the outbreak of the disease. Infected individuals in most cases, lack the capacity to contribute to non-agriculture labour. This reduces non-agriculture labour and ultimately reduces the income that the individuals would have gained from engaging in non-agriculture activities.

Figure 1. A simplified causal loop diagram illustrating the impact of floods on communities in Northern Ghana.



Causal loop diagrams are used to show how variables that are interrelated affect one another. They are also called cause-effect diagrams. Positive relationships between variables (denoted with the sign “+”) indicate a change in the same direction of the two variables while negative relationships (denoted with the sign “-”) indicate a change in opposite directions. In a positive relationship, an increase in one factor will lead to a corresponding increase in another factor and vice versa. In negative relationships an increase in one factor will lead to a decrease in the other factor and vice versa. Each of the loops or sub-systems in Figure 1 has been expanded and explained in Figure 4, Figure 5 and Figure 6.

Another important effect of flooding is the destruction of the environment leading to a decrease in environmental quality. Indications of post-flood decline in environmental quality include:

- 1- The existence of swamps which become breeding grounds for water-borne diseases;
- 2- Destruction of homes, grain stores, social and economic infrastructures by flood waters;
- 3- Destruction of farmlands together with crops and farm animals;
- 4- Accumulation of massive quantities of silt on key community structures like water supply, sewage treatment, and others which paralyzes crucial life-support and ecosystem services.

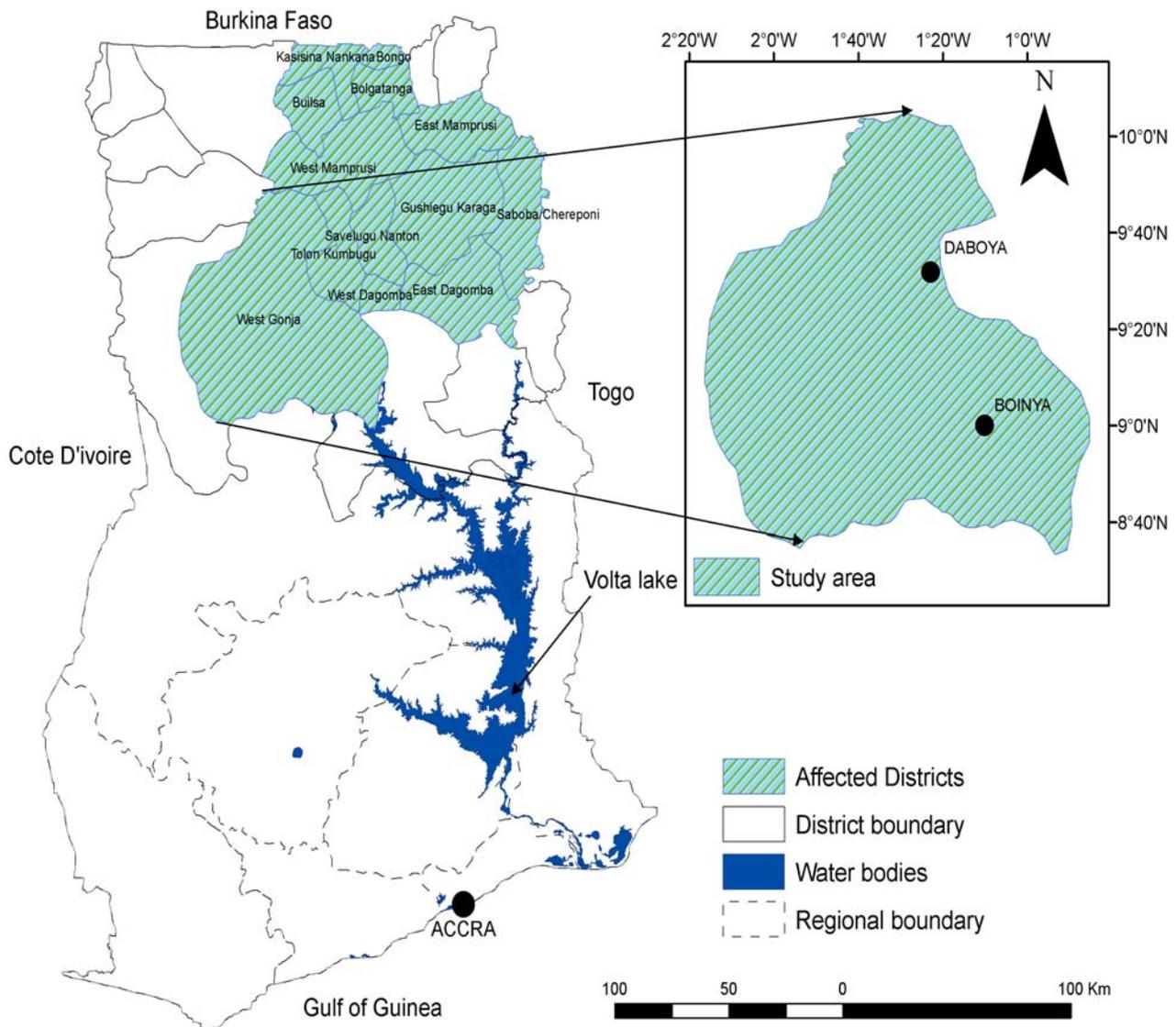
2. Materials and Methods

2.1. Area of Investigation

Location

The study was undertaken in the Gonja municipality which is located in the Guinea savannah agro-ecological system of the Northern Region of Ghana between latitude $8^{\circ}33'12.107''\text{N}$ to $10^{\circ}4'31.877''\text{N}$ and longitude $0^{\circ}44'54.137''\text{W}$ to $2^{\circ}16'31.641''\text{W}$ (Figure 2). The area covers a land surface area of approximately $8,353 \text{ km}^2$. Specifically, two communities; Boinya in the Central Gonja District and Daboya in the West Gonja District; were identified and selected for this studies.

Figure 2. Map of worst flood affected districts (green shaded region), part of which is the study area.

