Article:
Yiran, GAB and Stringer, LC orcid.org/0000-0003-0017-1654 (2017) Adaptation to climatic hazards in the savannah ecosystem: improving adaptation policy and action. Environmental Management, 60 (4). pp. 665-678. ISSN 0364-152X

https://doi.org/10.1007/s00267-017-0901-9

Title: Adaptation to climatic hazards in the savannah ecosystem: improving adaptation policy and action

Abstract: People in Ghana's savannah ecosystem have historically experienced a range of climatic hazards that have affected their livelihoods. In view of current climate variability and change, and projected increases in extreme events, adaptation to climate risks is vital. Policies have been put in place to enhance adaptation across sub-Saharan Africa in accordance with international agreements. At the same time, local people, through experience, have learned to adapt. This paper examines current policy actions and their implementation alongside an assessment of barriers to local adaptation. In doing so it links adaptation policy and practice. Policy documents were analysed that covered key livelihood sectors which were identified as climate sensitive. These included agriculture, water, housing and health policies, as well as the National Climate Change Policy. In-depth interviews and focus group discussions were also held with key stakeholders in the Upper East Region of Ghana. Analyses were carried using thematic content analysis. Although policies and actions complement each other, their integration is weak. Financial, institutional, social, and technological barriers hinder successful local implementation of some policy actions, while lack of local involvement in policy formulation also hinders adaptation practice. Integration of local perspectives into policy needs to be strengthened in order to enhance adaptation. Coupled with this is a need to consider adaptation to climate change in development policies and to pursue efforts to reduce or remove the key barriers to implementation at the local level.

Keywords: Adaptation; Policy action; Multiple climatic hazards; Savannah ecosystem

Authors Information

Gerald A. B. Yiran, PhD (gyiran@ug.edu.gh) corresponding Author

Senior Lecturer, Department of Geography and Resource Development, School of Social Sciences, University of Ghana.

Lindsay C. Stringer, PhD (L.Stringer@leeds.ac.uk)

Professor, Sustainability Research Institute School Earth and Environment, University of Leeds.

1. Introduction

Projections indicate the Earth will continue to get warmer during the 21st century (IPCC, 2014), with climate variability and change (CVC) interacting with several other pressures and stresses that affect people's lives (Stringer et al, 2010). While all the key climate models project temperature rises until the end of 2100 over West Africa, projections for rainfall are mixed showing rainfall decreases at the beginning of the rainy season and increases towards the end (Biasutti and Sobel, 2009; Biasutti et al., 2009; Seth et al., 2010). Similar mixed results on rainfall were obtained by Stanturf et al. (2011) when they ran all 16 ensembles of the atmosphere-ocean coupled global climate models (AOGCMs) under three of the Special Report on Emissions Scenarios (SRES) emissions scenarios (B1, A1B2 and A2) over the region.

In Ghana, mean annual temperatures have risen by about 1°C since 1960, with a more rapid increase in the Guinea and Sudan savannas of Northern Ghana (Minia, 2008). Dry season mean temperatures are projected to rise by about 3°C by 2080, especially in Northern Ghana (Minia, 2008). Rainfall however, has been highly variable since 1960, with a downward trend (Nkrumah et al., 2014). In the Guinea and Sudan savannahs, while temperature is increasing and projected to increase, projected precipitation shows both increases and decreases. Decreases range between 25% and 28%, while increases range between 24% and 32% in wet season rainfall (Stanturf et al., 2011). The projected decrease in the early part of the rainy season implies high likelihood of frequent and intense droughts/dry spells and a small delay in the monsoon season, whereas intensification of late-season rains implies high likelihood of frequent floods and heavy rainfall events. These climate hazards (high temperatures, dry spells/droughts, heavy rainfall, floods and windstorms) are already occurring in the savanna ecosystem of Ghana and affecting the livelihood and socio-cultural settings of the population (Stanturf et al., 2011; Antwi-Agyei et al., 2012; IPCC, 2014; Yiran and Stringer, 2016). Yiran (2014) showed that the people in the

savanna ecosystem are not able to adapt effectively to current climate challenges, leading to high vulnerabilities. Projected increases in frequency and severity of these climatic hazards will most likely exacerbate vulnerabilities if proactive adaptation measures are not put in place.

Adapting and responding to CVC is imperative (Nelson et al., 2007) as impacts are inevitable. Adaptation to CVC has been seen as necessary for poor countries and communities, especially those in sub-Saharan Africa, where nations contribute very little to the global greenhouse gas emissions yet suffer the brunt of climate risks (Ludi et al., 2012). There is nevertheless a serious climate change adaptation policy gap in the African continent (Mburia, 2015). While many of Africa's Least developed Countries have developed National Adaptation Plans of Action (NAPAs) under the United Nations Framework Convention on Climate Change (UNFCCC) (Stringer et al., 2010), and these are gradually being implemented (Moors et al., 2011), Ghana, like many low middle income to middle income countries was not required to prepare a NAPA. Instead, the country operated with development policies geared towards achieving the Millennium Development Goals (MDGs) and now the Sustainable Development Goals (SDGs) (Yiran, 2014). These goals have targets which countries translate for specific sectors. However, the MDGs/SDGs cannot be achieved without reference to adaptation to climate change because most sectors in Ghana that support livelihoods, such as agriculture, health, housing, water, roads, energy are climate sensitive (Yiran and Stringer, 2016). Until recently (when Ghana developed a climate change policy which is yet to be implemented), Ghana's policy adaptation actions were derived from actions linked to these sectoral policies while local people developed their own autonomous adaptations to tackle CVC. The implementation of policies and the ways in which they interact with local autonomous adaptation actions in many countries has been met with a number of challenges that can be described as barriers (e.g. Urwin and Jordan, 2008; Ekstrom et

al., 2011). Understanding these barriers and their links to practice remains an important knowledge gap.

Recognition that barriers can be surmounted and that there is an urgent need to adapt, has motivated a growing body of research into this area (e.g., Adger et al. 2009; Ekstrom et al., 2011; Moser and Ekstrom, 2012; Antwi-Agyei et al., 2014; Islam et al., 2014). Nevertheless, much still remains to be learned (National Research Council, 2009). For example, Islam et al. (2014) identify a lack of knowledge about the interactions between barriers and stress that little is known about how these interactions affect the wellbeing of smallholder communities. Antwi-Agyei et al. (2014) also note that the focus on types of barriers by many studies in sub-Saharan Africa do not show how the barriers interact at different levels to influence adaptation.

Besides the focus on barriers, several studies on the gaps between the development of adaptation policy and its implementation have emerged in the last few decades (IPCC, 2014). These studies concern policy development/implementation (e.g. Dovers, 2005; Corfee-Morlot et al., 2011; Howlett and Giest, 2013), policy analysis (e.g. Urwin and Jordan, 2008; Dunn, 2012; Dupuis, 2013), provide policy reviews (e.g. Ford, 2008; Jordan and Lenschow, 2010; Dazé and Echeverría, 2016; Mensah et al., 2016) and offer policy conceptual and methodological frameworks (e.g. Gupta, 2012; Bauer and Knill, 2014; Vogel and Henstra, 2015). Many of these demonstrate challenges associated with the interaction or interplay of policy at different scales, horizontal or vertical (Young, 2002; Adger et al., 2005; Urwin and Jordan, 2008). Nevertheless, it remains critical to examine the interaction between policies and practices at the micro level where policies are implemented. This is especially vital in sub-Saharan Africa (SSA) where such studies are limited, policies largely do not target adaptation to CVC, and where resources and knowledge are lacking in relation to the expected CVC impacts (IPCC, 2014). Further, very few

studies have explored barriers to policy implementation sector by sector, let alone linking this to the interplay between policy and local practices. The questions we therefore ask are: to what extent do Ghana's development-oriented sector policies address adaptation to climate change? What kind of interplay exists between the policies, and between policies and local action? What kind of barriers frustrate implementation of these policies and actions?

