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## Climate variability and communities' vulnerability along Ghana's coastline

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### Abstract

Over the last three decades, communities along Ghana's coastline have been affected by storm surges, coastal floods and erosion from relatively less predictable hydro meteorological hazards and disasters. Using selected coastal communities in the Keta municipality, this study explores the vulnerabilities of coastal communities in Ghana and the effectiveness of emerging adaptation interventions. Evidence for the study was gathered through a review of relevant secondary documents; a household survey; focus group discussions and institutional consultations. The paper reveals several hydro meteorological risks (e.g., shoreline erosion, storm surges) which threaten the inundation of some communities and the destruction of infrastructure and coastal resources. While there is evidence of adaptive governance in terms of institutional efforts (construction of sea defence wall), there is limited state commitment towards climate change adaptation and poor local community engagement. State interventions require co-ordinated and sustained efforts from national and local level institutions to ensure adaptation and resilience to coastal vulnerability.

### Keywords:

Climate hazards;  
Resilience; Adaptation;  
Adaptive governance;  
Vulnerability

### Introduction - the threats of climate change, knowledge and preparedness

Climate variability and change have become major global concerns. Their impacts have produced widespread vulnerabilities across the globe (Adger et al. 2004; Gentle et al. 2014; Intergovernmental Panel for Climate Change [IPCC], 2007). For example, in Nepal, Gentle et al. (2014) report of an annual average rate of warming of 0.006°C, characterised by erratic rainfall, unpredictable onset of monsoon seasons and other vulnerabilities resulting from glacial lake floods. Others (e.g., Cobbinah & Anane, 2016; IPCC, 2007) have alleged that future effects of climate change are likely to threaten human survival, disturb the functionality of ecosystems and reduce agricultural output.

Although they are seen as global phenomena, the impacts of climate variability and change are mostly local (Adger et al. 2004; Appeaning-Addo, 2013; Boateng, 2009, 2010; Bryan et al. 2013; Cobbinah & Anane, 2016; Gentle et al. 2014; IPCC, 2007; Wiafe et al. 2013). Thus, local communities in poor developing countries have been recognized as the most vulnerable to the impacts of climate change, because their sustenance is formed around natural resources and the environment (United Nations Framework Convention on Climate Change [UNFCCC], 2006). Even in the local developing country context, climate change, for Gentle et al. (2014), has differential impacts. Of particular concern are the increasing threats on poor coastal communities (IPCC, 2001), including sea-level rise entailing increased flood frequency, tidal inundation, increased erosion and many ecological disorders (Dolan & Walker, 2006). In such situations, governments' response to, and local knowledge of climate change and variability, as well as adaptation, become necessary and urgent (see Picketts et al. 2013).

Regrettably, research indicates that many poor coastal communities and remote areas in Africa continue to suffer knowledge deficiency on climate change and variability and limited support from relevant state institutions towards adaptation (Appeaning Addo, 2013; Cobbinah & Anane, 2016; Sarpong & Anyidaho, 2012; Wiafe et al. 2013). To date, the understanding of climate change and its perceived and real impacts on communities in Africa is still evolving. As a result, efforts towards adaptation to the impacts of climate change have not been based on the understanding of the impacts of climate change (see Sarpong & Anyidaho, 2012); instead, they have been determined, motivated and sustained by donor funding. In most cases, national efforts towards tackling climate change in African countries (e.g., Ghana), according to Sarpong and Anyidaho (2012), are driven and dictated by international or donor agencies who consider climate change as part of conditions of support. However, understanding local level climate change impacts, state intervention policies and plans is critical in designing community adaptation and resilience mechanisms (Cobbinah & Anane, 2016).

It is true that in Ghana a number of studies have been carried out on the perceived and real impacts of climate change on coastal communities. These studies have largely concentrated on the geophysical analysis of possible impacts of climate change on coastal communities along Ghana's shoreline (Amoani et al. 2012; Angnuureng et al. 2013; Appeaning Addo & Adeyemi, 2013; Appeaning Addo et al. 2008, 2011; Boateng et al. 2017). Key areas of focus in these earlier works have been the impacts of sea rise on sea defence structures; shoreline recession due to storm surges and tidal waves; perennial flood events; coastal erosion and inundation. Unfortunately, not much has been done on the actual impacts of these geophysical and hydro meteorological events on residents in these coastal communities as well as state policy and structural interventions to ensure their adaptation and resilience to such impacts.

Considering that the impacts of climate change and variability are expected to intensify in the foreseeable future (Coumou & Rahmstorf, 2012; IPCC, 2007), research into how the world's most vulnerable people and communities are impacted by the changing weather events is necessary and timely. In response, this paper explores the vulnerability of coastal communities in Ghana. Thus, the paper uses the adaptive governance theoretical framework to examine households' vulnerability levels in coastal communities in the Keta municipality, located along the eastern coast of Ghana. The paper entails six sections. Section 1 introduces the research while Section 2 discusses the literature on climate change vulnerability in developing countries. Section 3 presents the study location and

the methods used. Section 4 presents the findings of the research. Section 5 presents discussions of the results. Finally, Section 6 presents some concluding remarks.

### Climate change vulnerabilities in coastal communities – a theoretical framework

Climate change and variability continue to pose a threat to lives and livelihoods in coastal communities in developing countries (IPCC, 2012). According to the UN-HABITAT (2011, p.1) “climate change threatens to have unprecedented negative impacts upon quality of life, economic and social stability”. Regrettably, the phenomenon has been predicted to have greater impacts on coastal regions which accommodate most of the world’s major cities (IPCC 2012; UCCRN, 2011) in the form of frequent and damaging water related disasters through sea level rise and storm surges, heavy and prolonged precipitation and changes in the flow of rivers in deltas (Girardet, 2008; UN-HABITAT, 2011). These extreme weather events, according to IPCC (2012), are expected to increase in both frequency and intensity. Especially variations in precipitation are projected to cause more floods in the future as the intensity of rainfall is expected to increase (UCCRN, 2011). The uncertainties related to these predictions make it difficult to estimate precisely the spatial, economic and social impacts of such events in the face of rapid urbanisation, especially in Africa (Satterthwaite, 2008). In the face of these vulnerabilities, what are the emerging interventions and how have they been designed and implemented?

