Diagnoses of the Adaptive Capacity of Urban Households to Floods: The Case of Dome Community in the Greater Accra Region of Ghana

Wendelina Acheampomah Boakye[1]

Simon Bawakyillenuo[2]*

Innocent Agbelie[2]

Abstract

Urban areas are adversely affected by climate change effects such as flooding and temperature increase, with developing countries being more susceptible to these effects. This paper therefore draws on the adaptive capacity framework to understand the determinants of the capacity of residents in an urban context to deal with floods. The determinants considered in the paper include knowledge and awareness, technology, infrastructure, institutions and economic resources. Using Dome in the Greater Accra Region of Ghana as a case study, a systematic random sampling technique was used to sample 371 respondents for the household questionnaire survey whilst institutional heads were purposively selected for in-depth interviews. The study revealed that flooding is the most prevalent climate related hazard in the study area. The study also established that the adaptive capacity of the people of Dome to floods is very low when all the determinants are taken into consideration; the awareness, ability and action dimensions with respect to wealth, gender and education categories are higher at all levels compared to the overall adaptive capacity. This is a clear indication that the determinants of the adaptive capacity are intertwined. Therefore, in order to ensure the presence of a high adaptive capacity in households of Dome to flood, all the determinants should be supported.

Keywords: climate change, adaptive capacity, urban areas, Dome, Ghana

[1]Institute for Environment and Sanitation Studies (IESS), University of Ghana, Legon, Accra, Ghana

[2]Institute of Statistical, Social and Economic Research (ISSER), University of Ghana, Legon, Accra, Ghana

*Corresponding author's email address: bawasius@isser.edu.gh

Introduction

Urban areas accommodate about half of the world's economic activities and population, hence, they are among the sectors that contribute enormously to the generation and emission of Greenhouse Gases (GHG) (Livingstone, 2007; Sówka & Bezyk, 2017). Due to changes in rainfall patterns, land use and drainage designs, urban areas are very often adversely affected by climate change extreme events (Miller & Hutchins, 2017). Although cities in developing countries contribute very little to the world's total GHGs, they are the most susceptible to the effects of climate change, especially flooding (Campbell-lendrum & Corvala, 2007). Countries in Sub-Saharan Africa are projected to have intense and frequent occurrence of extreme and erratic rainfall by the end of the 21st century (Niang et al., 2014). Aside their susceptibility to the effects of climate change, most developing countries are also affected by low adaptive capacity issues. Lwasa (2010) notes that the resilience of the global south is impeded, not by limitations in the awareness of climate change and adaptation measures, but by inherently low adaptive capacity. Accordingly, in a quest to boost their adaptation, the adaptive capacity component must be addressed first.

Climate change related extreme events such as flooding, increased temperature and storms pose a greater threat to development than any other phenomenon, especially in developing countries. The incidence of flooding, in particular, is a very common phenomenon due to increase in sea levels, heavier and prolonged rainfall patterns, and increased river flows (World Meteorological Organization –WMO-, 2012). Consequently, urban areas are at a higher risk due to the nature of clustered buildings, tarred roads and paved surfaces, which prevent surface water from seeping into the soil (Lwasa, 2010). The risk is even greater in third world countries where there are poor drainage systems, inadequacies in solid-waste management and a significant proportion of urban dwellers living in slums (Action Aid, 2006; Adelekan, 2010). Flooding, especially in sub-Saharan Africa, is due to climate change, poor drainage and waste management systems, which stem from less physical planning in the midst of rapid urbanization (Tiepolo, 2014). Although several factors contribute to the frequency of floods in most developing countries, climate change exacerbates this problem. According to the WMO (2012), whilst it is undeniable that urban flooding is an age-old problem due to unsustainable urban planning and inadequate infrastructure systems, the changing climate makes it more troublesome. In 2014, about 932 million urban dwellers lived in areas at high risk of flooding (Gu, Gerland, Pelletier, & Cohen, 2015).

Arguably, adaptation to climate change, specifically flooding, deserves to be at the heart of developmental agendas in developing countries. The ability to adapt to climate change depends on individual or institutional adaptive capacity (Brooks et al, 2005). It shows that the system has the ability and potential to respond to climate change and reduce its effect (IPCC, 2007). Therefore, the ability to adapt to the changing climate and its effects depends on the current circumstances of an individual (WMO, 2012). This paper, therefore, seeks to assess the strengths and weaknesses of the adaptive capacities of households in Dome—an urban area in the Greater Accra region—to flooding.

The next section of the paper contextualises the effects of flooding in urban areas and discusses literature on adaptation to climate change and flooding. The third section presents an overview of the study area and the research methodology used in the study. Section four discusses the relative adaptive capacities of households in the study area to flooding. The final section concludes the paper.

Literature Review

Contextualising Climate Change Induced Floods in Urban Areas

In the past few years, there has been a growing concern among various stakeholders including academicians, policy makers, and city planners about the effects of climate change on urban areas. This is premised on the fact that the majority of the world's population and infrastructure are concentrated in urban areas, which are the focal point for economic and political activities in every country. Urban areas are therefore the most intense impact zones for climate change extreme events such as intensive and prolonged rainfall, storms, drought and temperature increase. Though cities in the developed world are not spared the impacts of climate change, these effects are worst in developing countries which are undergoing rapid urbanization and are dependent on climate linked resources (Hunt & Watkiss, 2007; Campbell-lendrum & Corvala, 2007).

Most urban areas are at a high risk of experiencing at least one natural disaster (floods, drought, cyclones, volcanoes, landslides and earthquakes) in recent times due to the global environmental changes (United Nations, 2016). However, floods are the most common natural disasters in cities, followed by drought and cyclones (United Nations, 2016). Similarly, Smith (2009) points out that there will be an increase in the frequency and intensity of extreme weather conditions worldwide due to climate change, especially drought and flooding. The effect of these extreme climatic events is believed to have worsened in the past decade. Although all climate related extreme events have far-reaching consequences, this paper focuses on floods in the urban context. This is because floods are the most widespread, hazardous and frequent climate-related hazard in the world (Dhar & Nandargi, 2002; Niang et al., 2014; Gu et al., 2015).

