ROUTLEDGE HANDBOOK OF CLIMATE CHANGE IMPACTS ON INDIGENOUS PEOPLES AND LOCAL COMMUNITIES

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14

CHANGING TERRAIN

Evidence of climate change impacts and adaptive responses of Dagbani Indigenous communities, northern Ghana

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Introduction

Climate change remains a global issue creating environmental, social, and economic problems at different levels and scales (Mendelsohn et al., 2006; Popoola et al., 2020). Climate change has severely affected the livelihoods of people, especially those who depend heavily on the natural environment and/or have a low capacity to adapt (Tirivangasi and Nyahunda, 2019). Therefore, efforts are aimed at assisting vulnerable populations to adapt to the changing climate (Pörtner, 2022).

Sub-Saharan Africa is one of the most vulnerable regions, very susceptible to the impacts of climate change due to the overreliance of its economy on climate-sensitive activities and its very low adaptive capacity due to acute poverty levels (AGRA, 2018; Di Falco, 2018). The region highly depends on rainfall to provide water, food, and energy to its inhabitants (Ofori et al., 2021). The prevalence of rain-fed agriculture in most of sub-Saharan Africa makes its food systems highly sensitive to the changing rainfall (Thompson et al., 2010). High poverty rates, conflicts, poor management of natural resources, and low socioeconomic development also increase the region's vulnerability (Maja and Ayano, 2021). Meanwhile, temperatures on the African continent are projected to exceed the global average (with an increased average of 3–4°C). Changes in precipitation are also expected in the 21st century through to the 22nd century (Niang et al., 2014; Thompson et al., 2010).

Changes in the climatic conditions of sub-Saharan Africa have led to many environmental problems, such as an increased infestation of pests and diseases, household asset depletion, rural-urban migration, biodiversity loss, and ecosystem degradation (Abaje and Giwa, 2007; Muli et al., 2018; Theunissen, 2018). Also, climate change has resulted in extreme weather events, such as flooding, droughts, and soil erosion leading to a drastic reduction in crop yields and rising prices of food commodities (Bedeke, 2022; Ibe and Amikuzuno, 2019; Wossen et al., 2018).

The impact of climate change has led to the formulation of measures to help the vulnerable adapt (Bahadur et al., 2013; Berkes et al., 2013). The success of these measures at the local level depends on a deeper understanding of smallholders' perception of climate change impacts (Acquah et al., 2015). An incomplete assessment of climate change impacts that does not consider the conditions of local inhabitants poses a major problem for effective adaptation (Stott and Kettleborough, 2002). Consequently, climate change adaptation and policy formulation processes are

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flawed because of unrealistic projections and assumptions made about the conditions of local communities and Indigenous Peoples (Asare-Nuamah and Botchway, 2019).

Indigenous Peoples seldomly adopt transformative adaptation measures that change the fundamental attributes of their systems (O'Brien, 2012; Olsson et al., 2014). Rather, their responses rely on the interaction between people and their collective activities, which are mediated through kinship, friendship, and informal and formal institutions (Goulden et al., 2013; Moutouama et al., 2022). Indigenous Peoples have activities and networks that foster diversification and help reduce the impact of climate variability and change. However, those in Northern Ghana remain the most vulnerable to climate change despite the use of some local adaptation measures. (Armah et al., 2010; Chemura et al., 2020), more so those in Kumbungu (Musah et al., 2013; Nyadzi, 2016). As a result, the goals of this chapter are (1) to recognize and understand changes observed by people of Kumbungu descent in Northern Ghana, (2) to assess which of the observations are caused by the climate change, and (3) to identify local responses to these impacts. It pursues these objectives through the lens of the cultural theory of risk (Douglas and Wildavsky, 1982).

Theoretical framework

This chapter adopted the cultural theory of risk (CTR), which is based on the premise that people's perceptions of changes are influenced by their cultural environments (Dake, 1991; Johnson and Covello, 1987; Stern et al., 1995). A thorough understanding of the cultural influence on risk perception can be attained by using CTR to explain why and how people choose to react to environmental hazards. This can be done by combining CTR and local or traditional environmental knowledge about weather and climate-related threats (McNeeley and Lazrus, 2014).