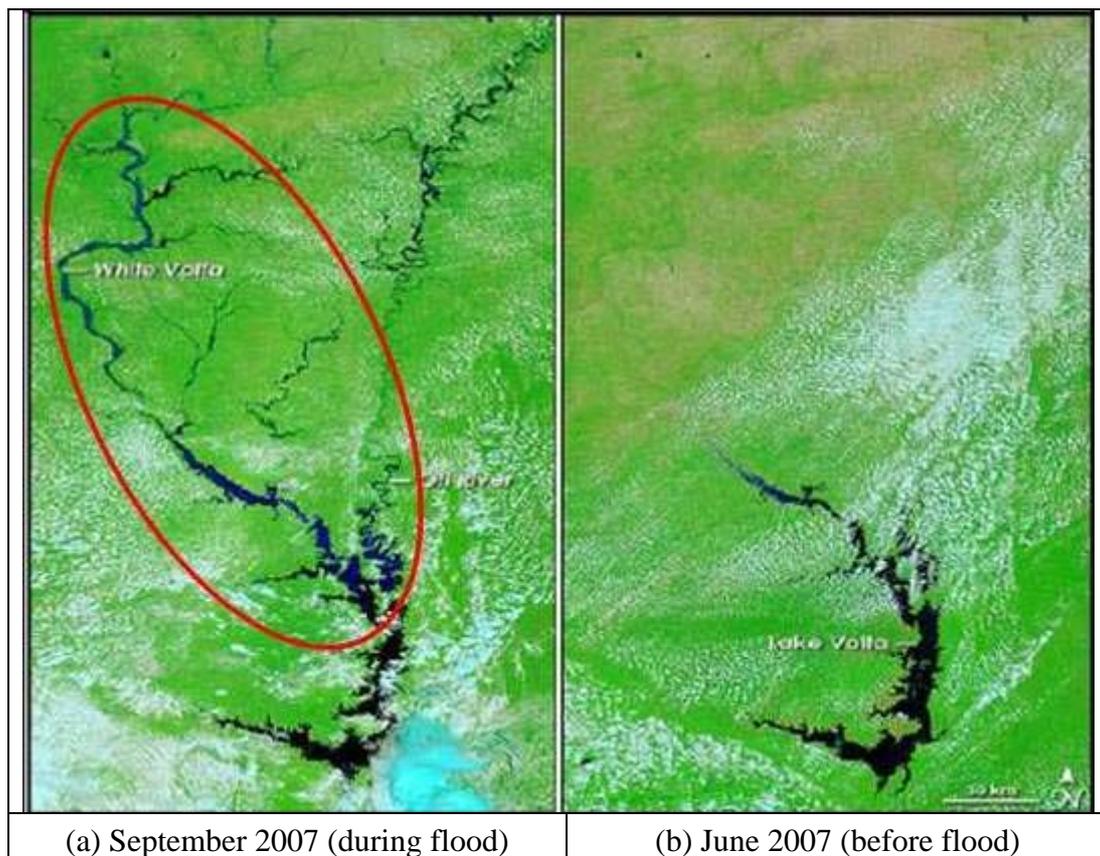


Climate

The climate of the study area is influenced by the movement of harmattan and monsoon winds, which controls the climate of the West African sub-region. The area has a unimodal rainy season

starting from May to September. Average annual rainfall is about 1100 mm with peak rainfall occurring in late August or early September. In 2007, the floods corresponded to the annual peak of precipitation input. Figure 3 shows the period immediately before and during the floods. Records of mean temperature and relative humidity obtained from the meteorological station within the study area indicates 27 °C and 61%, respectively.

Figure 3. MODIS Terra Images (a) during flood (September 2007) (b) before floods. The area highlighted in red on the September 2007 image shows how river systems are swollen compared to the period when the rainy season had just started in June (right).



Soils, relief and drainage

The topography is gently undulating and low in relief with mean slopes of 7%. The study area is drained by the White Volta River which rises north of Ouagadougou in Burkina Faso with nearly all tributaries from various sub-catchments in the region draining southward into the White Volta River. The soils of the area are largely typical Lixisols.

Vegetation

The study area falls within the Guinea savanna agro-ecological zone; which is much drier than southern areas of Ghana, due to its proximity to the Sahel, and the Sahara. The vegetation consists predominantly of grassland (less than 10% of tree cover), especially savanna with clusters of drought-resistant trees such as shea, dawadawa, neem, baobabs or acacias. The Guinea savanna vegetation belt has evolved from climatic factors and modified substantially by human activities. Human activities, notably, annual routine bush burning, inappropriate farming practices and indiscriminate felling of

trees for fuel wood and charcoal as well as poor animal husbandry practices have led to loss of the vegetative cover in the study area. These have culminated in loss of soil fertility and its adverse effects on crop cultivation.

Socio-economic activities

Agriculture is the predominant livelihood strategy for people in this area and the most important activity in terms of spatial extent. About 80% of the population of the region is engaged in farming and depends mainly on natural soil fertility with limited external inputs such as inorganic fertilizers. Notwithstanding the constraints to agricultural development including erratic rainfall pattern, low soil fertility, inadequate irrigation facilities, frequent wildfires, post harvest losses and difficulty in accessing credit, the region can be described as the bread basket of Ghana.

2.2. Data Collection

Survey over a period of one year (November 2007 to November 2008) was carried out in Boinya in the Central Gonja District and Daboya in the West Gonja District of the Northern Region. A total number of 220 randomly selected respondents consisting of 54 females (25%) and 166 males (75%) were sampled. The unit of analysis is individual resident members of the two communities and each community contributed equal sample size (110). Ninety-seven percent of respondents have lived in each of the communities for more than five years. The aim of the inquiry was to understand the livelihood structure, coping mechanisms before flooding and in the aftermath of floods, and the extent to which respondents were vulnerable. The two communities are heterogeneous in terms of culture, ethnicity, religion, social groupings, *etc.* Consequently, it was expected that vulnerability within the communities would not be uniform across the population. A number of opinion leaders in both communities were also interviewed as part of the survey. The interviews were carried out with the aid of semi-structured questionnaires. The questionnaires were applied to respondents in interview sessions. Other than the interviews, direct observations were also carried out in the two communities to ascertain damage caused to agricultural and non-agricultural assets. In addition, a number of stakeholder groups such as occupation-based cooperatives, district assembly officials, staff of the district education directorate, community based organizations (CBOs) and non-governmental organizations (NGOs) were interviewed to determine literacy rate, enrolment ratio, gender activity, and inequalities in income and opportunities.