According to the World Bank (2012), about 38% of the world's population lives in flood prone areas. Urban floods are aggravated by restrictions in water flow, coverage of ground with pavements and tarred roads (Africa Adaptation Initiative, 2006). The impact of climate change is mostly felt by the urban poor who live in unplanned settlements or slums (Satterthwaite, 2007; Adelekan, 2010; Gu et al., 2015). Four types of urban flooding have been recognised: localised flooding, which happens several times during rainfall season in slums; small streams, which flood after heavy rains; wet season floods, which happen during the rainy season, and major rivers overflowing due to engineering works such as dams (Action Aid, 2006; Satterthwaite, 2007). The impact of flooding in urban areas can be direct (e.g. destruction of infrastructure and loss of lives) or indirect (e.g. increase in the transmission of vector-borne diseases and reduction in economic growth). It has been argued that the most common effects of urban flooding are the destruction of structures, washing away of belongings, loss of lives and injuries, release of fuels and hazardous substances, and untreated sewage (WMO, 2012).

According to Kocornik et al. (2015), from 1985 to 2014, floods have claimed the lives of over 500,000 people, displaced more than 650,000,000 people and caused property and economic loss in excess of over $800 billion globally. Similarly, Gu et al. (2015) note that economic loss due to flooding in cities reached $6 billion in 2005 and is expected to reach $60-63 billion by 2050. In East Africa, an estimated 86,000 and 107,000 people will be displaced in Kenya and Mombasa respectively by 2030 due to flooding (Niang et al., 2014). In 2009, floods also affected about 600,000 people in West Africa, with countries like Ghana, Burkina Faso, Senegal and Niger being the worst hit (Di Baldassarre et al., 2010). In 2007 floods displaced about a million people in Ethiopia, Niger, Uganda, Togo, Mali and Burkina Faso, and in the same year floods claimed over 500 lives in Mozambique (Di Baldassarre et al., 2010). Floods also result in health risks, such as cholera and diarrhea, whilst stagnant water in urban areas due to floods serve as breeding places for malaria and dengue carrying vectors (Amis, 1997; Human Development Report, 2008; Adelekan, 2010).

Floods in Accra led to the loss of 300 billion Cedis worth of property, over 100 lives and the displacement of 10,000 people between 1955 and 1997 (Asumadu-Sarkodie, Owusu & Jayaweera, 2015). In 1995 and 2005, Accra recorded death tolls of 30 and 11 persons respectively from floods (Asumadu-Sarkodie, Owusu & Jayaweera, 2015). A report by the United Nations office for Coordination of Humanitarian Affairs (OCHA) (2010) noted that in 2010, floods affected 33, 602 people and took the lives of 36 people. However, the June 2015 flood in Accra is by far the most destructive. The floods, coupled with fire outbreaks, claimed over 200 lives and several millions of Ghana Cedis in property. Flood incidence and causes have been well documented in Accra by various studies. The Water Research Institute (WRI) categorised causes of flood into three broad factors: Meteorological factors including rainfall and storm surges, hydrological and anthropogenic activities (WRI, 2011 cited in Amoako & Boamah, 2014). Other studies, however, note that the frequency and severity of flood incidence have been exacerbated mostly by the overflow of the Odaw River beyond its banks (Hayward & Oguntoyinbo, 1987; Arkorful, 2008); massive and uncontrolled growth of Accra (Afeku, 2005; Karley, 2009; Rain et al., 2011); poor development control practices (Afeku, 2005; Karley, 2009); prevention of natural infiltration by impervious surface (Arnold et al., 1996; Yeboah, 2000, 2003; Afeku, 2005); poor flows in drainage network such as undersized, unconnected or improperly channeled drains and poor physical planning (Karley, 2009; Rain et al., 2011); waste mismanagement (Afeku, 2005); and informal housing development practices (Aryeetey-Attoh, 2001).

Climate Change and Adaptation

Climate change is one of the most important international environmental phenomena, hence, attracting several initiatives in response to its effects. The two main responses are mitigation and adaptation, to reduce emission of GHG and to curb the impact of climate variability respectively (Mallick et al., 2005). However, GHG emission trends are currently at the worst level (Simoes et al., 2010). The world's emission of GHG increased by 45% in the 1990s and has increased by about 30% since 2000 (Carter et al., 2015). Therefore, whilst early efforts were geared towards mitigation, especially by the developed countries due to their high emission level of GHGs, studies have shown that GHG emissions and climatic change have not abated (Smith, 2009; Lwasa, 2010). This does not imply that mitigation has been a waste of effort, because it also aims at reducing human induced climate change and may ultimately halt it in future. Nonetheless, changes in the climate are inevitable due to human development endeavors, historical emissions as well as the lifespans of GHGs which range from decades to centuries (IPCC, 2001; & Chatterjee, 2005). Thus, with the current mitigation strategies and developmental practices (IPCC, 2007), adaptation is paramount for protecting humans and the environment from the obvious effect of climate variability (Todaro & Smith, 2012; Bawakyillenuo et al., 2014). Urban areas generate about 70% of the global GHG because they consume about 60%-80% of the world's energy (Fujii, Iwata, & Managi, 2017).

The IPCC refers to adaptation as "the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities"

(IPCC, 2007, p.6). Adaptation was also defined by Smit and Wandel (2006) as responses to risks associated with interaction of environmental hazard and adaptive capacity. The concept of adaptation takes various dimensions depending on the degree of spontaneity, timing and reasons for implementation. Adaptation could, thus, be reactive or anticipatory, planned or autonomous, private or public (Smit & Pilifosova, 2001; Smit et al., 2000). Autonomous and planned adaptations are the two main forms that have been extensively researched. Autonomous adaptation is usually undertaken by individuals or households whereas planned adaptations are usually government interventions against an experience or in anticipation of climate variability (Todaro & Smith, 2011). Planned adaptation could trigger autonomous adaptation and vice versa. However, in certain instances planned adaptation could hinder autonomous adaptation because people may not see the need to adapt if the government has already made provision (Todaro & Smith, 2011).

