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## RESEARCH ARTICLE

### ‘The floods came and we lost everything’: weather extremes and households’ asset vulnerability and adaptation in rural Ghana

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Extreme weather events such as flooding have been observed to deplete households’ assets and render households vulnerable to shocks and poverty. Few empirical studies have however examined households’ asset vulnerability and adaptation to such extreme events in Ghana. Based on qualitative research with two ecologically fragile communities in Ghana, this paper explores the asset vulnerability and adaptation strategies of households against periodic flooding. Findings suggested that households’ assets most vulnerable to flooding were farmlands, human health, housing and financial savings. However, flooding did not affect households’ assets equally; the effects were gendered and differentiated, often occasioned by inequalities in exposure, vulnerability, access to resources, capabilities and opportunities. Nonetheless, many households are actively adapting their assets by acquiring new knowledge about early warning systems, employing different farming practices and diversifying their assets. Understanding the differences in households’ asset vulnerability as well as in the priorities that men and women, as well as the young and old, place on different asset adaptation strategies could therefore be important in the effectiveness of climate change adaptation as well as the sustainability of communities.

**Keywords:** climate change; weather extremes; flooding; assets; vulnerability; adaptation; Ghana

#### Introduction

Over the last three decades, climate change has become one of the most widely discussed global development challenges (Prowse & Scott, 2008). The recently published Intergovernmental Panel on Climate Change (IPCC) Fifth Report (2014) highlights the saliency of the subject of climate change in contemporary global development. The severity of the impact of climate change and extreme weather events is however projected to be felt more in the global south, particularly in rural Africa (FitzRoy & Papyrakis, 2010; IPCC, 2014).

One of the projected adverse impacts of climate change is floods (IPCC, 2014; Kundzewicz et al., 2014). The IPCC (2012) defines floods as the overflowing of the normal confines of streams or other body of water or the accumulation of water over areas that are not normally submerged. In the last few years, several countries in Africa, Asia and South America have experienced large and damaging floods. In 2011 for example, Mozambique, Namibia, South Africa, Uganda, Brazil, Columbia, Mexico, Cambodia, China, India, Korea, Pakistan and Thailand all experienced devastating floods, with fatalities exceeding 1000 in places such

as Columbia and the Philippines (Arnall, Thomas, Twyman, & Liverman, 2013; Kundzewicz, 2012). In 2012, destructive floods inducing more than 50 fatalities each, also occurred in Madagascar, Niger, Nigeria, Bangladesh, China, India, North and South Korea, Argentina and Haiti (Kundzewicz, 2012). In addition to these, one study recently projects a large increase in flood hazard in South Asia and Southeast Asia, as well as in parts of South America in the twenty-first century and beyond (Hirabayashi et al., 2013). In tropical Africa in particular, projections indicate an expected increase in the risk of floods (Hirabayashi et al., 2013). In fact some 800 million people worldwide or 11% of the world’s population are currently living in flood-prone areas, and about 70 million or 1% of the global population are exposed to floods each year (Kundzewicz et al., 2014). Even at constant hazard, it has been projected that the population living in flood-prone areas would grow to 940 million, while those exposed to flooding yearly would grow to 86 million, based on demographic change alone (Hirabayashi et al., 2013). Reported flood losses (adjusted for yearly inflation) have also increased from an average of US\$7 billion per year in the

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1980s to some US\$24 billion per year in the period 2001–2011 (Kundzewicz et al., 2014). Among the contributing factors to increased floods risks are massive urban development, reduced river-storage capacity, land subsidence from unregulated groundwater extraction, extreme events, rising sea levels and increased intense precipitation (Dahm, 2014).

Like many rural communities in Africa, rural areas in Ghana are increasingly becoming vulnerable and fragile environments for making a living (Armah et al., 2009; Westerhoff & Smit, 2009). A number of recent analyses of rainfall and temperature trends have suggested a decrease in precipitation in Ghana for the period 1980–2000 (as compared to 1950–1970) (Owusu & Waylen 2009, 2013). In particular, seasonal and local climatic variability has been widely reported. For instance, Kunstmann & Jung (2005) found that total annual precipitation in the catchment area of the Volta Basin was increasing by 5% but decreasing (up to 70%) in April. One high-resolution regional climate model for the Volta region of Ghana also suggested an annual mean temperature increase of 1.2–1.3°C (Jung & Kunstmann, 2007). Indeed, data from Ghana's Climate Change Assessment Report indicate a warming climate, with mean annual temperature rising by 1.0°C between 1960 and 2011 (Stanturf et al., 2011). Using data from a quality-controlled network of 14 gauges from the Ghana Meteorological Agency (GMet) for the period 1961–2010, Manzanas, Amekudzi, Preko, Herrera, and Gutiérrez (2014) also analysed precipitation variability trends in Ghana. Their analysis revealed, respectively, the existence of predominant decreasing and increasing precipitation trends in the GMet data for the first (1961–1985) and second (1986–2010) half of the period of study.

In Ghana, these observed and/or simulated precipitation and temperature changes are triggering a wide range of extreme weather events, including flooding, and this exposes many rural households to new forms of risks and vulnerabilities (Stanturf et al., 2011; Westerhoff & Smit, 2009). Indeed, the IPCC Fifth Assessment Report (2014) notes that extreme weather events resulting from climate change threaten the livelihood security and survival of the world's poor and increase their vulnerability to displacement, food insecurity, water shortages and health hazards. In view of the livelihood threats of climate change-related extreme weather events, it has been argued that without appropriate livelihoods and asset adaptation strategies, extreme weather events pose a threat of reducing sustainable livelihood options for the rural poor in Ghana (Armah et al., 2009; Assan, Caminade, & Obeng, 2009; Kumamoto & Mills, 2012; Westerhoff & Smit, 2009).

Since the impacts of climate change are not completely preventable, one approach to minimizing the effects is adaptation (IPCC, 2014). Part B of the 2014 IPCC report – which focuses on regional aspects of climate change –

particularly highlights the relevance of adaptation in mitigating the adverse effects of climate change, particularly in West Africa (see Niang et al., 2014). Adaptation in this context is adjustments to ecological, social and economic systems in response to actual or expected climatic stimuli and their effects or impacts, which moderates harm or exploits beneficial opportunities (IPCC, 2014). In the literature, the terms 'adaptation' and 'coping' are sometimes used interchangeably. The IPCC report however makes important distinctions: coping is short-term response and non-continuous process whereas adaptation practices and results are sustained and the process is continuous; coping is oriented towards survival whereas adaptation is oriented towards long-term livelihood security; coping is motivated by crisis and is usually reactive whereas adaptation involves planning; and coping is often prompted by a lack of alternative whereas adaptation focuses on finding alternatives, including combining old and new strategies and knowledge.