We begin to address these questions by reviewing sector policies and examine the interplay between national policies and local practices, identifying important areas of both support and conflict, and the barriers to implementation of sectoral policies and local actions. Our findings aid identification of those policy actions that require strengthening, as well as highlighting local practices that could be better integrated into and supported by policy to enhance adaptation to climate hazards. In doing this, we provide a valuable extension to the growing body of literature that has sought to better understand climate adaptation in Ghana (e.g. Stanturf et al., 2011; Antwi-Agyei et al., 2012; 2014; Bawakyillenuo et al., 2014). Our findings will also inform the implementation of policies linked to the SDGs and the national climate policy.

2. Methodology

Although Ghana has a decentralised governance system, most policies are formulated at the national level, in line with international considerations, especially the MDGs (now SDGs) and the country's obligations under the UNFCCC. Those policies targeting sectors identified as highly vulnerable to climatic hazards in the savanna ecosystem (i.e. agriculture, water, health and housing, see Yiran (2014)) were selected for analysis, so as to identify priority areas that can be improved to enhance adaptation. Specific climate policies were also included in the sample. To examine the implementation of the policies and barriers, we selected a region in Ghana where we

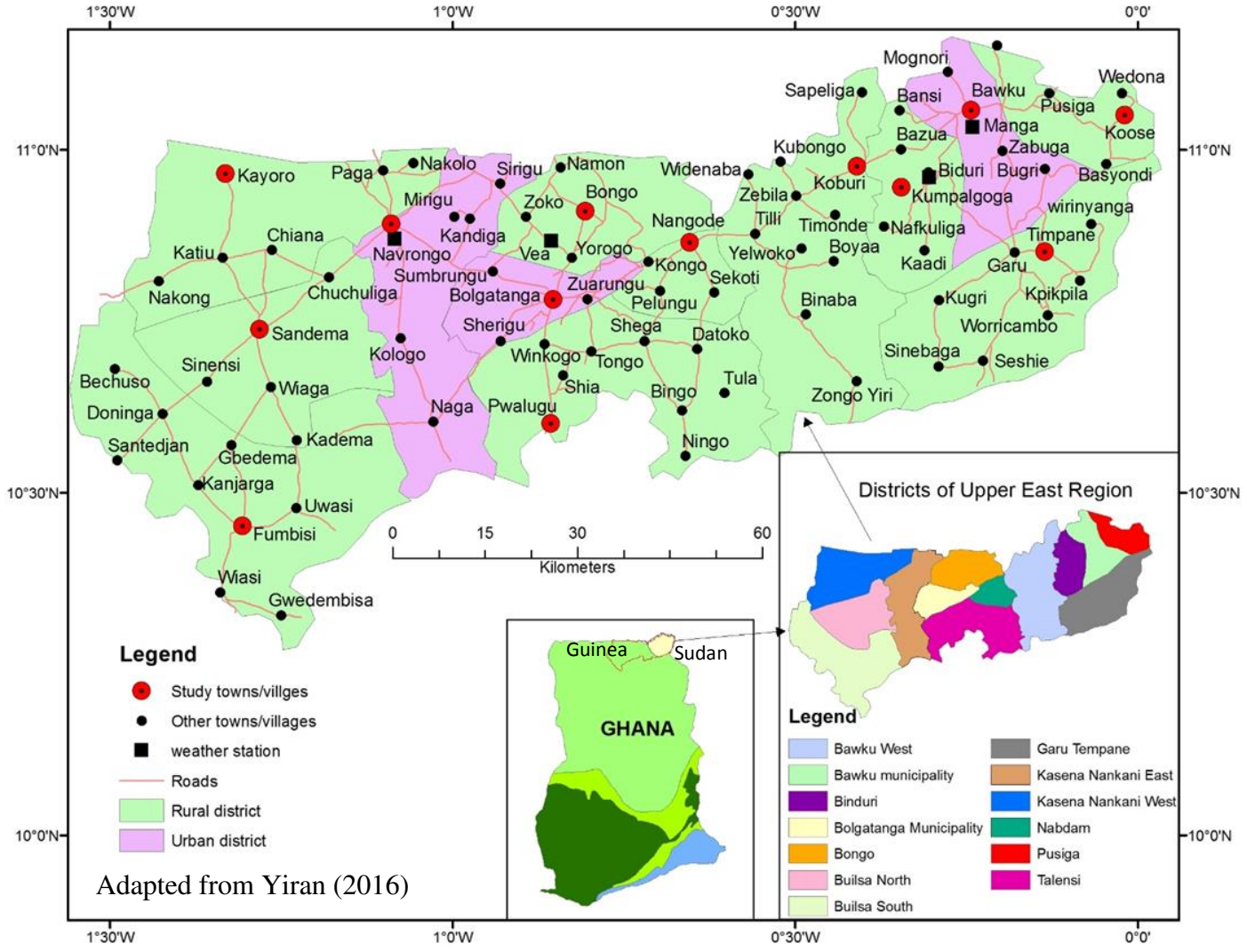
interviewed stakeholders. In the ensuing subsections, we discuss the study area, methods of data collection and analysis.

2.1 Study area

The study area selected was the Upper East Region (UER) (Fig. 1, adapted from Yiran, 2016). Though the savanna ecosystem stretches from latitude 7°N to latitude 11°N, the UER was chosen because it experiences nearly all the climatic hazards that occur in the savanna and receives the lowest rainfall (Logah et al., 2013). The region also has the highest percentage of poverty (90%) in the savanna ecosystem and is the only region with two variant ecological zones of the savanna (Guinea and Sudan, see Fig. 1) (Yiran, 2016). To conduct the focus group discussions and in-depth interviews (described later), thirteen communities were selected using the restricted random sampling technique (Steven and Olson, 2004). The three big towns (Bolgatanga, Bawku and Navrongo) were purposively selected to ensure that varying characteristics of urban areas were captured. A list of all communities in each of the remaining districts was generated. Communities were selected at random but ensuring that no two selected communities were within 10 km from each other. This allowed good spatial coverage of the region. Districts in the region are divided along major ethnic groups and therefore responses from any one community could reflect the generality of the district.

2.2 Methods of data collection

Policy documents from the climate sensitive sectors mentioned above as well as information from stakeholders were collected from the institutions responsible for implementing such policies.



Adapted from Yiran (2016)

147

148 **Fig. 1 Map of the study area**

149 More than 90% of the documents were downloaded from the institutional websites. Policy
150 documents include the National Climate Change Policy (NCCP) (2014), the Food and
151 Agricultural Sector Development Policy (FASDEP II) (2007) and its programmes and action
152 plans including the Medium Term Agricultural Sector Investment Plan (METASIP) (2009), the
153 Health Sector Policy (2007), the Housing Policy (2014) and the Water Sector Policy (2007).

