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Barriers to climate change adaptation in sub-Saharan Africa: evidence from northeast Ghana & systematic literature review

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Abstract

Despite the international significance attached to climate change adaptation, there remains a lack of understanding of the key barriers that impede the effective implementation of adaptation strategies by households across sub-Saharan Africa. Better understanding of the vulnerability of agriculture-dependent households to climate variability requires exploration of the barriers that constrain the implementation of adaptation strategies. This paper uses case studies from northeast Ghana and a systematic literature review to assess the barriers that restrict effective implementation of climate adaptations in sub-Saharan Africa. Results suggest that households are constrained by a range of barriers, the most important of which included financial barriers, institutional barriers and a lack of information on climate change characteristics. Findings highlight that the provision of credit facilities, development of early warning systems, effective communication of climate information and an understanding of the local context within which adaptations take place, are necessary pre-requisites to enhance climate adaptations and rural livelihoods in sub-Saharan Africa. Households need to be supported through the provision of micro-credit schemes, community empowerment and extension initiatives aimed at enhancing social networks within farming communities in order to reduce their vulnerability to the adverse impacts of climate variability.

Keywords: adaptation, climate change and variability, barriers, Ghana, sub-Saharan Africa, households, systematic review

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1 Introduction

International studies (e.g. Boko et al., 2007; Lobell et al., 2011) suggest that Africa is particularly vulnerable to climate change and variability. This vulnerability has been attributed to the continent's high poverty levels, low adaptive capacity, its dependence on rain-fed agriculture as well as its limited economic and institutional capacity (Boko et al., 2007). Research suggests that food production and related livelihoods will be disproportionately affected by climate change and variability in sub-Saharan Africa (hereafter, 'SSA') (e.g. Schlenker and Lobell, 2010). Climate change has even been described as a new security threat for Africa (Brown et al., 2007). Climatic projections suggest that prolonged and more intense droughts are likely to cause SSA to become drier (Boko et al., 2007; Christensen et al., 2007). Increasing mean annual temperatures will increase evapo-transpiration losses resulting in a reduction in soil moisture content. Boko et al. (2007) project that climate change will reduce net crop revenues by 90% by 2100. This is likely to exacerbate poverty and underdevelopment in many countries (Sissoko et al., 2011) and lead to significant migration both within countries and internationally.

In an attempt to reduce the adverse impacts of climate change and variability, households in SSA employ several strategies to cope with climate change and variability. Adaptation is therefore not new to farming households and communities, with many instances where adaptations have been employed in response to changes in the climate, for example, by altering settlement and agricultural patterns. However, climate change and its associated impacts add a new dimension and urgency to the adaptation challenge. Adaptation is the process by which stakeholders (including farmers) mitigate the adverse impacts of climate on their livelihoods and involves adjustments in lifestyle and economic structure in order to reduce the vulnerability of a system to climate change and variability (Smith et al., 2000). International efforts at finding solutions to climate change have recognised the role of adaptation as a policy option (Ford, 2007; Pielke et al., 2007). For example, Article 10 of the Kyoto Protocol and Article 4.1b of the United Nations Framework Convention on Climate Change (UNFCCC) commit parties to these treaties to promote adaptation to reduce the adverse impacts of climate change. In 2001, the Marrakesh Conference of Parties established the Adaptation Fund in order to finance adaptation initiatives by developing countries. The December 2010

meeting of the Conference of Parties in Cancun also established Green Climate Funds aimed at enabling long-term financing of adaptation and mitigation efforts by developing countries. Under the UNFCCC, least developing nations have also prepared and submitted National Adaptation Programme of Actions (NAPAs) to the Conference of Parties. Considerable research attention has been given to adaptation both in practice and politics (e.g. Pielke et al., 2007; Thomas et al., 2007; Preston et al., 2011).

Despite the significance attached to adaptation, there remains a lack of understanding of the key barriers that impede the effective implementation of adaptation strategies by households across SSA. Whilst extensive research on barriers to climate adaptation has been conducted elsewhere in regions such as Europe, Australia, Canada, and The United States (e.g. Jantarasami et al., 2010; Biesbroek et al., 2011; Barnett et al., 2013; Gero et al., 2012; Matasci et al., 2013; McNeeley, 2012), little empirical evidence exist on barriers to adaptation to climate change in SSA (e.g. Nielsen and Reenberg, 2010; Boyd et al., 2013; Sietz et al., 2011). The existing empirical evidence on barriers to climate adaptation in SSA is highly fragmented and context-specific. To achieve a better understanding of the vulnerability of agriculture-dependent households to climate change and variability requires exploration of the barriers that constrain the implementation of adaptation strategies.

Barriers are defined as factors, conditions or obstacles that reduce the effectiveness of adaptation strategies (Moser and Ekstrom, 2010; Huang et al., 2011). Barriers have been distinguished from limits to climate adaptations. In the fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC), limits are defined as “conditions or factors that render adaptation ineffective as a response to climate change and are largely insurmountable” (Adger et al., 2007, p. 733). Limits to climate adaptation are endogenous and absolute and therefore unsurpassable (Hulme et al., 2007; Dow et al., 2013). Many frameworks and approaches have been developed to understand the limits and barriers to climate adaptations (see Moser and Ekstrom, 2010; Kolikow et al., 2012; Lehmann et al., 2013; Dow et al., 2013). However, the identification and evaluation of barriers to climate adaptation measures by farmers is an aspect of adaptive research that has been less comprehensively researched (Howden et al., 2007; Preston and Stafford-

Smith, 2009). In contributing to this literature, this paper uses case studies and systematic literature review to:

(i) Identify the key adaptation strategies used by households in SSA with particular emphasis on migration and lessons from case study research in Ghana;

(ii) Assess the barriers that restrict the effective implementation of climate adaptations in case study villages and SSA more widely;

(iii) Draw policy recommendations and identify potential ways forward to enhance support aimed at reducing the vulnerability of smallholder farmers in SSA.