Adaptation to extreme weather events is therefore fundamental to long-term poverty reduction and sustainable community development (Brown, 2011; IPCC, 2012, 2014). Consequently, there have been calls for more community-based empirical research to understand how extreme weather events such as flooding affect households' assets and the ways in which households adapt their assets to cope with such adverse events (Kumamoto & Mills, 2012; Mallick et al., 2005; Sowers, Vengosh, & Weinthal, 2011). In Ghana, a number of recent studies have examined vulnerability to climate change and extreme weather events as well as local community adaptation practices. For example, Derbile and Kasie (2012) examined vulnerability of crop production to heavy precipitation in north-eastern Ghana. They found that heavy precipitation events often led to low food crop productivity, which rendered farmers vulnerable to food insecurity. Although various local adaptation strategies were observed, these were largely inadequate for eliminating vulnerability of crop production to heavy precipitation. Westerhoff and Smit (2009) also studied dynamic vulnerability and adaptation to multiple stressors in the Afram Plains of Ghana. They found that while community members experience a range of biophysical and socio-economic conditions that contribute to vulnerability, individual community members were also actively adapting their livelihoods to minimize vulnerability. Armah, Yawson, Yengoh, Odoi, and Afrifa (2010) also studied the impact of floods on livelihoods and vulnerability of natural resource dependent communities in northern Ghana. Their study suggests that some characteristics of the socio-cultural environment, especially the role of social networks, mitigated risk and vulnerability. Their results further suggest that both in case of seasonal variations in agricultural output and floods, individuals that have effectively diversified their livelihoods, both occupationally and geographically, were less sensitive than

individuals who mainly achieved entitlement to food via crop cultivation. Codjoe, Atidoh, and Burkett (2012) also assessed gender and occupational perspectives on adaptation to climate extremes in the Afram Plains of Ghana. Their study suggested that preferred adaptation strategies to climate extremes differed by both gender and occupation, and that the success with which communities cope with the impacts of climate change is influenced by existing conditions, forces and characteristics which are peculiar to each community.

The studies referred to above have provided pioneering insights into the issues of vulnerability and adaptation to climate change and extremes in Ghana, and our study builds on these previous researches. However, our study departs theoretically from these previous studies by analysing households' asset vulnerability and adaptation to flooding in rural Ghana through the lens of an asset-based vulnerability and adaptation (AVA) framework (more on this later). The use of such an analytical framework to examine household's asset vulnerability and adaptation to extreme weather events such as flooding is rare in the context of Ghana. In addition, the paper highlights how different assets are valued based on gender, age and occupation, as well as the ways in which households' asset vulnerability and adaptation capacities are gendered and differentiated. Such an analysis is also lacking despite the fact that considerable literature exists on vulnerability and adaptation to floods and weather-related disasters (Sultana, 2010). As climate change is likely to exacerbate extreme weather events including flooding, it is critical that such differentiations are understood so as to better inform current and future adaptation approaches and strategies aimed at lessening the effects of extreme weather events (Sultana, 2010). Our findings, which are discussed below, greatly improve understanding of the differentiated vulnerabilities and adaptation strategies of households during stressful extreme weather events such as flooding.

### Theoretical approach

Vulnerability and adaptation to extreme weather events have been addressed from different perspectives. Initial conceptualizations of vulnerability to environmental change tended to focus on either the nature of the physical hazard or the inherent societal characteristics (Westerhoff & Smit, 2009). Later conceptualizations however recognized the interaction of social and biophysical forces. For example, the 'disaster pressure and release' model proposed by Blaikie, Cannon, and Davis (1994) suggested that natural disasters are the result of the interactions of two processes: those generating inherent vulnerability of a society and those leading to the physical exposure to hazard. Similarly, the 'hazard of place' model by Cutter (1996) considered vulnerability as a combination of biophysical risk and social characteristics that render a

society cognizant of and susceptible and able to respond to that risk within a specific place. More recently, a number of new theoretical approaches have been developed, including disaster management and urban system approaches (IPCC, 2012; Simatele, 2010), Adger's (2003) social capital and collective action approach and Moser and Satterthwaite's (2008) AVA framework. In this paper, we draw on Moser and Satterthwaite's (2008) AVA framework, and related work by Adger (2003) and Dulal, Brodnig, Onoriose, and Thakur (2010) to examine the ways in which households' asset become vulnerable to flooding and how these assets are adapted to minimize vulnerability.

Broadly, the AVA framework has two main components: asset vulnerability and asset adaptation strategies (Figure 1). The asset vulnerability component of the framework involves an analysis of households' assets and the sensitivity of these assets to physical hazards such as flooding (Moser & Stein, 2010).

Vulnerability in this context defines the degree to which a system (asset in this case) is susceptible to, and unable to cope with adverse effects of climate change, including variability and extremes (IPCC, 2014). Thus vulnerability is expressed as a function of a system's exposure to climate stimuli, and its adaptive capacity (Westerhoff & Smit, 2009). Within the AVA framework, vulnerability is closely linked to the availability and nature of critical assets. Generally, an asset is defined as the stock of financial, human, natural or social resources that can be acquired, developed, improved and transferred across generations (Moser, 1998). In this paper, we understand assets not simply as resources that generate flows of consumption and additional stock or are used to build livelihoods, but they give people the capability to be and act, to reproduce, challenge or change the rules that govern the control, use and transformation of resources. In this way, assets could include both tangible and intangible resources, with the assets of the poor commonly identified as natural, physical, social, financial and human (Adger, 2003; Dulal et al., 2010; Moser, 1998). Physical assets include the stock of plant, equipment, infrastructure and other productive resources

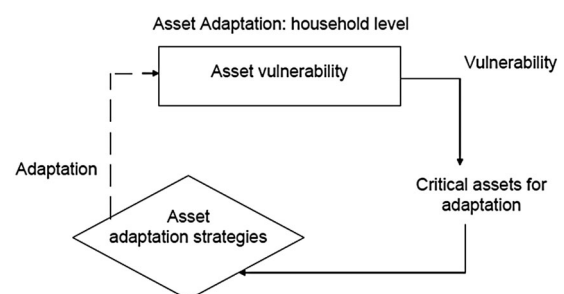


Figure 1. AVA framework (adopted from Moser & Satterthwaite, 2008).

owned by individuals or households. Financial assets comprise the financial resources available to people (savings and supplies of credit). Human assets include investments in education, health and nutrition of individuals. Social assets include intangible assets, defined as the rules, norms, obligations, reciprocity and trust embedded in social relations, social structures and societies' institutional arrangements (Dulal et al., 2010). In several related literatures, this social asset is often referred to as 'social capital' (Adger, 2003). Natural assets are the stock of environmentally provided assets such as soil, atmosphere, forests, minerals, water and wetlands.