Bawakyillenuo, Yaro, & Teye (2014) expatiated on the scalar dimension of adaptation. Adaptation, it has been argued, takes place at the international, national, regional, local, household and individual level, hence, it has implications not only for the current, but also for future generations due to its temporal scale (Bawakyillenuo, Yaro, & Teye, 2014). In support, Alland (1975) argued that adaptation should not be aimed at dealing with only current stresses, but also future changes that may occur. Adaptation is therefore executed by various agents in the human system at different levels of the above-mentioned scales.

Floods and Adaptation

The literature on adaptation to flooding in urban areas typically indicates how people are coping with the effect but not adapting (WMO, 2012). Measures such as temporal relocation, transfer of belongings to higher elevation and use of water proof techniques are coping mechanisms (WMO, 2012). These measures mean people are doing what they can in the event of flooding, but adaptation would involve more than that. Adaptation would mean a modification of the current system to respond to actual and expected climatic changes, including floods (IPCC, 2007). Although a link has been established between climate change and disasters such as flooding, most of these coping strategies cannot be linked to climate change but rather are a consequence of these disasters (UNDP, 2007). Against this backdrop, this sub-section reviews literature on adaptation strategies adopted by residents in urban areas.

Cities all over the world are affected by climate change, only in varied degrees. Most cities in the developed countries are currently adapting by incorporating measures for adaptation to urban flooding in their city plans and policies. For instance, in 2000, the Netherlands set out a detailed framework in their national policy called 'Room for the River' to protect its cities against floods (De Graaf, 2008; Liao, 2012). In 2003, Germany also developed a flood control Act to integrate climate change assessment into their national planning. Britain, on its part, is expected to spend €1 billion annually on flood management and coastal erosion by 2035 (Bennett & Hartwell-naguib, 2014). Also, the Japanese government has plans to build flood defense infrastructure estimated to cost about 93 billion USD.

In developing countries, especially in Sub-Sahara Africa, adaptation measures are usually based on indigenous knowledge and available resources. In India, women take refuge on bamboo platforms called 'machan' during flooding (BBC World Service Trust, 2010). In Nepal, communities adapt to floods by building early warning systems such as elevated watchtowers (BBC World Service Trust, 2010). Similarly, in Nairobi, people relocate to unaffected places; dig trenches and dykes to divert running water; secure structures with water proof materials; and use sandbags to block water from entering their homes (ActionAid, 2006). In Kampala, residents respond to floods by collectively working to open up drainage channels; constructing trenches to divert water; and seeking temporal shelters at public places such as schools and mosques (Lwasa, 2010). In Lagos, residents also believe that clearing drainage facilities would reduce floods.

In Ghana, the National Disaster Management Organisation (NADMO) is tasked with the response to natural disasters in general. Their activities can best be described more as dealing with the aftermath of floods than with adapting to flood. A study by Action Aid (2006) in Accra showed that residents use blocks, stones and furniture as high places; put valuables on rooftops and places of higher elevation, and relocate temporarily, as coping strategies in response to flooding.

Understanding adaptive capacity to floods

The adaptive capacity to climate related events such as flood is influenced by myriads of factors. In some instances, people's capacity is limited by various legal, social and political barriers. These factors are dependent on each other, hence, a setback in one affects the others. For instance, in Lagos, lack of good local governance has resulted in inadequate drainage, sewage, wastewater and solid waste management systems (Action Aid, 2006). Similarly, in Cotonou, Benin's largest city, there are no sewer systems and only small proportions of solid waste are collected due to poor planning and governance. Thus, institutional bottlenecks underpin the infrastructural capacity of the city to adapt, thereby limiting the overall adaptive capacity in the long run.

The propensity to adapt depends on the availability of funds. Funds are needed to research, plan, implement and communicate adaptive strategies, which in turn enhance adaptive capacity (Satterthwaite et al., 2007). Economic resources could be assets or financial resources (Smit et al., 2001). The adaptive capacity of a community is contingent on their access to economic resources (ODI, 2010). Although poverty does not necessarily mean susceptibility to climate change, it is key in determining the response (Smit et al, 2001). As has been argued, insufficient financial resources limit adaptation options (IISD, 2007). Similarly, Dinar et al (2008), in their study on climate change and agriculture in Africa, observe that household heads had the highest propensity to adapt because they had control over household resources. Therefore, an improvement in economic wealth plays a critical role in one's capacity to adapt to climatic effects.

Gender issues have become critical in recent times within climate change discourse. Gender is one of the factors that determine the degree to which people are affected by climate change. It has therefore been argued that it influences adaptive capacity strongly (ALP, 2013). Several studies have shown that women are more vulnerable to climatic effects than men (Lambrou & Piana, 2006; Röhr, 2006; Damptey & Essel, 2012) yet reports on climate related disasters are unclear about these variations (UNDP, 2007). Furthermore, women, especially those in developing countries, have lower capacity to adapt to change due to several socio-economic factors. Consequently, climate change related disasters claim more female victims than their male counterparts. For instance, floods in Bangladesh in 1991 claimed the lives of women five times more than men (UNDP, 2013). With regard to economic resources, women earn about twenty to seventy percent less than men annually (OECD, 2012). Institutionally, women are not well represented in decision-making positions to effectively influence gender-based climate change policies, which to some extent affect women's adaptive capacity (OECD, 2012). For example, in the Pacific Islands, only 19% of parliamentarians were women as at 2012 (OECD, 2012). The situation is similar in developing countries where men control the majority of natural and economic resources compared to women. ALP's (2013) study indicates that men and women have different adaptive capacities due to differences in access to information, resources and roles in decision making.

Another key factor that influences the adaptive capacity of any society is the literacy rate of the citizenry, measured by the level of educational attainment. According to Brooks et al. (2004), one's adaptive capacity is strongly influenced by one's level of education. This is because, high literacy enhances the dissemination and assimilation of information concerning climate change, which in turn enhances the level of awareness concerning climate change events. During an assessment of the adaptive capacity of Nigeria, Adejuwom (2013) observed that education was a major determinant of adaptive capacity. Accordingly, the study concluded that people with lower levels of educational attainment have lower adaptive capacity. In other related studies, Magalhães (1996), in an assessment of the capacity of Brazil, identified illiteracy as one of the main factors accounting for low adaptive capacity. Building strong adaptive capacity requires scientific knowledge of the problem and solutions (IPCC, 2001). Therefore, education plays a major role in adaptive capacity. According to UNDP (2007), new technologies and built infrastructure are not enough to tackle climate change extreme events, since knowledge is imperative.