Findings from this paper will help target appropriate region-specific climate adaptation policy to reduce the vulnerability of households in SSA and outline an agenda for further research.

2 Research design and methods

This paper uses a two-stage methodology. First, it uses primary empirical data from three villages in north eastern Ghana to provide local understanding of climate adaptation barriers. Second, it situates the locally-identified barriers within a systematic review of the wider adaptation literature to provide a comparative analysis of key barriers that restrict the implementation of adaptation strategies in SSA. The different agro-ecological zones of Ghana shares socioeconomic, agro-ecological and climatic characteristics similar to the Sahel and other parts of SSA. For instance, the socioeconomic characteristics of Ghana in terms of poverty levels and per capita GDP (of less than US$1000 per year) are similar to those of other West African countries (UNDP, 2010). Like Ghana, rain-fed agriculture provides employment to more than half of all the population in most of West Africa (UNDP, 2010). Therefore, Ghana is a useful case study context in which to undertake more detailed study to understand the key barriers to the effective implementation of adaptation strategies by households across the sub-region.

2.1 Case study analysis

This study is situated within the context of northeast Ghana. The Bongo district of the Upper East region (see Figure 1) was selected for this study where a previous study by Antwi-Agyei et al. (2012) identified this area as the most vulnerable district to drought in Ghana. The Bongo district is characterised by high poverty rates and poor soil fertility. The district lies within the Sudan savannah agro-ecological zone. The uni-modal rainfall pattern permits one main farming season from May/June–September/October (Dickson and Benneh, 1988). The district experiences average annual rainfall of 800–1000 mm (EPA, 2003), with maximum temperatures of 35°C and mean monthly minimum temperatures of 21°C (EPA, 2003). The major economic activity is subsistence agriculture with about 90% of the total population (77,885) in the Bongo district dependent on rain-fed agriculture for their livelihoods (GSS, 2011). The major crops grown include sorghum (*Sorghum bicolar*), millet (*Pennisetum glaucum*), rice (*Oryza sativa*), groundnut (*Arachis hypogea*), guinea corn (*Sorghum vulgare*) and maize (*Zea mays*). Based on expert and stakeholder interviews conducted with local experts at the Ministry of Food and Agriculture, three farming villages – Adaboya, Ayelbia and Vea (Figure 1) were selected for this study. These communities were selected because, according to the local experts and stakeholders, they were exposed to drought and have not been able to deal with this climate anomaly.

2.2 Research Methods

This paper uses qualitative data collected during May – August, 2010 and June – August, 2011. Data collection started with a rapid rural appraisal to gain an overview of the significant social and physical features of the selected villages (Chambers, 1994). A mixture of participatory methods including key informant interviews, focus group discussions and household questionnaire surveys were used allowing local people the opportunity to participate by sharing their experiences and knowledge to outline possible solutions to local climate challenges. A total of 135 structured household questionnaires were undertaken in the three villages (45 questionnaires in each village). Households were stratified into different wealth groups and a random sample of households was surveyed (Antwi-Agyei, 2012). Households are defined "as constituting of a group of people who own the same productive resources, live

together and feed from the same pot" (Yaro, 2006, p. 129). Purposive sampling was used to identify key informants. At least one focus group discussion was held in each farming village involving between 5 and 10 farmers of different socio-cultural backgrounds, to ensure triangulation of the key issues emerging from the household questionnaire. A total of 9 key informants were selected for in-depth interview into the issues raised at focus group discussions. These informants were selected based on their farming knowledge and experience of environmental change as presented during the focus group discussions and household questionnaire survey.