Moser and Satterthwaite (2008) therefore argue that vulnerability to sudden shocks from external factors such as flooding pushes individual households into a state of uncertainty, and increasing risk of asset depletion and destitution. This argument suggests that the greater the erosion of households' assets during flooding events, the greater the vulnerability or insecurity of a household. However, such vulnerability may not be uniform in a given population and could be mediated by such factors as gender, age, occupation and access to more diversified assets base, which could be relied on to pursue adaptation strategies. As Prowse (2008) argues, a broad asset base is critical in adaptive response of the poor against extreme weather events. The second component of the framework therefore goes beyond vulnerability to analyse the roles individual household's assets play in increasing adaptive capacity. In particular, the adaptive response component of the framework explores the practical adaptation strategies, which households employ to adapt their assets against extreme weather events (Moser & Stein, 2010). In this connection, the AVA framework recognizes the interconnectivity between the different assets that households own in the adaptation process, and the ways in which the presence of one asset could greatly facilitate the adaptation of other assets to minimize vulnerability. For example, related research by Adger (2003) and Dulal et al. (2010) have shown how adaptation to climate change does not only depend on how much physical or financial assets individuals and households own or how vulnerable individuals and households are. Rather, adaptation is a dynamic social process that is facilitated, in part, by the presence of social assets or social capital, the ability of societies to act collectively and the presence of supportive formal and informal institutions.

In adopting the AVA framework in this paper, we acknowledge that Moser and Satterthwaite (2008) developed their theoretical model from climate change adaptation among urban poor. We however believe the AVA framework is analytically useful in the context of rural Ghana for the following conceptual and practical reasons. First, our focus in this paper is on the assets of the poor hence our subject of analysis is very similar to that of Moser and Satterthwaite. Second, the focus on assets in

the AVA framework has greater analytical appeal, as it seems to address some of the problems associated with the use of income levels and consumption expenditures to undertake poverty and vulnerability analysis. For example, income levels and consumption expenditures do not typically reveal much about the well-being of the poor and the complex circumstances under which they construct their livelihoods (Moser, 1998; Moser & Satterthwaite, 2008). This problem is compounded by the fact that income levels and consumption expenditures are difficult to measure in the context of rural Ghana due to the informality of most rural economies. A focus on the assets rural households own therefore offers a better approach to understanding vulnerability and adaptation during flooding. This is because assets reflect the totality of livelihood conditions and vulnerabilities of a particular household, and a particular household's assets give an indication of who in a given community is more likely to be vulnerable or adapt to climate change (Moser & Satterthwaite, 2008; Prowse, 2008).

### Research context

This paper is based on a larger research that was conducted between July 2011 and December 2011 in two communities – Buiepe and Yapei – in the Central Gonja District (CGD) of Ghana. The aim was to explore households' asset vulnerability and adaptation during flooding. The CGD is located at the southwestern part of the Northern Region of Ghana. The district has an estimated total population of 87,877, of which 44,017 are females (Ghana Statistical Service, 2012). The population of the district is predominantly rural – 90% is located in rural communities with less than 500 people (Ghana Statistical Service, 2012). Agriculture is the main occupation of the people – it employs some 90% of the labour force (CGD Assembly, 2010). Agriculture is mainly rain-fed. Farm plots are small in size, scattered and managed by smallholder peasant farmers (CGD Assembly, 2010). More than 80% of farmers use hoes and cutlasses in cultivation. A greater number of farmers have little access to tractor services while a few use bullocks ploughs in land preparation (CGD Assembly, 2010). At the time of this research, about 79% of the district's population (aged 6 years and above) had never been to school (CGD Assembly, 2010).

The district was chosen mainly because it lies within one of the ecologically fragile zones of the northern region, where flooding occurs regularly (Stanturf et al., 2011). The CGD is located within the Guinea Savannah ecological zone of Ghana and is characterized by a low-lying area with altitude ranging between 150 and 300 m above sea level (Stanturf et al., 2011). It is traversed by two of the largest rivers in the country, namely the White and Black Volta (Stanturf et al., 2011). These rivers are the source of periodic flooding in the district, often



triggered by intensive rainfall (CGD Assembly, 2010). While the entire district is flood-prone, Buipe and Yapei have had the longest history of the occurrence of flooding, including the 1974, 1979, 2003, 2007, 2009 and 2010 floods (NADMO, 2010). The destructive effects of these floods have been widely documented by Ghana's National Disaster Management Organization (NADMO). In 2010 for example, 55 communities were affected by floods; about 700,000 people were displaced; 3234 houses collapsed, 23,588 acres of farmlands were destroyed and 1109 domestic animals including cattle, goats, sheep and chickens were destroyed at an estimated cost of GH¢ 206,780 (US\$103,390) (NADMO, 2010). Buipe and Yapei were however the most affected communities. By the end of November 2010 when the floods had fully subsided in Buipe, about 12,418 people were displaced, and 1196 houses and 8100 acres of farms were destroyed (NADMO, 2010). In Yapei too, 784 people were displaced and 2980 acres of farms were destroyed (NADMO, 2010).

The problem of flooding is compounded by the fact that majority (44.2%) of the inhabitants are poor and lack adequate infrastructure and social protection (Ghana Statistical Service, 2015). In addition to the regular threats of flooding and poverty, the economic and socio-political organization of the district makes it an interesting case study. Like most societies in Northern Ghana, many aspects of life are organized around the household, family, kinship and the community. The kinship system is patrilineal, and women are still generally more disadvantaged from a young age. Educational and economic opportunities for women are limited, and early and/or arranged marriages are common. The organization of kinship structure around patrilineal, property, ownership and right very often marginalizes women. As we show below, these social and economic disadvantages play important roles in households' assets vulnerability and adaptation to flooding.

## Methods

### *Research design*

To document households' collective and individual experiences with periodic flooding and AVA in a normal peer-group interpersonal exchange, a qualitative research design, similar to the community-based approach used by Burton, Huq, Lim, Pilifosova, and Schipper (2002), Ford and Smit (2004) and Westerhoff and Smit (2009), was adopted. The usefulness of a qualitative approach to vulnerability and adaptation analysis in the context of extreme weather events in Ghana has been demonstrated in the literature (see e.g. Westerhoff & Smit, 2009). A key element of our qualitative research approach was to engage community members as necessary sources of information on the kinds of assets they own, the ways in which these assets are differentially exposed when flooding

occurs, the adaptive strategies they employ and the conditions that constrain or facilitate their adaptation strategies. To this end, focus group discussions (FGDs) were the main data collection methods (Morgan & Krueger, 1993). Discussions in focus groups focused on exploring households experiences of flooding, the kind of assets rural people own, the roles of these assets in their livelihood construction, the ways in which flooding affects these assets and the strategies through which these assets are adapted to mitigate the adverse effects of flooding. In addition to a facilitator asking questions to elicit discussants' views using a pre-tested topic guide, several participatory activities were undertaken in the FGDs including participatory ranking of assets and adaptation strategies. Because of the interactive nature of the FGDs, participants were able to query and challenge each other as well as explain themselves, making it possible to assess how far views and opinions were shared or disputed. While our use of FGDs had several strengths, we acknowledge that group bias as well as the effect of 'dominant discussants' could have affected the outcome of FGDs as noted by other researchers elsewhere (Morgan & Krueger, 1993).

### *Research participants*

The main research participants were households, which were affected during the 2010 floods in Buipe and Yapei. A household in this context refers to a person or group of persons who live together, share the same cooking and eating arrangements and consider themselves a single unit (Ghana Statistical Service, 2008, 2014). One reason for focusing on household as the unit of analysis is that it is the basic unit of production and consumption as well as the unit that owns assets and determines adaptation strategies against extreme weather conditions (Stanturf et al., 2011).

