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Understanding Climate Change and Drought Perceptions, Impact and Responses in the Rural Savannah, West Africa

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Abstract: Rural communities in West Africa have long adopted a variety of coping and adaptation strategies to periods of climate variability and risks. These strategies have mostly been shaped by prevailing indigenous knowledge systems and shared understandings of the underlying causes of climate events. Despite the increasing scientific and policy attention to climate perceptions and integration of indigenous knowledge in climate governance, there is still a lag in going further to probe and consider the socio-cultural and cognitive systems that shape local appreciation of climate change risks and responses. Based largely on qualitative interviews, and complementary household surveys, the paper draws on the concepts of 'mental' and 'cognised' models to examine drought and climate change risk perceptions and responses in the rural savannah of North-eastern Ghana. Local farmers generally allude to changes in rainfall patterns and prolonged intra-seasonal dry spells. Based on subscriptions to local models of blame in explaining climate risks and impacts, it is also seen that prevailing socio-cultural beliefs and understandings of environmental events tend to inform the responses of farmers in addressing these perceived risks and impacts. The paper advocates for ongoing climate action and policy processes to consider the complexity of different actors and context (socio-cultural, institutional, power structures) in enhancing sustainable adaptation and mitigation measures in vulnerable rural communities.

Keywords: climate change; drought; perceptions; food insecurity; mental models; Savannah; West Africa

Citation: Adaawen, S. Understanding Climate Change and Drought Perceptions, Impact and Responses in the Rural Savannah, West Africa. *Atmosphere* **2021**, *12*, 594. https://doi.org/10.3390/atmos12050594

Academic Editor: Daniel Tsegai

Received: 28 November 2020
Accepted: 14 April 2021
Published: 3 May 2021

1. Introduction

Amidst ongoing changes in climatic and ecological systems, almost every part of the globe is witnessing an increase in frequency and intensity of extreme climatic events with widespread adverse impacts [1]. In comparison with other climate change-related extreme events like tropical cyclones, floods and heat waves, drought remains an insidious hazard that has consistently wreaked havoc and immense human suffering, more than any other natural hazard [2]. Drought may be conceived as a "prolonged absence or marked deficiency of precipitation" [3] (p. 198). It describes a "period of abnormally dry weather sufficiently prolonged for the lack of precipitation to cause a serious hydrological imbalance" [3] (p. 198). Whereas drought may occur over weeks to years, the related impacts are often indirect, manifest slowly and could even take longer to recover after conditions have improved; depending on the available institutional frameworks and capacities of the affected areas or countries. The phenomenon may further be broadly categorised into different types: meteorological (climatological), atmospheric, hydrological, physiological, agricultural and socio-economic droughts [4–6].

Within the period of 1900–2020 alone, a total of 748 major drought events (as of May 2020) have been recorded across the globe [7]. Guppy and Anderson [8] report that out of the 411 million people that were afflicted by disasters in 2016, for example, drought impact had accounted for 94% of the victims. Similar records of drought impact also detail the loss of 850,000 lives and a total of 350 million people as victims of drought events in Africa between 1900–2013 [9]. The projection is that more than 1.8 billion people across the

world will face acute water shortages, whilst two-thirds could potentially live under water-stressed conditions by 2025 due to drought impact on water availability [10]. As already manifesting in several natural resource-stressed areas like the Lake Chad basin and much of the Sahel in Africa [11–13], the associated competition for drought-induced scarce water resources could ignite latent conflicts and widespread displacement with implications for human and regional security [14–18]. These concerns have partly invigorated ongoing international efforts in addressing drought and climate change impacts [19].

1.1. Climate Change and Drought Impact in West Africa

Arguably, West Africa remains one of the most frequently affected and vulnerable regions to droughts and other climatic risks [20]. Long-term climate records point to the climatic regime across the region as generally characterised by multi-decadal climate variability and sustained periods of desiccation [21]. Besides the droughts and famines that ravaged the region in the 1970s and 1980s, and recently in 2012, the spectacle of alternating periods of 'good' and 'bad' years of rainfall, interspersed with periods of prolonged lack of precipitation, warm temperatures and dryness, are typical of the Sahelian climate to which rural farm households have long developed a plethora of responses [22,23]. The assortment of coping and adaptation strategies to droughts and other climatic shocks have mostly involved: the sale of livestock, petty trading, changes in cropping patterns, crop diversification and migration [24].