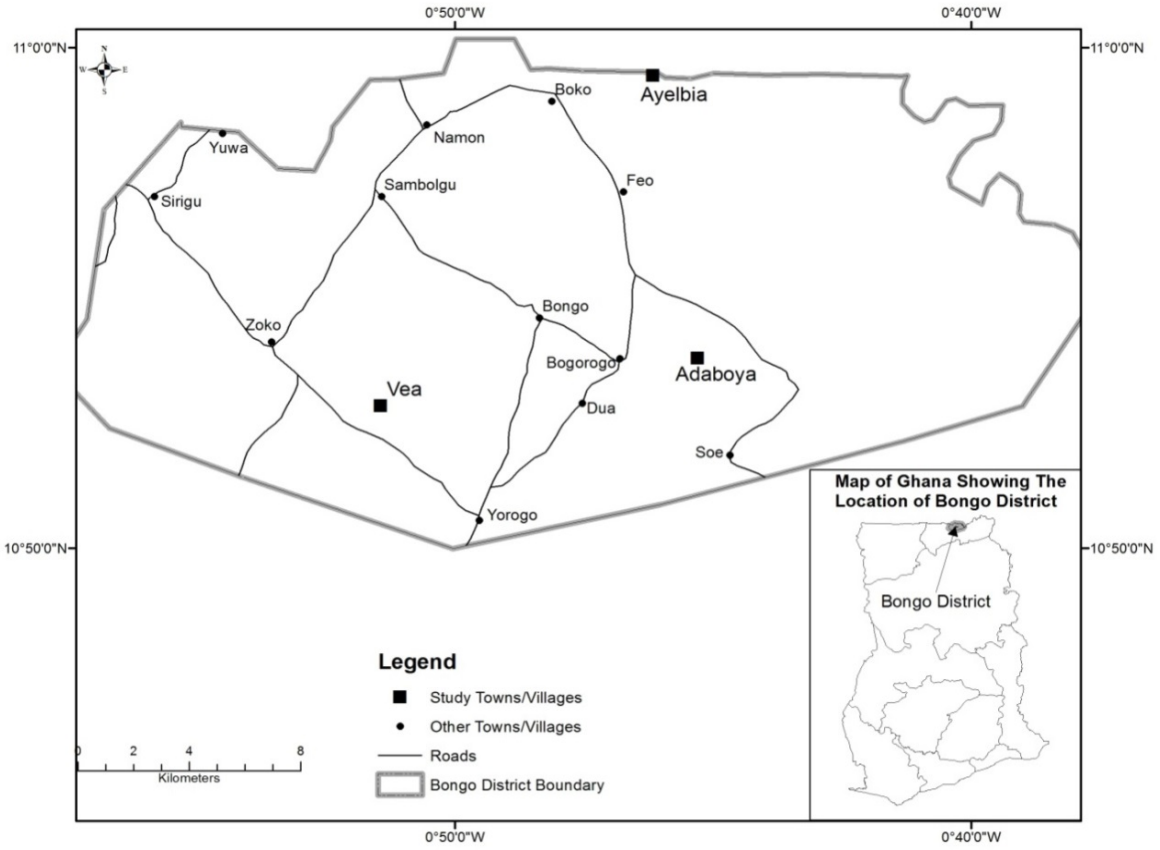

Figure 1: Case study villages in Bongo District, northern Ghana.

2.3 Systematic review of the literature on barriers to climate adaptation

A systematic review was conducted on peer-reviewed literature to explore the extent to which the barriers identified in the study villages have been reported in other studies in SSA. A realistic review approach that emphasises depth rather than breadth of the documents reviewed was adopted following the procedure outlined in Thompson et al. (2010) and Biesbroek et al. (2013). To do this, the key word

searches of terms including [barrier*] AND [climat* adaptation] AND [Africa] were conducted in the electronic database – Web of Science – in similar fashion as is described by Thompson et al. (2010), Biesbroek et al. (2013) and Ford *et al*. (2011). The analysis from the first phase – case studies – informed the selection of key words in the systematic literature review. The search was limited to articles that were published in English since 2000 to ensure that barriers identified in the literature were current (see Table 1 for exclusion and inclusion criteria). Additionally, the reference lists of relevant articles were manually checked to ensure that no relevant published articles on barriers to climate adaptation in SSA since 2000 were missed. This paper adopted a systematic approach to avoid the inherent biases relating to the selection and interpretation of content that often characterised traditional literature reviews (Biesbroek et al., 2013). Studies in climate change research including Thompson et al. (2010); Ford et al. (2011) and Biesbroek et al. (2013) have demonstrated the value of this methodological approach in gleaning knowledge from existing literature.

2.4 Data analysis

Quantitative data from the household questionnaire were coded in a way that Microsoft Excel (Version 2010) and Predictive Analytic Software (formerly SPSS) understand to enable appropriate statistical analysis to be made. Data were analysed using descriptive statistics and compared means, where possible. Qualitative data from interviews and focus groups were coded and indexed through intensive content analysis in order to identify major themes (Krippendorff, 2004). Structuring themes permitted the categorisation of the responses and identification of those that diverged from the common themes. Key informant interviews and focus group discussions were used to triangulate any contradictions observed in the data.

3 Results

The results of the household questionnaire surveys, focus group discussions and key informant interviews are presented in the following sections. First, we explore the key climate adaptations strategies used by households in the study villages and from the literature with particular emphasis on migration, which emerged as a key strategy

in the analysis. Second, we outline the key barriers to the implementation of adaptation strategies in Ghana. Third, we explore the policy implications of the findings for climate change adaptations and rural livelihoods in case study villages and SSA more widely.

Table 1: Criteria for including or excluding articles in the systematic review

Criteria	Excluded	Included	Justification
Date of publication	Articles published prior to January, 2000	Articles published between January, 2000 – July, 2013	It is assumed that considerable attention has been given to climate change research since 2000.
Language of publications	Articles that were published in languages other than English	Articles published in English	To facilitate understanding of published articles.
Main theme of publication	Articles that did not give particular attention to barriers to climate adaptation. Articles that related to human evolution or adaptation were not included	Articles that have the words barriers or limits or constraints or obstacles to adaptation in title or abstract	Since the focus of this study was to explore the key barriers to climate adaptation, the theme of the article needed to closely link to the objective of the study.
Availability of article	Articles that were not available in the Web of Science	Articles that were available in the Web of Science	The Web of Science provides an authoritative source for gleaning literature from published sources.
Country or region of study	Articles that focused on developed countries	Articles that had Africa as the major focus of the study	The study aimed at enhancing understanding of barriers in Africa and therefore selected papers that focused on the continent.
Type of article	Grey literature such as conference proceedings were not included.	Only peer-reviewed articles were included	To avoid grey literature and arbitrariness in the selection of research articles.