The development of CTR has demonstrated that people's risk preferences vary over time, in response to various circumstances and experiences (Bellamy and Hulme, 2011; Rayner, 1992; Spickard, 1989). This is consistent with the idea that culture is dynamic and emergent (Wolf, 1982). According to Rayner (1992), specific sorts of social organizations are linked to different kinds of worldviews. Different types of social organizations see and approach dangers in different ways. As a result, conflict over how groups with various institutional cultures organize and approach solutions may emerge (Thompson and Rayner, 1998).

As suggested by CTR, for sustainable adaptation to climate change to occur, all worldviews must be present and able to have a conversation about various perspectives and priorities (McNeeley and Lazrus, 2014). CTR provides a framework for analyzing cultural conflicts, such as those between groups of climate change "believers" and "non-believers," and it reveals how risk perceptions consistent with values and cultures can be identified (McNeeley, 2014). Engaging CTR at the community level enables the understanding of why measures intended to address climate change, such as adaptation and mitigation, are frequently contentious and even divisive within and between varied communities (McNeeley, 2014).

Methodology

Study area

This study was conducted in the Kumbungu district of Northern Ghana (Figure 14.1). The area is located in the tropical zone, characterized by lowlands and covered by savanna grassland (Abdul-Razak and Kruse, 2017). Kumbungu was selected on the basis that instrumental meteorological data was deficient, with little focus on the study of Indigenous indicators for climate change. The

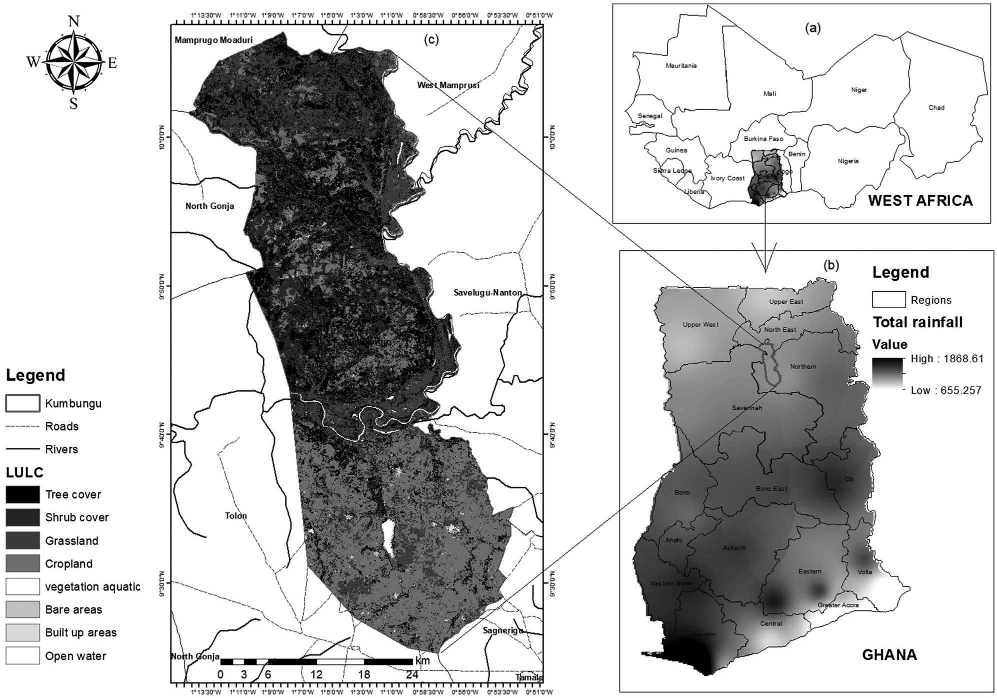

Figure 14.1 Map of the study area. (A) shows Ghana in West Africa. (B) Ghana with annual average rainfall from 1981 to 2010. (C) shows Kumbungu district with land use/cover.

Dagbani ethnic group, estimated at 1.2 million people in Ghana, makes up the local population. Almost all of the households in the district are involved in seasonal small-scale rain-fed agriculture with crops (e.g., sorghum, rice, maize, and millet) and poultry production accounting for about 95% of their total family income (GSS, 2015). Only a few households near the Bontanga Irrigation Project, employ dry-season irrigation (Nyadzi, 2016). Agriculture is negatively affected by the climatic conditions with six to seven months of the dry season (October/November–March/April) and five months of the rainy season (April/May to September/October) (Amikuzino and Donkoh 2012; Nyadzi et al., 2018). The area is also subject to the effects of recurrent floods and droughts (Stanturf et al., 2011; Asante and Amuakwa-Mensah, 2014)

Site selection, sample, and sampling techniques

The villages of Kpasolgu, Kushegu, and Wuba were selected for the study because they have relatively homogenous populations with typical environmental and socio-cultural conditions, and little influence from external forces, such as donor help. The sampling procedure followed those recommended by Reyes-García et al. (2023).

