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

3
4 **Abstract:** People in Ghana’s savannah ecosystem have historically experienced a range of
5 climatic hazards that have affected their livelihoods. In view of current climate variability and
6 change, and projected increases in extreme events, adaptation to climate risks is vital. Policies
7 have been put in place to enhance adaptation across sub-Saharan Africa in accordance with
8 international agreements. At the same time, local people, through experience, have learned to
9 adapt. This paper examines current policy actions and their implementation alongside an
10 assessment of barriers to local adaptation. In doing so it links adaptation policy and practice.
11 Policy documents were analysed that covered key livelihood sectors which were identified as
12 climate sensitive. These included agriculture, water, housing and health policies, as well as the
13 National Climate Change Policy. In-depth interviews and focus group discussions were also held
14 with key stakeholders in the Upper East Region of Ghana. Analyses were carried using thematic
15 content analysis. Although policies and actions complement each other, their integration is weak.
16 Financial, institutional, social, and technological barriers hinder successful local implementation
17 of some policy actions, while lack of local involvement in policy formulation also hinders
18 adaptation practice. Integration of local perspectives into policy needs to be strengthened in order
19 to enhance adaptation. Coupled with this is a need to consider adaptation to climate change in
20 development policies and to pursue efforts to reduce or remove the key barriers to
21 implementation at the local level.

22
23 **Keywords:** Adaptation; Policy action; Multiple climatic hazards; Savannah ecosystem

24
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33 **1. Introduction**

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

43 In Ghana, mean annual temperatures have risen by about 1°C since 1960, with a more rapid
44 increase in the Guinea and Sudan savannas of Northern Ghana (Minia, 2008). Dry season mean
45 temperatures are projected to rise by about 3°C by 2080, especially in Northern Ghana (Minia,
46 2008). Rainfall however, has been highly variable since 1960, with a downward trend (Nkrumah
47 et al., 2014). In the Guinea and Sudan savannahs, while temperature is increasing and projected
48 to increase, projected precipitation shows both increases and decreases. Decreases range between
49 25% and 28%, while increases range between 24% and 32% in wet season rainfall (Stanturf et
50 al., 2011). The projected decrease in the early part of the rainy season implies high likelihood of
51 frequent and intense droughts/dry spells and a small delay in the monsoon season, whereas
52 intensification of late-season rains implies high likelihood of frequent floods and heavy rainfall
53 events. These climate hazards (high temperatures, dry spells/droughts, heavy rainfall, floods and
54 windstorms) are already occurring in the savanna ecosystem of Ghana and affecting the
55 livelihood and socio-cultural settings of the population (Stanturf et al., 2011; Antwi-Agyei et al.,
56 2012; IPCC, 2014; Yiran and Stringer, 2016). Yiran (2014) showed that the people in the