Situated within the two key concepts of *vulnerability* and *adaptive governance*, this study argues that climate vulnerability can be managed through adaptive governance. Vulnerability in this study is explained as “the degree to which a system [community] is susceptible to, and unable to cope with, the adverse effects of climate change, including climate variability and extremes” (IPCC, 2007, p. 883). Within the climate change community, two main views of vulnerability emerge: The first is the “end point” view which conceptualises vulnerability as the residual impacts of climate change to which community (or the system in question) is not able to adapt. This view of vulnerability appears to be silent on the critical social, political, economic, political, biophysical and ecological *processes* going on within the community and beyond (but which have a bearing on community exposure, sensitivity and adaptive capacity). This is seen in the projections of vulnerability indices of climate change which concentrate on the quantifiable variables under various scenarios based on assumptions that are hardly affected by these social, economic, cultural and political processes (Füssel, 2010, p. 8).

In contrast, the “starting point” view of vulnerability to the impacts of climate change results from the complex inter-relationships of the social, economic and political processes at play within and beyond the community (or system) under consideration. This view assumes that vulnerability *is not given* but evolves and *can be produced* by a set of prevailing or consequential circumstances *arising* from several physical, social, economic and environmental factors which increase the exposure of a community to the impacts of global changes and hazards (UNISDR, 2004, p. 24). Vulnerability under the “starting point” view can also comprise the physical, socio-economic and/or political factors that adversely affect the communities’ ability to respond or adapt to the impacts of climate change and extreme events. O’Brien et al. (2007) refer to these two views (“end point” and “starting point”) of vulnerability as “outcome vulnerability” and “contextual vulnerability” respectively.

This study aligns with the second view as was earlier explained by Cannon (2000, p.45) who argues that vulnerability is largely derived from “political, economic and social contexts” and not simply

about “victims” of events in an “aggregated and apolitical manner”. Cannon (2000) therefore argues in favour of a political-economic explanation of vulnerability which gained some importance in the last decade of the 20<sup>th</sup> century (Cutter 1996; Pelling, 1997, 1998, 1999) and has continued to gain ground in current discussions in natural/environmental hazards and vulnerability research (Adger, 2006; Cutter et al. 2003; Few, 2003). This approach indicates that the causes of vulnerability lie in social, economic and political processes and disparity in access to resources and that vulnerability to hazards is often promoted by poverty, deprivation and marginalisation, and through related low response and recovery capacity.

A central theme in the literature is the thinking that vulnerability of a community is a function of two determinants: its exposure/sensitivity to hazardous conditions and ability/capacity to cope, adapt or recover from the effects of such conditions. The foregoing conceptualisation of vulnerability makes *adaptive capacity and/or governance* an important concept for tackling climate vulnerability. Adaptive governance is explained by Djalente et al. (2011) as the processes, networks and structures for building the capacities of communities to adequately respond to, cope with and recover from the impacts of climate change on vulnerable communities. This view is supported by Smit and Wandel (2006, p. 2867) who refer to “adaptive capacity” as a reflection of adaptation or adaptive governance, which “represent ways of reducing vulnerability”. In connecting *adaptive governance* to community vulnerability reduction, Djalente et al. (2011) outline four key factors necessary for building community adaptive capacities, namely: institutional arrangements; framework for participation and collaboration; continuous learning and innovation; and community self-organisation.

Institutional arrangements refer to the existence and networks of climate response institutions that formulate and implement policies to reduce climate vulnerabilities in affected communities. These institutions operate at all spatial levels and include ministries, departments and agencies of government, civil society organisations and community-based actors. These institutional measures improve the fit between knowledge, action, and social-ecological processes to help societal adaptation at the appropriate level (Djalente et al. 2011; Lebel et al. 2006). Toonen (2011) has suggested that the institutional arrangement can enhance belief and collaboration, and may attain more effective, equitable, and sustainable outcomes. Framework for participation and collaboration explains structures established for all stakeholders to plan, implement and monitor their adaptation practices at the community level. Such participatory and collaborative efforts may favourably influence the adaptive capacity of local actors. Similarly, the bringing together of knowledge from multiple stakeholders ensures effective processes and better outcomes (Pahl-Wostl, 2009).

Learning and innovation emphasise active socio-ecological engagements between communities and their environments (Djalente et al. 2011). Sometimes referred to as social or public learning, it is done through the accumulation of social-ecological learning and understanding - this is also referred to as “social memory.” Social memory is essentially accumulated experiences, values, debates, and decision-making processes that have been used as strategies to continually deal with environmental changes and hazards. When this memory is stored within institutions, it is called institutional memory or a knowledge system, or reservoir, of long-term social-ecological adaptation to change (Berkes & Folke, 2002). Finally, community self-organisation connotes an informal governance system in which diverse actors are knitted together across organisational levels to focus on common problems

(Folke et al. 2005). In climate vulnerability management, communities can organise themselves with or without external help, to respond to hazards resulting from geophysical changes.