In all 60 households – 34 in Buipe and 26 in Yapei – participated in the study. The majority of households (48) were male-headed. In line with the AVA framework, each household was made to choose two representatives – male and female. This was to ensure that the perspectives of both males and females in relation to households' asset vulnerability to, and adaptation against flooding, were adequately captured. Given that our research setting is largely patriarchal, and given that a number of previous researchers have found that both vulnerability and adaptation to climate change and related extreme weather events are often gendered (Neumayer & Plumper, 2007; Sultana, 2010), we felt that sampling an equal number of males and females into the study would allow us to explore the gender dimension of asset vulnerability and adaptation. In addition, we did not choose only household heads (traditionally defined as the head of a household) because initial discussions with community leaders suggested that in some instances household heads were not necessarily the key

decision-makers in the household. Similarly, it was reported that some household heads usually played no role in the initial acquisition of household assets and decisions about how the asset should be managed. Households were therefore allowed to choose their own representatives based on their own valuation of the role of each household member in relation to decision-making regarding asset acquisition and adaptation to extreme weather conditions. This was achieved after the researchers held initial meetings with each of the selected households. In these meetings, the researchers thoroughly explained the sampling procedures to all household members and encouraged them to nominate two representatives (male and female) who they feel have played or would be expected to play important roles as regards acquisition of assets and adaptation of these assets in the event of extreme weather conditions such as flooding. The total number of household representatives was therefore 120 – 60 males and 60 females. The ages of these participants ranged from 18 to 75 years – 15% were aged 18–30 years; 65% were aged 31–43 years; another 15% were aged 44–56 years; 3% were aged 57–69 years and 2% were aged 70+. Majority (77.6%) of the participants had no formal education. Majority (81.2%) of the participants were also smallholder farmers who practiced rain-fed agriculture.

To gain multiple perspectives on asset-based vulnerability and adaption to flooding as well as triangulate the data collected from FGDs, however, other key informants such as community leaders (chiefs and assembly members), community health nurses, community health officers and the district disaster management coordinator were also interviewed.

### ***Sampling and recruitment***

A mix of purposive and convenience sampling techniques was used to select households and key informants. The selection was based on a number of pre-set inclusion criteria: household should have been directly affected by at least one of the flood events; household should be available and willing to participate in the study and the two household representatives should have the ability/capacity to consent to participate in the research.

The actual recruitment process involved advertising the study at vantage points (local community markets, churches and mosques) using community and religious leaders, and the local community *gong gong* beaters (i.e. local community announcers). Only households that expressed interest in the study were contacted and subsequently invited to participate in the study.

### ***Data collection***

As noted above, FGDs were the main data collection method. Data were collected over a period of four months.

In all, 14 FGDs – 8 in Buiepe and 6 in Yapie – were completed with household representatives. The differences in the number of focus groups between the study communities is related to both differences in population size and the number of households who were affected by the 2010 floods. In each community, groups were segmented by age and sex. That is women aged 35 or younger and men aged 35 or younger, as well as women and men aged above 35 in separate groups, were formed. Segmentation was necessary because initial discussions with community leaders suggested that there were age and gender hierarchy conflicts in the study communities. For instance, younger men or women (18–35 years) were unlikely to freely express their views in the presence of older men or women (36 years above) because of cultural norms, which require young people to listen to their elders. Segmenting discussants by similar age groups and sex contributed to making participants more comfortable when expressing their opinions or sharing their experiences within the group context.

Groups consisted of 4–9 participants (1 group consisted of 4 discussants; another group consisted of 8 discussants and the remaining 12 groups had 9 discussants each). Discussions lasted 1.30–2 hours, and ended when a point of saturation was reached. All FGDs were held in the study communities at locations convenient to both the participants and the researchers. All the discussions were held in the local dialect – Gonja. One of the researchers facilitated all discussions in the focus groups.

To complement the FGDs, key informant interviews were conducted with three community leaders, three women leaders, two assemblymen, two community health officers and one district disaster management coordinator. Interviews were conducted in both Gonja and English, and lasted between 30 and 40 minutes. All discussions and interviews were audio-recorded alongside handwritten field notes with the consent of participants.

### ***Analysis***

After the completion of interviews, all audio-recorded interviews were transcribed and all non-English transcripts translated into English. All transcripts and interview notes were then read and reviewed for overall understanding. This first step was completed with separate summaries for each transcript outlining the key points participants made. All transcripts were then exported into NVivo 9 qualitative data analysis software, where the data were both deductively and inductively coded, and dominant themes were noted and collated. The final analysis was done using a combination of thematic and content analysis (Bernard, 1994).

### ***Results and discussion***

Participants' accounts in relation to households' asset vulnerability to, and adaptation against, floods converged

on a number of common themes, which are explored below.

### ***Assets and rural livelihood construction***

To understand the vulnerabilities of rural households to extreme weather conditions and how they adapt their assets, the researchers first examined the assets households own and the roles these assets play in their livelihood construction. As argued earlier, assets are critical resources that help households to construct meaningful livelihoods. Not only do assets make rural livelihood meaningful, but they also generate stock of benefits that can be accumulated and transferred to future generations (Rakodi, 1999).

Results from FGDs and key informant interviews suggest that households rely on multiple stocks of assets to construct their livelihoods. Table 1 shows the multiple stocks of assets participants reported as critical in their livelihood construction. These assets can be broadly characterized as comprising human capital, social capital, natural capital, financial capital and physical capital. These categories of assets are generally consistent with those previously identified and discussed under the theoretical framework of this paper. However, further discussions with research participants uncovered several dynamics in relation to the relative importance of different assets for the livelihood construction of different individuals even in the same household.

For instance, further analysis of data generated from participatory asset ranking exercises during FGDs revealed that a combination of household and individual characteristics such as gender, occupation, age and location determined which stock of assets were critical in their livelihood construction. Many older people (36+ years) ranked children and good health as the first (1) and second (2) most important assets for their livelihood construction (see Table 1). For instance, having children was reported to provide social and economic security in both old age and stressful times such as when flooding occurs. One elderly woman said:

I am getting older day by day, and cannot do the hard work I used to do. My children are the ones to take care of me, and help me in everything I do. I don't know what I will do without those children. (Female, 63years, FGD, Yapei)

Older participants also regarded 'good health' as another critical asset. Commenting on good health as critical asset in household livelihood construction and adaptation to flooding, one male discussant also said:

Health is wealth, and as farmers we are able to work well and face this challenge of flooding when we are healthy ... If your house gets damaged and your family members are in danger, can you solve the problem if you are not healthy? (Male, 73 years, FGD, Buipe)

According to this account, possessing good health rendered individuals, especially the aged, less vulnerable during extreme weather events such as flooding. Also, good health enabled them to be independent. In this way, it was reported that one was likely to survive the adverse effects of flooding if one were in a state of good health and thus less dependent on the support of others. Several young people however reported land, good health, education, children and house as the most important assets for their livelihood construction. As one young female discussant said:

For me what is really important is to have good health. Once I have good health, then education, children and a place to live ... I mean a house. These are my priorities. (Female, 27 years, FGD, Buipe)

Access to land for such young people was not only a critical productive resource but also it provided collateral and economic security during crisis. Being in a state of good health was seen as providing a stock of wealth as well as enabling their access to, and ability to work, while education enhances individuals' knowledge, skills set and capabilities to respond to challenges and as well broadens individual opportunities to be gainfully employed.