3. Results and Discussion

3.1. Community Demographics

Eighty percent of respondents had dependants while 20% did not have any dependants. The number of dependants of respondents ranges between 1 and 20, however, most respondents (33%) had between 1 and 5 dependants. Significantly, almost two-thirds of respondents had no formal education while the highest level of education for 24% of respondents was basic. Eight percent of respondents had received either secondary or vocational education. One percent each of respondents had received tertiary or non-formal education. Generally, percentage of male respondents who had obtained formal education was higher than for female respondents.

Respondents were involved in the following occupation types: fishing, farming, trading, teaching, dressmaking, health officer, masonry, weaving, studying and hair dressing. The predominant occupation of respondents were farming (66%) and fishing (17%). It was also from these two sources that respondents derived their major income. Seventy percent of respondents had over 10 years experience in farming while only 1% had been engaged in farming for less than one year. Farming activities of respondents included crop production (41%), animal husbandry (71%), and mixed farming (52%). The farm size of respondents ranged between 0.4 and 8 hectares; majority of respondents (45%) had farm size of 2.4-4 hectares while less than 2% had farm size of 6.4-8 hectares. The farming activity of 7% of respondents was solely for commercial purposes while that of 16% of respondents was solely for subsistence. The farming activity of 72% of respondents was both for commercial and subsistence ends. Farm-dependent annual income of respondents ranged between 20 and 850 Ghana Cedis (One Ghana Cedis was equivalent to 0.9 United States Dollars (USD) as at the time of data collection). However farm-dependent income of most of the respondents (40%) was about 400 Ghana Cedis. Sixty-six percent of respondents had farm-independent income while 33% did not have farm-independent income. Seventy-two percent of individuals who had farm-independent income derived it within the same community. Total household annual income for respondents ranged between 60-2500 Ghana Cedis. Significantly, the average annual income for males was higher than for females. The ratio of male to female income for comparable occupation was 5:2.

Only 9% of respondents lived in houses made of cement blocks. Twenty-five percent and 65% of respondents lived in thatch- and mud-houses respectively. While 45% of respondents owned their residence, 53% lived in accommodation owned by family or relatives. Another 2% lived in rented accommodation.

3.2. Reliance on weather information for agricultural activities and flood preparedness

Eighty percent of respondents rely on weather information for their agricultural activities while 18% do not. The sources for dissemination of weather information to respondents include agricultural extension agents, the media, as well as friends and relatives. The predominant channel is the media. Less than 2% of respondents obtained weather information from agricultural extension officers. This is unacceptable because although in Ghana, agricultural extension services have been very efficient in the dissemination of information to most farming communities the agriculture extension officer-farmer ratio of 1:2813 in the two communities is far below the national average of 1:400 [11]. While 76% of respondents trusted the sources of information, 4% do not trust the sources of information. About 97% of individuals who mistrusted the source of information cited the fact that previous weather forecasts have not been accurate leading to under- and over cultivation of crops by the respondents at one time or another. Sixty percent of respondents indicated that the flow of weather information has been intermittent, a situation which further diminished their reliance on the information. Only 22% of respondents indicated that they were aware that the 2007 floods were imminent. Even so, 94% of this group did not prepare for the floods. It is pertinent to ask why this group of respondents failed to act on the prior information they received. Could it be as a result of lack of confidence in the source of the information or they just did not know what to do nor had no option?

For the remaining 6% their preparation centred on short-term measures such as migrating to a new location with a few personal belongings, crossing the river to live in a nearby village, and premature harvesting of crops. More than 90% of those who were aware and prepared for the floods acknowledge that their preparation did not help them to better cope with the floods. Only 3% suppose their preparations better equipped them to cope with the floods. One percent of respondents mentioned that they obtained prior information from friends while 20% obtained the information from the media. The rest did not indicate the channel through which they received their information. The period of awareness for persons who had prior information on the flood ranges between one day and two months. More than 80% of them had the information less than one week before the incidence of floods. Less than 2% obtained the information one or more months prior to the event. Table 1 shows the number of respondents who have experienced flooding in their communities prior to the floods in 2007.

Table 1. Occurrence of floods in the study area.

Year	Number of Respondents affected by floods (N=220)
1985	8
1988	148
1993	4
1998	6
1999	54
2007	220

3.3. Impact of flooding on the two communities

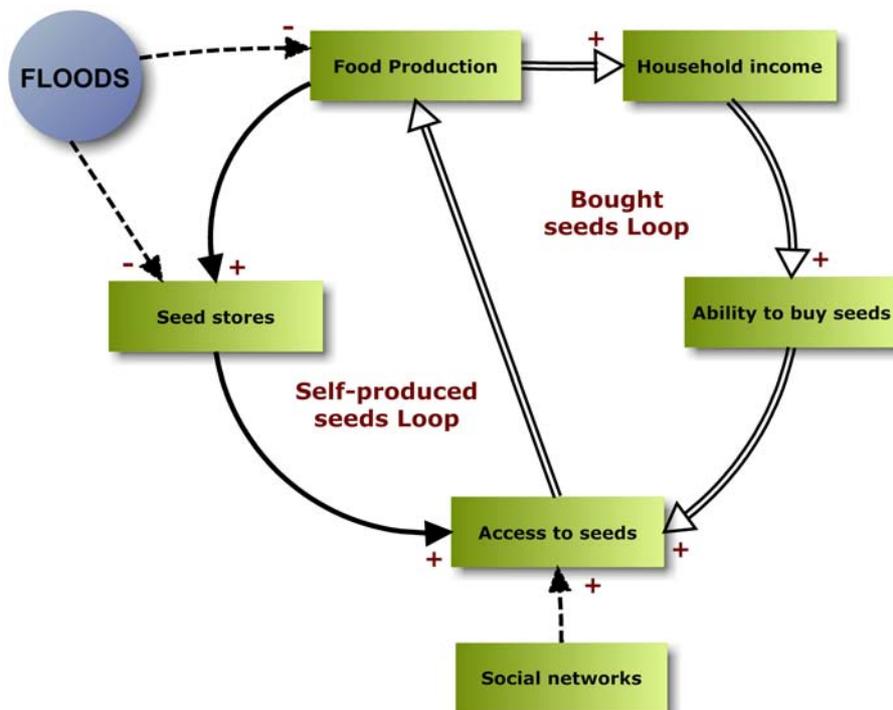
The impact of the floods on the two communities can be categorized into three components namely ecological effects (e.g. sweeping away of fertile top soil), humanitarian effects (e.g. ripping of roof on mud houses) and economic costs. The economic costs involve direct costs (e.g. loss of capital by traders), indirect costs (interruption of business activities) and macroeconomic (e.g. loss of GDP). The flooding that occurred in the two communities in 2007 is not the first. Close to 90% of respondents indicated that their communities have experienced similar situations in the past. Apart from the floods in 2007, three-fourth of respondents has previously been affected by at least two other incidents of flooding (Table 1). Respondents mentioned that during the previous floods their canoes, farm produce, food items, houses and fishing tools were destroyed. They also lost their farm animals. During the floods in 2007, they lost other personal effects in addition to the aforementioned: corn mills, television sets, bicycles and fishing nets among others. Their trading shops and church buildings were also affected by the 2007 floods. About ninety percent of respondents hinted that they are worse off after the flood than before. About 2% of respondents maintain that their livelihoods have improved after the floods. Another 8% suggest that they have not observed any significant changes in their lives.