In this paper, adaptive governance is conceptualised as the network of institutions (state and non-state), policy frameworks, programmes, regulations and communication channels that are employed to operationalise the four factors discussed above. In this conceptualisation, institutional arrangements focus on institutions such as Ministry of Works, Water Resources and Housing (MWWRH), Ministry of Local Government and Rural Development (MLGRD), Environmental Protection Agency (EPA), District Assemblies and various civil society organisations (CSOs) at the national and local levels for making and implementing climate intervention policies in Ghana. Participation and collaboration are supposed to be ensured through engagements between these state and non-state institutions and the climate affected coastal communities. In the context of this study, it is expected that over several years of being affected by storm surges, coastal erosion and inundation, the study communities have built on social memory and institutional knowledge through which they cope with, respond and adapt to the adverse effects of climate change. An important manifestation of such social learning and innovation should be the coastal communities' ability to self-organise and respond to climate related hazards.

## Material and methods

### *Research setting - climate change adaptation in coastal areas in Ghana*

The setting of Ghana at the crossroads of three hydro-climatic precincts, according to ITU News (2012), makes it prone to the impact of the El Niño Southern Oscillation, the Inter-Tropical Convergence Zone and the West Africa monsoon. As a result, the country is highly vulnerable to climate change, variability and uncertainty (Agyeman-Bonsu et al. 2008; ITU News, 2012). Ghana's average annual temperature is reported to have increased by 1°C over the past three decades. In addition, available data indicate a sea-level rise of 2.1 mm per year over the past three decades, with projections of 5.8 cm in 2020, 16.5 cm in 2050 and 34.5 cm in 2080 (UNEP & UNDP, 2010). The south eastern coastal belt of Ghana is reported to be the most affected, with many communities at risk of losing their livelihoods, houses and infrastructure such as roads and sea defense walls. Coastal erosion, flooding and shoreline retreat are pronounced along the eastern coast of Ghana, negatively impacting on coastal habitat, biodiversity, and livelihoods of residents. Yet, existing climate change adaptation measures have not been designed to build the capacities of affected communities to change their ecological, social and economic systems to adequately respond to the perceived and actual impacts of climate change/variability events (Cobbinah & Anane, 2016; Sarpong & Anyidaho, 2012; UNEP & UNDP, 2010). Affected communities and residents have not adjusted, to reduce their exposure and vulnerability and even take advantage of climate related occurrences.

Currently, climate change adaptation measures in Ghana, for UNEP and UNDP (2010), are mostly reactionary and hardly address climate change impacts. As a consequence, despite the introduction of the national climate change adaptation strategy in 2010 (UNEP & UNDP, 2010), Cobbinah and Anane (2016) argue that available adaptation measures are ad hoc, unsustainable and often local level initiatives, with limited national government support. Unfortunately, the limited adaptation

measures are directed towards the protection of donor agencies' projects (Cameron, 2011; Sarpong & Anyidoho, 2012). A study by Cameron (2011), using suggestive spending on climate change initiatives in Ghana between 2004 and 2011, estimates only US\$493.6 million in funding for climate change adaptation, which was spent on projects and programmes supported by foreign donor institutions. The government's attitude towards climate change policy initiatives, particularly on local community adaptation, seems to suggest that the reality and severity of climate change impacts have been taken for granted. This paper appraises the extent of vulnerability of poor coastal communities in the Keta municipality in Ghana (see Fig. 1) to climate variability and change; and the effectiveness of adaptive governance mechanisms.

The Keta municipality lies within longitudes 0.30°E and 1.05°E and latitudes 5.45°N and 6.005°N. It is one of the 25 administrative districts of the Volta Region, located in the south-eastern corner of Ghana (see Figs. 1 and 2). The municipality is largely rural, with two-thirds of the population depending on small scale rain-fed agriculture, and a strong linkage between crop farming, livestock rearing, fishing and forestry. With limited livelihood diversification options, the municipality is well known for its vegetable production, especially shallot. The population of the municipality in 2010 was 147,618 in 37,705 households (Ghana Statistical Service [GSS], 2014). Despite the dominance of Ewes (98.7%) – the major ethnic group in Volta Region of Ghana – the municipality has a relatively diverse mixture of people from different ethnic and cultural backgrounds (GSS, 2014).



Figure 1: Geographical location of Keta Municipality



The municipality is ranked high in vulnerability to climate change and variability due to the increasing rate of sea level rise and widespread coastal erosion (GSS, 2014). Out of the total land area of 1,086 km<sup>2</sup>, water bodies cover approximately 362 km<sup>2</sup> (about 30%), with the Keta Lagoon, which is about 12 km wide and 32 km long, being the largest in Ghana (Keta Municipal Assembly, 2018). Other lagoons include Angaw Agbatsivi, Logui, Nuyi and Klomi. Into these lagoons drain many streams (e.g., Angor, Avida, Awafila and Nukpehui) and some tributaries of the Volta River (GSS, 2014). Many of these streams are found in the municipality, although they are dwindling in size due to low rainfall, excessive evaporation and siltation. As a consequence, the quantity of water in the lagoons has considerably dwindled and tends to vary seasonally, leading to the emergence of islands in the Keta and other surrounding lagoons. Considering that communities in the Keta municipality are largely homogenous in terms of socio-economic activities and climate change experiences, this study was conducted in three communities namely Vordza, Atiavi and Dzifa (Fig. 2). These communities are low-lying coastal plains between 1 and 3.5 meters below sea level and experience similar climate change induced hazards such as erosion and storm surges.