SEMI-STRUCTURED INTERVIEWS

Five key informants were purposely selected for semi-structured interviews to explore and gather site-level data on local livelihoods, local timeline events, and seasonal calendar. Three pilot interviews were conducted first to clarify and contextualize the concepts in local settings and to train translators and research assistants. Also, using the quota sampling technique, the second part of the semi-structured interview was conducted with 18 individuals categorized as young (three men and three women) and old (three men and three women) from each of the three villages. To this sample, we asked questions regarding observable environmental changes attributed to climate change and adaptation/coping measures to respond to these changes (Reyes-García et al., 2023).

FOCUS GROUP DISCUSSIONS

Given that power-play could influence participation, three focus groups were created based on gender and age structure using a convenience sampling technique. The first focus group discussion was for men (mainly household heads) and counted with the participation of 13 people , the second was for women (old and young) with about 10 participants, and the third for the youth only (males) with about 11 participants.

SURVEY

Using information from semi-structured interviews and focus group discussions, a survey with two different parts was conducted. The first part was at the household level with 125 respondents and the second at the individual level with 175 respondents selected using a random sampling technique. The total number of households and individual interviews were uniformly distributed among the three villages. The first version of the survey was pre-tested with ten respondents.

Data collection

Data collection was conducted between November 2019 and June 2021(COVID-19 prolonged the data collection) and the process was divided into four main steps following the protocol developed by Reyes-García et al. (2023). *Step 1:* reconnaissance walks, observations, community meetings and conversations with well-informed locals, literature review, and key informants were used to gather the site and village levels data such as meteorological data, accessibility, infrastructure, seasonal calendar, livelihood and historical timelines of the area. *Step 2:* semi-structured interviews with key informants were used to gather data on observed changes, the direction of changes, the drivers of change, and adaptation techniques used to manage these changes. *Step 3:* The observational changes and adaptation actions identified were further discussed at focus group discussions for validation and elaboration. *Step 4:* A survey at the household and the individual level was organized to gather data on vulnerability, socio-demographics, Local Indicators of Climate Change Impacts (LICCIs), and Local Adaptation of Climate Change Impacts (LACCIs). The data were analyzed using Microsoft excel.

Results

Sample description

About 43% of the respondents opined that their lives have improved over the last 20 years, with the rest of the sample responding to have not seen any changes in their living conditions. Individuals in the study area have received some NGO and governmental sponsorships when undertaking various agriculture projects. Crop production is the primary source of income for all households. Results of the socio-demographics characteristics of individual respondents and household characteristics are shown in Tables 14.1 and 14.2.

Table 14.1 Socio-demographic characteristics of respondents

Individual-level information			
Items	*%*	*Items*	*%*
Gender		**Authority in village**	
Male	57	Yes	20
Female	43	No	80
Age		**Education**	
20–29	5	No formal education	44
30–39	5	Primary school	30
40–49	12	Middle school lever	18
50–59	25	High school graduate	8
60–69	31	**Farm size(ha)**	
70–79	16	<1	1
80–89	6	1–1.9	51
Access to information		2–2.9	47
Almost never	38	3–3.9	17
Almost daily	49	4–4.9	6
Weekly	11	>5	3
Monthly	2		
Sources of information			
Television		**Internet**	
Almost never	61	Almost never	91
Almost daily	29	Almost daily	5
Weekly	7	Weekly	3
Monthly	3	Monthly	1
Radio		**Mobile phone**	
Almost never	0	Almost never	1
Almost daily	95	Almost daily	65
Weekly	5	Weekly	30
Monthly	0	Monthly	4

Authors' construct (2022).