General local knowledge and understanding of climate and environmental dynamics, have often provided the context and basis on which rural farm households develop valuable adaptation strategies and resilience to climate risks across the region [25,26]. The evolving local knowledge and associated strategies have thrived on the wealth of differing experiences and culturally-embedded understandings of the environment over time [27]. In this light, resilience and the kind of responses that may be initiated in the face of drought impact and other climatic shocks, are peculiar to every locality and greatly shaped by the varying perceptions of people. The way people perceive 'risk' and threats to their wellbeing differs from one person to the other, and is also context-specific. Risk perception involves the "subjective assessment of the probability of a specified type of accident (or event) happening and how concerned we are with the consequences" [28] (p. 80). In effect, the kind of response people may consider is often shaped by their cultural or socially constructed knowledge of the perceived risk and its causes [29,30]. Culture is then pivotal in shaping the way people "perceive, understand, experience and respond to key elements of the worlds which they live in" ([27,31], p. 87).

Generally, the relevance and need to understand and integrate culture, as well as local knowledge into issues of climate change adaptation and development processes have long been recognised [32–34]. Whilst this may seem to be the case, it is also widely acknowledged that the integration of these elements will greatly enhance drought management, information dissemination and preparedness [35,36]. This is because local culture, perceptions or personal beliefs most often tend to overlap with scientific knowledge. Thus, the lack of consideration for these elements in climate action and policy processes could undermine planned adaptation efforts and the potential to enhance adaptive capacities at the local level [37,38]. As shown in the case of the *Fulbe* in Northern Burkina Faso, for example, cultural beliefs, values and practices posed as major constraints for locals to accept options of working in development projects, engaging in labour migration, allowing women to engage in economic activities and gardening as viable strategies to enhancing resilience to drought impact; despite the benefits that their *Rimaiibe* counterparts enjoyed in being actively involved in these activities [39]. In view of the growing recognition, the discussion has since witnessed an increasing focus on the socio-cultural dimensions of climate change, local perceptions, mitigation and adaptation in relation to scientific climatic data [24,40].

1.2. Research Problem and Questions

Despite the increasing scientific and policy focus on climate perceptions and integration of socio-cultural perspectives and indigenous knowledge systems in climate change policy development and governance, there is still a seeming lag in going further to probe and integrate the socio-cultural underpinnings and cognitive systems that shape local appreciation of climate change risks and responses [26]. In highlighting the relevance of long-term culturally defined local experience in climate change discourses, Crane [28] (p. 19) particularly bemoans the little attention to exploring the "relationships between empirical biophysical models and normative cultural models in ways that are robust, synergistic, and practical." Even in instances where local adaptations to climate change, drought and desertification overlap with policy-driven adaptations, the mutually supportive links are often poorly developed [37,41]. The question and need for a consideration of the underlying local cultural and cognitive systems are even more compelling when there are ambiguities or it is realised that there are a host of context-specific socio-cultural, political and economic underpinnings to climate risk responses [39,42].

As an environmentally fragile and natural resource-scarce semi-arid Savannah region, the perceptions of climate change, drought and environmental deterioration, as well as underlying causes and impact on agriculture, have often been the basis for different responses across rural communities. Aside from the limited knowledge, gaps and misconceptions of climate change and impacts on the part of local farmers and 'experts' (like agricultural extension agents) at the community level [43,44], the resort to subjective and culturally-embedded explanation and responses to climate/environmental change and impacts have continued to undermine efforts at environmental sustainability, climate mitigation and adaptation in the region. Both governmental and non-governmental interventions have been active in addressing climate/environmental change impacts, as well as improving the general socio-economic wellbeing of people in most rural communities across Northern Ghana [45].