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

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

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

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

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

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

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

117 **2. Methodology**

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

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

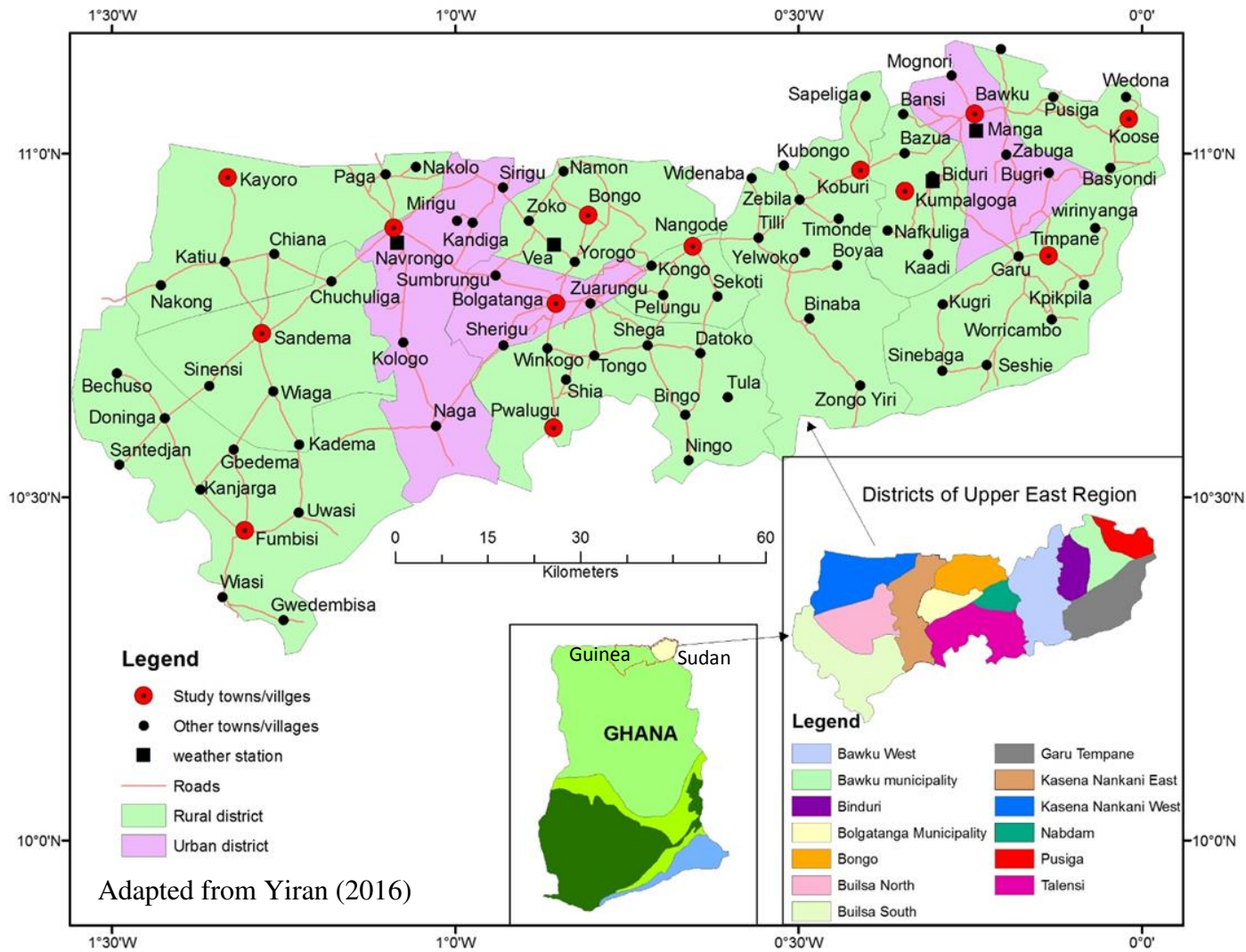
127 **2.1 Study area**

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

142

143 **2.2 Methods of data collection**

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



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 FDGs. 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

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

219 **3.1 Policy content analysis**

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

229 **Insert Table 1**

230 Although policy documents were not intended for adaptation, as can be seen in Table 1, the
231 water sector policy and National Urban Policy Action Plan contain actions that support
232 adaptation to CVC. Health and agricultural sector policies have actions that indirectly address
233 adaptation though not expressly stated. Almost every sectoral area has at least one action that has
234 something to do with adaptation, while the housing and water sectors have two focus/action
235 areas dealing with adaptation. The agriculture sector has one that is essential as far as adaptation
236 to CVC is concerned. The NCCP was more specific and has several programs devoted to
237 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 Veia dam.

260 In all the FGDs and IDIs, farmers (who constituted more than 80 percent¹ of the respondents)
261 confirmed the implementation of these actions. Participants/respondents in 10 out of the 13
262 surveyed towns/villages pointed to a dam/dugout in their communities that is used for various
263 agricultural activities. Use of groundwater through hand dug wells was also practiced by farmers
264 in river valleys and areas where it is easy to access groundwater. A young male farmer in
265 Kumpalgoga noted: “I usually dig a shallow well in the riverbed during the dry season to draw
266 water for my crops”. All respondents indicated that maize is now the major crop because the new
267 varieties withstand the drought and heat. In relation to water provision and use, all participants in
268 the surveyed towns/villages, except Pwalugu where it is difficult to sink a borehole, indicated
269 there is at least one borehole and/or well which has been constructed by CWSA or an NGO.
270 Most of these water points are fitted with receptacles to collect waste water for animals.