Floods are periodic occurrences but have large impacts on the process of food production, security and encouragement to out-migrate. The level of agricultural income, non-agricultural employment opportunities and social networks contribute as drivers of vulnerability of natural resource-dependent communities in northern Ghana. The levels of diseases in the communities depend on the nutrition standard, the general standard of living, and environmental tragedies like floods. The level of agricultural income, non-agricultural employment opportunities as well as social networks can be important in mitigating problems of physical and mental health in the community.

3.3.1. Floods and access to seeds

One important aspect of floods in northern Ghana is the damage they inflict on seeds. Most small-scale farmers’ safe-guard the most viable portions of their produce as seed for the next planting season. In the 2007 floods significant damage of food crops just nearing harvest meant that the farmers’ seed supply for the coming agricultural year was jeopardized. Floods may therefore affect seed supply either through affecting crop production (on farms) or destroying seed stores (in homes). Either way, the lack of seeds for subsequent planting could generate a reinforcing effect of lower food production and another resulting lack of seeds (Figure 4). Farmers may be able to supplement their seeds with limited bought supplies – either to make up for a deficiency or introduce produce with better traits into their stock. However, by reducing food production, floods may limit household income and reduce farmers ability to buy seeds which also creates another reinforcing effect of lower production and even lower ability to increase household income enough to afford seed purchases (Figure 4). When farmers are unable to produce their own seeds or buy them because of flood damage, they turn to family and friends for assistance which have often proven to be very helpful. This highlights the important role played by social networks as important tools for mitigation of flood induced vulnerability.

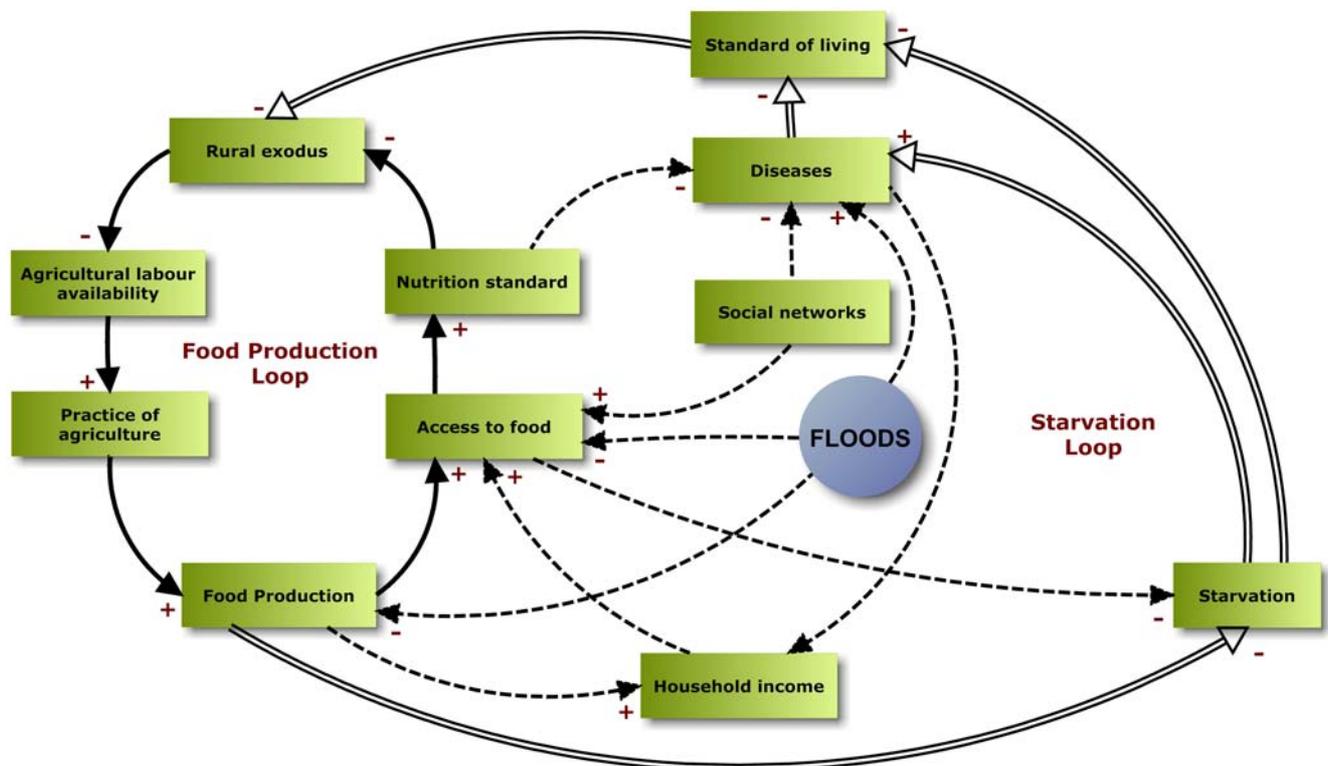
Figure 4. Causal loop diagram of the impact of floods on farmers access to seeds.