Figure 2: Location of case study communities

## Methods

A mixed method research approach was employed for this study (Johnson et al. 2007). This approach relates quantitative data collection methods with qualitative social science-based methods, which often deal with individuals' actions and relationship with local communities (Gentle et al. 2014). This approach was necessary to ensure that data provided are a true reflection of the climate change, vulnerability and adaptation situation in the study area, as it ensured triangulation. Qualitative methods of data collection included: in-depth interviews (n = 2 agency representatives) and focus group discussions (n = 3 events with 36 participants). The in-depth interviews focused on three key issues: (i) institutional or government recognition of the severity of climate change induced vulnerability in the study sites; (ii) institutional responses towards the management of climate change impacts in the study area; and (iii) the usefulness of the institutional or government responses in minimising climate change induced vulnerabilities. The focus group discussions were used to validate individual and agency responses, and further understand broadly local community concerns relating to climate change induced vulnerability and responses. A household level survey (n = 177 respondents) provided quantitative data using questionnaire which were designed using expert knowledge on climate change adaptation and climate vulnerability – for the list of climate change adaptation actions and vulnerabilities which are most commonly practiced and experienced respectively in the study area (see Li et al. 2017). In the questionnaire, household respondents were asked (i) to provide information related to observed changing weather patterns of the past years; (ii) to specify details of changes in climate that affect their socio-economic situation; and (iii) to express their views on their adaptive strategies to climate change impacts.

The primary data were collected through fieldwork in Ghana in March 2018. The fieldwork focused on collecting data at community and municipal levels. The study used a multi-scaled and multiple data collection process. Data was collected at the three case study communities, and at the municipal level in three phases focusing on individuals and agencies related to the research. As shown in Table 1, a household survey was carried out with household respondents to appreciate the degree of climate change induced hazards and impacts across the three selected case study communities. Applying the Slovin's formula:  $n = N / (1 + N(\alpha)^2)$ , where 'n' is the sample size, 'N' is the total number of households, 'α' is the margin of error (0.05), a total sample size of 177 households from the three case study communities were randomly selected for the household survey. The average time for the face-to-face household surveys was 55 minutes. Table 2 shows the characteristics of the community respondents.

**Table 1:** Sample Size Determination

| Case Study Communities | Number of Households | Sample Size |
|------------------------|----------------------|-------------|
| Atiavi                 | 115                  | 89          |
| Dzifa                  | 40                   | 36          |
| Vordza                 | 60                   | 52          |
| <b>Total</b>           | <b>215</b>           | <b>117</b>  |



**Table 2: Socio-economic characteristics of community respondents**

| Community | Sample (117) |        | Education (%) |    |    |    | Occupation (%) |    |     |     |   | Average Monthly Income |
|-----------|--------------|--------|---------------|----|----|----|----------------|----|-----|-----|---|------------------------|
|           | Male         | Female | N             | P  | JH | SH | FS             | F  | SSA | SOB | U | (GHS)                  |
| Atiavi    | 41           | 48     | 12            | 34 | 31 | 23 | 18             | 14 | 51  | 11  | 6 | 201                    |
| Dzifa     | 22           | 14     | 39            | 54 | 5  | 2  | 5              | 19 | 70  | 4   | 2 | 183                    |
| Vordza    | 21           | 31     | 32            | 48 | 15 | 5  | 8              | 18 | 52  | 6   | 2 | 198                    |

N = Never, P= Primary level, JH=Junior High School level, and SH=Senior High School level, FS = Forestry Sector, F = Fishing, SSA = Small Scale Agriculture, SOB = Self Owned Business, U = Unemployed

The second phase focused on focus group discussions (FGDs). Community and opinion leaders from each of the three communities were selected purposively to participate in FGDs, based on their experiences with and interests in climate change induced hazards and impacts, which emerged during the household surveys. Interviews during FGDs were recorded when participants' consent was sought. The average time for the FGDs was between 60 and 120 minutes depending on the community and opinion leaders' interests in the development trajectories of their communities, knowledge of and experience with climate change. As argued by Cobbinah and Anane (2016), the climate change concept is practically foreign to most communities in Ghana. As a result, the research participants were asked to describe their past and ongoing livelihoods and living experiences based on observed changing weather patterns and associated hazards. The meteorological data on temperature and rainfall records (1980 - 2013) were collected from the GEONET Cast Centre of the University of Energy and Natural Resources, Ghana to establish the patterns and dynamics of weather events in the case study area.

The third phase focused on semi-structured interviews with relevant agencies. For the statistical and policy data on climate change in the Keta municipality, semi-structured interviews were conducted with officials of the Keta Municipal Assembly, in charge of the socio-economic and physical development of the Keta Municipality; and the National Disaster Management Organisation (NADMO), responsible for managing disasters and emergencies. The interview conversations were recorded after seeking agency officials' consent and lasted between 45 and 60 minutes. The research findings were verified through FGDs with the community respondents in each of the three study communities in May 2018, and a summary report submitted to the selected agencies. This practice was useful in dealing with any inconsistencies that might have occurred in the data processing and analysis.

## Results

### **Major climate change induced hazards in coastal communities in Keta municipality**

Household respondents were asked to recall and describe the major climate change-induced hazards observed over the past years. Although many climate related hazards were identified, five remained dominant and were considered widespread across the Keta municipality. These were: unpredictable precipitation (reported by 94% of respondents), increasing incidence of erosion (mentioned by 69% of respondents), inundation from sea level rise (reported by 72% of respondents), flood (mentioned by 62% of respondents), and gully formation from short period of, and intense rainfall (mentioned by 48% of respondents). Some community respondents expressed their concerns:

*In this community [Vordza], many of the houses are now swallowed [submerged] by the sea, and the ones here [near to the sea shore] will also be submerged in few years to come if nothing is done about it ...Vordza 6, March 2018.*

*... It is difficult for us here [Atiavi], now I am into selling of water, chewing gum and non-alcoholic drinks [petty trading] along the road because I can't do shallot farming anymore. The time we expect the rain, it doesn't fall, and it falls heavily at periods that we don't expect it. This situation has made agriculture activity in this community unattractive ... Atiavi 18, March 2018.*

Given that communities in the Keta municipality are mostly agrarian and there is relatively poor quality infrastructure (e.g., housing, roads), the major hazards were related to agricultural activity and infrastructure, and the people emphasized the increasing incidence of crop damage from flooding and loss of access to farmlands and forestry resources as well as houses.