However, these interventions have often failed to achieve the desired impact. As shown by Samaddar et al. [46], climate change adaptation programmes in the region often fail or do not achieve the desired impact because of the penchant for these interventions to overlook or disregard the integration of the socio-cultural context, opinions and perspectives of beneficiaries at the local level. Besides issues such as poor financing, lack of capacity and consideration for culture, as well as limited participation as constraints to effective implementation of interventions and action [25,45,47], there is often the tendency for policymakers to assume a top-down approach or dismiss local socio-cultural contexts and perspectives in climate change adaptation policy processes in the area [46,48]. Yet, as respectively shown in the cases of climate change adaptation projects in Mozambique [49] and in Samoa (Fasit'otai village) [50], for example, the consideration and inclusion of local culture, traditional institutions and 'effective' participation can enhance resilience and adaptation to climate change at the local level.

Against the foregoing background, this study seeks to contribute to ongoing discussions on the need to consider local perceptions, culture, understanding and context in enhancing resilience to climate change impact, drought preparedness and sustainable environmental management in vulnerable areas [51–53]. The main goal is to examine drought and climate change perceptions, local responses and coping strategies with a specific focus on the rural savannah of Bongo District in the Upper East Region (UER) of North-eastern Ghana. The objective is to evoke a much more nuanced perspective to climate change perceptions, impact and related responses in enhancing sustainable formal or planned interventions at addressing climate change impact and environmental degradation at the local level.

Few studies on Northern Ghana have engaged the question of climate variability and change by juxtaposing rural farmers' perceptions, and adaptation strategies with long-term scientific climate data to ascertain the level of coherence—see [43,44,54–56]. Except for the few that approached the topic through a mixed methodological approach, most have

been based on statistical modelling of climate variability/change perceptions, resilience and adaptive capacity of rural farmers in the region. With a specific focus on the study area of Bongo, for example, Limantol et al. [55] and Aniah et al. [56] examined the topic by employing surveys and statistical analysis of the climate change experiences of farmers in relation to climate data around the catchment area of the Vea Irrigation Dam.

This paper recognises the relevance of these studies to the discussion. However, the motive is to contribute to the state-of-the-art by going beyond the numbers to examine the locally and culturally defined perceptions and narratives on: drought and climate change shocks, underlying causes, impacts and responses in the Bongo area. In doing so, this paper is guided by the following research questions: (a) how do farmers perceive drought and climate change in the area? (b) to what extent do these perceptions relate to existing records of climate (drought/rainfall) and agriculture in the area? (c) what factors influence and shape responses to droughts and other climate-related risks? It is envisaged that an engagement and understanding of the cognitive systems in which perceptions and responses to environmental changes are couched will highlight the emic perspectives of local farmers on how they perceive drought and climate change [44,57]. The hope is also to bring to light the contextualised actions that inform their responses, as well as shape coping strategies and adaptive capacity. Given that socio-cultural perspectives, local knowledge, understandings and actions to climate and environmental events are often at variance with formal scientific knowledge and interventions in most rural areas, the expectation is that a much more nuanced discussion will contribute to enhancing climate/drought risk policy processes in ways that will be culturally appropriate, acceptable and of local relevance.

After a brief engagement with the theoretical explications underpinning mental and cognised models, the paper is broadly divided into 4 sections. First, the paper discusses drought and climate variability in West Africa with a specific focus on the study area. This is followed by a brief background of the research context, study area and methodology. Afterwards, the paper focuses on farmers' perceptions of drought/climate change and impact on agriculture. The fourth section explores local understandings of the underlying causes of climate change, drought and the responses, after which the paper concludes with a discussion and options for consideration in enhancing context-specific and locally-relevant efforts at promoting resilience to drought and climate change impacts at the local level.

1.3. Unpacking Local Perceptions and Understanding of Climate Change and Variability: Mental and Cognised Models

Over the years, the theoretical discussions on cognitive models have elicited a great deal of discussions in understanding people's reasoning, actions and decision-making in relation to their interaction with the world, use of natural resources and understanding of climate change [58,59]. Jones et al. [60] (p. 47) conceive of mental models as simply "cognitive representations of reality." They explain that mental models are internal and exist within the mind. This makes it practically impossible to directly inspect or measure them. In this sense, mental models are inherently "personal, internal representations of external reality that people use to interact with the world" [60] (p. 1). The implication then is that mental models provide the locus or cognitive schemata within which humans base their actions, as well as filter, interpret and store information. As further explained by Downs [61], the reasoning and predictive capacity that people draw from their cognitive schemata allow for the ability to make generalisations and subsequent application to other contexts based on the accumulation of past experiences. Although mental models are often subjective and unique to each person, the reasoning and ability to predict are largely couched or based on complex array of associations and network of mental models known as 'schema' [60,62].