3.3.2. Flood induced starvation through the limitation of food production and reduced access to food

As already seen above, floods can restrict food production by damaging seeds either on-farm or off-farm (Figure 5). Floods can also render farms uncultivable for the time it is submerged and even deposit sediments on farms that will make cultivation expensive and difficult for some time. Floods therefore have a large potential of reducing food production. Such reduction in food production can reduce access to food, lower nutrition standards; encourage rural exodus and the loss of agricultural labour which further reduces food crop production in a vicious cycle (Figure 5). Starvation is another important outcome of floods in northern Ghana. Floods create an enabling environment for the proliferation of diseases and destroy produce on farms which drives the cycle of limited food production. Floods also directly limit access to food resources either distributed as aid, sold in distant markets or available from relatives in areas not affected by floods thereby reinforcing the starvation that may be created by destruction of crops by floods (Figure 5). The flood-induced decline in food production, and limitation in access to food all contribute to causing starvation that has been common among natural resource dependent communities in flood-prone areas. Given economies of these areas are heavily dependent on agriculture, flood damage of food production systems also mean a reduction in household income and ability to buy food and consequently, stem the starvation that follows periods of floods.

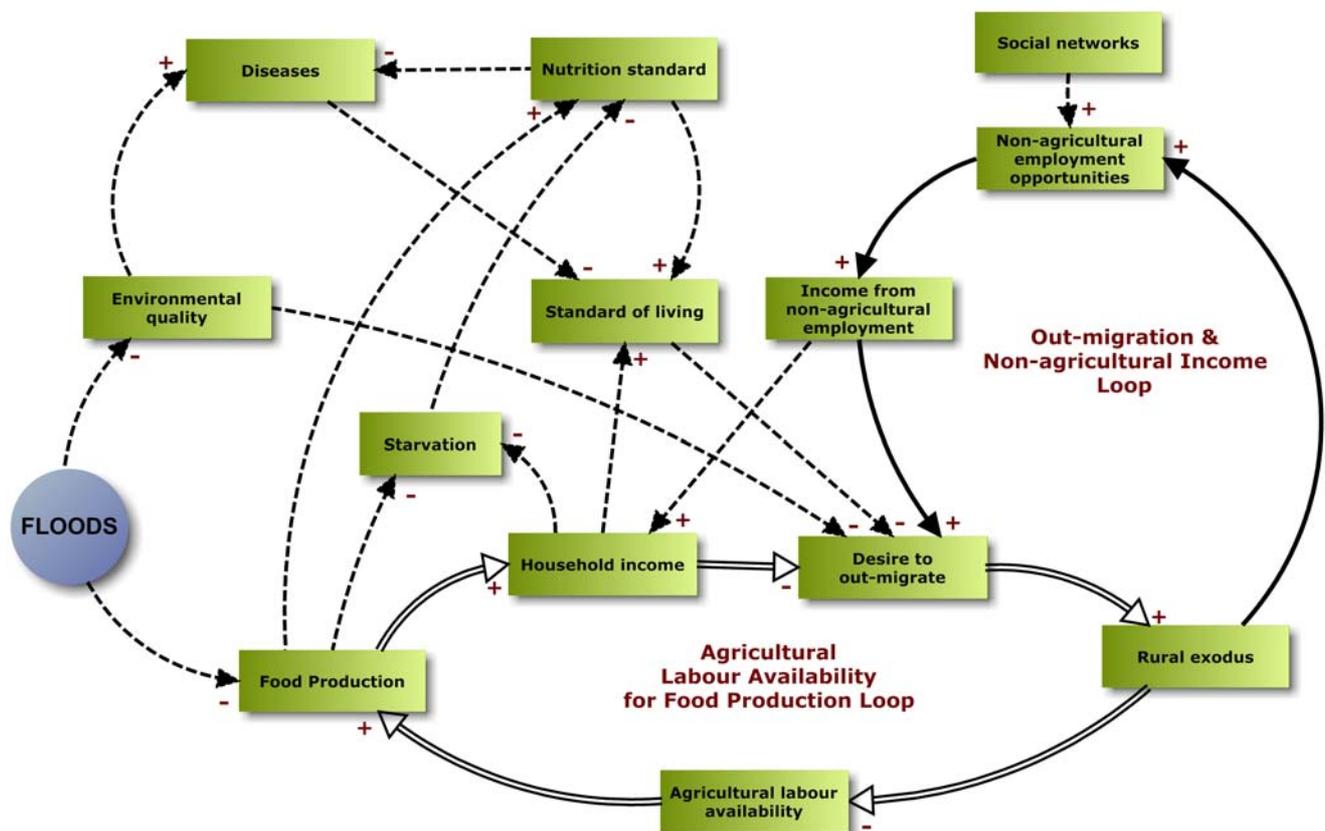
Figure 5. Causal loop diagram showing the effects of floods on food production, access and causation of starvation.



3.3.3. Floods and the desire to out-migrate

Floods act in different ways to influence the desire to out-migrate among natural resource-dependent residents of northern Ghana. Floods increase the desire to out-migrate by increasing the disease burden, decreasing environmental quality, reducing food production thereby increasing starvation and a decline in household income. The desire to out-migrate translates to rural exodus which reduces agricultural labour availability and for this reason, crop production in a reinforcing loop (Figure 6). Social networks can increase the desire to out-migrate by providing information on the available non-agricultural opportunities outside the communities. Non-agricultural employment opportunities outside the communities can serve as a means by which household income can be increased through remittances sent to families by relatives working in non-agricultural activities outside the community.

Figure 6. Rural-urban migration induced by floods.



The factors in the conceptual models (Figures 4, 5 and 6) potentially serve as indicators of the quality of livelihoods and the level of vulnerabilities within the two communities. However, the contribution of each factor to the quality of livelihood and degree of vulnerability is not uniform in the pre-flood and post-flood period. Based on interviews and observations within the communities, the factors in the conceptual models are ranked in Table 2. Each factor is assigned a value ranging from 0 to 1. Factors with values of less than 0.4 are considered to be low while factors with values of more than 0.75 are considered to be high. Factors with values ranging from 0.4 to 0.75 are considered to be average. It is significant to note that the values of these factors are dynamic and vary appreciably from the period immediately preceding the floods to the period immediately after the floods and thereafter.