154 Focus group discussions (FGDs) and in-depth interviews (IDIs) were held with community
155 members and institutional representatives (officials). Participants in FGDs comprised males and
156 females from age 18 upward who were economically active (Ghana Statistical Service, 2013).
157 We held one FGD in each community. We ensured we included a wide mixture of participants,
158 including people with different backgrounds, ranging from those who have experienced at least
159 one of the hazards and/or have knowledge of climate change, community leaders, rich/poor,
160 professionals and educated/non-educated. This made the number of participants in the meetings
161 range between 10 and 15 but this was manageable and comparable to other reports in the
162 literature (see Fern, 1982; Krueger and Casey, 2009). These people were identified following
163 initial meetings with opinion leaders in which the diversity of the communities was discussed.
164 We explained to participants that no point raised was irrelevant provided it related to climatic
165 events, helping to ensure a congenial atmosphere and fruitful discussions. The initial intention
166 was to hold a FGD in each district (in selected communities in Fig. 1). However, after five FGDs
167 (one in an urban community (Navrongo) and four in rural communities (Bongo, Koore,
168 Kumpalgogo and Tempane)), the information being obtained was almost the same. According to
169 Rebar et al. (2011), if after the 4th FGD, no new information is being added, then the discussions
170 are assumed to have reached a saturation point and the FGD process should end.

171 For the IDIs, six individuals, drawn from similar backgrounds as the FDGs, were interviewed
172 in each study community. Participants in IDIs were identified during FDGs so interviewees were
173 not part of the FGDs. In communities where FDGs were not held, discussions with the Assembly
174 member, Chief and his elders during the community entry stage identified participants for the
175 IDIs. Also, twenty-five institutions drawn from both government institutions and NGOs in the
176 region that engage in climate related issues were contacted for IDIs. These included the district
177 offices of Ministry of Food and Agriculture (MOFA), National Disaster Management
178 Organisation (NADMO), Ghana Irrigation Development Authority (GIDA) and NGOs who were
179 collaborating with these government agencies. An interview was also held with the regional
180 NADMO Coordinator. Efforts were made to interview officials of Community Water and
181 Sanitation Agency and Ghana Red Cross Society but these attempts proved futile. However,
182 interviews with cognate institutions, the regional NADMO coordinator and the residents
183 provided insights into the activities of these institutions. Officials of the agencies were
184 considered as experts as well as policy implementers.

185 **2.3 Data analysis**

186 Until the promulgation of the NCCP, which was launched in 2014, climate responses in Ghana
187 were tied to the development agenda, which was driven by sectoral policies. Thus, these policies
188 were reviewed to see the extent to which they supported adaptation and to identify possible
189 weaknesses. We also compared policy implementation and local actions to examine possible
190 areas of reinforcement/conflict. Gaining the perspectives of local actors (policy implementers)
191 and local people is key in understanding the interplay between policies as well as the links
192 between policies and local actions (see also Urwin and Jordan, 2008).

193 In reviewing the documents, we followed a content analysis approach (i.e. qualitative
194 document analysis) which has been widely used (see WHO, 2009; Huang et al., 2010; Wesley,
195 2010). First, we read through the policy documents to identify themes or focal areas we
196 considered aided adaptation to climatic events. These sections were noted. We then thoroughly
197 read the identified themes or focal areas and their objectives, actions and outputs on identified
198 themes or focal areas were recorded. At this stage, we categorised the themes or focal areas and
199 their programs/actions that address climatic hazards in the study area identified by Yiran et al.
200 (2017). These include droughts/high temperatures and flooding/heavy rainfall events. We next
201 examined the implementation of policy actions and their outcomes by analysing FGDs and IDIs
202 held with community members and officials using thematic content analysis. Here also, the notes
203 were read and analysed to identify actions, following the same procedure adopted for the policy
204 analysis. Activities mentioned in the interviews were grouped into themes. Themes were then
205 labelled as actions and categorised into those that resulted from the implementation of the
206 policies and those that constituted local adaptations. This considered whether the respondents
207 learned the activity or action from extension agents/NGOs, from neighbours or from experience
208 and compared the responses from both implementers and local people. A brief literary
209 description of some of the responses and direct quotations from respondents in the FGDs and
210 IDIs were also made to explain/provide deeper insight into some findings. From the responses,
211 we also identified actions that have been successfully implemented, local good practices, as well
212 as highlighting barriers to implementation.

213 **3. Results**

214 Sector policies are formulated at national level and intended to be implemented at district level.
215 This could be viewed as a top down approach to policy implementation. This section presents the

results of the policy analysis (top-down approach) and the analysis of the focus group discussions and in-depth interviews (bottom-up approach). Presentation of barriers and opportunities that emerge following the analysis of the two approaches then follows.

3.1 Policy content analysis

Four sectoral policies and the NCCP, taken from sectors that were identified as most vulnerable to CVC in the savannah of Ghana, were reviewed. No reference was made to CVC in the health sector policy, while it was referenced once and thrice in in the agricultural sector policy and the housing sector policy respectively. The water sector policy and the Ghana National Urban Policy Action Plan have policy actions that focus on CVC. However, the housing sector policy only has policy initiatives and no actions; it was therefore substituted with the National Urban Policy Action Plan which contained actions for the housing sector. The NCCP programs were more focused on adaptation than mitigation. All policy actions critical for adaptation to CVC are shown in Table 1.

Insert Table 1

Although policy documents were not intended for adaptation, as can be seen in Table 1, the water sector policy and National Urban Policy Action Plan contain actions that support adaptation to CVC. Health and agricultural sector policies have actions that indirectly address adaptation though not expressly stated. Almost every sectoral area has at least one action that has something to do with adaptation, while the housing and water sectors have two focus/action areas dealing with adaptation. The agriculture sector has one that is essential as far as adaptation to CVC is concerned. The NCCP was more specific and has several programs devoted to enhancing adaptation (Table 1). The NCCP also went a step further to budget the programmes

238 and actions and identified institutions within the sectors where such actions can be
239 mainstreamed. It also had a log-frame indicating timelines. This demonstrates the political will
240 and commitment behind the NCCP.

241 **3.2 Interview results**

242 In the interviews with policy implementers and local people, it was realised that some policy
243 actions have been implemented and well received by the actors while some had not. Local people
244 have been adapting autonomously to the climatic hazards and have therefore developed adaptive
245 strategies that they consider successful. Table 2 summarises the findings of the interviews and
246 FGDs with officials and community members in the study area. Although the NCCP had not yet
247 been implemented, some autonomous adaptations were similar actions within the policy.

248 **Insert Table 2**

249 The agricultural sector policy focused on improving productivity. Actions were therefore geared
250 towards tackling challenges that tended to reduce productivity. Officials in the sector observed a
251 high dependency on rainfall which is erratic, and coupled with extreme heat, affects the
252 productivity of crops and livestock. Some agriculture policy actions meant to reduce dependency
253 on rainfall, captured as evidence of implementation in Table 2, were rolled out. Records from the
254 agriculture offices indicate about eight and six drought/heat tolerant varieties of maize and rice
255 respectively have been introduced. Records from GIDA also indicate over 200 dams/dugouts
256 have been constructed throughout UER. Data from Ghana Water Company (GWC) and the
257 Community Water and Sanitation Agency (CWSA) indicate that nearly all towns/villages are
258 served with water from mechanised boreholes, hand pump boreholes or wells except Bolgatanga
259 township, which is served with treated water from the Vea dam.