3.1 Adaptation strategies employed by households in case study villages

Table 2 shows that at the micro-level, households in the case study villages employ several on-farm and off-adaptation strategies including, but not limited to, livelihood diversification, crop diversification, labour migration, planting drought-tolerant crops, and using irrigation. The results also suggest other key adaptation strategies include changing the timing of planting, using indigenous knowledge to develop climate models as well as planting early maturing varieties of crops in an attempt to reduce

the negative impacts of climate variability (particularly droughts) on their livelihoods. Other households claimed reducing their food consumption as well as changing their diets to cope with climate variability (see Table 2). Though crop diversification has long since been the traditional norm for households in the case study villages, focus group participants reported that it is assuming a greater significance as a climate adaptation strategy. The use of irrigation facilities among small-holder farmers to reduce crop failure due to meteorological drought in other northern Ghanaian dryland agricultural systems has been documented by Laube et al. (2012). Studies have shown that local farmers in SSA have rich and sophisticated agro-ecological knowledge useful for climate adaptation (e.g. Nyong et al., 2007; Speranza et al., 2010; Naess, 2013). These adaptations are perceived to be successful as households have depended on them to withstand the adverse impacts of the climate on their livelihoods. Migration was cited as a key adaptation by the majority of the households that participated in the study (90%; *n* = 122) (see Table 2), and therefore special attention is given to migration in the following section.

3.2 Migration as a climate adaptation strategy in sub-Saharan Africa

Migration has long been part of the history of households in northern Ghana (Rademacher-Schulz and Mahama, 2012; Van der Geest, 2011). However, droughts since the 1970s have added greater importance to migration as a climate adaptation strategy more widely. Results from the present study suggest that the majority of households (90%; *n* = 122) sampled in the three farming villages, reported that at least one member of their household had migrated over the period 2006–2011 as a strategy to cope with climate variability. Focus group participants claimed that after harvest in October/November, many of the farmers, mostly the younger ones, leave for southern Ghana, especially Ashanti and Greater Accra regions, where the climatic conditions and job opportunities are better. This is illustrated in the following interview remarks:

> *Our youth are all moving to southern Ghana in search of job opportunities and good farming conditions because in this village the farming season is only from late June to October and after that there is no work for our youth. The environmental conditions are so harsh and do not make farming attractive any longer to our youth* [Key informant, Vea, August, 2010].

Table 2: Adaptation strategies in the study villages and SSA more widely

Adaptation strategies	Type of adaptation	Long-term or short term	Proportion of households in study villages*	Documented examples from elsewhere SSA in the literature
Changing the timing of planting	On-farm adaptation	Long term	90 (122)	Bryan et al. (2009) (Ethiopia and South Africa) Waha et al. (2012)
Planting early maturing crops	On-farm adaptation	Long term	52 (70)	Cavatassi et al. (2011) (Ethiopia)
Crop diversification	On-farm adaptation	Long term	90 (121)	Mary and Majule (2009) (Tanzania)
Planting drought-tolerant crops	On-farm adaptation	Long term	71(96)	Stringer et al. (2009) (Malawi and Swaziland)
Using irrigation	On-farm adaptation	Long term	13 (18)	Enfors and Gordon (2008) (Tanzania); Laube et al (2012) Ghana
Livelihood diversification	Off-farm adaptation	Long term	36(48)	Barrett et al. (2001) (Burkina Faso) Newsham and Thomas (2011) (Namibia)
Relying on family and friends	Off-farm adaptation	Short tem	45(61)	Thomas et al. (2007) (South Africa)
Using agro-ecological knowledge	Off-farm adaptation	Long term	72(97)	Roncoli et al. (2002) (Burkina Faso); (Uganda), Speranza et al. (2010) (Kenya)
Migration	Off-farm adaptation	Short term	90(122)	Wouterse and Taylor (2008) (Burkina Faso); Van der Geest (2011) Ghana
Changing diets	Off-farm adaptation	Short term	73(98)	
Reducing food consumption	Off-farm adaptation	Short term	77(104)	

Source: Modified from Antwi-Agyei et al. (under review)

*Numbers in parenthesis indicate counts of households and those not in parentheses are percentages

Qualitative interview data suggest that when farmers in the case study villages have depleted their food reserves during the dry season, they either migrate or call on the assistance of their family members who have migrated to southern Ghana to salvage the situation and prevent destitution. Farmers were asked why they or members of their households migrated out of these communities. Results show that farmers migrate in response to climate variability (particularly drought) and other harsh environmental conditions as well as socioeconomic pressures. This is detailed in a typical comment by a farmer:

> *It is important to feed my family during the dry season and one of the key strategies is to migrate to the south and work as a labourer. This helps me to get money and send some to my family to buy food. Also, there are few employment opportunities in the north compared to southern Ghana. There are no industries and markets in the north and this makes living here quite difficult* [Ayelbia, August, 2011].

Emphasising the extent of drought-induced migration, a farmer provided a characteristic remark:

> *… from November to May, there is no farming in this village as we depend entirely on the rains for our farming activities. You cannot stay here and starve so the best option is to migrate to work on people's farms to get money. When there is drought, you have nothing to eat; the only option is to migrate* [Adaboya, August, 2010].