Table 14.2 Household characteristics

Household-level information			
Items	*%*	*Items*	*%*
Monetary debts		**Control over the food they eat**	
Does not owe any money	62	Full control	66
Owes money	38	Some control	34
Number of houses		**Food preference**	
1	1	I mostly eat the food I like, but sometimes have to eat something else	38
2	34	I always eat the food I like	61

(*Continued*)

Table 14.2 (Continued)

Household-level information			
Items	*%*	*Items*	*%*
3	53	I mostly eat food I do not prefer, but sometimes I could eat the food I like	1
4	11	**Freshwater quality**	
5	1	water quality sometimes was not good	45
Government support		**Water quality is usually good**	54
Yes	53	often not good	1
No	47	**Freshwater quantity**	
NGO support		Sometimes we do not have enough water	45
Yes	70	We always have enough water	54
No	30	often we do not have water	1
Well-being		**Freshwater control**	
Better	43	Full	65
Worse	26	Some	35
Same	31	**Freshwater preference**	
Food quality		I mostly do not have access to my preferred water sources, but sometimes I do	3
I did not always have access to safe and nutritious food	32	I mostly have access to my preferred water sources, but not always	51
I usually had access to safe and nutritious food	68	I always have access to my preferred water sources	46
Food quantity			
We always had enough food	89		
Sometimes we didn't have enough food	11		

Authors' construct (2022).

Observed environmental changes

A large number of survey respondents had observed significant environmental changes and were able to point out the directions and the extent to which these changes are affecting their households (Table 14.3). All the respondents reported an increase in rainfall variability, frequency of heavy rainfall, and decrease in crop maturation time. Almost everyone reported a shortened rainy season, an increased frequency of hot/warm days, wind temperature, and average temperature. More than half of the respondents reported a decrease in the number of windy days. Respondents also mention that these changes significantly affect their households by interfering with their daily lives and affecting farm activities and crop growth. Other observable changes that affect their households at varying degrees include an increase in livestock mortality, an increase in the frequency of crop pests, an increase in wildfire frequency, an increase in wind-induced soil erosion and soil loss, a decrease in the quality of pasture, and a decrease in the intensity/strength of cold waves.

Table 14.3 Observable climate change impacts and their effect on households in the Kumbungu community ($n = 125$)

Observable changes	*Noticed*	*%*	*Direction of change*	*%*	*Effect on household (categories created based on responses)*	*%*
Change in the intensity/ strength of cold waves	Yes	77	Increase	2	Does not affect me at all	89
	No	23	Decrease	98	Affects me a little	1
					Affects me a lot	10
Changes in mean temperature	Yes	73	Increase	98	Does not affect me at all	71
	No	27	Decrease	2	Affects me a little	8
					Affects me a lot	21
Changes in wind-induced soil erosion and soil loss	Yes	78	Increase	100	Does not affect me at all	24
	No	22	Decrease	0	Affects me a little	35
					Affects me a lot	41
Changes in wildfire frequency	Yes	81	Increase	100	Does not affect me at all	8
	No	19	Decrease	0	Affects me a little	23
					Affects me a lot	69
Changes in rainfall variability	Yes	99	Increase	100	Does not affect me at all	1
	No	1	Decrease	0	Affects me a little	9
					Affects me a lot	90
Changes in seasons length /duration/ / disappearance	Yes	100	Shorter	98	Does not affect me at all	1
	No	0	Longer	2	Affects me a little	10
					Affects me a lot	89
Changes in the frequency of heavy rainfall events	Yes	98	Increase	100	Does not affect me at all	4
	No	2	Decrease	0	Affects me a little	7
					Affects me a lot	89
Changes in the frequency of crop 'pests' (insects, birds, larvae, etc.)	Yes	98	Increase	100	Does not affect me at all	1
	No	2	Decrease	0	Affects me a little	5
					Affects me a lot	94
Changes in livestock mortality	Yes	63	Increase	100	Does not affect me at all	44
	No	37	Decrease	0	Affects me a little	24
					Affects me a lot	33
Changes in the number of windy days	Yes	44	Increase	39	Does not affect me at all	58
	No	56	Decrease	61	Affects me a little	16
					Affects me a lot	26
Changes in crop maturation time	Yes	32	Increase	100	Does not affect me at all	53
	No	68	Decrease	0	Affects me a little	29
					Affects me a lot	18
Changes in the abundance or density of wild plant or fungi species		28	Increase	6	Does not affect me at all	55
		72	Decrease	94	Affects me a little	31
					Affects me a lot	14
Changes in the quality of pasture		26	Increase	4	Does not affect me at all	53
		74	Decrease	96	Affects me a little	38
					Affects me a lot	9
Changes in wind temperature	Yes	37	Increase	100	Does not affect me at all	47
	No	63	Decrease	0	Affects me a little	39
					Affects me a lot	14
Changes in the frequency of hot/warm days	Yes	98	Increase	100	Does not affect me at all	18
	No	2	Decrease	0	Affects me a little	20
					Affects me a lot	60

Authors' construct (2022).

