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Managing the wet and dry – local adaptation mechanisms for climate change in the Tamale Metropolis, Ghana

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ABSTRACT

Many African cities are experiencing signs of climate change and variability. In Ghana, the phenomenon has affected many livelihoods and households. In response, residents and households have built indigenous knowledge and grassroots approaches that are yet to receive policy attention. This study adds to the growing research on grassroots coping strategies in emerging African cities, using Tamale, in Northern Ghana as the case study context. Rooted in a mixed-methods design, the study engaged a total of 127 participants, out of which 123 household heads were randomly selected and surveyed, 4 key informants interviewed and 6 focus group discussions conducted in the selected communities. Data obtained from the household survey were analysed with SPSS, while in-depth interviews and FGDs were transcribed and subjected to content analysis. The study revealed locally observed signs of climate change and variability. In response to these hazards, affected communities and households draw on indigenous knowledge, and coping strategies including community mobilisation for action; migration, livelihood diversification, and social capital built at the family level. These grassroots coping mechanisms are not coordinated and not respected by local government institutions. Strategies for incorporating local adaptation measures into urban planning and development policies are discussed.

1. Introduction and context of climate change

Climate change is a global phenomenon, but Africa is at the receiving end of its harsh impacts (IPCC, 2022; Cobbinah & Addaney, 2019). Incidentally, the continent has the lowest per capita greenhouse gas (GHG) emissions (IPCC, 2022), but the most affected the widespread impacts of climate change and variability. For instance, in West Africa, the observed mean annual and seasonal temperatures have increased by about 1–3°C since the mid-1970s. The frequency of very hot days (> 35°C) and tropical nights (>20°C) has increased respectively by 1–9 days and 4–13 nights per decade between 1961 and 2014 (IPCC, 2022). Again, recent projections show that manifestations of climate change will further increase on the continent (IPCC, 2022). Sadly, African countries are the least prepared for its impacts (Cobbinah & Addaney, 2019). Thus, many countries in Africa do not have established systems for addressing the effects of climate change (Korah & Cobbinah, 2019). Although many of these countries subscribe to international treaties on climate change (such as 2016 Paris climate accord, 1995 Kyoto Protocol), local commitment is limited due to inadequate funding and lack of technical capacities (Cobbinah, 2021). For instance, Diko (2019, p. 519) observed that climate interventions in urban Ghana were ambiguous and lacked "information on the nature, uniqueness, and specific climate change impact these projects will tackle".

In urban Ghana, some previous studies have explored institutional responses to climate change adaptation (Korah & Cobbinah, 2019). Like many African countries, Ghana holds membership of international conventions and treaties on climate change, and as such, have documented required policies and programmes. For instance, there are the Ghana's (Updated) Nationally Determined Contribution to Climate Change (2012, 2021), National Climate Change Adaptation Strategy (2010 – 2020), the National Climate Change Policy (2013) among others (GoG, 2013; 2021). Cobbinah & Addaney (2019) also explored various themes including policies and practices on climate change, and some local responses and adaptation strategies such as migration and livelihood diversification among others without showing how these were informed or supported by national policies. Thus, indigenous coping mechanisms and strategies for climate change in growing cities is still emerging.

To add to this emerging discourse, this study explores the range of knowledge-based grassroots climate change coping strategies deployed by neighbourhoods and households in Ghana's northern city of Tamale, and how they are supported and/or impeded by national climate adaptation policies.

Specifically, the paper poses and answers the following questions: a. What is the current level of knowledge on climate change in the Tamale metropolis? b. Which factors shape existing knowledge on climate change? c. What are the current grassroots coping strategies? And d. How are the grassroots coping strategies shaped by national policies for climate change adaptation?

The paper is structured into five main sections. The first section, of which this paragraph is a part, presents the introduction and background to the study. This is followed by section two, covering the review of relevant literature. Section three presents the approach and methods adopted for the study. Section four presents analysis and discussion of results; conclusion and recommendations are presented under section five.

2. Responding to climate change: Evidence from Africa and Ghana

Currently, there are two main approaches in responding to climate change in Africa (Cobbinah & Finn, 2023). These are mitigation and adaptation. Mitigation connotes all activities, interventions and policies aimed at reducing, avoiding or coping with the impacts of climate change and/or variability (Zoleta-Nantes, 2000). As a slightly improved response, adaptation is the conscious process of alignments to detected or projected climate and its effects (IPCC, 2013). It occurs in the context of statistical, ethical, and economical alterations as well as transformations in information technologies, governance, and social systems in response to climate change (O'Brien & Leichenko 2000). Adapting to climate change is a necessary step to remaining resilient in today's competitive economic systems. Climate Change adaptation hitherto did not receive the needed attention in the early periods of the global climate change fight. There was greater attention on mitigation and its impacts on the environment and people (Kates, 2000). Currently, adaptation has gained more attention to the extent that a special section in the fourth assessment report of the IPCC (2007), was devoted to it.