FGDs with both men and women also showed gendered valuation of different household assets. For example, while most male participants ranked, in descending order, land, house, good health, livestock and savings as the most important assets for their livelihood construction, most women reported that having healthy children, especially male children, good family relations, land for food crop cultivation and education were the most critical assets for their livelihood construction (see Table 1). Most men argued that their very existence was intricately tied to land and that in addition to being used for food crop and livestock production as well as housing to provide shelter for their household, land could be used as collateral and economic security during crisis. For most rural communities in particular, land provides direct source of household income through collection and sale of fuel wood and fruits such as shea and baobab. Women valued children in general because such children often provide future social and economic security.

I say my children are my most important assets because they will take care of me in the future. (Female, 28 years, FGD, Yapei)

Importantly, however, not all children were equally valued. Further discussions in both FGDs and key informant interviews revealed both men and women valued male children as the most critical compared to their female counterparts.

For me my male children are my most precious possessions. Because of them I know my husband lineage will continue ... they are the ones who will take over and



Table 1. Critical household assets for livelihood construction ranked from most critical (1) to least critical (10) by gender and age.

Asset	Role in livelihood construction	Asset ranking			
		Male		Female	
		18–35 years	36+ years	18–35 years	36+ years
Children	<ul style="list-style-type: none"> <li>• Help perform household chores</li> <li>• Take care of the elderly (social security in old age)</li> <li>• Provide labour for farm work</li> </ul>	8	1	4	1
Land (Farmland and residential land)	<ul style="list-style-type: none"> <li>• Provides collateral and economic security during crisis</li> <li>• Provides source of household income through collection and sale of fuel wood and fruits such as shea and baobab</li> <li>• Used for food crop and livestock production</li> <li>• Used for housing to provide shelter for household</li> </ul>	1	3	1	6
Good health	<ul style="list-style-type: none"> <li>• Renders individuals less vulnerable to diseases and hardships</li> <li>• Enhances access and ability to work</li> <li>• Provides a stock of wealth</li> <li>• Promotes self-independence</li> </ul>	3	6	2	2
Education	<ul style="list-style-type: none"> <li>• Enhances individuals' knowledge, skills set and capabilities to respond to challenges</li> <li>• Enhances access and ability to work</li> </ul>	7	4	3	3
Crops (food and commercial)	<ul style="list-style-type: none"> <li>• Provide source of food</li> <li>• Provide source of household income</li> </ul>	6	5	9	9
Livestock	<ul style="list-style-type: none"> <li>• Provides source of farm labour (e.g. tilling the land, and carting farm produce home or to market)</li> <li>• Provides source of household income</li> <li>• Act as source of household food and nourishment</li> <li>• Provides collateral and economic security during crisis</li> </ul>	4	9	8	7
House	<ul style="list-style-type: none"> <li>• Provides shelter</li> <li>• Provides storage for other assets</li> <li>• Provides collateral and economic security during crisis</li> </ul>	2	10	5	5
Household goods	<ul style="list-style-type: none"> <li>• Provides collateral and economic security during crisis</li> <li>• Used for producing other household asset</li> </ul>	7	4	3	3
Savings/credit	<ul style="list-style-type: none"> <li>• Increase household purchasing power</li> <li>• Provides economic security during crisis</li> <li>• Used for paying children's school fees</li> <li>• Used for purchasing farm inputs</li> </ul>	5	8	6	9
Social relations (family and community)	<ul style="list-style-type: none"> <li>• Provide comfort and sense of belonging</li> <li>• Provide support and solidarity in times of need</li> </ul>	9	2	10	4

continue the lineage when we are dead and gone. (Male, 53 years, FGD, Buipe)

One female participant said:

I think my two sons are my most precious assets. I say this because these children will continue their father's lineage in the future. I am sure if I gave birth to only female

children, my husband would have thrown me out of the marriage long ago. (Female, 39 years, FGD, Buipe)

Thus male children are particularly valued because they often guarantee some married women a place in their marriages due largely to the patrilineal system of kinship organization, which expects the male child to perpetuate the

patrilineage. Such gendered valuation of children is therefore not surprising given that our study setting is patrilineal whereby male children are expected to perpetuate their respective patrilineages. However, it does have implications for access to resources, educational opportunities and even adaptive response when extreme weather events such as flooding occurs. As some participants reported, preferences for male children often result in lesser attention to females in situations of flooding.

For me my sons are my most important resource. That is why whenever the floods come I always plead with my husband to first send them to my brother who lives at the next town where the floods do not normally happen. (Female, 29 years, FGD, Yapei)

Women also valued good social relations for a number of reasons. For instance, it was reported in female FGDs that women's caring and productive roles often involve working in partnership with other people such as relatives and friends. Therefore, cultivating good social relationships was essential to effective livelihood construction. One young female discussant illustrated the point like this:

I am a pupils' teacher and at the moment I have a child. Very often I cannot take my child to school because it will affect my teaching. So I need help. Because of the good relationship I enjoy with my sister and my friend, they have been taking care of my child when I am working. So for me having good relationship with the people around me is very crucial. (Female, 19 years, FGD, Buiepe)

Differences in valuations of the role of assets in livelihood construction were also revealed in the accounts of different occupational and spatial groupings. For example, most households whose primary economic activity was farming reported farmland, good health and access to credit as the most critical assets in composing their livelihoods.

As a farmer, my number one priority is having access to abundant and fertile land ... I then must be healthy to be able to work on the land. The other important thing is support like access to credit to buy input and hire other services. (Male, 43 years, FGD, Yapei)

For most households in urban settings such as Buiepe, having a house and some savings were the most critical assets. For instance, having a house not only provides shelter. It also serves as collateral and economic security during crisis. Besides, within the urban environment where demand for housing is often high, it was reported that individuals or households who own houses could easily rent or lease them out to generate additional income in times of crisis.

Taken together, our findings here suggest that individual and household characteristics do play a role in the definition and determination of which assets are important, and

that people in the same household or community may value the same assets quite differently. This knowledge is clearly important for targeting purposes and should therefore be taken into account when planning responses to build households resilience and adaptation against extreme weather events such as flooding.

### *Household's assets vulnerability to flooding*

Vulnerability of human systems and assets to deteriorating environmental conditions is one of the projected effects of climate change and related extreme weather events (IPCC, 2014). This study therefore explored how flooding affected the assets of households in Buiepe and Yapei. Table 2 presents a summary of the different ways in which flooding has rendered critical household assets vulnerable in Buiepe and Yapei. In both FGDs and informant interviews, participants' narrative accounts suggested that the frequency of flooding has undoubtedly had serious adverse impact on their critical assets by exposing them to new risks, and worsening existing vulnerabilities.