Additionally, increasing warming temperatures was reported during the FGDs as jeopardizing the future of farming, fishing and forestry which are the mainstay occupations for the residents in the Keta municipality:

*"Our [Dzifa community] major concern is our economic activity [fishing] ... We all know the weather sometimes becomes very hot [warm] that we have to stay outside our rooms in the night. The fish also feel the same. Because the weather is hot [warm], we don't get the required catch, the fish have gone deep into the sea where the water is not very hot [warm]. Even we as humans complain when the weather is hot..." Dzifa FGD, March 2018.*

*"Because of the warm weather [temperatures], bushfires are common, and this destroys our trees..." Atiavi FGD, March 2018.*

In such situations, the survival of the communities is also threatened. The perspectives on changing climate expressed by the community respondents and community leaders in relation to changing precipitation and temperature was compared with the meteorological data (1980 - 2013) from the GEONET Cast Centre of the University of Energy and Natural Resources, Ghana. The analysis

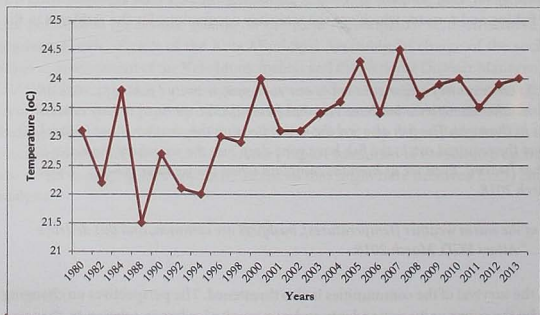
shows that while both mean annual maximum and minimum temperatures are gradually increasing, precipitation is highly variable (see Figs. 3 and 4, and Table 3). The most vulnerable livelihood resources mentioned by the community respondents were vegetable (shallot) cultivation (68%), growing of other vegetables (36%), increasing salinity of water resources (52%), and loss of and/or less fertile farmlands (61%). The quote below is representative of the frustrations expressed by the communities during the focus group discussions:

*"We [Vordza community] can't do farming in this community as we used to about 20 years ago. There are no enough farmlands due to inundation by the sea and the lake and even the one available is no more fertile because of continuous cultivation. At first, we used to produce shallot and other vegetables for markets in cities like Accra and Kumasi but now production has reduced considerably ..."* Vordza FGD, March 2018.

The environmental change emerging through climate change and variability inflicts harsh and extreme environmental conditions on small scale farmers and creates negative consequences on their living conditions, making their survival uncertain. For instance, community respondents in Vordza (61%) and Atiavi (57%) mentioned that their agricultural investment in the form of crop farming was washed away by floods in 2012:

*In 2011, I went for a loan from the Credit Union to support my shallot cultivation [crop farming]. Just as I was about to harvest my crops, we had a very severe flood and all my crops were washed away... If it hadn't been my cousin living in Accra who settled my loan debt, I would have been in jail by now ...* Atiavi 12, March 2018.

*"... Living in this community is pleasant anymore especially if you are farmer like me. You can expand your farm because of limited land, your output also keeps declining because of unpredictable weather conditions, and the banks will take you to court if you default in loan repayment ..."* Vordza, 8, March 2018.



**Figure 3:** Variation of average annual minimum temperature in the Keta Municipality (1980-2013)

Source: GEONET Cast Centre, University of Energy and Natural Resources, Ghana, 2014.

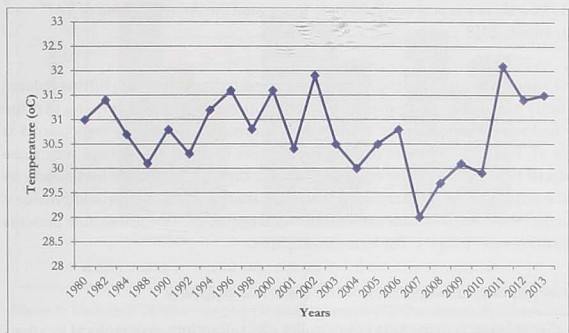


Figure 4: Variation of average annual maximum temperature in Keta municipality (1980-2013)

Source: GEONET Cast Centre, University of Energy and Natural Resources, Ghana, 2014

Table 3: Annual Rainfall Pattern of the Keta Municipality, Volta Region (1980-2013)

| Year | Annual Total Rainfall (mm) |
|------|----------------------------|
| 1980 | 737.4                      |
| 1985 | 821.3                      |
| 1990 | 803.9                      |
| 1995 | 805.0                      |
| 2000 | 822.3                      |
| 2005 | 749.2                      |
| 2010 | 802.7                      |
| 2013 | 734.2                      |



Findings from this research indicate that the severity of major climate change induced hazards is experienced by poor households that derive their subsistence from natural resources and small-scale rain-fed agriculture. As presented in Table 2, the majority of the community respondents have a low level of formal education and low income and are mostly women. As a result, across the three case study communities, women small scale farmers (52%), fishermen and fishmongers (14%) and forestry workers (34%) repeatedly mentioned and discussed these major climate change induced hazards, which they said were making their livelihood difficult:

*"I am vegetable farmer in this community, but the truth is that I am very poor. I can't plan my farming season anymore due to uncertain weather conditions. In fact, I am struggling to survive ..."* Dzifa 2, March 2018.

*"I learnt this trade [fishing] from my father but now I can't pass it on to my children because it is no more lucrative and attractive. You will toil all night and have very little catch. How do you expect my children to live a good life doing this kind of job?"*  
Vordza 21, March, 2018.