Responding to environmental changes: adaptation strategies, enablers, and barriers

In response to the observable climate change impacts listed in Table 14.3, Dagbani people at Kumbungu use some adaptation practices (Table 14.4). The application of chemical fertilizers and changing crop varieties emerged as the most used strategies to battle the impacts of changing climates on agriculture. The abrupt changes in climatic conditions, such as drought, have made farmers adopt harvesting rainwater for irrigation in the dry season and supplement rainfall in the wet season. According to the respondents, the low number of people engaged in building rain harvesting systems is due to the high initial cost involved in constructing the water harvesting system. Farmers in the community also plant more trees to provide shade and fresh air and have adjusted the structure and orientation of buildings to provide ample ventilation during the hot season. The use of sandbags along farmlands and river banks was also adopted to reduce the impacts of flood and erosion. The respondents use chemical insecticides and pesticides to control farm pests, as well as mosquitoes and other harmful household insects. With regards to rainfall variability and unpredictability, they rely on weather and seasonal climate forecast information provided through extension services and or radio stations to estimate the timing and amount of expected rainfall for decisions such as when, what, and how to plant. The forecast information is primarily generated by Ghana Meteorological Agency (GMet) and some private entities like ISOKO. To prevent strong winds from damaging crops/trees, buildings and other farm structures, informants engage in staking crops/trees and fortifying buildings against wind and storm destruction. Few informants engage in off-farm activities such as construction work and selling provisions as an essential adaptation practice to supplement the household income especially when yield is less than anticipated.

New crop varieties have been adopted in the community; the most common being New Rice for Africa (NERICA), which has become the most adopted staple crop in the community. Farmers report that NERICA matures early and withstand long periods of drought, disease, and pest infestations and meet the market demand. Farmers in the area attributed the sudden adoption of the new crop varieties, including NERICA, to the changing rainfall patterns, and temperature changes but also to changes in the market and value chain demands. The same reasons (i.e., changing climatic conditions, changing markets, and value chain) were given as the main drivers for abandoning certain local crop varieties such as foxtail millet, local okra species, and local rice varieties. Also, respondents have abandoned some adaptation measures because of their effectiveness in addressing climate impact, for example, the majority of farmers no longer use climate information from GMet (Table 14.3). In some cases, respondents do not have any adaptation measure to address such impacts, for example, no measures had been put in place to prevent the extinction of some local birds.

From the survey, farmers indicate reasons and enablers that inform the adoption of certain adaptation practices. The high benefits derived from adaptation to reduce climate change impacts, high climate change impacts, high severity/damage potential of climate change and its impacts, and sufficient/high financial capital are some of the driving forces in selecting and implementing an adaptation measure (Table 14.4).

Results also show that certain factors limit the implementation of adaptation strategies in the study area (Table 14.4). A key barrier to adaptation was their inability to afford or develop the right adaptation strategies due to a lack of money. The respondents claim poverty is a major factor as to which adaptation measures to be adopted. For example, modifying building structures requires high financial investments, which are unavailable. Also, results from the survey show that little or no

Table 14.4 Adaptation strategies identified at the Kumbungu community

Adaptation strategies	*Adopted*		*Categorized enablers (out of % of those who adopt)*		*Reasons for adoption*	*Categorized barriers*	
	Item	*%*	*Item*	*%*		*Item*	*%*
Build rain harvesting systems to collect water	Yes	20	(High) benefits from adaptation to reduce climate change impacts	60	● To save water for daily activities during long dry seasons	Lack of financial capital	100
	No	45.6	High climate change impacts	28			
	Not anymore	33.6	High severity/damage potential of climate change and its impacts	51.6			
We plant more trees	Yes	49.6	Belief in the potential for other positive side effects of adaptation/coping measure	3.2	● To provide shade from the hot sun ● To provide fresh air	Low benefits from adaptation	0.8
	No	28.8	High climate change impacts	19.4		Time constraint	93.6
	Not anymore	21.6	High severity/damage potential of climate change and its impacts	17.7		Habit/Custom/Preference	5.6
			Other (high) risks (not related to climate change	1.6			
Apply chemical fertilizers	Yes	97.6	(High) benefits from adaptation to reduce climate change impacts	51.6	● To increase the yield of our crops	Lack of financial capital	100
	No	2.4	High climate change impacts	4.1	● To improve the fertility of our soils		
	Not anymore	0	Other (high) risks (not related to climate change	44.3			
Make changes to buildings to make them airy	Yes	36	(High) benefits from adaptation to reduce climate change impacts	35.6	● The weather is hot nowadays	Lack of financial capital	96.8
	No	32	High climate change impacts	44.4	● Reduces heat in the room	Habit/Custom/Preference	1.6
	Not anymore	32	High severity/damage potential of climate change and its impacts	20		Time constraint	1.6
Off-farm activities	Yes	5.6	Other (high) risks (not related to climate change	85.7	● To raise extra income	Lack of financial capital	88.8
	No	38.4	Sufficient/High financial capital	14.3	● To supplement the money gained from agricultural activities	Habit/Custom/Preference	0.8
	Not anymore	56				Low benefits from adaptation	4
						Time constraint	5.6
						Others	0.8