Between these two major responses to climate change, adaptation is reported as being operational from African countries. Mitigation measures are far expansive, and require more commitment in terms of technology and finance; such measures are often pursued by heavy industrialised countries such United States of America, China, among others (IPCC, 2022). Adaptation measures to climate change are mostly localised decisions and actions employed by individuals and institutions at various spheres in Africa (Folke, 2006). Since these actions are local and scattered, Cobinnah and Addaney (2019, p.5) recommend "harnessing the wealth of innovation concentration to strengthen the adaptive capacities of cities". Nonetheless, care must be taken to capture climate change related adaptation decisions and actions from other actions influenced by social and economic situations, although the distinction may be difficult (Adger et al. 2001).

Existing studies have documented some climate change adaptation strategies that various categories of people employ. First in urban areas, adaptive responses to climate change typically include elevating structures (e.g., housing units) above flood height, construction of communal drains, desilting of local drains (Amoako, 2018; Korah & Cobbinah, 2019). This is often capital intensive, and are embarked on by well-to-do families in the urban space. Secondly, people build partnerships to strengthen adaptive capacities (Mazeka, et al. 2019). This may include the formation of local evacuation teams in floodable areas (Orach, 2009). Thirdly, some people in Africa migrate (often temporally). For instance, In Sudan, Ethiopia and Ghana, vulnerable families send the older men to big cities for wage labour, especially when the reason for moving related to environmental factors such as draught, no farm work during dry season, low crop yield among others (Orach, 2009; Mazeka, et al. 2019; Cobinnah and Kosoe, 2019). Remittances from the migrants enable to their relatives back home to diversify their income sources. Due to the financial resource requirement for migration, "individuals most vulnerable to climate change are not necessarily the ones likely to migrate" (Cobinnah and Kosoe, 2019, p. 113). Furthermore, some well-to-do families are able to adapt to technologies such as liquified petroleum gas (LPG) as a source fuel, rather than firewood (Cobbinah & Addaney, 2019).

For vulnerable families and natural resource dependent livelihoods, climate change adaptation strategies include marginally diversifying farming and/or introducing improved farming practice. This includes rearing of livestock and fishing farming, varying the composition of cultivated crops and changing the methods of cultivating (Schlingmann, et al., 2021; Ajibade, et al., 2019). For instance, Ajibade et al., (2019) reported that smallholder rice farmers in Nigeria plant different rice seedlings as a strategy to mitigate flood-related losses in their farming activities. This method ensures early harvest before the peak of rainfall which usually results in flooding. In Northern Ghana, farmers have adapted to several practices which including agroforestry practices, drought-resistance crops, use of improved seeds, changes in planting seasons, short-duration crops, composting and mulching (Fagariba et al., 2018).

It is said that adaptation must integrate localised actions undertaken by the individuals in reaction to the changing climatic conditions (IPCC, 2022). Are these local and individual adaptation strategies adequately integrated in Ghana's climate change adaptation policies? And to what extent could these strategies benefit the larger population experiencing similar impacts from climate change? This study is premised on these questions, which are very important because they are integral part of the adaptation process. The processes of adaptation include ascertaining risks, assessing actionable options, coming out with conditions that enable adaptation, galvanizing resources, carrying out adaptations, and revision of options with new learning (Gross, et al, 2016). Many African countries, per their membership of international conventions and treaties on

climate change have prepared policies to address the impacts of climate change in their respective countries. Ghana for instance has policies to manage climate change as indicated earlier. Some scholars have argued that Ghana's challenge in addressing climate change impacts is more of implementation issue, than availability of policies (e.g. Asibey, et al. 2022). Nonetheless, the extent to which the policies and frameworks incorporate local and individual adaptation strategies can be assessed from both implementation and sufficient provisions in the policies.

Adequate information is necessary for local communities to be resilient towards climate change impacts (Reid et.al, 2009). Scholars such as Neville & Mohammed (2010) have called for the engagement of people with divergent backgrounds, skills, experiences, and expertise to produce adequate information on climate change. Some studies posit that an inadequate climate change information can be a barrier for people to differentiate between effective and ineffective response strategies to the climate change menace (Neville & Mohammed, 2010;). Consequently, most traditional adaptation strategies have been proven less effective because of their limited alignment with contemporary or technological strategies (Cobbinah and Kosoe, 2019).

The foregoing review has shown that climate change and its variability is a reality in African countries. Manifesting itself through extreme weather conditions such as high temperature, erratic rainfall patterns, and flooding among others, climate change is worsening the plight of many African cities. The attempts at adaptation have been fragmented and involved different temporal and spatial scales of actions such as migration, evacuations, diversifying farming activities. Again, research and policy has been slow in tackling the impacts of, and adaptation to, climate change. However, there are emerging works to continuously shape policy and grassroots adaptation in urban areas; this study is one of such studies, and it sets a good context for exploring indigenous responses to climate change.