Unfortunately, these households often depend on poor traditional technology, which further reduces their adaptive capacity and compound poverty. In such a situation, it is unsurprising that the household survey findings indicate that the average daily income of community respondents is below US\$ 2 (Table 2). While the future of the municipality lies in the ability to cope with these climate change induced hazards and realise opportunities that support sustainable livelihoods, an understanding of the extent of climate change impacts in the study communities would provide a clearer picture as to the effectiveness of both national and local responses. The next section presents findings on impacts of climate change in the Keta municipality.

### ***Climate change impacts and responses in the Keta municipality***

The major climate change impacts in the Keta municipality affect all sectors, geographical locations and residents differentially, depending on the extent of the individual and collective vulnerabilities. The study reveals that community vulnerabilities to climate variability and change are directly related to their exposure to the impacts of sea erosion, flooding and occasional cases of droughts. As a result, the economic, social and infrastructural strengths of the affected communities are severely impacted, with cumulative consequences on the survival of residents. On the economic front, the majority of community respondents reported that their agricultural activities have suffered considerable setbacks in recent times due to climate related hazards (Fig. 5). As discussed in Section 4.1, the agricultural sector remains the largest employer in the Keta municipality in particular and Ghana as a whole. In this case, it is understandable that the increasing variability and unpredictability of rainfall was reported by the community respondents and emphasised by community and opinion leaders as increasing the risk associated with farming:

*Every farmer in this community [Atiavi] is complaining about poor yield and debts. For the past about five years or so, farming in this community has become a lottery, you plant with the hope that the rain will fall which in most cases it doesn't. But previously, we could tell when the rain will fall and when the sun will shine. It is difficult for us here now. The government should come to our aid ..."* Atiavi FGD, March 2018.

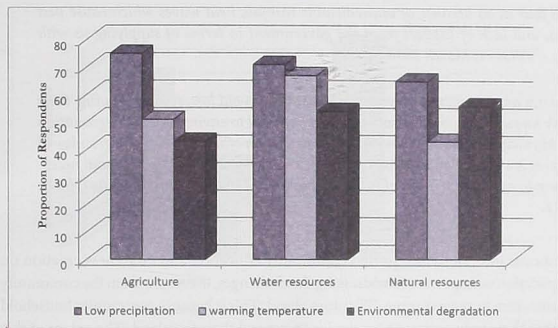


Figure 5: Impacts of climate change on economic resources in the case study communities

Another economic impact of climate change discussed by the community respondents relates to water resources. Findings from the household Survey show that residents of the study communities in Ghana are particularly worried about saltwater intrusion without centralised water management systems. This situation according to the community respondents (73%) has deprived them of access to potable water for both domestic and commercial uses. Others (21%) linked declining agricultural income and cases of malnutrition and poor health in the case study communities to limited access to potable water supplies, which they related to changing weather conditions. Unfortunately, institutional interview data indicate that there is no current intervention to deal with saltwater intrusion:

*"Some communities in the municipality have reported this issue [saltwater intrusion] to us [Municipal Assembly]. But, currently as an Assembly, there is no immediate project or plan to address the saltwater intrusion situation. But it is something that the Assembly is working hard to get support in the form of funds and other logistics to deal with it ... Municipal Development Planning Officer, March 2018.*

Additionally, interviews with officials of relevant institutions and FGDs revealed a different dimension to the economic impacts of climate change. According to the agency representatives, climate change and variability are impacting on natural resources in the municipality through a reduction in biodiversity caused by increasing cases of droughts and unsustainable harvesting of natural resources to support local livelihood. Natural resource degradation resulting from climate change has negative implications for economic development because such resources serve as sources of food, income, tourism, foreign exchange and biodiversity necessary for effective functioning of the ecosystem. Unfortunately, the agency officials and community respondents reported that recent changing weather events have resulted in intensified small-scale rain-fed agriculture, leading to natural resource depletion:

*"I used to farm on four acres of land before the year 2000. Since that time, my output has been declining so I expanded my farm to increase my output. As I speak to you know, I farm on a seven acre now but the output is not different from the time I used*

*to farm on four acres because of unpredictable rainfall, heat waves which cause pest infestations, and lack of support from the government in terms of supplying us with fertilizers ....”* Atiavi 1, March 2018.

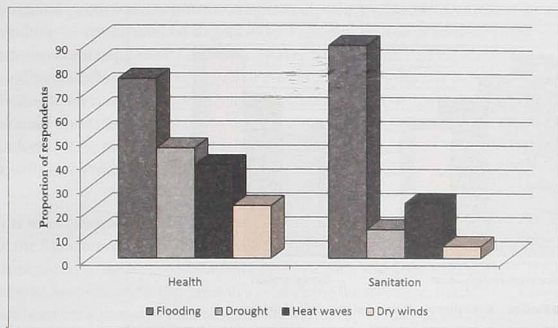
*“We are aware of some farmers trying to break even [avoid losses] by expanding their farms ... We know this method is not ideal as it can lead to environmental degradation ... So, we [Municipal Assembly] have involved extension officers and other agricultural experts to provide education to farmers on how to maximise production without necessarily having to expand their farmland...”* Municipal Development Planning Officer, March 2018.

Although the institutional interviewees reported community education and awareness creation on natural resource degradation as important in addressing the challenges, the results from the community household respondents seem to suggest some difficulties ahead. This is because community household respondents argue that their only option to survival is to expand their farmland. The extent of this situation was revealed when 42%, 28% and 38% of respondents in Atiavi, Vordza, and Dzifa reported that they had expanded their farmlands.