Staking crops/trees and also fortify our buildings	Yes	56	(High) benefits from adaptation to reduce climate change impacts	54.9	● To prevent strong winds from pulling down crops/ trees and buildings	Low benefits from adaptation	97.6
	No	15.2	High climate change impacts	26.8		Time constraint	2.4
	Not anymore	28	High severity/damage potential of climate change and its impacts	19.7			
Use insecticides and pesticides chemicals	Yes	86	(High) benefits from adaptation to reduce climate change impacts	72	● Kill insects and pests on the farm	Lack of financial capital	100
	No	6	High climate change impacts	4.7	● To kill mosquitoes and other harmful organisms in the house		
	Not anymore	8	High severity/damage potential of climate change and its impacts	1.9			
			Other (high) risks	21.5			
Use sandbags	Yes	59.2	(High) benefits from adaptation to reduce climate change impacts	71.6	● To prevent soil erosion due to rainfall	Low benefits from adaptation	90.4
						Habit/custom/preference	3.2
	No	10.4	High climate change impacts	16.2		Time constraint	3.2
	Not anymore	30.4	High severity/damage potential of climate change and its impacts	10.8		Other trade-offs/ incompatibilities	3.2
			Others	1.4			
Plant short-term season crop varieties	Yes	100	(High) benefits from adaptation to reduce climate change impacts	62.4	● The starting date for many crops has changed and become shorter	Lack of financial capital	100
	No	0	Belief in the potential for other positive side effects of adaptation/coping measure	1.6	● Improve yield		
	Not anymore	0	High climate change impacts	19.2			
			High severity/damage potential of climate change and its impacts	11.2			
			Other (high) risks	1.6			
Use weather and climate forecasts for planning	Yes	59.2	(High) benefits from adaptation to reduce climate change impacts	64.9	● To determine the timing and amount of rainfall to take a planting decision	Lack of external support	76
	No	26.4	High climate change impacts	23%		Lack of social capital	0.8
	Not anymore	14.4	High severity/damage potential of climate change and its impacts	12.2			23.2

Authors' construct (2022).

access to weather and climate forecast information impedes farm decision-making. Even individuals who had access to forecast information reported a mismatch between the information provided and farm decision needs given particular local conditions. Some adaptation measures, such as using sandbags to control erosion quickly become ineffective as climate change impacts intensify. Time constraints and habits were some of the limiting factors affecting the implementation of adaptation measures such as planting trees, staking crops and trees, or fortifying buildings.

Discussion

Agriculture employs almost all of the inhabitants in the study area and it is challenged by water scarcity and drought, conditions that are likely to be aggravated due to the observable changing patterns in climatic factors. Informants in the area reported a rising trend in mean temperature, frequency of hot/warm days, and wind temperature, showing a warming climate in the study area. Across Ghana, the rate of warming is most rapid in the northern inland regions than in other parts of the country (Klutse et al., 2020; World Bank, 2010). Rainfall in the study area remains variable over short periods, though an increase in the frequency of heavy events is perceived by farmers. Other studies using farmers' observations and meteorological data have discussed similar trends in Northern Ghana, where Kumbungu is located (Amikuzino and Donkoh 2012; Awuni et al., 2018; Frimpong et al., 2014; Issahaku et al., 2016; Nyadzi, 2016). Almost all of the observable changes identified in Kumbungu have also been found elsewhere in Africa and well documented by previous studies (Agbo, 2013; Farauta et al., 2011; Gebreyesus et al., 2016; Kemausour et al., 2011). In contrast to previous work, our study brings detailed information on the percentage of informants who notice the change, its direction, and its effect on households. The impact of changing temperatures and rainfall will result in a decrease in crop production across sub-Saharan Africa (Barrios et al., 2008; Schlenker and Lobell, 2010).