One young female participant narrated her experience thus:

Every now and then the floods come and our properties are destroyed. A year ago [referring to 2010] the floods came and we lost everything. I have used all my money to support my husband whose farm got destroyed. This is making it difficult for us to make a decent living again ... our children's education has been badly affected. (Female, 21 years, FGD, Yapei)

In all FGDs and most in-depth interviews with key informants, children, health, farmlands, housing and livestock were identified as the assets which were not only most vulnerable to flooding, but also which when affected, endangered their livelihood most. Apart from the direct asset vulnerabilities listed in Table 2, sudden exposure to floods was reported to generate a complex web of additional vulnerabilities. For instance, it was reported that depletion of savings and destruction of food crops as a result of floods created food insecurity, malnutrition and limited access to work. These vulnerabilities were reported to exacerbate abject poverty and environmental degradation as poor households seek desperate measures to survive on available natural resources. Accordingly, these vulnerabilities were often likely to be worse when recovery times are short before the occurrence of another adverse weather extreme event.

But again, it was discovered that individual and household characteristics such as age and gender determined the extent to which one is susceptible to flooding. In this regard, most of the participants stated that farmers as compared to civil service workers, women as compared to men, women-headed households as compared to male-headed households, children as compared to adults and rural as

compared to urban households, were the most vulnerable groups of people. Children, as assets, were reported to be most vulnerable to waterborne diseases and infection during flooding events. They were also more likely to drown and die from flooding than adults. In this way, households which depend on children to provide both domestic labour for current livelihood construction and future economic security were reported to be more vulnerable. Similarly, it was reported that exposure of farmlands and/or food crops to floods exacerbated the vulnerability of households heavily dependent on agriculture. For instance, apart from the fact that food crops are destroyed and farmlands become inaccessible during flooding, it was reported that flooding often result in excessive erosion. This often reduced soil fertility and the value of agricultural and commercial lands. Thus farmers' vulnerabilities arose partly from the fact that their main livelihood activity (agriculture) is tied to the natural environment and the fact that extreme weather events such as flooding exert important influences on agricultural output.

For women, especially women-headed households, vulnerabilities arose from a number of factors: the fact that women are often burdened with the task of finding safe drinking water and food when flooding occurs partly because of male migration; the fact that women often face additional health treats due partly to difficulties meeting their sanitation needs resulting from lack sanitation and privacy during flood events and the fact that many of them are already poor and have both low resources to make significant investment in diversifying their assets and the capacity to act quickly when the level of damage is extensive or make significant investment in adaptation strategies against severe shocks and stress that arise from weather extremes such as floods. As one participant noted during key informant interview session:

Whenever the floods come, we all suffer... but the sad reality is that those who suffer most are our women. Most of them have no education and usually do not have sufficient land and financial resources to make important live-transforming decisions during flooding events. (Male, 53 years, Informant Interview, Yapei)

Another participant said:

You know our children and we women are already a disadvantaged group. So whenever there is flooding, we suffer the most because we do not have sufficient resources to help us make decisions that would minimise our exposure to flooding. (Female, 32 years, Informant Interview, Buipe)

Indeed, several accounts from women and key informants underscored the fact that the effects of natural disasters such as flooding are not gender neutral. Rather, the effects are gendered and differentiated, and these gendered effects are usually occasioned by inequalities in exposure and sensitivity as well as inequalities in access to resources,

capabilities and opportunities that systematically disadvantage certain groups, especially women, women-headed households and children. Several accounts here appeared to link women's greater vulnerability to the fact that women in Buipe and Yapei generally suffer several multiple deprivations including lack of education and limited property owning rights. These multiple deprivations, in and of themselves, often constitute important sources of vulnerability, which are then exacerbated when flooding strikes.

In planning responses to natural disasters such as floods in Buipe and Yapei, it is important to recognize and take into account the fact that floods do not affect households and communities equally as if by an arbitrary stroke of nature. Rather, flood impacts are contingent on the vulnerability of individual affected people or households, which can and often does systematically differ across economic, class, gender, age, occupational and rural and urban groups.

### *Households' asset adaptation strategies*

With increasing occurrence of weather extremes and their adverse impact on the assets and livelihood sources of households, the question that needs to be addressed is how households adapt their assets to cope with such stressful events. This question was indeed one of the central concerns of this study. This section discusses deliberate and practical actions that households adopt to adapt their assets against the adverse impact of flooding. Participants were asked to discuss how they adapt their household assets to cope with periodic flooding. Table 3 shows the various strategies households employ to protect their assets from depleting and to adapt against flooding. The table also shows participants preferred asset adaptation strategies. These were generated from participatory ranking exercises in FGDs where participants were asked to rank the various adaptation strategies from most preferred (1) to least preferred.

Generally, most households adopt multiple adaptation strategies to lessen their exposure to hazards wrought by flooding, and to exploit new opportunities within and out of their livelihood systems. While a number of these asset adaptation strategies cut across gender, age and occupation, several of them were gendered and differentiated. This is consistent with Codjoe et al. (2012) assessment of gender and occupational perspectives on adaptation to climate extremes in the Afram Plains of Ghana in which they found that adaptation strategies to climate extremes were differentiated by gender and occupation. In the case of health (human asset) for instance, both men and women said they have joined Ghana's national health insurance scheme (NHIS) in order to have easy access to medical care in the event of injury or ill-health including cholera or malaria during or after flooding.

Table 2. Households' perceptions of vulnerability of critical household assets to flooding.

Asset	Vulnerability to Flooding
Education	<ul style="list-style-type: none"> <li>• Disruption of children's education</li> </ul>
Children	<ul style="list-style-type: none"> <li>• Vulnerable to waterborne disease and infection</li> <li>• Vulnerable to drowning</li> <li>• Interruption in children's education</li> </ul>
Land (Farmland and residential land)	<ul style="list-style-type: none"> <li>• Destruction of farmlands through excessive erosion</li> <li>• Inaccessibility of farm lands</li> <li>• Reduction in the value of commercial land</li> </ul>
Good health	<ul style="list-style-type: none"> <li>• Exposure to waterborne diseases and infection – dysentery and cholera</li> <li>• Increased risk of drowning</li> <li>• Increased risk of malaria</li> <li>• Water contamination and increased risk of water insecurity</li> <li>• Increased psychological and mental health problems</li> </ul>
Crops (food and commercial)	<ul style="list-style-type: none"> <li>• Destruction of food and commercial crops</li> </ul>
Livestock	<ul style="list-style-type: none"> <li>• Drowning and death of livestock</li> </ul>
House	<ul style="list-style-type: none"> <li>• Collapse of building</li> <li>• Damages to building</li> <li>• Homelessness</li> </ul>
Savings/credit	<ul style="list-style-type: none"> <li>• Increased risks of savings depletion</li> <li>• Credit becomes difficult to access</li> </ul>
Household goods	<ul style="list-style-type: none"> <li>• Destruction of productive household resources and asset</li> </ul>
Social relations (family and community)	<ul style="list-style-type: none"> <li>• More pressure on family and community members</li> <li>• Loss of loved family and community members through flood-related death</li> </ul>