Methodology

The paper uses an eclectic methodological approach to assess the adaptive capacity of urban dwellers in Dome, a suburb of Accra, to flood. Specifically, both qualitative and quantitative methodological techniques are applied to understand the issues around people's ability to adapt to flood in the aforementioned research area. These two techniques are complementary in that they address each other's weaknesses and are thus useful for the examination of complex issues (Teye, 2012). Therefore, the survey tools applied in the study were household survey questionnaire and individual in-depth interviews. Respondents were sampled using the systematic random sampling technique. One household in each house structure was interviewed, and in instances where there were more than one household, simple random sampling was used to select one household. Recorded audio interviews were transcribed, categorised and subjected to content analysis. The quantitative data on the other hand were analysed using SPSS version 20 and subjected to descriptive analysis.

Sample frame for quantitative household survey and assets classification

The survey sampled 371 households for the purpose of the study, and the heads of these households, who are believed to possess optimum control over household resources and decision making, responded to the questions. This sample was selected from a total of 10, 393 households (GSS, 2014) based on a significance level of 5% and a confidence level of 95%. The survey gathered information on perceptions of climate change, adaptive strategies being practiced and their relevance, and determinants of adaptive capacity to climate related hazards. About 63.9% of the respondents were males whilst the remaining 36.1% were females. Only 10.5% of respondents had not received any form of formal education. Although 60 per cent of the respondents were familiar with the term *climate change*, only a few could explain what it means.

This, therefore, affects their capacity and adaptation capabilities to deal with flooding. During the survey, average prices of household assets were used as proxies to estimate the economic resources of the various households because respondents might not be comfortable disclosing the actual cost of such assets (Table 1). According to the Ghana living standards report (GSS, 2014), the majority of the population in Accra have an average annual per capita of GH₵ 6,337. This is the latest report on the living standard of the average Ghanaian. Therefore, using this as a measure, the asset values of respondents were categorised into Low Asset (GH₵25-2000), Medium asset (GH₵2001-10,000) and High asset (GH₵10,001-100,000).

Table 1. Prevailing average prices of various household items

ITEMS	PRICES (GH₵)
Television	1000
Electric fan	100
Air-condition	600
Energy efficient refrigerators	800
Non-energy efficient refrigerators	400
Cars	20000
Motorbikes	5000
Bicycle	200
Gas stove	200
Coal pot	25

Source: Authors' compilation, 2015

Sample frame for qualitative individual in-depth interviews (IIs)

In order to probe further for deeper understanding of issues not captured in the household survey questionnaire, in-depth interviews were conducted with heads of some selected institutions and households during the questionnaire survey. The sampling process for the in-depth interview participants was purposive, involving 20 household heads who were purposely selected and interviewed based on their status and location in the community as well as their resource base. About 10 of these respondents were selected from low-income flood prone areas and the remaining 10 from high income areas unaffected by floods. These respondents were interviewed to gain further understanding of the weaknesses and strengths identified during the survey questionnaire administration. The institutional heads that were interviewed included the Ga East Assembly Municipal Planning Officer, the Administrator of Dome Zonal Council, the Chairman of the Dome Traditional Council and the Coordinator for NADMO in the municipality.

Description of Study Area – Dome

The study was conducted in Dome (Figure 1), the largest urban community, in terms of landmass, in the Ga East Municipality of Accra. The 2010 population census put the community's population at 39,868 persons with an intercensal growth rate of 4.2% (GSS, 2010). Per the intercensal growth rate of 4.2%, the projected population of Dome as at 2015 was 40,705. The community can be described as cosmopolitan because it has people from all ethnic groups in Ghana, with Akans forming the majority. Christianity is the main religion in the area, followed by Islam, with African traditional religion placing third. The community serves as the hub for all businesses in the municipality because the largest market of the municipality is situated there. Therefore, most of its residents are employed in the trading and service sectors. The community has only one health clinic that is supposed to serve almost 41,000 people, hence, some residents access healthcare needs in nearby communities' hospitals. The study area has schools at all levels of education except senior high school and tertiary levels. Temperature increase and flooding are the most dominant effects of climate change in this municipality. Some of the factors that account for these effects include clearing of vegetation and reclamation of wetlands for residential and commercial use, inadequate drainage, poor waste management system and inappropriate siting of structures (GEMA, 2014).