Notwithstanding the variability in the values, these factors could be used in converting the conceptual models into quantitative models.

Table 2. Ranking of factors in the loops (indicators of vulnerability and livelihoods).

Factor	Pre-flood (April-June 2007)	Post-flood (November 2007-November 2008)
Food production	0.75 {high}	0.30{low}
Household income	0.50{average}	0.25{low}
Agriculture labour	0.78{high}	0.35{low}
Rural exodus	0.42{average}	0.76{high}
Standard of living	0.40{average}	0.25{low}
Disease	0.35{low}	0.70{high}
Environmental quality	0.76{high}	0.35{low}
Nutrition standard	0.68{average}	0.28{low}
Non-agric income	0.60{average}	0.45{average}
Access to food	0.77{high}	0.35{low}
Seed stores	0.78{high}	0.20{low}
Social network	0.65{average}	0.55{average}

3.4. Flood-induced Coping Strategies

Coping strategies by persons affected by floods can be considered at the individual level and/or social level [12]. Coping strategies in the communities can be divided into three: immediate, short-term and long-term as shown in Table 3. "Immediate" refers to actions that are undertaken during and in the immediate aftermath of the flood. "Short-term" refers to a period less than one month after the floods and "Long-term" refers to the period more than one month after the floods. Some of the strategies that respondents implemented to cope with the floods include the following: roofing of thatch houses for money, fishing, weeding the farms of other individuals in return for food, trading and selling in nearby townships, obtaining loans from social contacts, selling of livestock, premature harvesting of crops, weaving and basketry, dependence on food from previous crop seasons, and resettlement in other towns (geographical diversification). This is reflected in the *out migration* and *non-agric labour income* loops. Respondents were simultaneously involved in two or more of such activities in order to survive (income diversification). 15% of respondents strongly agreed that these actions were effective in assisting them cope with the floods. Another 68% of respondents agree with this assertion while 7% disagreed. 10% did not respond to this issue. Sixty percent of respondents pointed out that they had acquired traditional skills and knowledge that assisted them to cope with the

floods. The skills include construction of thatch houses, swimming, paddling of canoes, climbing, weeding, artisanal fishing, weaving and basketry. However, 40% of respondents lacked these skills.

Table 3. Timelines for the implementation of flood coping mechanisms in the study area by individuals and families, governmental and non-governmental organizations.

Responsibility	Goals	Immediate	Short-term	Long-term	Comments
Individuals and Households	Access to food and other emergency aid	✓			During floods, the immediate concern is that of survival - people make efforts to access food, water and other aid that may be available
	Rebuilding a base for subsistence food production		✓		Immediately after the floods, residents (mainly farmers) first try to be able to feed themselves through subsistence food production
	Income generation through agriculture		✓		After being able to feed themselves, they begin looking for opportunity to sell surpluses
	Non-agricultural income generation			✓	Non-agricultural income generating activities come second place to food production in predominantly agricultural communities
	Out-migration to zones of less risk & better opportunities			✓	People eventually think of leaving the area in favour of zones with less risk and more economic and social opportunity
	Rebuilding damaged houses			✓	After living in temporary shelters for the duration of the floods, people struggle to rebuild what is left of their permanent homes immediately after the floods
Government and NGOs	Rebuilding public services		✓		Immediately after floods, public services like water treatment, sewage disposal and others are up for repairs
	Distribution of food aid	✓			Food aid distribution is an immediate concern and task for governmental and non-governmental organization during floods
	Coping with the disease burden	✓			The disease burden (cholera, diarrhea, and other water-borne diseases) are all part of flood associated to which officials have to provide immediate
	Education & sensitization			✓	Education and sensitization on preparedness, mitigation, coping with floods is the long-term goal of government - aimed at reducing vulnerabilities to this disaster
	Demarcating risk zones			✓	Government through its town planning policies will demarcate risk zones where habitation is not allowed in a bid to reduce exposure of the populace to risk

Ninety percent of respondents mentioned that they have learnt new skills and acquired knowledge that will better equip them to cope with future flood. The new knowledge and skills include how to paddle and swim faster than before, how to ensure proper storage and preservation of harvested crops, how to build fortified cement houses, the need to site farming activities far from river banks, and the need to pay more attention to weather information. After the floods, respondents acquired most of the

skills and knowledge through the instrumentality of civil society groups. Twenty percent of respondents strongly agree that they are confident of their capacity to better cope with future flood events and 76% agree with this observation. However, 4% of respondents disagree with this observation.

3.5. Social Support and Networks

It is important to confront the risks associated with over-dependence on subsistence agriculture in natural resource dependent communities in order to stimulate a more intensified and sustainable livelihood systems. Consequently, the interconnections between groups sharing common resources need to be addressed [15]. Bonding, bridging and linking relationships that builds trust and common interests and the networks that support them within, between and beyond communities (collectively referred to as social capital) need to be examined, strengthened and, where appropriate, created [15]. Participation is both essential and apposite [16]. However, the overarching goal is the quality of participatory relationships and how those relations are interconnected [16].

Social capital has been identified as critical to adaptation [6]. Almost all respondents received remittances from relatives living outside the flood zone. Apart from this kind of support, a number of organizations provided relief items to the flood victims. The organizations that supported the flood victims can be categorized into two: external and internal. External organizations include various United Nations and bilateral development partners. The internal organizations can be sub-divided into local, regional and national. The local organizations include community based organisations; the National Disaster Management Organization (NADMO) and religious bodies. Support for the flood victims was mainly in the form of money, food items, and clothing.