Emanating from these observations is that farmers in these communities migrate partly due to the absence of adequate rainfall which leads to drought and eventually famine. Nonetheless, they are also confronted with other socio-political and economic challenges that partly influence the decision to migrate (Mertz et al., 2010; Quinn et al., 2011). Hence, migration decisions by households were determined not only by the lack of rainfall, but also by a host of overlapping causes. For instance, in addition to lack of adequate rainfall, households reported declining soil fertility (40%), lack of employment opportunities (30%) and poor infrastructure development (15%) as some of the reasons why members of their households migrate to the south. Important to note is that once in southern Ghana, the literature reports that the majority of these migrant farmers mostly work as (i) labourers on other people's

farms, (ii) watchmen or security officers and; (iii) head porters ("*kayayei*") (Awumbila and Ardayfio-Schandorf, 2008). These activities are all low income livelihood opportunities. Most of these migrant farmers find it extremely difficult to obtain employment in the formal sector because of their lack of skills and low educational standards.

These results compare favourably with findings from other studies on migration in Ghana and the wider literature (Rademacher-Schulz and Mahama, 2012; Van der Geest, 2011; Meze-Hausken, 2000). For instance, a report on the "*Where the Rain Falls*" project by Care International shows that households in the Nadowli district of Ghana migrate because of food insecurity linked closely to climate variability (Rademacher-Schulz and Mahama, 2012). A review of the literature suggests that migration as an adaptive strategy is not uncommon in other parts of SSA (Tyson et al., 2002; Meze-Hausken, 2000). In most parts of SSA, temporary migration has been used as both reactive and anticipatory response to drought-induced food insecurity. For instance, Dabi et al. (2008) observed that labour migration was one of the principal strategies indicated by rural households in northern Nigeria as both a past and present climate adaptation strategy. A recent study by Scheffran et al. (2012) also indicates that migration may contribute to resilience and innovation in climate adaptation in northwest Africa. This is because migrant workers can enhance livelihoods and build the resilience of the original home communities through remittances.

3.3 Barriers to climate adaptation in sub-Saharan Africa

In an attempt to understand what restricts households from implementing adaptation strategies, households were asked to identify key barriers to climate adaptations. The most commonly identified barrier was the lack of financial resources. Almost 97% (*n* = 131) of households cited a lack of financial resources as a serious barrier (Table 3). About 65% (*n* = 88) also perceived a lack of information on climate change characteristics, whilst 33% (*n* = 45) reported that a lack of institutional capacity to facilitate agricultural adaptation served as barriers. About 26% (*n* = 35) of the respondents described social-cultural barriers such as belief systems and local norms as serious obstacle. Another 28% (*n* = 38) and 7% (*n* = 9) of the households identified technological barriers and a lack of infrastructural development including

ready markets respectively (see Table 3). Households also reported unavailability of credit facilities to purchase farm inputs such as fertilizers, farm implements and pay labourers. This has serious implications for climate adaptation and agricultural development more broadly in SSA. The risks presented by climate change to the livelihoods of these households are set to increase (IPCC, 2007), yet the mechanisms needed to reduce this risk are not fully supported.

3.4 Results from the systematic review

The systematic review yielded 63 articles that were reduced to 18 articles following the inclusion and exclusion criteria described in Table 1. The abstracts of the 18 articles were carefully read and this was trimmed down to 13 articles. Table 4 shows the textual analysis of the 13 selected articles. The 5 articles were excluded from the systematic review because these articles did not give particular attention to climate adaptation barriers and were not also focused on developing countries, particularly SSA. The results show that there has been relatively considerable research into the barriers of climate change adaptations in SSA during the last five years (2008-2013) with the majority of the selected articles published between 2008 and 2013 (Table 4). The results also indicate that the majority of the reviewed publications focused on agricultural adaptation, water management and multiple sectors. Further, the result shows that financial and institutional barriers constituted the majority of barriers identified in the reviewed publications (Table 4). Using the institutional affiliations of the lead author, the results of the systematic review show that the majority (77%) of the lead authors were based in institutions outside Africa (Table 4).

Table 3: Barriers to climate adaptation identified in case study villages

Barriers to adaptation	Proportion of households*	Documented examples from the literature	Adaptation strategies affected in case studies and the literature more widely
Financial barriers	97(131)	Bryan et al. (2009); Huang et al. (2011), Peterson (2013); Gero et al. (2012); Antwi-Agyei (2012); Measham et al (2011)	Planting trees, planting improved varieties of crops, diversification of livelihoods activities, changing the timing of planting.
Lack of information on climate change characteristics	65 (88)	Boyd et al., (2013); Ziervogel et al (2010); Measham et al. (2011), Mukheibir and Ziervogel (2007); Adger et al. (2009).	Changing the timing of planting, planting early maturing varieties, using irrigation, development of early warning systems.
Social-cultural barriers	26(35)	Adger et al. (2003), Jones and Boyd (2011); Nielsen and Rosenberg (2010); Adger et al., (2009); Adger et al. (2012); Stafford-Smith et al. (2011).	Temporary migration, changing the timing of planting.
Institutional barriers including political barrier	33(45)	Jantarasami et al. (2010); Biesbroek et al. (2013), McNeeley (2012); Eriksen and Lind (2009); Sietz et al. (2011); Amundsen et al. (2010); Measham et al (2011); Ford et al. (2011)	Planting of improved varieties of crops, development of early warning systems, using irrigation systems.
Lack of infrastructural development including ready markets	7 (9)	This is related mostly to lack of resources to mitigate the adverse impacts of climate change and variability.	Planting drought-tolerant crops, diversification of livelihoods and crops diversification.
Technological barriers	28(38)	Most studies relate technological barriers to development of early warning systems in SSS (e.g. Boyd et al., 2013) as well as technical expertise in climate research (see Washington et al., 2004).	Development of early warning systems, developing drought-tolerant crops.