In all the FGDs and IDIs, farmers (who constituted more than 80 percent[1] of the respondents) confirmed the implementation of these actions. Participants/respondents in 10 out of the 13 surveyed towns/villages pointed to a dam/dugout in their communities that is used for various agricultural activities. Use of groundwater through hand dug wells was also practiced by farmers in river valleys and areas where it is easy to access groundwater. A young male famer in Kumpalgoga noted: "I usually dig a shallow well in the riverbed during the dry season to draw water for my crops". All respondents indicated that maize is now the major crop because the new varieties withstand the drought and heat. In relation to water provision and use, all participants in the surveyed towns/villages, except Pwalugu where it is difficult to sink a borehole, indicated there is at least one borehole and/or well which has been constructed by CWSA or an NGO. Most of these water points are fitted with receptacles to collect waste water for animals.

The health sector policy actions largely addressed the general wellbeing of the people and thus respond to CVC related health issues. All respondents observed that access to health care has improved greatly due to an increase in health facilities over time and the introduction of mobile clinics and the health insurance scheme. Interviews with health workers supported this, as evidenced by a statement from a Community Health Nurse in charge of one of the Community-based Health Planning Services (CHPS) compounds in Talensi district: "Since I came here, I have managed a lot of minor ailments that could have resulted in severe CSM and malaria cases. In fact, I can say that there is improvement in the health status of the people in my catchment area". Before the introduction of the CHPS, the people in these communities had to walk at least 5 km to the nearest health facility. According to this nurse, the people hitherto relied on self-

[1] Because most professionals in the region also engage in farming

281 medication using herbs or drugs (sometimes expired) bought from unprofessional vendors who
282 came to the communities and only reported to a health facility when the case was out of control.

283 With regards to the housing policy, very little was seen on the ground as houses continued to
284 be built in flood prone areas. This can be deduced from the sentiments of five participants in the
285 FGD in Navrongo. These participants live in a valley and explained how they now witness more
286 frequent and severe flooding in the area because water courses have been built on. Similar views
287 were expressed in the IDIs in Bolgatanga and Bawku with people living in or near valleys.
288 According to these people, they still live there because of lower rent and floods last a few hours.
289 Early warning signals from Agriculture Extension Agents, information service vans and radio
290 were reported to help a lot as people are able to put some safety measures in place to reduce
291 impacts. Family members or neighbours were found to serve as first responders following
292 occurrence of a hazard, particularly in rural communities where aid in terms of food and
293 temporary accommodation for flood victims is urgently/desperately needed. In an IDI with an
294 old lady in Bongo, a victim of rainstorm, she said "I was nearly killed when my room collapsed
295 on me but for the timely intervention of my senior husband's son who rescued me. He
296 accommodated me until my room was reconstructed".

297 **3.3 Barriers to local level adaptation**

298 We found also that the policies and local actions faced challenges. This section presents the
299 challenges to policy implementation, drawing on and extending the types of barriers identified by
300 Antwi-Agyei et al. (2014). First, the climate hazards themselves are considered as they affect all
301 sectors and hinder adaptation to CVC. After that, the analysis is presented sector by sector as
302 summarised in Table 3.

Insert Table 3

In FGDs and IDIs, everybody saw aridity (dry spells/drought and high temperatures) as a major challenge. These events lead to poor crop growth and yield, affect water availability for agricultural and domestic activities and increasing illnesses. Flooding often destroyed household properties, and washed away or submerged crops. Injuries resulting from collapsed structures as well as increasing malaria were reported. Both dry and wet events were reported by officials to pose challenges to poverty alleviation efforts, food security, and increased malnutrition and place financial and logistical burdens on the health sector.

Second, according to officials, insufficient budgetary support and delays in release of funds stalled the implementation of most actions in the policies. Overlapping actions in the sectoral policies were also seen as barriers. Officials stated that in most cases, overlaps led to duplication or non-implementation of interventions. Although the NCCP tried to address this by assigning actions to sectors and institutions, lack of coordination remained problematic. One official, who has read the NCCP, advised that NCCP implementers should constantly engage the other sector ministries, else it will be seen as a policy from another ministry and actions will not be budgeted for. In Navrongo, Tempane, Kubore and Kumpalgoga participants of both FGDs and IDIs (especially farmers, traders and food processors) complained of lack of markets and credit facilities. A young farmer in Tempane said: “I do not have money to buy a watering can, so I sprinkle using a bucket and calabash and that wastes a lot of water, my energy and time”. Various other social, cultural, technological and political barriers were also noted (Table 3). For example, an old farmer in Nangodi said: “I cannot stop farming early millet completely because before harvest, I have to call my ancestors to come and taste the food before I eat. This cannot be done with maize because my ancestors will consider it strange food”. However, we found that

326 the adoption of new varieties and gardening/dry season farming is faster and more widespread
327 amongst the young and educated because >70 % of all respondents below 35 years of age had
328 some form of education and embraced the new technologies.

329

330 **4. Discussion**

331 Our analysis indicates that across all sectors, some policy actions have been implemented or
332 initiated and have been embraced by the people. There are also local adaptations taking place,
333 some of which are supported by policy. Some policy actions have achieved successes because
334 they overlap with local practices. Whereas local adaptations have been reactive to climate
335 hazards in combination with other pressures people face, policy actions have been largely
336 concerned with the broader development framework, framed around the MDGs and now the
337 SDGs. For example, people have been practicing crop/livelihood diversification. This is found to
338 serve as a buffer to shocks and stresses from climatic hazards (Mkwambisi, 2009), but from a
339 policy perspective, such adaptations target multiple MDGs and SDGs. The successes chalked by
340 this particular intervention reinforce Schipper's (2007) statement that adaptation and sustainable
341 development have to take place simultaneously in order to achieve broader developmental goals.
342 This is starting to be recognized in the growing literature on climate compatible development,
343 where development is pursued together with adaptation and mitigation (see Suckall et al., 2014).
344 This recognition is further strengthened by suggestions that the policy setting in which adaptive
345 decisions are taken need to be considered in order to avert them constraining adaptation (see
346 Urwin and Jordan, 2008). The European Union took a key step to integrate adaptation to climate
347 change into all relevant policies about a decade ago (EU, 2006). Such steps remain critical in
348 Africa.

Sectoral policies in our analysis were often developed without reference to other sector policies with similar agendas. This results in interactions between adaptive responses which may undermine some policy actions (Adger et al., 2005). Lack of policy coherence could concentrate projects in certain areas and duplicate results while demanding extra funding, putting a double strain on limited national resources. Another danger is that actions may not be implemented because institutions may think that others may carry out that action. Some of these challenges have also been found to affect adaptation in southern Africa (Stringer et al., 2009) and constitute adverse or negative interactions between policies at the local level (Willows and Connell, 2003; Oberthür and Gehring, 2006). Despite these problems, policies strive to increase productivity and improve human welfare while maintaining the savannah ecosystem's integrity. This kind of interaction could be analogous to what Oberthür and Gehring (2006) term synergy or enhanced adaptation.