Studies have reported that changes in climate factors, in particular rainfall and temperature, are crucial to agricultural output (Chepkoech et al., 2018; Nyatuame et al., 2014). The changing pattern in rainfall and temperature in the study area, in addition to a decrease in crop maturation time and shortened length of growing seasons, puts agriculture under threat, as crop failure may increase. As demonstrated by the results of this study, Indigenous People already acknowledge the impact of changing climatic factors on their livelihoods. The negative impact of increasing temperatures and decreasing rainfall has implications for soil and water management and agricultural productivity in general. Also, an increase in temperature, coupled with warm nights and reduced rainfall, affects crops and weed growth, and increases the prevalence of insects, pests, and diseases (Hatfield et al. 2011). Moreover, livestock in the study area are exposed to the direct impacts of high temperatures, affecting their feeding, reproduction, disease prevention, and health in general. Given that farming in the study area is primarily for sustaining family food supply and income (MOFA, 2015), the life and livelihood of the Dagbani people are also under threat.

The type of adaptation practices adopted by the Dagbani suggests the extent of climate impact and the efforts to mitigate them. The unpredictability of the rainfall has increased the demand for weather and seasonal climate information in the study area. However, a major barrier to using climate information was mistrust of the information as the information is not timely provided and does not match needs. Studies have shown that the difficulties to predict the weather and seasonal climate leave serious implications for food production and livelihoods and therefore some farmers combine Indigenous and scientific forecast information to formulate farm decisions. This is also the case in Northern Ghana (Antwi-Agyei et al., 2021; Baffour-Ata et al., 2022; Nyadzi et al., 2018, 2021, 2022; Nyamekye et al., 2021).

The accelerated rate of climate change impact raises new questions regarding the effectiveness of adaptive measures, and what could limit adaptation practices. Results show that a lack of financial resources is a major barrier to implementing appropriate adaptation strategies in the study area. Antwi-Agyei et al. (2015) reported that financial barriers due to a lack of credit facilities are among the most important obstacles hindering the implementation of climate adaptation strategies by farmers in Northern Ghana. The lack of credit facilities as a barrier to adaptation has also been found elsewhere in Africa (Asare-Nuamah et al., 2022; Deressa et al., 2009; Oramah et al., 2022). Therefore we recommend the creation and strengthening of social groups to combine resources, especially financial resources to formulate effective adaptation measures to address climate change impacts

We recognize that while this chapter focuses on identifying climate impact, adaptation, and barriers, it does not examine their multilevel interactions to influence the livelihood of the Dagbani people of Kumbugu. Further research should focus on how barriers influence adaptation and how the adaptation practices will evolve in the future, and the need for transformative adaptation at the local level.

Finally, by applying the cultural theory of risk (CTR), our study provides empirical evidence about local and context-specific impacts of climate change and the factors that influence Indigenous people's adaptation decisions. Moreover, approaching the study from the CTR perspective reveals that the social connections and cultural worldviews of the Dagbani people in Kumbungu, which include their fundamental beliefs about their society and the environment, shape how they perceive the impact of climate change and select the adaptation technique suitable to their local environment.

Conclusion and recommendations

This chapter has provided a nuanced understanding of how climate change poses complex challenges to Dagbani people at Kumbungu in Northern Ghana. Dagbani people have several adaptation strategies to deal with the negative impacts of climate change, but finance remains the major barrier to implementing adaptation strategies. We recommend that social groups should be formed to combine resources to be able to afford and or formulate better adaptation strategies. Households need to be supported with micro-credit schemes. The inclusion of Indigenous people in adaptation policy formulation is highly recommended to offer context, restore trust and increase the useability of these measures. The provision of accurate weather and seasonal climate forecast information that is actionable for climate sensitive decision-making is needed given that most farmers have no confidence in the existing forecast information received. Installing more meteorological stations will serve as a means of obtaining and providing real-time weather and seasonal climate information to the Dagbani people in Kumbugu. Finally, we conclude that through the lens of the cultural theory of risk, empirical evidence has been generated to show that social connections and cultural worldviews of the Indigenous people shape how they perceive context-specific climate change impacts and select suitable adaptation strategies.

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