As expected, the range of vulnerability among the respondents was very wide and thus the ability of individuals to adapt to the floods was not uniform across the population. The results show that some groups women (childless widows, the elderly) and children are more prone to damage, loss and suffering in the context of the frequency and magnitude of the floods. However, NADMO had no specific policies targeted at these groups. This situation undermines the sustainability of the relief programmes initiated by NADMO. Key variables explaining variations of vulnerability include class (which includes differences in wealth), occupation, ethnicity, gender, disability and health status, age and the nature and extent of social networks. Individuals were uncertain of the livelihood opportunities outside their communities. However, extensive rural–urban migration has occurred in the two communities in response to the economic and social inequalities inherent the two communities. Such migration followed the loss of land used by poor farmers and pastoralists, and discriminatory pricing of crops produced in small quantities by poor farmers. Migration has equally forced increased numbers of individuals to seek living space and subsistence on flood-prone land within and alongside the Volta River. The practice is unsustainable in the long term; however, individuals were more concerned with their short term subsistence than events that might occur in the distant future. It is evident that thinking in the short term in this case affected the quality of the decision making of the migrants who were not aware of the risks associated with migration. Some individuals however, were aware but chose to migrate. It is likely that this group evaluated the risks associated with migration to be lower than the risks associated with staying in their original location. Out-migration has led to the erosion of local

knowledge that might serve to reduce vulnerability to floods and a loss of the skills required for coping in the aftermath of the flood.

There are two different ways of livelihood diversification in which individuals respond to deteriorating climatic conditions. To begin with, the perceived drought or flood risk *encouraged* people to diversify (as a preventive strategy) and secondly, sub-subsistence crop output, caused by a combination of inadequate rainfall and soil fertility decline, *compelled* people to diversify their livelihoods. To deal with outstanding, severe food shortages (for example caused by floods), individuals can also rely, to a large extent, on non-agricultural income generating activities (*non-agriculture income loop*). When the food crisis is area-wide, the efficiency of these strategies is likely to decrease because of increasing food prices, competition, and a lack of clients due to a general scarcity of money in the local economy. Analyses of coping strategies hint that remittances from migrant relatives are a more efficient coping strategy in case of area-wide crisis. People preserve claims on these relatives for times when they are really needy. This behaviour reflected in the aftermath of floods that occurred in 2007. The advantage of the geographical spread of family networks is that crisis in one location is less likely to coincide with crisis in the other location. For the same reason, seasonal labour migration often remains an effective strategy to gain access to money to buy food when local non-farm income opportunities have lost some effectiveness (*rural exodus chain*). This is how the individuals in the two communities have adapted to vulnerability in times of seasonal shortages of food supply and in times of occurrence of floods.

The individual households encouraged their family members to migrate out in order to attract the remittances sent for family support by the workers in urban centres (*rural exodus chain*). This situation was occasioned by the erroneous belief that income levels in urban centres were very high, a belief that was amply demonstrated by the opulent lifestyles of returnee workers within the communities. In the short term, remittances from the migrants serve as buffer for their family members in time of need. In the long term however, this migration feeds into the depletion of skilled labour. Thus, the paucity of skilled labour in the communities emerges (*agriculture labour loop*). Some of the migrants are equipped with knowledge of indigenous herbal medicine, seed production and storage. Their migration therefore constitutes loss of skills that could be useful in the advent of floods. In this way we are led from proximate and specific cause to more remote 'root causes' of vulnerability in the two communities.

The respondents were asked to put their present situation into perspective by comparing it with the situation in the past. The answers to these questions do expose some inclinations in the individuals' sources of livelihood but they do not elucidate the *processes* that give rise to the individuals' present situation of vulnerability. Although the findings indicate that there are important variations in sources of livelihood between individuals and households, these variations did not justify a categorization in different livelihood systems. Virtually all households in the sample are elements of the same livelihood system: that of cultivators who own livestock and who have diversified their livelihoods with non-farm and/or off-farm income.

The results show that adaptations to agricultural resource fluctuations consist of a range of livelihood strategies and responses at individual, household and community level. At the level of the individual farmer or farming activity, these can be characterised as flexibility within agriculture (targeting different crops according to seasonal availability, affordability and accessibility),

geographical mobility and livelihood diversification. Diversified livelihoods are also a feature of household strategies, with members of farming households often being involved in different economic sectors to smooth the effects of resource variations (*non-agricultural income loop*). A variety of intra-household responses are also evident, such as allocation of family labour in time of need (*agricultural labour loop*), or acceptance of income variation and modification of grain consumption patterns (*seed availability loop*). Individual and household livelihood adaptability is sustained by enabling institutions.

Flexible financial mechanisms at local level recognise the inherent variability of farming. For instance exchange of food with labour is not uncommon in the two communities (*non agriculture labour loop*). While recognising that such adaptations may be a function of a particular set of circumstances and should not be generalised, collectively they do provide challenges to many of the fundamental tenets of previous rural agricultural resources management. Most respondents had access to social capital in terms of remittances from relatives living outside the flood zone. However, the impact of the remittance was not extensive for three reasons. First of all, the remittances typically arrived after the most critical period of vulnerability for flood victims had elapsed. Second, the most affected flood victims were more often than not cut off from the mainstream community and thus were unable to exploit their social capital. Third, the diffusion of benefits of social capital to the communities was sometimes exclusionary. The results show that individuals who were not members of the ruling political party were excluded from particular activities such as access to relief items in the aftermath of the floods regardless of the extent to which they were vulnerable. This issue reflects inequality of access to social services. The issue of sustainability of this practice is therefore brought into question. Hence vulnerability is reproduced within certain parts of social systems through deep structural elements.

In the *non-agricultural income loop*, several types of non-cropping income *activities* and *passive* sources of income can be distinguished: animal husbandry, foraging and local non-farm activities; off-farm income (seasonal labour migration and remittances from migrant relatives); gifts from other households in the area; and (food) aid from government agencies and NGOs. Local non-farm income generating activities include *female* non-farm income activities, such as hairdressing, sewing, weaving and petty trading; a large variety of *male* casual jobs, such as masonry, carpentry, tailoring, butchering, fishing, shoe repair and block moulding; formal income (mostly in civil service); pensions and income from property. Although some of these activities were low-yielding, the importance of these activities in mitigating vulnerability cannot be underestimated.