3. Approaches and Methodology

3.1 Study setting

The study adopted the city of Tamale, the capital of the Northern region (see Figure 1). In the selection of the city and study communities, the authors did not consider Tamale as a Metropolitan Area, but as a functional area. This was to allow for the selection of communities that are really hit by climate change. As a result, there are communities selected outside the traditional TaMA. According the GSS (2014), Tamale has a population of about 223,252, out of which males form 49.7%, while females accounted for 50.2%. In recent years, there has been a rising situation of climate change and its associated impacts in the Metropolis. Manifestations of these include erratic rainfall patterns, rising temperatures, perennial bush fires, floods, and droughts, which affects water availability, crop productivity, food security, and the general livelihoods (Cobinnah and Kosoe, 2020). Figure 1 shows a map of the functional area of Tamale and the six communities that are earmarked for the study (Fuo, Zagyuri, Koblimahagu, Tuutingli, Zoozugu, and Wurishe). It is worth mentioning that Zayuri and Fuo are not within the Tamale Metropolitan Assembly, but they interact closely with the study district. Also, Zayuri and Fuo have similar impact of climate change to that of Tamale Metropolis, hence these two communities were included in the study. These communities were noted to have been hit by climatic conditions in the metropolis over the years, according to the officials of the Metropolitan Assembly.

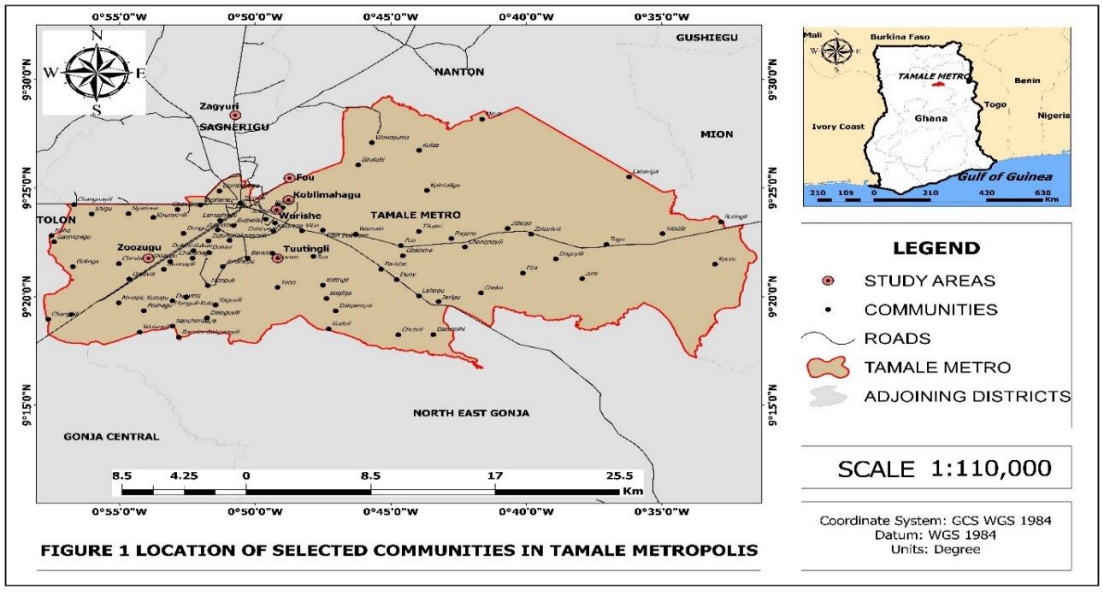

Figure 1: Location of Study Communities in the Tamale Metropolis
Source: Drawn by Authors, December 2022

3.2 Methodology

The study adopted mixed-methods approach, employing both quantitative and qualitative techniques to collect and analyse data on climate change knowledge, local adaptation responses/strategies, and their relationship with climate change policies and programmes. The paper adopted a desk review of four policy and programme documents on climate change adaptation. Based on these two survey tools were designed: a questionnaire, interview guides and FGDs check list.

A total of 127 participants. This includes 123 households' heads randomly sampled, at a confidence limit of 9% from 9,875 households of the six study communities (see Table 1). In the absence of community population figures, the 2010 figures were projected at an annual rate of 2.5%. The 9% confidence limit was applied to ensure that statistically reliability. To validate responses from the survey, 6 focus group discussions were conducted, one in each study community with 12 participants per community – making a total of 72. In addition to this, 4 key informants, 3 from the Environmental Protection Agency (EPA) and 1 from the Tamale Metropolitan Assembly (TaMA) were engaged. These officials were engaged to obtain detailed data on evidence of climate change and grassroots coping strategies in the Metropolis. The field data collection was done between September to November 2022.

Table 1: Sample Size Determination

Name of Community	Number of Households	Sample Size
Fuo	679	12
Tuutingli	1,985	24
Zoozugu	1,232	15
Wurishie	1,995	24
Koblimahagu	2,106	25
Zagyuri	1,878	23
Total	**9,875**[1]	**123**

Source: Authors' Field Study, November 2022.

The quantitative data was analysed using the Statistical Package for Social Science (SPSS version 21) to allow for frequencies, measures of central tendencies and cross tabulation among variables. The qualitative responses were recorded, transcribed and the contents analysed to identify patterns and logic. By using this approach, the climate change adaptation strategies such as livelihood diversification, migration, extended family support, among others emerged as distinct themes from the open-ended responses from both the questionnaire administration and key informant interviews. The presentation of qualitative data was supported with direct quotations of selected respondents.

[1] Number of households were estimated from the 2014 Population and Housing Census

4. Results and Discussions

Under this section, empirical answers to the study's research questions have been discussed under the respective themes.