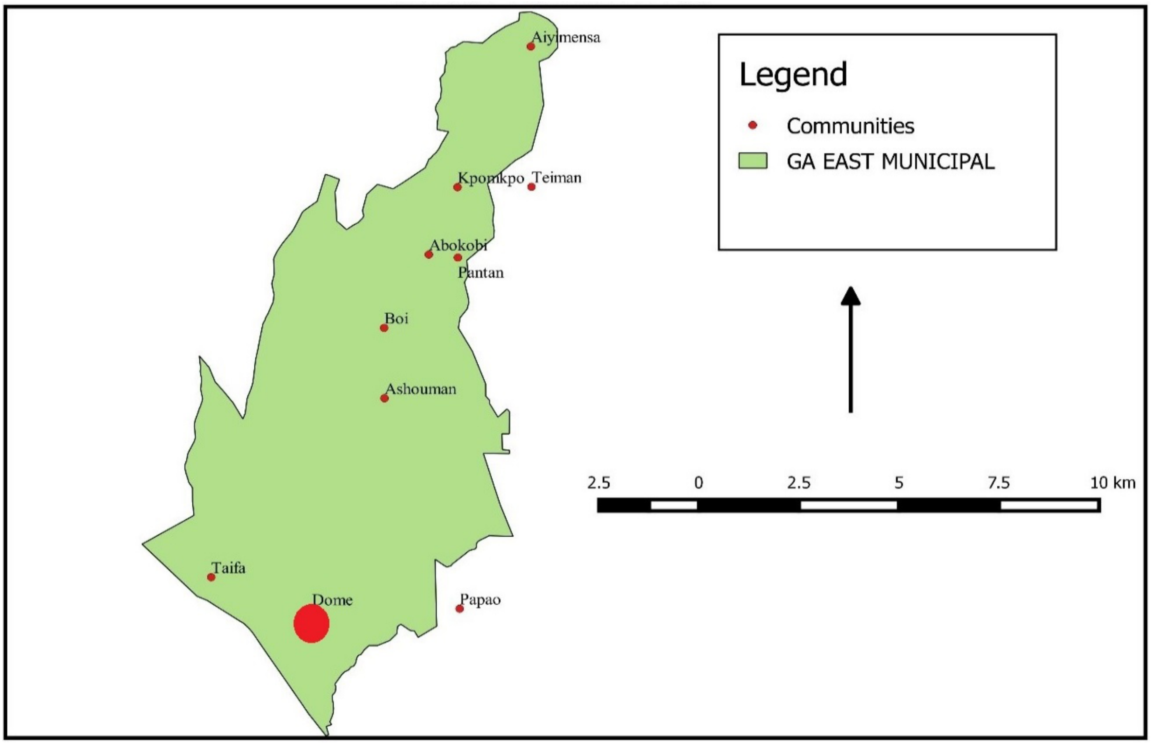

Figure 1: Map of Ga East with reference to the study community, Dome
Source: GEMA, 2014

Conceptualizing Measurement of Adaptive Capacity

There is a consensus in adaptation studies that current knowledge on adaptive capacity is inadequate to predict future responses to climate change (IISD, 2007). However, successfully adapting to the changing climate requires an understanding of existing prospects. Adaptive capacity refers to a system's ability to evolve and react to climate-related hazards so as to avoid their recurrence and reduce the magnitude of damage (Vincent, 2007). It is the "vector of resources and assets that represent the asset base from which adaptation actions and investments can be made" (Vincent, 2007; p. 13).

The existing literature indicates that adaptive capacity is the basis for vulnerability assessment and a precondition for developing and implementing adaptation strategies (Adger et al, 2004; Brooks et al., 2005; IPCC, 2007; Vincent, 2007). According to the IPCC (2001), adaptive capacity is determined by the characteristics of a system (community, country or region) that influence the ability to adapt. These characteristics are usually determined by indicators. However, there is no consensus on how the capacity to adapt is measured; this is subject to each writer's own judgment. Accordingly, adaptive capacity is immeasurable (Smit & Wandel, 2006). Similarly, Williamson et al. (2010), in their assessment of adaptive capacity, emphasised that the inability to measure indicators directly is the main deficit of the adaptive capacity framework. Research efforts to assess adaptive capacity in order to aid decision making are met with conceptual and data problems (Vincent, 2007). Below are discussions on the approach to measuring adaptive capacity and the determinants (or indicators) of adaptive capacity framework.

Approach of measurement

Adaptive capacity is multi-dimensional, therefore both quantitative and qualitative indicators are employed for its measurement. According to Yole and Tol (2002), the majority of indicators in determining adaptive capacity cannot be quantified, but they can be described qualitatively. Clearly, this inability to quantify poses a problem regarding the measurement of adaptive capacity. For instance, whilst the asset base of households can be easily quantified, the perception of people about the risks posed by floods or temperature increase can only be assessed qualitatively.

The determinants of adaptive capacity framework

Deductively, adaptive capacity cannot be easily assessed without recourse to its determinants (ODI, 2010). Adaptive capacity as a concept gained prominence in the climate change literature after it was introduced in the IPCC Third Assessment Report (McCarthy et al, 2001 as cited in Schroter, 2004). The IPCC (2001) identified economic wealth, technology, information and skills, infrastructure, institutions and equity as the main determinants of adaptive capacity, though no distinctions were made as to the level at which they could be used (ODI, 2010). Therefore, several researches have probed and modified these determinants. Whereas some have focused on one aspect of the determinants such as institutions (see Yaro et al., 2015; Upton, 2011), others have looked at adaptive capacity holistically (see Engle, 2011). Yet others have introduced additional and alternative approaches for determining adaptive capacity (Williamson et al, 2010). However, it is important to note that all the determinants of adaptive capacity are dependent on each other.

In an attempt to find a suitable method of assessing the determinants of adaptive capacity, several frameworks have been developed. For instance, Schroter et al. (2004), in their assessment of ecosystem vulnerability, categorised the IPCC determinants into three main dimensions: awareness, ability and action. In this study, awareness included the determinants of equality and knowledge; ability comprised determinants of technology and infrastructure; and action consisted of the determinants of flexibility and economic power. Juhola et al. (2012), in their assessment of the adaptive capacity of Nordic countries, adopted Schroter et al.'s method, but the framework added indicators to prevent simplification of determinants. A study by Asante et al. (2012) established that the capacity to adapt to climate change effects depends on the knowledge and necessity to adapt; awareness of the problem; level of technology and ability to develop new ones; access to infrastructure and level of institutional support.

The above review clearly indicates the lack of consensus in the measurement and determinants of adaptive capacity, so that different studies have employed different determinants and measurement approaches. However, this paper adopts the framework developed by Juhola et al. (2012) to anchor its content. Indicators will be developed for further clarification of the determinants with reference to the scale and data availability for the study. Accordingly, the study is based on three main dimensions: awareness, ability and action. The awareness dimension focuses on the perception of individuals about a phenomenon. This dimension consists of knowledge and awareness, given that knowledge and awareness are prerequisites for identifying adaptive strategies (Huq et al., 2005). Empirically, the findings of Magalhães (1996) in assessing the adaptive capacity of Brazil identified knowledge as one of the main factors for low adaptive capacity. This indicator was measured in this present paper using the perceptions of individuals about the changes in rainfall, prevalence of floods and their effects in Dome. Respondents were categorised as strongly/highly aware of climate change and related flood incidence if their responses indicated familiarity with climate change and perceived changes in rainfall pattern in the last 20 years, whilst non-familiarity with climate change and perception of no changes in rainfall pattern in the last 20 years amounted to "weak awareness". The awareness index (in percentage terms) is generated based on aggregated responses of the respondents with respect to the various components/determinants discussed.