Interaction with stakeholders at the two district assemblies revealed that there was no budgetary allocation from central government to either district for the purpose of mitigating floods. This situation has compromised the capacity of the two district assemblies to financially assist the communities. The 'institutional context' of rural livelihoods is significantly altered, for better or worse, by decentralisation, and livelihoods precepts can help track the effects of these changes on the expansion or contraction of opportunities that permit the poor to build their own pathways out of poverty[13]. In this case, it appears that the institutional context of livelihoods has been changed for the worse due to lack of budgetary support from central government to the two district assemblies. Budget surplus and world trade shares are functions of economic power. For the past forty years, the economy of Ghana has not recorded any budget surplus. In fact more than 50% of Ghana's budget is donor supported.

Furthermore, in most cases donors have defaulted in fulfilling their obligations leading to budget deficits. This situation affects equitable financial resource allocation to competing sectors of the Ghanaian economy. Although these issues operate at a larger spatial (national level), it has a bearing on the community level economy because it is the government that furnishes the district assembly with funding through the District Assembly Common Fund (DACF) for onward delivery of social services at the community level.

The relationship between adaptive capacity and vulnerability (in terms of potential impacts, sensitivity and exposure) is complex [14]. However, it seems evident from the above that the low adaptive capacity of the two communities makes them more vulnerable to future natural disasters such as floods. As indicated earlier, some of the respondents may have acquired traditional skills and knowledge in order to better cope with future floods. However, the nature of the acquired skills suggests that individuals can adequately cope with floods only in the short term.

4. Conclusion

Farming is a significant part of the rural economy in Boinya and Daboya even in the aftermath of flooding. However, increasingly livelihoods are becoming diverse. Nonetheless, the preeminent role of agriculture in reducing vulnerability to floods has not shifted significantly. In relation to the sensitivity of the livelihoods, there are large differences between individuals in the study area. Individuals that have effectively diversified their livelihoods, both occupationally and geographically, are much less sensitive than individuals who mainly achieve entitlement to food through crop cultivation. The seasonal and inter-annual variations in food prices can be very high, but few farmers have to purchase a *large* part of their food needs. Still, for the most vulnerable and food insecure individuals, the high prices of food in the lean season can certainly constitute an immense vulnerability and an incentive to migrate even in the face of the risks and uncertainties associated with migration.

Some characteristics of the socio-cultural environment in the two communities appear to mitigate risk and reduce vulnerability. In this regard the farming groups; and the safety-nets provided by the geographically dispersed extended family are crucial in reducing vulnerability. To reduce livelihood vulnerability, most farmers in the research area choose to diversify their livelihoods (both occupationally and geographically) rather than to invest in a sustainable intensification of agriculture. Farming is a high-risk occupation and one is prone to cyclical fluctuations in crop yield and seasonal variability, some of which are highly unpredictable in occurrence. Diversification reduces the risk of livelihood failure by spreading it across more than one income source. It also helps to overcome the uneven use of assets (principally labour) caused by seasonality, to reduce vulnerability, to generate financial resources in the absence of credit markets, and it confers a host of other advantages in the presence of widespread market failures and uncertainties.

Acknowledgements

We wish to express our profound gratitude to the anonymous reviewers for their constructive criticisms and suggestions.

References

1. McCusker, B.; Carr, E.R. The co-production of livelihoods and land use change : Case studies from South Africa and Ghana. *GeoForum* **2006**, *37*, 790-804.
2. Yaro, J.A. Theorizing Food Insecurity: building a livelihood framework for researching food insecurity. *Nor. Geogr. Tidsskr.* **2004**, *58*, 23-37.
3. UNOCHA. United Nations Office for the Coordination of Humanitarian Affairs, Ghana Floods Flash Appeals 2007. <http://www.reliefweb.int/fts> (accessed on 30 December 2007).
4. Hesselberg, J.; Yaro, J.A. An assessment of the extent and causes of food insecurity in Northern Ghana using a Livelihood Vulnerability Framework. *GeoJournal* **2006**, *67*, 41-55.
5. Adger, N. Vulnerability. *Glob. Environ. Change* **2006**, *16*, 268-281.
6. Pelling, M.; High, C. Understanding Adaptation: What can Social Capital offer assessments of Adaptive Capacity? *Glob. Environ. Change* **2005**, *15*, 308-319.
7. Wisner, B.; Blaikie, P.; Cannon, T.; Davis, I. *At Risk: natural hazards, people's vulnerability and disasters*. 2nd ed.; Routledge: New York, NY, USA, 2003; pp. 15-134.
8. Ellis, F.; Allison, E.H. Livelihoods Approach and Management of small-scale fisheries. *Mar. Policy* **2001**, *25*, 377-388.
9. Ghana Statistical Service. *Ghana Living Standards Survey Report of the Fourth Round*. Ghana Statistical Service: Accra, Ghana, 2005; pp. 15-26.
10. Ghana Statistical Service. *2000 Population and Housing Census*. Summary Report of Final Results, Ghana Statistical Service: Accra, Ghana, 2002; pp. 10-75.
11. Awudu, A.; Wallace, H. Structural adjustment and economic efficiency of rice farmers in northern Ghana. *Econ. Dev Cult. Herit.* **2007**, *48*, 503-520.
12. Grothmann, T.; Patt, A. Adaptive Capacity and Human Cognition: The process of individual adaptation to climate change. *Glob. Environ. Change.* **2005**, *5*, 199-213.
13. Osbahr, H.; Twyman, C.; Adger, N.W.; Thomas, D.S.G. Effective livelihood adaptation to climate change disturbance: Scale dimensions of practice in Mozambique. *Geoforum* **2008**, *39*, 1951-1964.
14. Whitehead, A. Tracking Livelihood Change: Theoretical, Methodological and Empirical Perspectives from North-East Ghana. *J. S. Afr. Stud.* **2002**, *28*, 575-598.
15. Moore, K.M.; Bertelsen, M.; Cisse, S.; Kodio, A. Conflict and agro-pastoral development. In *Conflict, social capital and managing natural resources: a West African case study*; Moore, K.M., Ed.; CAB International: Wallingford, UK, 2005; pp. 1-23.
16. Pretty, J.; Buck, L. Social capital and social learning in the process of natural resource management. In *Natural Resources Management in African Agriculture*. Barrett, C.B., Place, F., Aboud, A.A., Eds.; CAB International: Wallingford, UK, 2002; pp. 23-33.