4.1 Local knowledge and understanding of climate change in Tamale

As many as 81.3% of respondents indicated the knowledge, experience and understanding of climate change and variability and their associated impacts, while 15.5% are unaware of the phenomenon. Interestingly, 3.3% of respondents do not believe in climate change, even though they acknowledged the occasional variability in climatic conditions. Knowledge among respondents has been built through personal observations, direct encounter with the effects of climate change, and engagement with officials of state institutions including EPA, TaMA and others. Respondents' observations were summarised to include 'changes in weather conditions caused by nature and human' (75.5%), 'changes in the geophysical environmental' (12%) or 'news on the depletion of the ozone layer' (10%). The high level of climate change knowledge among residents was earlier found by Cobbinah and Kosoe (2019, p. 103) who indicated that 87% of people in Tamale know about climate change but perceive it as a "complex and mysterious local issue, which is extremely difficult to express or communicate". Contrary to this earlier finding, respondents in the current study expressed increased understanding about climate change in terms of human activities, changes in the environmental conditions and expanded information from state sources. This view had been expressed earlier by Taderera (2010) who argued that despite the low level of technology for measuring the impacts of climate change, residents in most sub-Saharan African countries are able to identify and understand the trends of a changing climate.

In spite of the increased understanding and growing knowledge in climate change and its associated impacts on livelihoods and the environment, there are also intensified community sensitisation and public education activities implemented by the northern regional EPA over the past 5 years. The study also revealed that the level of formal education of respondents also influenced the level of understanding and knowledge of climate change as shown in Table 2. From Table 2, out of the 123 respondents as many as 88, representing 71.5% had tertiary education and they appear to be the respondent group that had knowledge on all the observed local manifestations and impacts of climate change. This view is also supported by Brechin (2003), who pointed

to the effects of socio-demographic characteristics such as educational level, age, gender and occupation on a person's comprehension and perception of climate change.

Table 2: Educational Level and Understanding of Climate Change

Variables of Observations		Understanding of CC				Total
		Changes in weather conditions caused by nature and Human beings	Changes in the environment	Depletion of the ozone layer	No idea	
Educational Background	Basic level	2	1	1	0	4
	JHS	3	0	1	0	4
	SHS	22	1	4	0	27
	Tertiary	66	13	7	2	88
Total		93	15	13	2	123

Source: Field Survey, November 2022

UNESCO (2013) has also pointed out the importance of education and intellectual capacity in understanding the complexities of climate change and variability. To support this view, a study by Neville and Mohammed (2010) also revealed reduced knowledge of Climate Change among peasant farmers who mostly have little or no education. Thus, the science of climate change is complex and can easily be misconstrued (Leiserowitz, 2006), but people with good education may be able to comprehend and take appropriate actions.

Some observed local manifestations of climate change impacts were recorded. These include flood events (48%), increasing temperatures (15%) and erratic rainfall pattern (13.8%). Other respondents also mentioned drought, low soil quality, and high rate of respiratory diseases. Earlier studies in Ghana have confirmed these occurrences as evidence of climate change (Ranasinghe, et al, 2021; Amoako, et al., 2018). This shows that the people of Tamale are aware of climate change and its impacts. For instance, Mabe et al. (2014) cited rainfall variability, changes in relative humidity, bright sunshine duration and increased temperatures as evidence of climate change in northern Ghana. Similarly, Nti (2012) in a study on climate change vulnerability and coping mechanisms in the Northern region of Ghana affirmed that prolonged droughts, devastating floods, bush fires, and erratic rainfall patterns provide ample evidence of the effects of climate change variability. Unreliable rainfall patterns and soil infertility have also been identified by farmers as climate change adversely affects crop yields (Amoako et al.,2018).

Thus, this section has demonstrated substantial experience and knowledge of climate change among respondents in and around the city of Tamale. This increased knowledge has been shaped by levels of education and relevant socio-demographic characteristics such as age, gender and locational circumstances. Findings under this section reflect the view of Cobinnah and Kosoe (2019, p. 135) that "the local people have some knowledge about climate change". This level of understanding influences the coping strategies people adopt, as illustrated in the next section.

4.3 Local Adaptation and Coping Mechanisms

Climate change is one of the most important global challenges of our time, yet comprehension of public response to this issue remains noticeably incomplete (Jaspal, 2012). Local adaptation strategies are a prerequisite for adequate planning for robust climate change adaptation (UNFCCC, 2007). Adapting to climate change must be at all levels, from National to community and individual level. The field survey revealed that households in the metropolis have been practicing both spontaneous and aforethought strategies in their quest to adjust to the changing climate based on the resources and finances at their disposal. The study revealed that households in Tamale have adopted various coping mechanisms These include collective action, migration, diversification of livelihoods, use of new technology and extended family support. These are discussed below.