271 The health sector policy actions largely addressed the general wellbeing of the people and thus
272 respond to CVC related health issues. All respondents observed that access to health care has
273 improved greatly due to an increase in health facilities over time and the introduction of mobile
274 clinics and the health insurance scheme. Interviews with health workers supported this, as
275 evidenced by a statement from a Community Health Nurse in charge of one of the Community-
276 based Health Planning Services (CHPS) compounds in Talensi district: “Since I came here, I
277 have managed a lot of minor ailments that could have resulted in severe CSM and malaria cases.
278 In fact, I can say that there is improvement in the health status of the people in my catchment
279 area”. Before the introduction of the CHPS, the people in these communities had to walk at least
280 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.

303 **Insert Table 3**

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

311 Second, according to officials, insufficient budgetary support and delays in release of funds
312 stalled the implementation of most actions in the policies. Overlapping actions in the sectoral
313 policies were also seen as barriers. Officials stated that in most cases, overlaps led to duplication
314 or non-implementation of interventions. Although the NCCP tried to address this by assigning
315 actions to sectors and institutions, lack of coordination remained problematic. One official, who
316 has read the NCCP, advised that NCCP implementers should constantly engage the other sector
317 ministries, else it will be seen as a policy from another ministry and actions will not be budgeted
318 for. In Navrongo, Tempane, Kubore and Kumpalgoga participants of both FGDs and IDIs
319 (especially farmers, traders and food processors) complained of lack of markets and credit
320 facilities. A young farmer in Tempane said: “I do not have money to buy a watering can, so I
321 sprinkle using a bucket and calabash and that wastes a lot of water, my energy and time”.
322 Various other social, cultural, technological and political barriers were also noted (Table 3). For
323 example, an old farmer in Nangodi said: “I cannot stop farming early millet completely because
324 before harvest, I have to call my ancestors to come and taste the food before I eat. This cannot be
325 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.

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

361 Most of the policies we analysed took a top-down approach, being formulated at the national
362 level without the involvement of the actors. They were then brought to the local level for
363 implementation. The evidence of this approach from the interviews was the omission of good
364 practices by local actors that could be reinforced by policy if broader consultation or
365 involvement of most stakeholders had taken place. Farmers take a more holistic approach
366 towards adaptation, evaluating and responding to the range of pressures that affect their
367 livelihoods and well-being. This is noted as a key difference between the dominant sector
368 approach of adaptation within policy compared with reality on the ground. We observed that
369 policy actions that supported or stimulated local practices were quickly adopted locally. For
370 example, increasingly, people are using groundwater extracted largely from wells and riverbeds
371 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

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

407 Whereas policies focus largely on the development agenda, people are adapting to current
408 climate change challenges. Studies show that the last 3 decades (1983-2012) have been the
409 warmest in the last 1400 years (IPCC, 2014). This period has recorded very high temperatures
410 and uneven distribution of rainfall in the savanna ecosystem of Ghana leading to frequent
411 occurrence of extreme events such as floods, high temperatures, dry spells/droughts, heavy
412 rainfall and windstorms (Yiran and Stinger, 2016). The onset, cessation and cumulated rainfall of
413 the season have also been affected. Our analysis shows that lack of synergy between policy and
414 local action has resulted in ineffective adaptation and the failure of some policy actions to
415 achieve their targets. This calls for strengthening of policy by integrating good local adaptive
416 practices and paying more attention to climatic issues to enhance future adaptations. Research
417 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.

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

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641

642

643 **Table 1 Content analysis of policy documents**

Policy	Policy actions	Can enhance adaptation to
Agriculture sector		
Objective: Food security and emergency preparedness	<ul style="list-style-type: none"> - 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
	<ul style="list-style-type: none"> - 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 adaptation and provide skill training to ensure preparedness on climate change and adaptation strategies 	
Program: Rapid response and disaster management	<ul style="list-style-type: none"> - 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			
	<ul style="list-style-type: none"> - 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 	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - 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)