Most of the policies we analysed took a top-down approach, being formulated at the national level without the involvement of the actors. They were then brought to the local level for implementation. The evidence of this approach from the interviews was the omission of good practices by local actors that could be reinforced by policy if broader consultation or involvement of most stakeholders had taken place. Farmers take a more holistic approach towards adaptation, evaluating and responding to the range of pressures that affect their livelihoods and well-being. This is noted as a key difference between the dominant sector approach of adaptation within policy compared with reality on the ground. We observed that policy actions that supported or stimulated local practices were quickly adopted locally. For example, increasingly, people are using groundwater extracted largely from wells and riverbeds to irrigate their crops (Yiran, 2014), an irrigation action stimulated by the agricultural policy.

372 UNECA (2011) has observed that there is abundant groundwater distribution (which is resilient
373 to climate variations) across SSA and therefore tapping it can enhance climate change
374 adaptation. The guinea fowl (*Numida meleagris galeatus*), a drought resistant bird, which has
375 been part of the agricultural system has the potential to increase productivity and income (Teye
376 and Adam, 2000; Gono et al., 2013) if given special policy focus. Our FGD participants
377 identified death of keets due to excessive heat and predators and hatching of eggs as major
378 barriers to guinea fowl production, similar to observations by Teye and Adam, (2000). However,
379 some farmers have adopted good practices where keets are kept under the shade of trees with the
380 ground watered to keep the temperature cooler. Policy could help to upscale and roll out such
381 practices for wider beneficial effect.

382 Another key finding is that even though Ghana has ratified most of the climate change
383 agreements, adaptation is yet to be clearly integrated into most sector policies. This, Urwin and
384 Jordan (2008) revealed, is a result of the top-down approach to policy implementation.
385 Insufficient or lack of consultation with the local people may lead to a lack of local acceptance of
386 some actions, especially due to cultural reasons and/or difficulty in implementing them. For
387 example, maize cultivars were initially rejected because maize was not considered "proper food"
388 for dinner and its flour is not used for sacrifices (Yiran, 2014). Amankwah et al. (2012)
389 attributed the unviability of commercialisation of small ruminant production in northern Ghana
390 to cultural value systems. Consultation with people could help to identify ways around these
391 cultural barriers.

392 The NCCP which took a much broader consultative and more bottom-up approach in its
393 design, has most of these sectors, particularly agriculture, water and health, as focus areas.
394 However, its implementation may be challenged because of bureaucratic bottlenecks and lack of

political will. None of the political parties explicitly include adaptation to CVC in their campaign pledges and therefore concentrate on fulfilling those pledges other than adaptation. However, Sova et al. (2014) noted that building the capacity of political parties to include climate adaptation strategies into their manifestos could put the development agenda of the country on a good trajectory. It is worth noting that some of the pledges in the manifestos may indirectly lead to adaptation, but adaptation has to be given equal priority as CVC affects major sectors that support the livelihoods of the people. With the exception of the NCCP, all the other policies did not have timelines for action or budgets, neither did they identify sources of funding for their policy actions. One of the reasons for the lack of timelines is that the actions were statements of intent that were not clearly expressed. These vague actions together with the insufficient budgetary support contributed largely to delays, which according to Stringer et al. (2010), can increase the cost of implementation of interventions and hence increase the costs of adaptation.

Whereas policies focus largely on the development agenda, people are adapting to current climate change challenges. Studies show that the last 3 decades (1983-2012) have been the warmest in the last 1400 years (IPCC, 2014). This period has recorded very high temperatures and uneven distribution of rainfall in the savanna ecosystem of Ghana leading to frequent occurrence of extreme events such as floods, high temperatures, dry spells/droughts, heavy rainfall and windstorms (Yiran and Stinger, 2016). The onset, cessation and cumulated rainfall of the season have also been affected. Our analysis shows that lack of synergy between policy and local action has resulted in ineffective adaptation and the failure of some policy actions to achieve their targets. This calls for strengthening of policy by integrating good local adaptive practices and paying more attention to climatic issues to enhance future adaptations. Research shows that support to local-level adaptation is best achieved by starting with existing local

418 adaptive capacity, and incorporating and building upon present coping strategies and norms,
419 including indigenous practices (Dixon et al., 2014; Bermann et al., 2012). An effective way to
420 ensure that local practices and adaptation to climatic hazards are taken on board in policy
421 development is through the participation of all stakeholders (Stringer et al., 2009). Participatory
422 approaches will also increase awareness of the people of the impacts of climatic hazards and the
423 implications of the use of hazard prone areas (Yiran et al., 2012). As noted by Urwin and Jordan
424 (2008), it is vital to use both approaches, top-down and bottom-up, in the policy formulation-
425 implementation chain.

426 ## 5. Conclusions and recommendations

427 We set out to examine current policy objectives, implementation as well as local adaptations. We
428 found that sector policies are complementary, aimed towards achieving the MDGs and now the
429 SDGs, though with some overlaps and duplication. Some policy actions that were not formulated
430 with adaptation in mind were found to be very relevant for adaptation to climatic hazards. Some
431 policy actions and local practices reinforce each other, though many local concerns and good
432 practices are not taken advantage of and upscaled or outscaled through policy. This is largely
433 explained by the top-down approach to policy development. Thus, the link between policy and
434 local adaptation needs further consideration. Several barriers to the implementation of the
435 policies for adaptation to climatic hazards were noted. As we transition towards the SDGs,
436 adaptation to climate change demands a concerted effort. For policies to achieve their targets and
437 promote sustainable development in the context of climate hazards, they should explicitly
438 consider adaptation and take a participatory approach in their development in order for decision-
439 makers to work towards reducing the barriers.

Specifically, the agriculture sector policy should embrace good local practices, refocus to be climate smart and incorporate continuous education/sensitisation of farmers. Also, irrigation and other rainwater harvesting techniques should be adopted while further research into the sustainability of groundwater for sprinkler irrigation needs to be explored. The health sector policy needs to be implemented without delay, especially those aspects aiming to increase access and reduce cost of healthcare for the poor. We recommend payment of premiums by instalment and increased focus on health educational campaigns. Enforcing legislation, especially regarding land use and building codes, and public sensitization, will reduce exposure to some hazards and enhance adaptation, particularly linked to the housing sector. We further recommend that an adaptation desk be set up to oversee to implementation of the NCCP and other relevant policy actions by the sector ministries.

References

Adger, W.N., Arnell, N. & Tompkins, E. (2005). Successful adaptation to climate change across scales. *Global Environmental Change 15*, 77–86.

Adger, W. N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D., Naess, L., Wolf, J. & Wreford, A. (2009). Are there social limits to adaptation to climate change? *Climatic Change*. 93: 335-354.

Amankwah, K., Klerkx, L., Oosting, S.J., Sakyi-Dawson, O., van der Zijpp, A.J. & Millar, D. (2012). Diagnosing constraints to market participation of small ruminant producers in Northern Ghana: An innovation systems analysis. *NJAS - Wageningen Journal of Life Sciences 60– 63*:37–47

Antwi-Agyei, P., Dougill, A.J. & Stringer, L.C. (2014). Barriers to climate change adaptation: evidence from northeast Ghana in the context of a systematic literature review. *Climate and Development*. DOI:10.1080/17565529.2014.951013

Antwi-Agyei, P., Fraser, D.G., Dougill, A.J., Stringer, L.C. & Simelton, E. (2012). Mapping the vulnerability of crop production to drought in Ghana using rainfall yield and socioeconomic data. *Applied Geography, 32*: 324-334. www.elservier.com/locate/apgeog.