4.3.1 Adaptation via collective actions in communities

As indicated earlier, flooding and warming were indicated by many of the respondents as the main manifestation of climate change in Tamale. In response, it was found that people in some communities had put their resources and efforts together to adapt to climate change. With the notion of 'unity is strength', several community-based projects have been undertaken. this includes community tree planting initiatives, protection of lands and farms from bush burning during the dry season, forest conservative activities, and instituting by-laws in close consultation with their local authorities. One of the focus group discussions had the following revelation to share with the study:

> "Through our efforts, we have been able to plant a lot of trees in the neighbourhood. Our efforts were even given a boost by the Environmental Protection Agency (EPA) when they presented us with 400

> pieces of acacia to complement our efforts. Our community as a result of these efforts have prevented people from cutting down trees. If you are to build and as a result you have to cut down a tree, then you will need to plant the same number of trees as replacement either near your building or somewhere in the community" (Respondent 1, Focus Group, Zoozugu; November, 2022)

Thus, in Tamale metropolis, through collective efforts in some communities like Zoozugu, people are not only planting trees but also preventing tree cutting without replacement. Furthermore, with the support from state agencies like the EPA, the community's tree planning initiative and by-law was strengthened and established. In fact, planting more trees is one of the mitigative actions to reduce the rate ozone layer depletion. but for people in Tamale, more trees will provide shade and reduce the heat during day and night hours, and this could be achieved through collective action. In another community, it was found that collective action was used to construct drains to deal with flooding.

> "As a result of perennial flooding in this community, we have now come together to mobilise funds to construct gutters and drainage systems. Luckily on our part, these efforts are yielding the needed results. For instance, last year, there were no major floods in the community as compared to the previous years to which we were faced with heavy floods in every part of the community, this affected children and women most especially" (Respondent 2, Focus Group, Wurishe; November, 2022)

Collective action is a viable strategy in response to external stresses such as climate change as seen this study; it has been used to address many societal problems (Kiptot & Franzel, 2012). This reflects other studies (Amoako, 2018; Korah & Cobbinah, 2019) where some communities in Accra contributed resources to desilt choked gutters to prevent flooding. Collective action also occurs through association or group activities. For instance, Cobinnah & Kosoe (2019) found in Tamale that people joined credit unions and took loans to supplement their livelihoods as an adaptation response to draught and food shortages. Elsewhere, it is reported that household heads who belong to farmer-based groups are most likely to plant trees or cover crops to adapt to prolonged droughts due to its labour-intensive nature (Mabe et al, 2014). By these and finding from this study, it is appropriate to say that collective action, whether at community or group/association level is an appropriate adaptation response, especially where the collective effort is augmented by state support.

4.3.2 Adaptation via Migration

Climate change has the potency of increasing migration from rural to urban areas as people flee their homes to escape the adverse effects of the changing climate (IPCC, 2013). In the field survey, about 27% of respondents mentioned migration as a coping mechanism for them to adapt to climate change. In some of the focus group discussions, it was revealed that current changes in rainfall patterns and respondents' incapability to ascertain these changes well enough to adjust their cropping calendars led to a higher incidence of crop failure in their various communities. Again, it emerged that when households are faced with incidences such as bad harvest which is now ubiquitous in the metropolis, most households see it as the perfect window to migrate. From these, the reasons for migrating were erratic rainfall patterns, crop failures, and bad harvest. These reflect Cobinnah & Kosoe (2019) that the adaptation induced migration factors include, low crop yield, water stress, and lack of work during dry seasons. Climate Change events such as floods and droughts can be an instantaneous push factor whilst future changes such as desertification can lead to a reduction in living standards that raises the cost of staying versus leaving (Adamo, 2003). Adger et al. (2001), also argued that those changes to the environment which usually led to infertile soils, is a threat to human security and a window for a new system for migration. Many who migrate mostly give reasons like economic and food security motives, but the main motive for their decision usually lies greatly in the changing climate (Warner et al., 2012).

The study found that household members, particularly women between 15 to 30 years, are usually the ones who migrate as revealed by the field survey. This is considered an opportunity for them to prove their worth to their families and thus dubbed "happy moment", by migrating down south of Ghana (particularly Kumasi and Accra) to look for money so that they support their families to cope with bad harvest among others. Thus, when they migrate, it helps the family in two ways: to reduce the family's burden on the limited resources available, and to bring in some support. These findings confirm several studies already reported (IPCC, 2022; Cobbinah and Kosoe, 2019). For instance, the IPCC (2022) reported that in many African countries, the climate change induced migration is often within the same country or region. Although some studies such as Cobbinah and Kosoe (2019) have reported that of external migration, which involve people moving from the Northern part of Ghana to Europe and Australia, the in-country migration is more predominant due to the transportation cost. The World Bank (2010), in a study in Northern savannah, noted that migration is a significant scheme for both poor and non-poor in Ghana. The non-poor families could support more planned and expensive migration cost (Cobinnah & Kosoe, 2019; World Bank, 2010).

Migration generally has greater potential to reduce risks for stressors, such climate change. In terms of adaptation to climate change, although migration has been adopted as a strategy as migrants could send in some remittances (Awumbila, 2017) limited technical and financial support could limits its meaningful contribution to climate resistance (IPCC, 2022). Studies have shown that male migration can increase burdens of household and agricultural work (IPCC, 2022). This possibly explains why in this study, it was reported that it was the young women, especially who

migrated, leaving the older males behind for farming activities. In Burkina Faso, Beauchemin & Schoumaker (2005) found that droughts that persisted in the 1970s and 1980s resulted in a chunk of people migrating from rural to urban areas in their greater numbers. This affected farming activities in the rural areas, resulting in form security crises. In the urban centres, the migration increases pressure on the available infrastructure, housing and employment, presenting another stress for the migrants.