I used to not register for the NHIS ... because my family members were not getting sick. However, because of the frequent flooding and the unpredictable nature of damage it can cause these days, I decided to enrol all my family members on the scheme. Now if flooding happens and I lose everything and any of my family members fall sick, I will not be worried because I know I will not be saddled with hospital bills. (Male, 44 years, FGD, Bupei)

Several male participants however reported that they were concurrently adopting different farming practices against flooding. One male participant illustrated this point in the quote below:

I own two different plots of farmlands, one near the river basin on which I cultivate vegetables during the dry season because of access to water. But in the rainy season since the floods can come at any time, I farm on the second land upland far away. Though the second farmland sometimes gets submerged, it could have been worse if I cultivated on the first. (Male, 39 years, FGD, Yapei)

In this regard, access and ownership of more farmlands emerged as an important determinant of a household's

ability to adapt. But reports from households headed by women who traditionally have limited access to, and ownership of land, and whose usufruct rights to land usually depend on inheritance or goodwill of a man, suggested that such women had limited adaptation capacity.

For people like us women who do not own land in this community, it is difficult to quickly turn things around when our small farmlands are destroyed by floods. Because I don't have enough land, I am forced to grow crops on my small farmland despite the fact that it has been destroyed by the floods on several occasions. (Female, 42 years, FGD, Yapei)

In this way, gender came out strongly as an important determinant of both access to landed resources and ability to successfully adapt during and after flooding events. The district NADMO coordinator in Bupei corroborated this gendered differentiation in relation to land ownership and adaptive capacity in one of our key informant interview sessions:

The flooding affects all members in the community, but it is worse for women, especially those who don't have



Table 3. Households' asset adaptation strategies ranked from most preferred adaptation strategy (1) to least preferred (9) by gender and age.

Critical assets	Asset adaptation strategies	Preferred adaptation strategies			
		Male		Female	
		18–35 years	36+ years	18–35 years	36+ years
Health	• Keep environment clean after floods	4	2	3	1
	• Join NHIS	1	6	2	7
	• Filter and boil water collected from streams and wells before drinking	7	3	4	4
	• Collect water from safer sources	3	1	1	2
	• Harvest rainwater directly	5	4	5	3
	• Raise platforms of hand tube wells before and during floods	2	7	6	5
	• Relying on traditional herbal medicine	6	5	7	6
Land (Farmland and residential land)	• Avoid deforestation	3	2	3	5
	• Plant more trees on land	6	3	2	6
	• Practice land rotation (farm on highlands during rainy season and lower grounds during dry season)	2	4	4	2
	• Abandon farm land in flood-prone areas and migrate to higher ground neighbouring communities	1	1	1	1
	• Extend farm lands to marginal areas nearby	5	6	6	4
	• Farm intensively on small plots of lands least affected	4	5	5	3
	• Send children to schools in communities where flooding is non-existent or minimal	3	1	1	3
Education	• Relocate schools to higher grounds	1	2	2	2
	• Train school children to swim	2	3	3	1
Crops (food and commercial)	• Grow water resistant crops	1	4	4	1
	• Grow short life span crops	2	2	3	3
	• Harvest early before floods	3	3	2	2
	• Avoid growing crops near river banks	4	1	1	4
Livestock	• Use local materials (like banana plants) for the construction of temporary platforms for cattle and poultry birds	5	5	6	5
	• Relocate livestock to other family relations in safer locations when prior flood warning is given	4	6	5	4
	• Keep birds in floating cages	3	4	4	3
	• Keep birds in cases and hang them on tree branches	2	2	3	2
	• House livestock on raised ground or platforms	1	1	2	1
	• Sell livestock before onset of rains	6	3	1	6
	• Repair and rebuilding of affected houses	1	2	7	1
House	• Relocate to high grounds	7	1	1	8
	• Dig drains around house	8	6	6	7
	• Raise plinths	5	7	5	6
	• Use clay and other water resistant traditional building materials to construct house	6	9	9	2
	• Build house on raised ground	2	3	2	3
	• Use cement and concrete to lay foundation of house	3	4	3	4
	• Use cement and concrete to build new houses	4	5	4	5
Savings/credit	• Plant trees around house	9	8	7	9
	• Join a micro-credit scheme ( <i>susu</i> )	3	2	4	2
	• Migrate to seek employment elsewhere	2	4	1	4
	• Engage in off farm income generating activity	1	1	2	1
Social relations	• Sale of available disposal asset	4	3	3	3
	• Stay with friends and family during flood	6	3	4	1
	• Borrow cash or crop seeds after flood	2	6	6	6
	• Provide support to those most in need especially children, elderly and women	3	5	5	2
	• Rely on NGOs and disaster management organizations for aid	8	8	8	8
	• Engage in food exchange	5	2	3	5
	• Share food	4	1	2	4
	• Rely on support from local churches and mosques	7	7	7	7
	• Engage in communal labour to rebuild community	1	4	1	3

husbands and who do not have the right to own property like land.

Some participants also indicated that they have shifted to growing only flood tolerant crops such as rice in order to mitigate the adverse effects of flooding. Others reported that they farm intensively on small plots of lands least affected and even extend farming to marginal areas. In this regard, it appears that not all the adaptive responses and strategies households used have positive impact on the environment. For instance, interviews with some households and key informants showed how intensive cultivation of small plots of farmlands and marginal lands have led to environmental degradation that reduces windows of opportunities for future generation. Other participants reported the importance of knowledge about early warning systems as very useful in reducing their vulnerability to flooding and other extreme weather conditions and increasing their ability to respond quickly. Several participants reported that they have invested money in buying radio sets in order to get more education on disaster preventive measures and early warning information about weather condition from the GMet and NADMO. Others also said they attended community meetings organized by non-governmental organizations (NGOs) on how to respond to disasters and to reconstruct their livelihoods after disaster.

Several participants also reported their continuous participation in diverse livelihood activities to reduce their vulnerabilities. For instance, some younger male participants said that apart from farming, they also engaged in charcoal business so that when their farms are destroyed they can rely on savings made from their charcoal business. A number of female participants also reported engaging in trading petty household consumables such as pepper and salt alongside their farming activities. Interestingly, these adaptation strategies seem to reproduce existing gender-based and age-related roles differentiations. For instance, roles or activities that required physical strength were reported to be traditionally performed by males, especially young men. Since charcoal burning is an activity requiring physical strength, young men were reported to be more likely to turn to charcoal burning as an adaptive strategy while more females resort to such less physically demanding activities as selling household commodities.

When the floods occur, people turn to different strategies to survive. Usually, men in this community turn to alternative activities like charcoal burning. You know these activities are physically demanding and men are traditionally expected to perform them ... most of us women also resort to activities like trading in household goods ... you know these activities are less demanding and so most women are comfortable doing them. (Female, 35, Informant Interview, Yapei)

Migration was also reported as an adaptation strategy. In both male and female FGDs, several discussants reported

that some members of their household do migrate to urban towns and cities during the rainy seasons when floods are rampant to seek employment opportunities to support their families.