*Numbers in parenthesis indicate counts of households and those not in parentheses are percentages

Table 4: Textual analysis of selected publications from systematic review

Article no.	Year	Main focus of article	Information barriers	Financial (economic) barriers	Institutional (political) barriers	Technical barriers	Social-cultural barriers	Other barriers	Lead author based in Africa
1	2010	Water management	X	X	X				Non-Africa
2	2011	Multiple	X		X				Non-Africa
3	2009	Water management			X				Non-Africa
4	2010	Multiple	X	X	X	X			Non-Africa
5	2008	Water management		X		X			Africa
6	2009	Agriculture	X	X				X	Non-Africa
7	2011	Multiple	X	X	X	X			Non-Africa
8	2011	Multiple	X	X	X	X			Non-Africa
9	2011	Agriculture			X	X			Non-Africa
10	2012	Agriculture		X	X			X	Non-Africa
11	2007	Multiple		X	X	X			Africa
12	2012	Agriculture		X				X	Africa
13	2010	Multiple					X		Non-Africa

X indicates that the particular barrier was identified or highlighted in the article. The other barriers include lack of access to land, market etc.

4 Discussion

The findings from the case studies and systematic review are now discussed in order to outline policy recommendations to reduce the vulnerability of households in SSA to climate variability. In doing this the implications of the findings for project level support and livelihoods of households in SSA are also explored.

4.1 Migration-environment nexus

The results on labour migration confirm several studies suggesting that people migrate in response to harsh climate conditions as an adaptive mechanism (McLeman and Smit, 2006; Gemenne, 2011). Rademacher-Schulz and Mahama (2012) and Van der Geest (2011) similarly observed that environmental factors including shifts in rainfall seasons and increased intensity and frequency of droughts are among the key drivers for migration of farmers from northern to southern Ghana. It is also significant to stress that food insecurity and lack of livelihood opportunities in northern Ghana could be partly attributed to poor national policies (for example those on agriculture and economic development). In terms of economy, Ghana has a stark north-south divide with the south being relatively prosperous because of a great number of job opportunities. Government policies during the colonial as well as the pre-colonial times have tended to structurally neglect the north. This has resulted in a widening gap in terms of livelihood opportunities between households in the north and those in the south. People who solely depend on rain-fed agriculture for their livelihoods (as in many SSA countries) may have their livelihood activities jeopardised by climate change and variability (particularly drought). Hence, such households may have few options other than to migrate to find alternative livelihoods elsewhere.

4.2 Understanding barriers to climate adaptations in sub-Saharan Africa

In the following sections the key barriers identified in the case study villages and the literature are explored. In doing this, the implications for climate adaptations are flagged up.

4.2.1 Financial barriers

The results suggest that financial barriers are one of the key barriers that restrict implementation of adaptation strategies by households in SSA (e.g. Peterson, 2013; Antwi-Agyei, 2012; Bryan et al., 2009; Kithiia, 2011). Financial barriers are largely related to budget deficits experienced in many economies across SSA cities (UN-HABITAT, 2010). Every form of adaptation entails some direct or indirect financial costs. For instance, the use of improved varieties of crops including groundnut have been reported as one of the key adaptation strategies for farmers in northern Ghana (see Peterson, 2013). Such fast-growing groundnuts have kept farming households in northern Ghana afloat in the midst of chaotic rainfall patterns (Peterson, 2013), However, farmers have often reported difficulties in accessing such improved varieties of groundnuts. Even when such improved varieties are available, their price may be prohibitive making it difficult for many small-holder farmers to access. Thus, farmers have often sought to use their own saved seeds or alternatively purchase such seeds from the local markets. Bryan et al. (2009) have also reported that financial barriers due to lack of credit facilities are one of the most important obstacles hindering the implementation of appropriate climate adaptation strategies by farmers in Ethiopia.

Generally, small-scale farmers in the case study villages are considered poor. For instance, data from the Ghana Statistical Service indicate that an estimated 90% in the case study villages live on less than $1.00 per day and are therefore considered poor (GSS, 2000). Poor households have a limited amount of capital assets that may be needed to reduce the impacts of climate variability on their livelihoods and thus may be least prepared to deal with climate related shocks (see Dasgupta and Baschieri, 2010).

4.2.2 Social-cultural barriers

The belief systems of a particular group of people can constitute one of the greatest barriers to the implementation of climate adaptation strategies by households. Strongly held beliefs, cultural practices and value systems and the worldviews of individuals or groups, greatly influence the way they perceive climate change and thereby their subsequent adaptation strategies (Jones and Boyd, 2011; Stafford-Smith et al., 2011; Adger et al., 2012). Culture is central to the decision to adapt and

thus, the identification of risks and the subsequent implementation of appropriate adaptation strategies (Adger et al., 2012). Within the same geographical region, different cultural groups may act differently in their response to risks including the adverse impacts of climate change (Adger *et al*, 2012), and such responses may be greatly influenced by the pre-existing belief systems and values and norms of the group (Moser and Ekstrom, 2010). For example, cultural practices prevented the *Fulbe* in northern Burkina Faso from embracing livelihood diversification adaptations strategies such as development work, labour migration and gardening to reduce their vulnerability to drought. Contrary, their counterparts, the *Rimaiibe,* have used labour migration and diversification of livelihoods as adaptation strategies (Nielsen and Reenberg, 2010). With regard to migration, Rademacher-Schulz and Mahama (2012) observed that social and cultural norms constrain female migration compared to male migration in the Nadowli district of Ghana. This potentially limits the adaptation options available to such female farmers.