4.3.3 Adaptation through Diversification of Livelihoods

Climate change impacts such as low harvest result in erratic rainfall reduces incomes of farming households (Ajibade et al., 2019). It thus, renders some income sources unreliable. In response, it was found that about 19.5% of respondents considered diversifying their livelihood to adapt to climate change and its menace. Surprisingly, almost about 95% of respondents were already involved in two or more jobs. The reasons for doing more than one job/work resulted from uncertainties in farming resulting from climate variabilities, knowledge and skill set through education, and the general economic situation in the country. However, for farming households, it was certain that climate change had compelled many of them to explore other livelihood options, while maintaining farming. During a focus group discussion, one participant shared his perspective on livelihood diversification, which was supported by many other participants The perspective is that farming has been unreliable at least for the past 5 years, and thus, to survive, there should be other income sources. The participant specifically made the following comment:

> "Growing up my father was a complete farmer, so myself though educated has also turned up to be a farmer too. During their time they could cope because the lands were not depleted like now, and thus they were fertile. But in our time farming has become more expensive, you have to apply many bags of fertilizer before you can get a good yield. Sometimes you manage to get these bags of fertilizer through government subsidies, but rains fail you big time, then you are worse off. Because of this, I have turned my attention to doing business as well, I now buy and sell cashew as well" (Respondent 3, focus group; Wurishe; November,2022).

The above finding reflects Cobbinah and Anane (2016) that farming households were engaging in off-farm activities to cope with the ever-changing weather pattern in the Jaman North district. This includes trading activities in all kinds of products, such sachet water, alcohol, among others. Income from diversified activities enables households decrease their vulnerability to climate variability (Yaro, 2013). The ability of households to possess income will justify their ability to access food with their high purchasing power as a result of their involvement in alternative livelihoods. The World Bank (2010) in a study also noted that there is a higher rate of livelihood diversification among men than women in Northern Ghana. They posited that apart from most of them being involved in agricultural activities, they have turned their attention to off-farm activities such as shea nut, dawadawa' and fuel/firewood gathering as alternative livelihoods.

Beyond Ghana, studies have shown that expansion or diversification of income sources is a strategy that households that are predominantly farmers adopt. A survey done by Mertz et al. (2010) concluded that in the south of Burkina Faso, most farmers are now involved in dry season planting of green leafy vegetables and off-farm activities so that they can cope with the changing climate. This is further supported by an elaborate study at the lower level in the north of Burkina Faso, where a chunk of people who are farmers, are now involved in activities such as trading, beekeeping and its likes, all these are not dependent on the climate and topography of the area (Nielsen & Reenberg, 2010).

The study revealed other means by which the respondents diversified their livelihood. This includes changing methods of farming and crops cultivated. Farmers in the metropolis now opt for different farming methods like mixed cropping, adapting to new technology such as conservation agricultural practices that retain a great amount of soil moisture, tree planting (afforestation) and agroforestry among others. A respondent noted:

> "As a result of the late start of the rains and early end of it, we now plant our crops before the coming of rains or immediately after the first rain. This is to make sure we make maximum use of the rain before it says goodbye to us" (Respondent 4, Focus Group, Zoozugu; November, 2022).

This confirms Amoako et al. (2018) view that most farmers in northern Ghana were adopting improved farming methods in response to climate change impacts of agriculture. Some of these methods include the use of cover crops to reduce evapotranspiration; use of drought resistant seeds; use of farm manure or mulching to boost soil fertility; and use of different farming systems which include crop rotation, mixed cropping and land rotation. Other strategies which were captured included farming methods such as irrigation methods, inorganic fertilizer usage, early planting and use of virgin lands for farming and among others. The World Bank (2010) earlier noted that farmers in the Tetauku and Boayini in the Savannah zone now plant early before the rains start so that they get the maximum benefit from the ever-shortened rainfall patterns which have been bequeathed to them by the changing climate.

4.3.4 Extended family system as a coping mechanism

Livelihood within the savannah zone is largely subjected to patriarchal arrangement. The patriarchal system emphasizes men, especially the older man, and ascribes resources such as land to the person, while the remaining family members support the production process (World Bank, 2010). As a result, the extended family system is a key feature of the

Tamale metropolis. It is considered as a tradition that must not get extinct at all cost. Most vulnerable people in the metropolis still depend on their extended family system as a safety net in times of stress. The survey revealed that about 16.3% of respondents resort to extended family systems as a social cover during times of stress as a consequence of climate change and unfavourable weather patterns. One of the respondents in a focus group exclaimed:

> "When my family and I were hit by a flood in 2017, I was scandalized and did not know what to do. Fortunately, my extended family were the first people to come to my aid, they relocated me and my family to our family house. Without them, I would not have known what to do at that particular juncture" (Respondent 5, Focus Group; Koblimahagu; November, 2022)

This confirms how the extended family system can help people cope with their lives during climate-related crises, particularly in the metropolis. This practice is not limited to Ghana. For instance, Akinnagbe and Irohibe (2015), asserted that in western Sudan families meet to discuss family members whom they should fund to travel abroad to help others through remittances when the need arises. This practice was also revealed by the study, one of the respondents asserted:

> "My older brother's son who is in Australia, was very helpful when my house was pulled down by a rainstorm. Through his efforts, I was able to build three (3) rooms in which my family and I are now comfortable" (Respondent 5, Zoozugu; November, 2022)

This reveals how extended family systems can help people to cope with stress caused by climate change and its manifestations. From the survey, it was revealed that most of the households in the metropolis live in their 'family houses' This helps them to cope with stress and climate-related disasters by acting as social capital for them. Studies have shown that family establishments that can boast of humongous family sizes are most likely to take advantage and use more labour-intensive adaptive or coping measures because they have a large labour pool (Anley, et al., 2007). This reflects Dzramedo, et al. (2018) that although there is a shift in Ghanaian society towards the modernised nuclear family, the extended family system is still strong and plays effective social welfare roles.

4.4 Ghana's policy responses to local community and individual adaptation strategies

The previous section has shown that at the individual and local levels people adapt to climate change as they encounter its impacts. Thus, even without any national policy and action on climate adaptation, the local people still adopt various strategies although these are often uncoordinated, and hence may not be effective (Cobinnah and Addaney, 2019). This is where national policies and programmes become necessary, to support, coordinate and maximise the local efforts to effectively respond to climate change. Against the argument by some researchers (e.g. Asibey, et al, 2022) that Ghana's challenge in response to climate change is more of implementation than availability of documents, this section assesses Ghana's policy response to climate change adaptation strategies of local and individual community members in Tamale. This is done from two perspectives: national policy and programming on climate change adaptation, and the institutional responses to adaptation strategies of the local community and individuals in the Tamale metropolis.

Table 3 provides an assessment of some key Ghana's climate change policy documents. The assessment shows that adaptation is a major component of all the documents reviewed. It features in the objects or purpose of the policy or programme document. The National Climate Change Policy that was prepared about a decade ago, prioritises adaptation and mitigation strategies to respond to climate change. Ghana's Nationally Determined Contribution (NDC) to Climate Change was first prepared in 2012, revised in 2015, and updated in 2021. In all these NDC versions, climate change adaptation strategies are outlined. Specifically, the 2015 version aims at the attainment of low carbon climate resilience through effective adaptation and greenhouse gas (GHG) emission reduction in areas of food security, land use, infrastructure, social development among others. The National Climate Change Adaptation Strategy (NCCAS) (2010-2020), together with the National Climate Change Adaptation Plan Framework (2018) aim to mainstream climate change in the nations planning systems to ensure that the global menace is tackled from all sectors and government structures (GoG, 2018).

Table 3: Assessment of Ghana's Climate Change Policies/Documents for Adaptation Measures and Actions

S/N	Policy document	Main objectives	Adaptation focus	Provisions for communities/ households

1	Ghana's Nationally Determined Contributions to Climate Change (2012/2015)	- Attainment of low carbon climate resilience through effective adaptation and greenhouse gas (GHG) emission reduction in: - Sustainable land use including food security - Climate proof infrastructure - Equitable social development - Sustainable mass transportation - Sustainable energy security - Sustainable forest management; - Alternative urban waste management	- Yes, 11 adaptation policy actions - Building Agriculture resilience - Adding value to forest resources utilisation - Planning resilient infrastructure in cities - Providing early warning and disaster prevention - Managing climate-induced health risk - integrated water resources management - Resilience for Gender and the Vulnerable	- Yes, but a few actions: - Adoption of modified community-based agriculture; - Adoption of climate informed information system including traditional knowledge on health risk management
2	National Climate Change Adaptation Strategy (2010 – 2020)	- Mainstreaming climate resilience and decreased vulnerability to the Ghanaians - Increase awareness on linkage between climate adaptation and national development - Increase robustness of infrastructure development - Promote technology innovation	Yes, mainly. Lists 10 priority adaptation actions including: - Enhancing early warning systems - Alternative livelihoods - Agriculture diversification - Improved access to healthcare - Enhancing fisheries resource management	Yes, but general: - Town/area councils are to prepare their adaptation plans and submit to district assemblies for incorporation into district plans
3	National Climate Change Policy (2013)	- Effective adaptation and mitigation in areas of energy and infrastructure, natural resource management, agriculture and food security, and disaster preparedness. - Social development for a more coherent, equitable and integrated society	- Yes, outlines effective adaptation as one policy objective	Yes, recognizes community-based adaptation measures and small-scale adaptation strategies by communities
4	National Climate Change Adaptation Plan Framework (2018)	- Identify priority climate adaptation actions in the medium and long term. - Facilitate institutional coordination around climate change adaptation. - Accelerate the mobilization of funds for climate change adaptation	- Yes, mainly focused on adaptation planning processes	Yes, builds community-based adaptation approach into the framework; Ensures participation and collaboration in decision making

It is also significant to underscore the extent to which adaptation is emphasised in all of the documents reviewed. The NDC and NCCAS particularly outlines specific adaptation policies or priority area. Looking at the list provided in Table 3, the adaptation focal areas often include agriculture diversification and resilience, disaster warning systems, health risk management, value addition to forest resources, and resilient infrastructure, taking into consideration gender and the vulnerable. These adaptation provisions often target communities, groups or sectors much more than individuals. The NDC for instance makes provisions for modified community-based agriculture and the use of traditional knowledge for responding to health risks. All the other national documents make general provisions for community adaptation such as the zonal councils making their climate change adaptation plans for inclusion in the district medium term development plans.