The ability dimension is centered on the competencies of a community in relation to a phenomenon. Hence, this dimension is determined using the infrastructure and technological level of the community, taking into account assertions that technology and infrastructural development improve capacity to adapt to a phenomenon (Smit et al, 2001; Sokona & Denton, 2001). In this paper, technology is measured using the availability of early warning systems and the current adaptation technologies as indicators, whilst infrastructure is measured using access to mobile phones, health facilities, road networks, water, drainage facilities and solid-waste management as indicators. Specifically, an indication of receiving flood warning signs, coupled with accessibility to mobile phones, health facilities, pipe borne water as well as door-to-door (franchise) and recycling waste management systems, constitute high ability-capacity to adapt to flooding. The reverse of these determinants constitutes low ability-capacity to adapt to flooding in this study. The ability index (in percentage terms) is generated based on aggregated responses of the respondents with respect to the various components/determinants as discussed in the text.

Lastly, the action dimension focuses on the capacity to take steps towards adaptation. Availability of economic resources and institutional capacity are used as indicators for this dimension, considering that insufficient financial resources limit adaptation options (IISD, 2007). Economic resource in this paper is measured using the income levels and the asset base of households, whilst institutional support to victims of floods and municipal climate change policies are used to measure institutional capacity. Respondents with medium (GH₵2001-10,000) and high (GH₵10,001-100,000) asset values coupled with institutional capacity in terms of receiving and giving help to a neighbor, support from other institutions and effectiveness of the local government (Municipal Assembly), are deemed to be highly 'action-adaptive' to flood. The index is generated based on aggregated responses of the respondents with respect to the various components/determinants. Summaries of the proxy indicators of the five determinants and further re-categorisation into the three dimensions are shown in Figure 2 and Table 2 below.

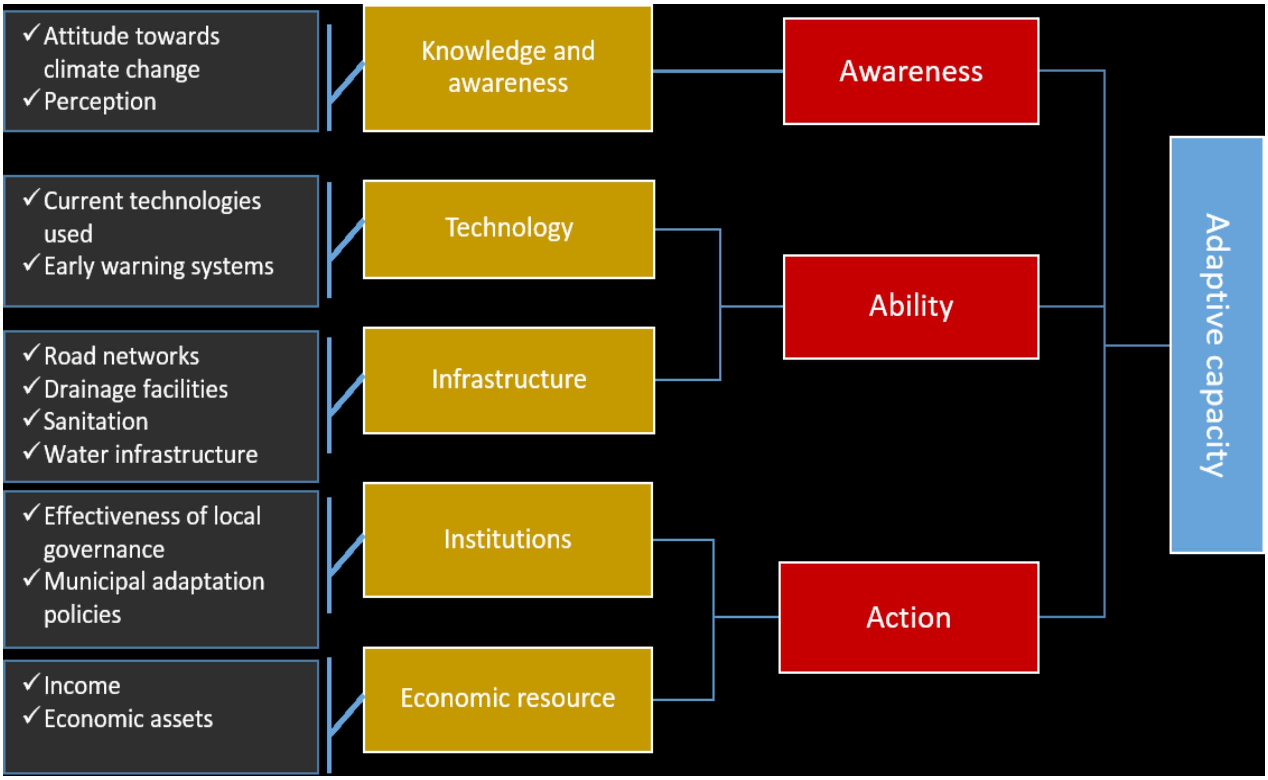

Figure 2: Dimensions and determinants of adaptive capacity framework

Source: Adapted from Juhola et al. (2012)

Table 2: Measuring adaptive capacity in Dome

Determinant	Proxy	Relevance	Methodology
Knowledge and awareness	Attitude towards climate change	Attitude assesses their understanding of the severity of the problem	Questionnaire surveys
	Perception	How they perceive flooding to influence their preparedness to adapt to incidences.	Questionnaire surveys and in-depth interviews
Technology	Current technologies used	Level of technology used gives insight about ability to afford new technologies in future	Questionnaire surveys
	Early warning systems	Knowledge on impending disasters influences the ability to adapt	Questionnaire surveys
Infrastructure	Road networks	Good road networks also influence adaptive capacity	Questionnaire surveys
	Drainage facilities	The existence of drainage facilities enhances the ability to adapt to flooding	Questionnaire surveys and in-depth interviews
	Sanitation	Good sanitary conditions also enhance adaptive capacity and reduce the effects of flood incidence	Questionnaire surveys and in-depth interviews
	Water infrastructure	Availability of good water infrastructure is necessary for coping with disasters	Questionnaire surveys
Institutions	Effectiveness of local governance	The roles of local institutions are important for adaptive capacity	Questionnaire surveys and in-depth interviews
	Municipal adaptation policies	Policies serve as guidelines for coping with floods, and thus, are relevant for adaptive capacity	Questionnaire surveys, in-depth interviews
Economic resources	Income	Income will be used to fund adaptation practices	Questionnaire surveys
	Economic assets	Current assets determine the resources available to support adaptive strategies	Questionnaire surveys