Jones and Boyd (2011) observed that societal norms and values act as major barrier to successful climate adaptation in Western Nepal. Social barriers may be cognitive, normative or institutional governance and structure (see Jones and Boyd, 2011). Cognitive barriers involve psychological and thought processes that influence individuals' reactions to risks including climate change (Swim et al., 2011). Normative barriers include cultural norms and values that could influence individuals' responses to environmental (including climate) change. Individuals and groups employ a range of cognitive strategies to avoid "accepting the possibility of unpleasant futures and the need to act now" (Stafford-Smith et al., 2011, p. 201). These strategies include active and casual denials, blame shifting, as well as reinterpreting the threat. In this regard, the appreciation of the local context within which climate adaptation takes place is quite critical. Indeed, there is increasing demand for adaptation strategies that acknowledge local context such as belief systems and indigenous knowledge (e.g. Jennings and Magrath, 2009).

4.2.3 Lack of information on climate change characteristics

Access to information on climate change characteristics is a very powerful tool that can be used to enhance the adoption and implementation of adaptation strategies by households in SSA. This is particularly important for Africa (IPCC, 2007) and Ghana

in particular, where there are few climate projections due to lack of appropriate climate data. This is crucially important considering that most farming systems in SSA depend on rain-fed agricultural systems. Hence, lack of appropriate climate information could be critical for food security. Even when climate information has been provided, it usually comes in the form of seasonal forecasts that may not be useful in long-term planning of agricultural activities (Ziervogel et al., 2010). This has often contributed to food insecurity. The information barriers, similar to findings by Adger et al. (2009), suggest that information and awareness on climate change could potentially serve as barrier to successful implementation of adaptation practices.

Drought preparedness involves the development of emergency plan and early warning systems that have the capacity to provide real-time climate information to aid decision making on drought (Boyd et al., 2013). Providing early warning systems and climate risk information for drought mitigation has been acknowledged by major international conferences such as the World Summit on Sustainable Development as well as the Johannesburg Plan of Implementation of Agenda 21. One of the key policy priorities at the World Summit Sustainable Development was the provision of early warning systems that are affordable and locally available to the people so as to enhance timely responses to incidences of drought. Successful implementation of climate adaptation strategies requires that farmers do not only have sufficient knowledge about the available options, but also have adequate capability to assess the available options so as to make informed decisions on the best adaptation strategies (Lee, 2007). In Zimbabwe, Patt and Gwata (2002) reported that the usefulness of seasonal forecasts may be limited by issues relating to credibility, scale, cognitive capacity, legitimacy as well as institutional and procedural barriers.

The lack of appropriate information on climate change characteristics could be related to the lack of adequate and state-of-the art equipment at meteorological departments across this region. Many of the weather stations are ill-equipped to produce real-time scale climate information for adaptation. This prevents the timely prediction and forecast of the rainfall pattern to enable farmers to make informed decisions. Farmers in the case study villages and more widely in Ghana have therefore tended to use their indigenous and agroecological knowledge, based on the past experience, to form complex mental models of the climate with which they forecast the weather.

4.2.4 Institutional barriers

Institutions are defined as the “social cement which link stakeholders to access to capital of different kinds to the means of exercising power and so define the gateways which they pass on the route to positive or negative adaptations” (Davies, 1996, p. 24). Institutions play a crucial role in enhancing the capacity of local communities to cope with climate variability and providing mechanisms that help to shape the social and individual interactions within the society (Agrawal and Perrin, 2009). A review by Biesbroek et al. (2013) revealed that governmental institutions are key to enabling or removing barriers to climate adaptation. Adaptation policies in many SSA countries tend to be top-down, driven by the central government that has often constrained adaptive strategies at the regional and local levels. In Mozambique, Sietz et al. (2011) asserted that institutional barriers at the individual and organisational levels could influence the mainstreaming of adaptation strategies.

In many farming communities in SSA, extension officers are supposed to be the link between the scientific community and farmers by facilitating the flow of scientific ways of farming, including the adoption of innovative ways of farming, to farmers. However, in many cases the extension officers may be overwhelmed by the numbers of communities they serve, making it practically impossible to attend to the needs of all farmers. The lack of climate adaptation information including weak institutional capacity coupled with the intra-annual rainfall variability and increased temperature will place food security in many SSA countries, under considerable stress. Institutional barriers could also be related to political barriers. Based on fieldwork in Kenya, Eriksen and Lind (2009) reported that people’s responses to drought may be greatly influenced by the prevailing political process. In a review of adaptation practices in developed countries, Ford *et al* (2011) reported that a lack of political will at the local levels was a major barrier to climate adaptation.

4.2.5 Technological barriers

In the literature, technological barriers are considered as one of the key barriers to climate adaptation in SSA (Kithiia, 2011). Households can only employ the adaptation tools and options that have been developed (Kolikow et al., 2012), and

which are applicable in the local contexts. In characterising adaptation to climate change in agriculture, Smit and Skinner (2002) identified technological developments as one of the four key agricultural adaptation pathways. Technological developments including the development of new crop varieties, early warning systems as well as the development of irrigation techniques are critical to climate adaptations. However, in SSA where the level of technological development is quite limited, households may not have the full range of adaptation options that may be available in developed countries. In this regard, the lack of advanced technologies across SSA may constrain the adaptation opportunities and capabilities of households to employ some of the more advanced technologies that could enhance food security and related livelihoods through the development of early warning systems.