In Tamale Metropolis, the study found some household or community adaptation strategies that have direct relationship with climate change programmes/projects implemented in the northern regions. Interaction with the official at the EPA

official revealed two projects that have informed or supported adaptation strategies of the households. These include the Ghana Environmental and Resource Management Project (2009-2015), and the Sustainable Land and Water Management Project (GERMP) (2011-2025). The drafting of the projects and implementation were informed by national programmes and policies on climate change as indicated by the EPA official interviewed:

> "Climate change is a global thing but nations have their policies. In the design of the projects the key consideration was referencing national policies. Therefore, these projects were prepared and carried out in tandem with Ghana's National Climate Change Policy (NCCP) to combat drought and desertification." (Key Informant Interview I, Tamale; November, 2022).

These projects had afforestation and sustainable livelihood components, and as such exposed the communities to various adaptation strategies. Through collective efforts of some communities in the metropolis, as indicated earlier, EPA provided fast growing tree seedlings for planting in the communities. The target areas included river bodies, so as to enhance farming during dry season. In addition to the afforestation, the GERMP introduced households to alternative livelihood activities such as goat and grasscutter rearing as well as village savings and loans associations (VSLA) to improve savings and access to credit facilities. All these are climate change adaptation strategies that individuals and households adopted in the study area. For instance, Cobinnah and Kosoe (2019) found that formation of VLSAs was a collective action that people used to diversify their income and livelihood.

Thus, the study has shown that the national policies and plans on climate change have informed and supported community/household level adaptation strategies. This means not all of the adaptation strategies discussed in the previous section are emanating from the respondents' ingenuity or indigenous knowledge. Some strategies such as tree planting, formation of VSLA, or usage of improved energy for cooking, among others were informed by programmes and projects implemented by national institutions such as the EPA. In part, EPA funded the growing of trees in the communities, although it was made possible by the community's collective action. This shows some form of funding community/household adaptation strategy although climate change adaptation financing is very limited in the global south (Diko, 2019; IPCC, 2022). It must also be noted that it may be difficult for national policy or programme to finance some of the individualized adaptation strategies such migration or family support. Such strategies were informed by peculiarities of the individuals or households and were employed without any recourse to communal arrangements. Therefore, the extent to which national policies and programmes on climate change may respond to, or be informed by, depends also on the communality or individuality of the of adaptation strategy being employed.

5. Conclusion and recommendations

This study extends the discourse on the current knowledge and responses to the impact of climate change in urban areas of the global south. Adopting Tamale, an emerging metropolitan area in Ghana, as a case context, the study attempted to explore the level of knowledge among residents, sources of their knowledge, grassroot responses, and how these are shaped by national policies. The study reveals high level of knowledge among residents. Particularly, most residents are aware of the causes, manifestations and effects of climate change in their neighbourhoods. They are able to distinguish between the manifestations of climate change and climate variability; and have local names, situations and circumstances to depict these differences. While these findings are not particularly novel, they point to the continuous expansion of climate knowledge at the local level. Again, the sources of local knowledge on climate change also reveals expanded conversations among local elites and indigenous households on the subject. For instance, the study reveals that local primary schools, information centres and radio stations have shown improved interest in the impact of climate change on livelihoods and infrastructure.

In line with expanded indigenous knowledge, residents have devised various local responses to either cope or mitigate the impact of climate change at both household and community levels. Significant among these responses include diversification of local livelihoods, structured community action, migration and activating family level social networks. Again, these findings confirm views from existing literature (Cobbinnah and Kosoe, 2019) except the use of the extended family system. The significance of this finding is in the fact that climate action is discussed at family levels as a way of showing the expansion of local climate knowledge and the readiness of family members to support their affected ones. Thus, the extended family members or house served as protective cover for people affected by flood or draught to navigate the stress and remain afloat. In a society where there is a gradual shift towards the nuclear family system (Dzramedo, et al., 2018), climate change may compel people to re-establish strong ties with the extended family structure since it provides opportunities for adaptation.

Interestingly, in spite of the expanded knowledge at the community level there seem to be limited connection between national policy of climate change and local action and responses. This finding, though expected, is surprising because many respondents were unaware of national policy but were seen to be operating within its tenets. This is a further indication that climate knowledge is growing alongside national policies. While not much has been done to harmonise local action and national policy this presents huge opportunity for that to happen. Again, this finding points to the need for future climate policies to adopt bottom-up approach in their formulation. Given that many African countries are still limited in terms of real programmes and

projects to address climate change, it is important that practical and less expensive adaptation strategies are documented, demonstrated and shared for many people to adopt to their local situations. in this regard, we recommend the integration of the local adaptation strategies into national programmes and policies. This can be done through the involvement of local stakeholders. As its key contribution, this study throws light on the need to continuously monitor the operational and functional relationships between national climate policies and coordinated local action, especially in countries where sub-national institutions are weak and financially less capable.

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