The social impacts of climate change, as reported by the community respondents, relate to the health and sanitation sectors which continue to experience duress. As illustrated in Figure 6, the community respondents explained climate change impacts on the health sector in relation to flooding, drought, heat waves, and dry and warm winds. These factors, according to the community respondents, have interacted to cause increasing cases of water, air and food borne diseases. Complicating matters further are the widespread insanitary conditions in Ghana. The majority of the respondents explained that given the poor sanitation conditions in the Keta municipality, coupled with recent flood incidents, there is a rise in cases of malaria and cholera, while increasing heat waves are raising fears of cerebrospinal meningitis:

*“We are also part of the problem that we are facing ... We litter our streets and sometimes dump waste [solid waste] in gutters [drains]. What do we expect when these unexpected rains come? I think as a community we will continue to experience many cases of malaria and cholera until we change our attitude towards the environment...”*  
Dzifa FGD, March 2018.

Emphasizing the extensiveness of the social impacts of climate change across Ghana (Fig. 6), the NADMO official indicated that in northern Ghana, for instance, there are incidences of guinea worm infection in some communities owing to climate change induced limited potable water supply. In this sense, the negative social impacts from climate change are not only limited to the Keta municipality but have widespread implications across Ghana. The institutional representatives emphasised that community training and education were part of ongoing efforts to minimize the social impacts, which the community respondents confirmed but indicated that the interventions are concentrated in the Keta Township where the municipal assembly is located.



**Figure 6:** Social impacts of climate change on case study communities

In addition to the economic and social impacts, climate change in the Keta municipality is impacting on local infrastructure such as roads, houses, drains and all other structures that sustain human survival. Household survey findings revealed that climate change induced hazards such as flooding, rainstorms, and strong winds are becoming ever more frequent and unpredictable. Although the Keta municipality is one of the under developed districts in Ghana with limited infrastructural facilities, what little is available is subjected to the effects of intense climatic impacts, particularly flooding. According to most community respondents (85%) and community and opinion leaders, important infrastructural facilities, particularly roads in the Keta municipality are unable to withstand the shocks of recent climate change impacts. This perspective was emphasised by the institutional officials who indicated that major infrastructure such as roads remains the responsibility of the national government, as the local government does not have adequate resources to undertake such projects or carry out major repair works.

While the impacts of climate change on infrastructure seem severe, the threat of coastal erosion aided by rising sea levels was mentioned and extensively discussed by both community respondents and agency officials as destroying coastal communities, sweeping in its path millions of dollars' worth of infrastructure (e.g., roads, houses etc.). As illustrated in Fig. 7, community respondents strongly believe coastal erosion from sea level rise and infrastructure destruction from flood and other related events are major impacts associated with climate change.



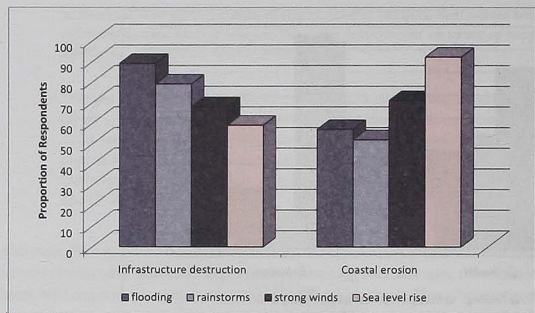


Figure 7: Climate change impacts on local infrastructure in coastal communities

## Discussion

As indicated earlier, most studies on climate variability and change in Ghana have not paid attention to the internal dynamics of communities' vulnerability and emerging policy and structural interventions. Findings from this study were intended to draw attention to these critical subjects. Thus, the study points to increasing climate vulnerability in communities in the Keta municipality. The meteorological data show unpredictable rainfall and warming temperatures with the resultant extensification of farmland for small-scale agriculture. This finding is consistent with the UNEP and UNDP's (2010) projection of a reduction in total precipitation with a high degree of variability in the foreseeable future with devastating impacts on the livelihoods and survival of Ghanaian communities. Similar findings were reported by Cobbinah and Anane (2016), who found that rural communities in the Brong Ahafo region of Ghana are expanding their farmlands as a strategy to break even and maintain their normal productivity level. Thus, with the predominance of small-scale rain-fed agriculture in the Keta municipality, any adverse changes in precipitation and temperature patterns would have dire consequences on productivity. Unfortunately, efforts to tackle climate change in Ghana (Keta) and elsewhere in Africa have frequently focused on mitigation (e.g., reducing carbon emission), with limited attention to local level impacts and adaptation (e.g., coping measures of vulnerable societies) (IPCC, 2007; Sarpong & Anyidaho, 2012; Stainforth et al. 2007).

It has also been revealed that the intensity and impacts of climate variability and change in the Keta municipality have far-reaching implications for national development. These implications are in the areas of community protection, provision of life-saving infrastructure and the sustenance of local livelihoods. These implications are to adequately respond to the many geophysical (e.g., sea level rise) and structural (poor infrastructure) causes found to be responsible for risks and exposure of communities to the impacts of climate change. As discussed in Section 3.2, the intensification of coastal erosion, coupled with the reclamation of land from the Keta lagoon, is pushing some households in the municipality to live on insecure and marginal lands. Similarly, historical-

ly natural pristine environments are gradually being subjected to small scale rain-fed agriculture, resulting in environmental degradation. Presently, access to potable water, good sanitation and infrastructure (e.g., roads) in the study area has been affected primarily because these infrastructural facilities have been destroyed or cut-off from residents due to the incidence of flooding. This finding lends credence to previous work (UNEP & UNDP, 2010) that found that recent changes in weather events are impacting on the availability of water resources and community infrastructure. Unfortunately, in Ghana, and many African countries, in infrastructure design consideration is not usually given to climate risk.