It is worthwhile to stress that technological options for climate adaptation are also implemented within appropriate socioeconomic, legal and institutional framework (Klein et al., 2001), which most sub-Saharan countries tend to lack. The Africa climate report commissioned by the UK Government identified low technical expertise in climate modelling as one of the key challenges to climate change research in Africa (Washington et al., 2004). Lack of technology is also related to inadequate funding on agriculture and climate change research by governments across Africa (Enete and Amusa, 2010).

4.2.6 Lack of infrastructure development including ready markets

Though related to agricultural development more widely, the lack of readily available markets was identified by households to constitute a major obstacle to the successful implementation of climate adaptation strategies, including the planting of drought-tolerant crops and diversification of crops. A lack of market is related to lack of appropriate storage facilities for farm produce in the case study villages. Indeed, the lack of storage facilities weakens the bargaining power of the small-scale farmers when it comes to negotiating the prices of farm produce. This is because most of them cannot store their produce and therefore accept whatever price they are offered. One key adaptation strategies for small-holders farmers in dryland farming systems in SSA is the use of drought-tolerant crops. In this regard, the virtues of cassava (*Manihot esculenta*) as an answer to climate adaptation in Africa have been documented (see Jarvis et al., 2012). To this end, extension officers have been

encouraging farming households in Ghana to plant cassava. Despite its potential as a drought-tolerant crop, households reported difficulties in selling cassava compared to maize and emphasised the cultural appeal for maize. The lack of ready markets as a barrier to climate adaptation is, perhaps, fully appreciated when it is related to the obligation of households to fulfil their credit repayments. If households are not able to get good prices for their produce, they will not be able to repay their loans and this will have serious implications for their ability to contract future loans to implement adaptation strategies. Lack of market access is also related to poor physical infrastructure development such as road networks in many farming villages across SSA. Harsh environmental conditions coupled with a lack of access to markets as well as well-functioning financial institutions have contributed to food insecurity in the case study villages.

5 Policy implications and the way forward

In the following section, this paper explores the policy implications based on the findings from the case study villages and the systematic review for climate adaptations in SSA.

5.1 Provision of credit facilities for climate adaptation

Government should liaise with banks to extend credit facilities to farmers, because most farmers cannot provide the necessary collateral that banks demand for the provision of credit. It is significant to stress that it is most desirable to give financial assistance to farmers at the beginning of the farming season when they need to e.g. hire tractors to prepare their farm lands and purchase farm inputs in order to take advantage of the early rains. This means that the processes involved in granting credit facilities and loans to farmers should be initiated well in advance of the farming season.

5.2 Development of early warning systems and effective communication channels for climate adaptation

Governments across SSA should invest heavily in early warning systems on drought and floods to aid farmers in planning their farming operations (Boyd et al., 2013).

Effective communication of information on climate adaptation is essential for adaptation by households as communication increases understanding and awareness (Moser, 2010). In this regard, appropriate communication mechanisms including the use of local radio stations broadcasting in local dialect could be used to ensure that such climate information and warnings reach the intended farmers.

5.3 Improving human capital development to facilitate climate adaptation

Sub-Saharan Africa has low expertise in climate research (Washington et al., 2004). Hence, there should be concerted efforts to improve the overall human capital development in order to improve quality research into climate-related livelihoods problems. The role of extension services in agricultural adaptation to climate change has been documented in Nigeria (Mustapha et al., 2012). Efforts should be made by policy makers to improve farming practices by strengthening the capacity of extension officers through increased staff numbers and training of staff with different specialisms linked to different crops, especially staple crops such as maize, rice, sorghum and millet that hold great prospect for food security in Ghana and SSA more widely.

5.4 Appropriate institutional and policy environments

It is further recommended that appropriate institutional and policy environments should be created for climate adaptations. Supportive institutional framework at the local, national and international levels is critical in enabling successful climate adaptations (Schipper and Pelling, 2006). In addition, there is the need for proper coordination amongst the various institutions involved in climate adaptations. For instance, there should be close collaboration between the meteorological services and extension services for forecasts to be made available for agricultural adaptations.

5.5 Understanding the prevailing cultural norms and practices

Climate adaptations are not undertaken in a “stand-alone fashion” but rather within the prevailing societal norms and cultural practices (Adger *et al*., 2012). Therefore, adaptation practices should take cognisance of these cultural norms and belief

systems in order to increase their appeal and acceptance by the local community. It is recommended that local indigenous knowledge on climate adaptations should be synthesised. Rural households in dryland farming systems in Africa have used their local knowledge to develop coping strategies to buffer against risk and uncertainties in the weather (Roncoli et al., 2002). Therefore, policy makers should consider and appropriately integrate local agro-ecological knowledge with scientific climate assessments in the design and implementation of climate adaptation strategies.

6 Conclusions

By combining case studies and a systematic literature review, this paper has provided a nuanced understanding of the key barriers by demonstrating that households in the case study villages and SSA more widely are confronted by several factors that restrict the implementation of adaptation strategies. Key barriers identified include a lack of financial resources, lack of information on climate change characteristics, institutional barriers, technological barriers as well as social-cultural barriers. Others include limited access to improved varieties and a lack of ready markets. It should be pointed out that these barriers act interdependently to restrict the ability of households to adapt to climate change and variability. Therefore, policy makers need to devise a holistic and coordinated approach in dealing with these barriers. This paper contributes to the academic discourse on climate adaptations by providing empirical evidence to deepen our understanding of the barriers that confront small-scale farmers in their attempt to implement appropriate adaptation strategies to manage the negative impacts of climate change and variability.

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