Source: Adapted from Juhola et al. (2012)

Discussion

The ability to cope with climate change depends on the knowledge of the threat posed (ODI, 2010). Analysis of data for this study indicates that flooding is the most prevalent climate related event in the study area and, thus, poses the most threat to the Dome community. About 336 (90.6%) out of the 371 respondents sampled for this study affirmed the assertion that flooding is the most prevalent climate related event in the community compared to increased temperature, storms and high rainfall intensity. When asked about their experience, 194 (52.3%) of respondents indicated that they have been affected by flooding in the community. Having identified the main threat to the community, the paper proceeds to discuss the capacity to adapt to this threat. Below are discussions of these threats in relation to the various determinants of the adaptive capacity framework. The 'awareness, ability and action capacities' for adaptation to flood are discussed distinctively, but each in comparison with the overall adaptive capacity per the indices reported in Tables 3, 4 and 5. The aggregated percentile indices computed show that residents in Dome have a relatively higher awareness capacity (58.2%) compared to ability (40.4%) and action (47%) capacities. In other words, residents in Dome are better equipped with a reasonable level of information on flood incidents in the area, but less equipped with technology, infrastructure and sufficient resources to cope with the threat. This explains the low overall adaptive capacity status of residents of Dome to climate change when all the dimensions are combined to compute the aggregated percentile indices. Also reported in Tables 3, 4 and 5 are Chi-square statistics with their corresponding probability values. These statistics test the significance of the observed differences between the adaptive capacities within the various categories of respondents, that is, within the wealth, gender and education categories distinctively.

Awareness Capacity Vis-à-vis Overall Adaptive Capacity

Table 3 shows the estimated percentile indices of the awareness capacity vis-à-vis overall adaptive capacity for wealth, gender and educational categories of respondents in Dome. As revealed in the table, a significant proportion of households have high awareness capacity. The data revealed that about 58.2% of respondent households have high awareness capacity to floods in Dome. However, only 10% of respondent households have the overall adaptive capacity to flooding in the community. This implies that, whilst many have adequate knowledge of flooding issues in the community, they lack adequate capacity in other determinant areas to effectively adapt to floods.

In analysing awareness and overall adaptive capacity among various wealth categories, it emerged that respondents who have high-valued assets such as vehicles and home appliances have the highest awareness capacity as well as overall adaptive capacity. This conforms to findings in Smit et al. (2001) and Satterthwaite et al. (2007). The observed differences in the awareness capacity for the different wealth categories of respondents is statistically significant at 1%. In terms of gender of the household head, the empirical evidence indicates that male headed households have high awareness capacity (63%) relative to female headed households (50%), and this difference is statistically significant at 1%. Similar dominance for male headed households is observed in the overall adaptive capacity, in tandem with the findings from Damptey and Essel (2012) and Lambrou and Piana (2006). Finally, regarding educational level attained, the empirical findings reveal that highly educated respondents (that is, those with tertiary education) have higher awareness capacity than fairly educated (that is, those with elementary, middle, 'O' level and 'A' level and vocational school education) and uneducated respondents. The observed differences with respect to educational level are significant at 1%.

Table 3: Indices of awareness capacity on floods and overall flood adaptive capacity vis-à-vis wealth, gender and education categories of respondents in Dome

	Index (%)	
	Awareness capacity	Overall adaptive capacity
Wealth Category		
Low Assets	66.7	0
Medium Assets	49.1	9.6
High Assets	73.8	11.9
Chi-square(Pr)	*20.8(0.00)****	*2.2(0.33)*
Gender of HH head		
Male-headed	62.9	11.8
Female-headed	50.0	6.7
Chi-square(Pr)	*5.8(0.02)****	*2.5(0.12)*
Education		
Uneducated	43.6	5.1
Fairly educated	52.9	10.0
Highly educated	85.9	12.7
Chi-square(Pr)	*28.9(0.00)****	*1.6(0.45)*
Entire sample	58.2	10.0

Source: Authors' computation 2015

NB: *** shows statistical significance at 1%

Clearly, the awareness capacity of respondents with respect to wealth, gender and education is higher at all levels compared to the overall adaptive capacity. This observation could be attributed to the fact that flooding is experienced in most parts of the Dome community. One respondent remarked during the in-depth interview that:

> *"I will be very surprised if someone who stays in Dome isn't aware of floods in the area. It happens every year and people lose their properties"* (A 42 years old Driver in Dome).

The observed differences in the overall adaptive capacity per the various wealth, gender and education categories are insignificant, implying that many people, irrespective of their wealth, gender and educational background, lack adequate adaptive capacity, and are therefore affected by floods in Dome. This contrasts with the findings of IPCC (2001) that high awareness of climate change induced floods improved overall adaptive capacity, for this paper reveals that although many people have high awareness level, they manifest very low adaptive capacity in relation to all the determinants. Therefore, whilst knowledge of the problem is important, it does not guarantee a solution for it.

Ability Capacity Vis-à-vis Overall Adaptive Capacity

The ability dimension of adaptive capacity is centered on the experience of a community in relation to a phenomenon. As stated by Smit et al. (2001), technology and infrastructural development improve one's adaptive capacity to a phenomenon. In view of this, the indicators for this dimension are the infrastructure and technological knowhow of the Dome community. As observed in Table 4 below, the ability dimension at each level of the wealth, gender and education categories is higher than the overall adaptive capacity. Comparatively, the ability dimension (40.4%) of the sampled respondents is higher than their overall adaptive capacity (10.0%). However, only the observed differences with respect to education are significant. The differences with respect to wealth levels could be attributed to the fact that most households only cope with the current situation based on what their resources can afford them. As noted by WMO (2012), people react to incidence of flood when it happens, but do not modify or change their infrastructure to adapt. For instance, people dig trenches, relocate temporarily or move their belongings to places with higher elevations during floods. The following responses from some respondents in the Dome community in relation to their adaptive strategies illustrate this point:

> *"I start digging a small trench in front of my house to the big drain at the opposite side because that is all I can do to prevent all my things from flooding"* (30-year-old trader)

> *"I put the valuable things I have in the house on tables, chairs and bed in the house whenever it rains and the house and rooms I occupy get flooded, because that is the best way of preventing my things from flooding"* (45 year old steel bender).