Bawakyillenuo, S., Yaro, J.A. & Teye, J. (2014). Exploring the autonomous adaptation strategies to climate change and climate variability in selected villages in the rural northern savannah zone

469 of Ghana, *Local Environment: The International Journal of Justice and Sustainability*, DOI:
470 10.1080/13549839.2014.965671

471 Bauer, M.W. & Knill, C. (2014). A conceptual framework for the comparative analysis of policy
472 change: measurement, explanation and strategies of policy dismantling. J. Compar. Policy Anal.
473 16, 28–44.

474 Bermann, R., Quinn, C. & Paavola, J. (2012). The role of institutions in the transformation of
475 coping capacity to sustainable adaptive capacity. *Environmental Development, 2*: 86–100

476 Biasutti, M., & Sobel, A. H. (2009). Delayed seasonal cycle and African monsoon in a warmer
477 climate. *Geophys. Res. Lett., 36*, L23707.

478 Biasutti, M., Sobel, A. H. & Camargo, S. J. (2009). The role of the Sahara Low in summertime
479 Sahel rainfall variability and change in the CMIP3 models. *J. Clim., 22*, 5755–5771.

480 Corfee-Morlot, J., Cochran, I., Hallegatte, S. & Teasdale, P.-J. (2011). Multilevel risk
481 governance and urban adaptation policy. *Climate Change 104*, 169–197.

482 Dazé, A. and Echeverría, D. (2016). Review of current and planned adaptation action in Ghana.
483 CARIAA Working Paper no. 9. International Development Research Centre, Ottawa, Canada
484 and UK Aid, London, United Kingdom. Available online at: www.idrc.ca/cariaa.

485 Dixon, J.L., Stringer, L.C. & Challinor, A.J. (2014). Farming System Evolution and Adaptive
486 Capacity: Insights for Adaptation Support. *Resources*, *3*, 182-214.
487 doi:10.3390/resources3010182.

488 Dovers, S. (2005). *Environment and Sustainability Policy: Creation, Implementation,*
489 *Evaluation*. Federation Press, Sydney.

490 Dunn, W.N. (2012). *Public Policy Analysis: An Introduction*. Fifth edition. Pearson, Boston.

491 Dupuis, J. & Knoepfel, P. (2013). The adaptation policy paradox: the implementation deficit of
492 policies framed as climate change adaptation. *Ecological Society, 18*, 31–46.

493 Ekstrom, J.A., Moser, S.C. & Torn, M. (2011). *Barriers to Climate Change Adaptation: A*
494 *Diagnostic Framework*. California Energy Commission. Publication Number: CEC-500-2011-
495 004.
496
497 EU (2006). Renewed EU Sustainable Development Strategy. DOC 10117/06.
498 http://ec.europa.eu/environment/eussd/S.
499
500 Fern, E. F. (1982). The Use of Focus Groups for Idea Generation: The Effects of Group Size,
501 Acquaintanceship, and Moderator on Response Quantity and Quality. *Journal of Marketing*
502 *Research, 19*, 1: 1-13.
503
504 Ford, J. (2008). Emerging trends in climate change policy: the role of adaptation. *International*
505 *Public Policy Review, 3*, 1–16.
506

Gono, R.K., Svinurai, W. & Muzvondiwa, J.V. (2013). Constraints and Opportunities to Guinea Fowl Production in Zimbabwe: A Case Study of the Midlands Province, Zimbabwe. *International Journal of Science and Research (IJSR), India*. *2*, 3: 236-239. www.ijsr.net

Gupta, K., 2012. Comparative public policy: using the comparative method to advance our understanding of the policy process. *Policy Stud. J*. 40, 11–26.

Howlett, M. & Giest, S. (2013). The policy-making process. In: [Araral, J., Eduardo, Fritzen, S., Howlett, M., Ramesh, M., Wu, X. (Eds.)], *Routledge Handbook of Public Policy*. Routledge, London/New York, pp. 17–28.

Huang, X., Zhao, D., Brown, C.G., Wu, Y. & Waldron, S.A. (2010). Environmental Issues and Policy Priorities in China: A Content Analysis of Government Documents. China: *An International Journal*, *8*, 2: 220-246. DOI 10.1353/chn.2010.0007.

IPCC (2014). Regional Aspects (Africa). *Climate Change 2014: Summary for Policy Makers.* Synthesis Report. Intergovernmental Panel on Climate Change (IPCC), Geneva, Switzerland, 32pp.

Islam M.M., Sallu, S., Hubacek, K. & Paavola, J. (2014). Limits and barriers to adaptation to climate variability and change in Bangladeshi coastal fishing communities. *Marine Policy*. *43*: 208-216. doi:10.1016/j.marpol.2013.06.007.

Jordan, A. & Lenschow, A. (2010). Environmental policy integration: a state of the art review. Environ. Policy Govern. 20, 147–158.

Krueger, R.A. & Casey, M.A. (2009). Focus groups: a practical guide for applied research. 4. Thousand Oaks, California: Sage.

Logah, F.Y., Obuobie, E., Ofori, D. & Kankam-Yeboah, K. (2013). Analysis of Rainfall Variability in Ghana. *International Journal of Latest Research in Engineering and Computing (IJLREC),* 1, 1:1-8. www.ijlrec.com

Ludi, E., Jones, L. & Levine, S. (2012). *Changing focus? How to take adaptive capacity seriously. Evidence from Africa shows that development interventions could do more*. ODI Briefing Paper 71. Overseas Development Institute (ODI). London, UK. pp 4.

Mburia, R. (2015). *Africa Climate Change Policy: An adaptation and development challenge in a dangerous world*. Climate Emergency Institute and Climate Action Solution.

Mensah, A., Anderson, K., & Nelson, W. (2016), Review of Adaptation Related Policies in Ghana, DECCMA Working Paper, Deltas, Vulnerability and Climate Change: Migration and Adaptation, IDRC Project Number 107642. Available online at: www.deccma.com, date accessed 24/01/2017.

Minia, Z. (2008). Climate change scenario development. In: *Ghana Climate Change Impacts, Vulnerability and Adaptation Assessments* [W. K. Agyemang-Bonsu, (ed.)]. Environmental Protection Agency, Accra, Ghana. 2-13

Mkwambisi, D.D. (2009). Urban agriculture and food security in Lilongwe and Blantyre, Malawi. In: *Agriculture in Urban Planning: Generating Livelihoods and Food Security* [M. Reedwood (ed.)]. Earthscan, London. 91–103.

MOFA (2007). *Food and Agriculture Sector Development Policy (FASDEP II).* Ministry of Food and Agriculture. Accra, Ghana.

MOFA (2009). *Medium Term Agriculture Sector Investment Plan (METASIP)*. Volume 2: Programme of Actions. Ministry of Food and Agriculture. Accra, Ghana.

MOH (2007). *The National Health Policy: Creating Wealth through Health*. Ministry of Health. Accra, Ghana.

Moors, E.J., Groot, A., Biemans, H., van Scheltinga, C.T., Siderius, C., Stoffel, M., Huggel, C., Wiltshire, A., Mathison, C., Ridley, J., Jacob, D., Kumar, P., Bhadwal, S., Gosain, A. & Collins, D.N. (2011). Adaptation to changing water resources in the Ganges basin, northern India. *Environmental Science Policy, 14*:758–769. http://www.sciencedirect.com/science/article/pii/S1462901111000372

Moser, S.C. & Ekstrom, J.A. (2012). Identifying and Overcoming Barriers to Climate Change Adaptation in San Francisco Bay: Results from Case Studies. California Energy Commission. Publication number: CEC-500-2012-034.