The last time the flood came and destroyed all my crops, my strategy was to travel down south. That way I was able to work in other peoples' farms and made some money, which I then used to buy food following my return. (Male, 26 years, FGD, Buiepe)

Younger men were however more likely to migrate compared to their older counterparts. Although younger females were also reported to occasionally migrate during flooding events, women were generally reported as having lower propensities to migrate compared with their male counterparts.

In times like this [referring to flooding], we encourage our young men to move to other towns where things are better. That way they can earn some income which they can use to support their families ... These days, some of our young women also migrate ... they also travel out ... though more men than women travel out of the community during flooding. (Female, 52 years, FGD, Yapei)

Indeed, migration (especially of young men) as a livelihood adaptation strategy in the aftermath of floods has been widely documented in the literature (Codjoe et al., 2012; Sultana, 2010). However, similar to findings from previous research (Sultana, 2010), migration of men was reported to place additional burden on women in terms of the performance of domestic and non-domestic responsibilities, including meeting households' food and nutritional requirements, and caring for the aged and children.

The problem with this [referring to migration of young men] is that our women are left behind to struggle to cater for themselves, their children and even the aged. (Male, 47 years, Informant Interview, Buiepe)

One other important adaptive strategy that participants in FGDs and informant interviews reported is the building up of social capital through informal social institutions such as friendship and kinship. Most participants in this study viewed social capital as a very powerful asset that increases their adaptive capacity. Links with neighbours, family relations and NGOs were reported as sources of support when the impact of damage is beyond individual's capability to recover on their own. Participants specifically reported that an individual's link with the church, neighbours and nearby communities broadened the support base on which one can rely during and after flood events. Embedded in this adaptive strategy is the concept of reciprocity, which enables households and community members to make claims of some minimum welfare entitlement during flooding because of their affiliation and

association with others. One female participant in Buipe related her experience thus:

Last year my husband and I lost everything, our farm and house. Had it not been our family and friends, we could not have had a place to live with our and children.

Discussions with participants suggested that community bonds and trust were important factors for decreasing vulnerability to extreme weather events, although there were important variations between the two study communities. For example, the effectiveness of relying on social capital and networks to build resilience against flooding appeared to be stronger in Buipe where in addition to informal social institutions, there exist more formal institutions such as NGOs and micro-credit unions. In Buipe, the complementary roles of formal and informal institutions provided more opportunities such as network engagement and information sharing, which households exploited to increase their livelihood resilience and adaptive capacity compared to those in Yapei. Several participants in Buipe said that they have joined micro-credit schemes – services not readily available in Yapei – as a form of insurance measure and to also increase their access to credit to rebuild their livelihoods and assets acquisitions during and after flood disasters. The findings here support earlier studies that suggested that effective adaptation does not take place in vacuum but requires the support of a wide range of formal and informal institutions including government agencies and NGOs (see Adger, 2003; Westerhoff & Smit, 2009).

But inevitably, the various adaptation strategies themselves present unique opportunities and challenges. Aside the fact that some of the strategies can only provide short-term relief and are therefore not sustainable, participants' priorities and preferred adaptation strategies diverged and converged in significantly interesting ways (see Table 3). With regard to convergence for example, all the different participants in this study agreed that 'abandoning farm land in flood prone areas and migrating to higher ground neighbouring communities' was the most preferred way to adapt their land (farmland and residential) against flooding. Similarly, most discussants agreed that 'relocating schools to higher grounds' was their most preferred way of adapting education against flooding. Convergence in terms of the priorities of men, women, the young and the aged on the above-mentioned asset adaptation strategies clearly provides opportunities for instituting contextually relevant, long-term and sustainable asset adaptation solutions against flooding in the study context. Indeed, the asset adaptation strategies on which the preferences of most participants strongly converged should be the starting point of real solutions to the problems of flooding and asset vulnerability in Buipe and Yapei.

There are however a number of areas where there is divergence in terms of preferred adaptation strategy. For

instance, discussants in female FGDs and discussants under age 35 ranked 'relocation to high grounds' as their most preferred way to adapt housing to flooding. Discussants in male FGDs and discussants above age 35 however ranked 'relocation to high grounds' as one of the least preferred way to adapt housing to flooding (see Table 3). While this seeming disjunction in the above-mentioned area of adaptation strategy could be the natural product of a context that is diverse, it clearly points to the potential for conflict and policy failure, particularly when external interventions are being implemented without regard to this differentiated preferences in adaptation strategy. Understanding the differences in the priorities that men and women, as well as the young and old place on different asset adaptation strategies may prove to be important in the effectiveness of climate change adaptation as well as the sustainability of communities (Codjoe et al., 2012).

### Conclusion and policy implications

The study reported in this paper is one of the first studies in Ghana to explore AVA strategies of households against adverse extreme weather-related events. The study responds to recent calls within the empirical research literature for more research to understand how extreme weather events such as flooding affect households' assets and the ways in which households adapt their assets against such adverse events (Dulal et al., 2010; Mallick et al., 2005). Taken together, the findings from this study suggest that many rural households do experience severe asset-related vulnerability due to occasional floods, and these vulnerabilities contributed to eroding households' assets, constrained asset accumulation and hampered sustainable livelihood construction as well as poverty reduction. However, flooding did not affect households' assets equally. Rather, the effects are gendered and differentiated, often occasioned by inequalities in exposure, vulnerability, access to resources, capabilities and opportunities. Nevertheless, the study also demonstrated that rural households are not passive victims of circumstances. Many households are actively adapting their assets using a combination of indigenous and modern knowledge systems and practices. These asset adaptation strategies, though may not be easily observable to the outsider because of the multi-dimensional and small scale at which they occur, could nevertheless become known through appropriately designed research that allows for the perspectives of households to be explored. We believe the use of the AVA framework in combination with the qualitative inquiry approach in this paper enabled a better understanding of the kind of assets rural people own, the roles of these assets in their livelihood construction, the ways in which flooding affect these assets and the ways in which households adapt these assets to mitigate the adverse effects of flooding.

While acknowledging that these findings may have been framed by some of the contextual factors highlighted earlier as well as methodological limitations such as group biases, the different asset vulnerabilities and adaptation strategies documented here have the potential to inform learning and change. For example, knowledge that vulnerabilities and response strategies to flooding are differentiated by age, gender, occupation and location could be used to design interventions that target the most vulnerable segments of the society such as women and children. For example, policies and programmes could be implemented to expand women's access to land, education and credit. Such policies have the potential to contribute both to women's asset accumulation and adaptive capacity during flooding. Understanding the differences in households' asset vulnerability as well as in the priorities that men and women, as well as the young and old, place on different asset adaptation strategies could therefore be important in the effectiveness of climate change adaptation as well as the sustainability of communities. Without this type of understanding and differentiated policy responses, adaptation to extreme weather events such as flooding is likely to be ineffectual or even maladaptive.

### Disclosure statement

No potential conflict of interest was reported by the authors.

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