These adaptive strategies are just mechanisms for coping with floods, but not long-term strategies to prevent the effects of future floods. Therefore, their capacity to reduce future floods or their effects is very low. In addition, the majority of households with low assets are within slum areas where drainage facilities and layouts are very poor. According to one of such respondents:

> *"The floods began after the construction of the bridge and expansion of the drains five years ago. I think the construction of the drains has worsened the situation"* (56-year old businessman)

Also, highly educated people have higher ability. Without adequate knowledge, the mere availability of technologies and infrastructure in a certain community will not increase the inhabitants' adaptive capacity. There is the need to have knowledge on how such technologies and infrastructure can effectively be utilised. This observation mirrors the assertion made by UNDP (2007) that knowledge plays a significant role in ability.

Table 4: Indices of ability to adapt to floods and overall flood adaptive capacity vis-à-vis wealth, gender and education categories of respondents in Dome

	Index (%)	
	Ability	Overall adaptive capacity
Wealth Category		
Low Assets	20.0	0
Medium Assets	38.7	9.6
High Assets	46.0	11.9
Chi-square(Pr)	*4.5(0.10)*	*2.2(0.33)*
Gender of HH head		
Male-headed	42.2	11.8
Female-headed	37.3	6.7
Chi-square(Pr)	*0.8(0.36)*	*2.5(0.12)*
Education		
Uneducated	18.0	5.1
Fairly educated	41.0	10.0
Highly educated	50.7	12.7
Chi-square(Pr)	*11.3(0.00)****	*1.6(0.45)*
Entire sample	40.4	10.0

Source: Authors' computation 2015

NB: *** shows statistical significance at 1%

Action Capacity Vis-à-vis Overall Adaptive Capacity

The action dimension focuses on the capacity to take steps towards adaptation. Availability of economic resources and institutional capacity is used as an indicator for this dimension. In Table 5, it is observed that the action capacity of respondents in Dome is higher (46.9%) than the overall adaptive capacity (10.0%). Less than 50% of the respondents have action capacities, because the majority are not so resourceful, whilst the institutions (Local Assembly and NADMO) do not offer much capacity avenues. Similar to the other dimensions, the awareness capacity for all categories, that is, wealth, education and gender at each level is higher than the overall adaptive capacity. The observed differences in the action capacities of the three wealth categories are due to the fact that, although households with low assets are the most vulnerable to floods in Dome, they also have inadequate economic resources for adaptation. On the other hand, households with high assets are relatively less affected, and therefore have a better adaptive capacity because of their economic resources.

Table 5: Indices of action for flood adaptation and overall flood adaptive capacity vis-à-vis wealth, gender and education categories of respondents in Dome

	Index (%)	
	Action	Overall adaptive capacity
Wealth Category		
Low Assets	0	0
Medium Assets	51.3	9.6
High Assets	44.4	11.9
Chi-square(Pr)	*15.3(0.00)****	*2.2(0.33)*
Gender of HH head		
Male-headed	46.4	11.8
Female-headed	47.8	6.7
Chi-square(Pr)	*0.1(0.80)*	*2.5(0.12)*
Education		
Uneducated	69.2	5.1
Fairly educated	47.5	10.0
Highly educated	32.4	12.7
Chi-square(Pr)	*13.8(0.00)****	*1.6(0.45)*
Entire sample	46.9	10.0

Source: Authors' computation 2015

NB: *** shows statistical significance at 1%

Furthermore, the Dome community currently does not have any policy on floods and how to prevent or reduce their future impacts. It was revealed that NADMO was the only institution that provides support during floods, as the municipal assembly, which is the local governing body, does not provide support in any form. Some respondents even hold the view that the municipal assembly aggravates the situation. One disgruntled respondent, for instance, expressed his frustration with the municipal assembly as follows:

> *"They just come construct (drains) and demolish houses without consulting any one. Before they constructed these drains, we were not experiencing these floods. The floods began about five years ago when the bridge was constructed, and it nearly carried someone away"* (56 years old businessman).

However, in an in-depth interview with the municipal planning officer, it was argued that the municipal assembly plays several roles in enhancing the adaptation of residents in Dome in the event of floods. The following account was given:

> *"During these disasters the municipal assembly supports by providing funds to the NADMO office in the municipality to procure relief items. Aside from this, the municipal assembly also performs regulatory functions by denying people permits to build in waterways, demolishing of unauthorised buildings, building of new drains, desilting of drains and provision of sanitary bye-laws."* (Planning Officer, Ga East Municipal Assembly, 23rd June 2015).

Conclusion

Using Dome, an urban area in the Ga East Municipality in the Greater Accra region, the paper examined the adaptive capacity of households to flooding through the application of both qualitative and quantitative approaches. Urban flooding poses a great risk to human safety and sustainable development as evidenced by the cost of damages and lives lost since 1990. Although floods in Dome began in recent years due to urbanization, the risks they pose to residents are not different from what pertains in other urban areas. Over the years, properties, livelihoods and lives have been lost due to these floods. An assessment of the adaptive capacity of residents to the flood incidences has therefore become necessary. By adopting a mixed approach, the paper established that although the adaptive capacity of the people of Dome to floods is very low when all the determinants are taken into consideration, capacity in terms of the awareness, ability and action dimensions, when considered separately, vis-a-vis wealth, gender and education categories, is higher at all levels compared to the overall adaptive capacity. It is therefore an indication that the determinants of adaptive capacity are intertwined. Hence, in order to have a high adaptive capacity, all the determinants should be given equal attention and tackled holistically. For instance, the paper reveals that, in comparison to the other dimensions, the Dome community has a high awareness capacity to flooding due to the frequent exposure of the majority of the residents to this incidence. Notwithstanding this high awareness, the overall adaptive capacity is low because of relatively low 'ability-capacity' (poor infrastructural development and inadequate access to technology) and 'action-ability' (inadequate policies and institutional support as well as economic resources) to be able to effectively implement adaptive strategies. Findings in the paper, therefore, add to knowledge in the framework of the underpinning adaptive elements to flooding that need attention in the Dome community in Accra.

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