MWRWH (2007). *National Water Policy.* Government of Ghana. Ministry of Water Resources, Works and Housing. Accra. Ghana

National Research Council (2009). *Informing Decisions in a Changing Climate*. Washington, D.C.: National Academies Press.

Nelson, D.R., Adger, W.N. & Brown, K. (2007). Adaptation to environmental change: Contributions of a resilience framework. *Annual Review of Environment and Resources, 32*, 395–419.

Nkrumah, F., Klutse, N.A.B., Adukpo, D.C., Owusu, K., Quagraine, K.A., Owusu, A. & Gutowski Jr., W. (2014). Rainfall Variability over Ghana: Model versus Rain Gauge Observation. *International Journal of Geosciences, 5*, 673-683. http://dx.doi.org/10.4236/ijg.2014.57060.

Oberthür, S. & Gehring, T. (Eds.). (2006). *Institutional Interaction in Global Environmental Governance*. The MIT Press: Cambridge, MA.

Rebar, C.R., Gersch C.J., Macnee, C.L. & McCabe, S. (2011). Understanding Nursing Research (3rd Edition). London: Lippincott Williams & Wilkins.

Schipper, E.L.F. (2007). Climate Change, Adaptation and Development: Exploring the Linkages. Tyndall Working Paper 107.

Seth, A., Rojas, M. & Rauscher, S. A. (2010). CMIP3 projected changes in the annual cycle of the South American Monsoon. *Clim. Change, 98*: 331–357.

Sova, C.A., Chaudhury, A.S., Nelson, W.A., Nutsukpo, D.K. & Zougmoré, R. (2014). Climate Change Adaptation Policy in Ghana: Priorities for the Agriculture Sector. *Working Paper No. 68*. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at www.ccafs.cgiar.org. Last date accessed 24/01/2017.

Stanturf, J.A., Warren Jr., M.L., Charnley, S., Polasky, S.C., Goodrick, S.L., Armah, F. & Nyako, Y.A. (2011). *Ghana: climate change vulnerability and adaptation assessment*. United States Agency for International Development (USAID).

Stevens, D.L. & Olsen, A.R. (2004). *Spatially-restricted Random Sampling Designs for Design-based and Model-based Estimation*. In Accuracy 2000: Proceedings of the 4th International Symposium on Spatial Accuracy Assessment in Natural Resources and Environmental Sciences. Delft University Press. The Netherlands. Pp 609-616.

Stringer L.C., Dyer, J.C., Reed, M.S., Dougill, A.J., Twyman, C. & Mkwambisi, D. (2009). Adaptations to climate change, drought and desertification: insights to enhance policy in southern Africa, *Environmental Science and Policy*, *12*: 748-765. doi:10.1016/j.envsci.2009.04.002

Stringer, L.C., Mkwambisi, D., Dougill A.J. & Dyer, J.C. (2010). Household and policy adaptations to climate change and desertification: perspectives from Malawi. *Climate and Development*, pp.145-160. doi: 10.3763/cdev.2010.0042

Suckall, N., Tompkins E. & Stringer, L. (2014). Identifying trade-offs between adaptation, mitigation and development in community responses to climate and socio-economic stresses: Evidence from Zanzibar, Tanzania. *Applied Geography*. 46 (2014) 111e121.

Teye, G.A. and Adam, M. (2000) Constraints to Guinea fowl production in Northern Ghana: A case study of the Damongo area. *Ghana Jnl agric. Sci. 33*: 153-157.

UNECA (2011) Climate Change and Water in Africa: Analysis of Knowledge Gaps and Needs, Working paper 4. http://www.uneca.org/acpc/publications.

Urwin, K. & Jordan, A. (2008). Does public policy support or undermine climate change adaptation? Exploring policy interplay across different scales of governance. *Global Environ. Change, 18*, 180–191.

Vogel, B. & Henstra, D. (2015). Studying local climate adaptation: A heuristic research framework for comparative policy analysis. *Global Environmental Change 31*, 110–120.

Wesley, J.J. (2010). Qualitative Document Analysis in Political Science. Working Paper. T2PP Workshop, 9-10 April 2010, Vrije Universiteit Amsterdam.

WHO (2009). Promoting sport and enhancing health in European Union countries: a policy content analysis to support action. World Health Organization, Regional Officer for Europe.

Willows, R.I. & Connell, R.K. (Eds.). (2003). *Climate Adaptation: Risk Uncertainty and Decision-Making*. UKCIP, Oxford.

Yiran, G.A.B. (2014). Hazards and Vulnerability Mapping for Adaptation to Climate Risks in Savanna Ecosystem: A Case Study of the Upper East Region, Ghana. A thesis submitted to the School of Graduate Studies in fulfillment for the award of Doctor of philosophy degree in Geography and Resource Development. University of Ghana.

Yiran, G.A.B. (2016). Mapping Social Capital for Adaptation to Climatic Variability in a Savannah Ecosystem of Ghana. In [Yaro, J.A. & Hesselberg, J. (eds.)]: *Adaptation to Climate Change and Variability in Rural West Africa*. p 215-237. DOI 10.1007/978-3-319-31499-0_12.

Yiran, G.A.B., Kusimi, J.M, & Kufogbe, S.K. (2012). A synthesis of remote sensing and local knowledge approaches in land degradation assessment in the Bawku East District, Ghana. *International Journal of Applied Earth Observation and Geoinformation 14:* 204–213.

Yiran, G.A.B. & Stringer, L.C. (2016). Spatio-temporal analyses of impacts of multiple climatic hazards in a savannah ecosystem of Ghana. *Climate Risk Management 14*: 11–26. http://dx.doi.org/10.1016/j.crm.2016.09.003.

Yiran, G.A.B., Stringer, L.C., Attua, E.M., Evans, A.J., Challinor, A.J. & Gyasi, E.A. (2017). Spatial Mapping of Vulnerability of Multi-sector to Multi-hazards in the Savanna Ecosystem in Ghana. *Regional Environmental Change*. *17*, 3:665–676. DOI: 10.1007/s10113-016-1054-8.

Young, O.R. (2002). *The Institutional Dimensions of Environmental Change: Fit, Interplay and Scale*. The MIT Press, Cambridge, MA.

Table 1 Content analysis of policy documents

Policy	**Policy actions**	**Can enhance adaptation to**
Agriculture sector		
Objective: Food security and emergency preparedness	- Introduce improved crop varieties - Increase access to fertilizer - Seed/planting material - Introduce improved livestock breeds - Rehabilitate irrigation dams (Vea and Tono) - Identify sites for micro irrigation systems - Facilitate installation and establishment of pump irrigation systems - Facilitate the formation of water users' associations at the irrigation sites. - Promote use of existing small community and small scale dams - Identify suitable areas for the construction of community small scale irrigation dams and establish small scale furrow irrigation systems	Dry spell Droughts Floods
Health sector		
Policy result area: Human resources	- The increase in the production, recruitment and retention of health workers, focusing on middle-level health professionals	Climate related health risks (i.e.