It is worth mentioning that the impacts of climate change are not the only causes of vulnerability in the Keta municipality. It is true that recent and perhaps the largest sea defence project in Ghana constructed in the Keta municipality between 2001 and 2002 with the aim of halting rapid coastal erosion has reduced further erosion by stabilising the shoreline. In addition, a flood control structure has been constructed to protect residents within the vicinity of Keta lagoon from extreme flooding conditions, and more land has been reclaimed from the lagoon in Keta, Vordza and Kedzi, for rebuilding houses and businesses lost to sea level rise (Dredges, 2000).

Yet, the community respondents reported several cases of recent flooding and increased erosion, which they believed are results of climate change. The unwillingness of the government, both local and national, to initiate and implement climate change adaptation schemes that reflect the aspirations and needs of the communities remains a major challenge. For example, despite the preparation of Ghana's national climate change adaptation strategy by the UNEP and UNDP in 2010, its implementation has remained a challenge. Though the national climate action policy strategy has been influenced by international funders, there is no evidence of plans to localise and actualise these strategies. This may explain Sarpong and Anyidoho's (2012) claim that climate change adaptation policy measures in Ghana are prepared to increase Ghana's funding opportunities rather than to support local resilience.

The aforementioned researchers argue that Ghana's policy commitment to climate change is underpinned by two principles. The first is the recognition of climate change as a global problem that requires actions from all countries, especially those in sub-Saharan Africa because of their high vulnerability to the impacts of climate change. Thus, Ghana is only playing its part in extenuating the global problem. The second viewpoint suggests that Ghana's interest in climate change is influenced and dominated by international actors who provide funding for climate change policy initiatives. Thus, climate change has been related to other development issues (e.g., HIV/AIDS) where governments of developing countries depend on donors or development partners for direction and support.

Within such a context, it is not surprising that the 2010 national climate change adaptation strategy of Ghana, prepared and funded by international organisations (e.g., UNEP, UNDP) appears lacking in local plans and actions. This situation underlies the extent of the government's unresponsiveness to climate change impacts in Ghana. This research shows that there is limited country-level direction from the central government and active participation of local communities, especially in areas such as Keta that are impacted by climate change. It is therefore expected that the local communities will have low adaptive capacity, particularly in the areas of learning and innovation, participation and collaboration.

The research findings seem to suggest that the impacts of climate change are exacerbating the vulnerability of poor coastal communities that are already faced with limited livelihood options, inadequate and poor state of infrastructure and persistent poverty. The findings also support the view that it may not be possible to address climate change vulnerability of communities without addressing all the four critical issues related to adaptive governance, policy and implementation, as these issues remain a major obstacle in the march towards sustainable adaptation to climate change impacts in Ghana. This finding has practical implications for climate change adaptation planning and implementation, considering the different geographical enclaves, the different categories of people and their socio-economic inclinations and the scale of exposure to climate change induced hazards.

Climate change and its associated impacts and vulnerability outcomes are by no means simple and unchallenging. A strong local and national government commitment and regular local level consultation, in relation to building capacity, providing local knowledge and enriching local support, are fundamental conditions in responding to the impacts to climate change now and in the future. Achieving these fundamental conditions has the potential to ensure effective adaptive governance by creating opportunities for learning and innovation in the local communities, ensuring effective functioning of institutions, particularly state institutions in the area of climate change, opening platforms for local community engagement and collaboration on climate change adaptation interventions, and promoting self-organisational efforts amongst the local communities.

## Conclusions

This paper sought to provide local context understanding of the extent of community vulnerability to, and current interventions for managing climate change impacts, using the Keta municipality in Ghana as a case study. The paper concludes that the local communities in the Keta municipality of the Volta Region of Ghana are already experiencing impacts of climate change and variability. The small scale rain-fed agriculture is mostly impacted by various climate change induced hazards. The erratic rainfall, increasing trend of drying water resources, environmental degradation, warming temperatures and increasing coastal erosion show that the livelihoods and survival of residents in coastal areas of Ghana, particularly Keta municipality will become more challenging in the face of changing climatic conditions. The findings presented in this article provide empirical evidence from a context where there is dominance of traditional knowledge on climate change vulnerability and impacts over conventional knowledge.

The research findings confirm that coastal communities in poor developing countries are most affected by the impacts of climate change. Although climate change vulnerability is widespread across Ghana and many developing countries, overall vulnerability varies according to location of communities, occupation, gender, and availability of support, in terms of capacity building and local knowledge. These differences were due to higher sensitivity of the poor to the impact of coastal livelihoods on the environment and natural resources, and lower adaptive capacity in terms of limited livelihood diversification strategies and limited infrastructure.

However, within the framework of adaptive governance, the findings show limited evidence of adaptation. Lack of access to climate change information and infrastructure services, and over reliance

on natural resources and the environment remain major determining factors causing vulnerability in Ghana. This situation weakens the institutional arrangements, limits opportunities for learning, innovation and self-organisation, and further prevents participation and collaboration. The findings provide further evidence and ground realities to the claim that climate change is occurring in Ghana, with dire consequences on various sectors of the economy. In the Keta municipality, major climate change impacts relate to economic, social and infrastructural cohorts. The finding has an implication for the national climate change adaptation strategy in Ghana recently developed by the UNEP and UNDP which, although it provides measures for responsibly adapting to climate change hazards and impacts, has effectively ignored the notion of local level implementation in terms of responding to vulnerability and the degree of climate change impacts in poor communities. Therefore, although the national climate change adaptation strategy was prepared in 2010, until now, local communities, particularly coastal communities continue to experience the increasing threats of climate change impacts. This situation highlights the weakness of the institutional arrangement in promoting adaptive governance in the local communities. Similarly, there is limited opportunity for learning and innovation as the local communities continue to use poor traditional farming technology in the face of declining and unpredictable precipitation.

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