Policy	Policy actions	Can enhance adaptation to
	- The advocacy for orientation and mobilization of other professionals, including, but not limited to, teachers and agricultural extension workers, in contributing to the promotion and maintenance of good health practice	malaria, CSM, Cholera, etc.)
Policy result area: Health infrastructure	- Investment in the construction of a health service infrastructure - Ensuring of sufficient financing for priority renovations and planned preventive maintenance of existing health service facilities	Climate related health risks
Policy result area: Health supplies and logistics	- Promotion of local production of supplies and logistics including pharmaceuticals and traditional medicines for the national and regional/international markets	Climate related health risks
Policy result area: Health financing	- To pursue equity in health financing, with special emphasis on risk pooling, targeting resources to services for the poor and vulnerable groups	Climate related health risks
Water sector		
Focus area 1: Integrated water resources management	- Promote partnerships between the public and private sectors for the protection and conservation of water resources	Floods
Focus area 6: Climate variability and change	- Construct flood protection structures at appropriate locations - Apply appropriate technologies to efficient early warning systems - Establish and enforce appropriate buffer zones along river - Ensure that land-use planning/building regulations are adequate and enforced - Ensure rainwater harvesting techniques are incorporated into the building code and enforced	Floods Droughts Dry spells
Housing sector		
Action area 8: Urban safety and Security	- Mainstream security and disaster prevention into urban planning and management systems - Acquire ecologically sensitive areas, and flood prone areas and designate and protect them as nature reserves	Floods
Action area 10: Climate Change Adaptation and Mitigation	- Adopt energy conserving systems/technologies in public and private buildings - Introduce or strengthen school curricula awareness on climate change - Intensify public education programmes (including video clips) for awareness creation on climate change, mitigation and adaptation strategies - Develop structure plans with clear provision for open spaces, green belts and other amenity values	Floods Droughts Dry spells High temperatures
The NCCP		
Program: Develop climate resilient infrastructures	- Support the development of climate proof infrastructure that provide key services to increase resilience of communities during extreme climate events - Ensure safe and constant water supply during times of floods and droughts - Ensure that rural communities have access to all weather roads and reliable access to markets and key services	All climatic hazards
Program: Early warning mechanisms	- Document and disseminate appropriate community-based indigenous early warning systems on climate related disasters - Establish effective hazard monitoring and early warning systems with sound scientific and technological basis. - Enhance the technical capacity of Ghana Meteorological Agency (GMet) and other related institutions such as Water Resources Commission (WRC), the Universities and the Geological Survey Department (GSD).	All climatic hazards
Program: Public education and adaption skills	- Promote the use of ICT and information systems to enhance access to public information on Climate Change Adaptation.	All climatic hazards

Policy	Policy actions	Can enhance adaptation to
	- Build capacity of the media and establish clear working relationship and links to ensure the media is well placed to support climate change adaptation. - Increase public awareness on climate change adaption and provide skill training to ensure preparedness on climate change and adaptation strategies	
Program: Rapid response and disaster management	- Strengthen the institutional framework for disaster risk response and management. - Enhance institutional capacity of agencies in disaster risk management especially NADMO - Improve technical capacity and facilities to communities for rapid response to disasters and disaster management. - Review, update, adopt and disseminate National Disaster Management Strategy and Emergency Preparedness/Response Policy and Framework	All climatic hazards

644 Source: Government of Ghana policy documents (constructed by Authors)

645

646 **Table 2 Summary of results from interviews**

Sector	Evidence of policy actions implantation	Autonomous adaptive actions	Can enhance adaptation to
Agriculture			
	- Heat and drought tolerant crops (maize varieties, soya bean) introduced - Seeds sold in markets and agriculture input outlets - Some improved livestock breeds introduced - Rehabilitation of dams started - Some dams/dugouts are used	- Crop diversification, mixed/inter cropping, - Transplanting - Soil moisture conservation measures such as mulching, stone bunds, watering crops in the evening, etc. practiced - Flood recession agriculture practiced in some areas - Early planting and harvesting before floods - Ploughing across slopes to reduce runoff - Dry season gardening/farming using groundwater from wells - Keep different types of livestock and birds with lower water requirements - Keets are raised in pens under shades with the ground watered to control temperature - some weed only in the morning and evening/late afternoon	Dry spell Droughts Floods
Health			
Policy result area: Human resources	- Enrolment increased, more training schools built - Outreach programmes, TV and Radio jingles on food safety and sanitation, provision of sanitation facilities		Climate related health risks (i.e. malaria, CSM, Cholera, etc.)
Policy result area: Health infrastructure	Building of health facilities, Presby mobile clinic, ambulances,		Climate related health risks
Policy result area:	- Pharmacy/chemical stores,		Climate related

Sector	Evidence of policy actions implantation	Autonomous adaptive actions	Can enhance adaptation to
Health supplies and logistics	traditional medicine producers, improved supplies of vaccines, drugs, etc.		health risks
Policy result area: Health financing	Health insurance, subsidies on medicines		Climate related health risks
Water			
Focus area 1: Integrated water resources management	- Collaboration between Ghana water company, water resources commission, community water and sanitation agency and NGOs to construct dams/dugouts, boreholes, wells - Rehabilitation of dams started	Individuals dig wells by homes and on riverbeds	Floods
Focus area 6: Climate variability and change	Buffer zone policy formulated	Some individuals in urban towns harvest rain water for domestic use	Floods Droughts Dry spells
Housing			
Action area 8: Urban safety and Security	Flood prone areas identified		Floods
Action area 10: Climate Change Adaptation and Mitigation	- Sensitization on the media, NGOs educate farmers - Urban towns have planning schemes	Use of local building materials to control room temperature	Floods Droughts Dry spells High temperatures
The NCCP			
Program: Develop climate resilient infrastructures	- Ambulances service available, use of schools and other public places are temporary shelters - Water points constructed at safe places - Gravelling of feeder roads, construction of bridges,		All climatic hazards
Program: Early warning mechanisms	- Use of mobile vans to sound warnings, radio/TV announcements - GMet is densifying its weather observatories with modern equipment	Community announcements, peer to peer communication (i.e. announcement by word of mouth)	All climatic hazards
Program: Public education and adaption skills	- Telecommunication services available in almost all communities	- Use mobile phones - Radio/TV education programs - Relatives act as first responders, rescue, treat or send the	All climatic hazards

Sector	Evidence of policy actions implantation	Autonomous adaptive actions	Can enhance adaptation to
	- NGOs and other institutions educate people on climate change	sick/injured to hospital	
Program: Rapid response and disaster management		NADMO and other institutions are very slow	All climatic hazards

647 Source: Authors' own construct

648

649 **Table 3: Barriers to adaptation to climatic hazards in the study area**

Barriers	Components	Sector affected
Natural hazards	dry spells, droughts, high temperatures, heavy rainfall events, flooding	All sectors
Financial	Insufficient budgetary support, Poverty, lack of credit, delayed release of funds for projects	All sectors
Cultural	Belief system, taste for traditional food crops, land management practices	Agriculture, health
Political	Political promises and interference, corruption, inadequate institutional capacity	All sectors
Infrastructure	Limited irrigation facilities, inadequate health facilities, poor roads	All sectors
Social	Limited access to land, insecure land tenure system, limited knowhow, illiteracy, conflicts	Agriculture, health
Technological	Lack of agricultural inputs, lack of storage/processing facilities, inadequate early warning system, uncertainties in weather	Agriculture, housing, health,

650 Source (Authors' own construct)