Without recourse to debates on the working of mental models, as whether they are primarily drawn from long- or short-term memory or knowledge, the 'schema' construct and its relevance in explaining the complexity of cultural meaning under 'cultural schema' is of particular relevance to this paper. As explained by Jones et al. [60] (p. 48), 'schema'

basically describes the "long-term knowledge structures which people use to interpret and make predictions about the world around them." In the view of Quinn [63] (p. 38), 'schema' is essentially a "generic version of (some part of) the world built up from experience and stored in memory." Its allure is based on the fact that whilst schemas are dynamic, those built on repeated experiences of a similar sort become relatively stable, influencing our interpretations of subsequent experiences more than they are altered by them [63]. By sharing experiences, therefore, people implicitly share schemas. Shared schemas in this sense somewhat relates to 'cognised models'.

According to Rappaport [64] (p. 238), a 'cognised model' is a "model of the environment conceived by the people who act in it." It encompasses an appreciation of a people's knowledge of their environment and beliefs concerning it. The theoretical explications underpinning cognised models is that people's shared understanding of the underlying causes of events often inform their behaviour and actions. That is to say: people's perceptions, understanding and actions are inherently shaped by the society and culture in which they are embedded. As such, a cognised model of the environment will in this case be envisioned as "part of a population's means of adjusting to its environment" [64] (p. 239). But when it is considered that individual mental models of the environment are embedded in shared socio-cultural understanding and structures [62], 'cultural schemas' could be understood as shared experiences that have been internalised over time and from which cultural meaning is derived and used to interpret, perceive and relate to the world or environment [60,63].

In this sense, local farmers' mental models of climate change or shocks will encompass the "summative conception of all a community's climate knowledge based on their observations and experiences of past and ongoing climate variability" [52] (p. 224). As exemplified in the case of blue crab management in the Chesapeake Bay (Maryland City, VA, USA), the cultural understanding of watermen was that God was the ultimate steward of natural resources [53]. Whilst they argued that nature had a way of taking care of itself, it was also believed that only God and nature could determine the abundance and scarcity of blue crabs. It was thus inconceivable for scientific findings or quantitative monitoring to be able to explain the behaviour and population of crabs. According to the watermen, nature was unpredictable and determined by God; hence their stern opposition to the scientific findings on dwindling the population and regulation of blue crabs harvesting [53].

Whilst application of the cultural model in the case of blue crab management in the Chesapeake Bay reveals the ecological knowledge and cultural beliefs of the watermen, it also brings to light the different perspectives and need to consider the cultural frame of local or vulnerable persons in designing interventions for effective resource management and climate change adaptation. So, in trying to understand the cognitive landscape within which local farmers perceive, interpret and respond to drought and climate shocks, 'cultural schemas' will allow for a focus on shared experiences, understandings and representations of external reality as socially constructed, and influenced by their cultural beliefs. It is envisaged that this will further provide vital points of entry for national climate and agricultural policy processes in considering the worldview and corresponding responses of rural farmers so as to adequately incorporate what fits the context and preference in terms of adaptation [44–46].

1.4. The Study Area in a Broader Context

The study area of Bongo District is one of the 15 districts that constitute the Upper East Region (UER) of North-eastern Ghana. With a total land area of 459.5 km^2, the district is located between longitudes 0.45° W and latitude 10.50° N to 11.09° N (see Figure 1). The area falls within the Savannah Ecological Zone which is marked by a Guinea Savannah to the southern fringes that grades sharply to a Sudan Savannah towards the north-eastern part of the region [65]. As a semi-arid Savannah, the vegetation of the area is marked by drought resistant parkia (dawadawa), kapok, shea, neem and adansonia digitata (baobab) tree species, interspersed with grasses and shrubs. The continuous cultivation of land,

overgrazing and related human activities have further accelerated the rate and extent of land degradation through the loss of vegetative cover, severe erosion and loss of soil fertility.

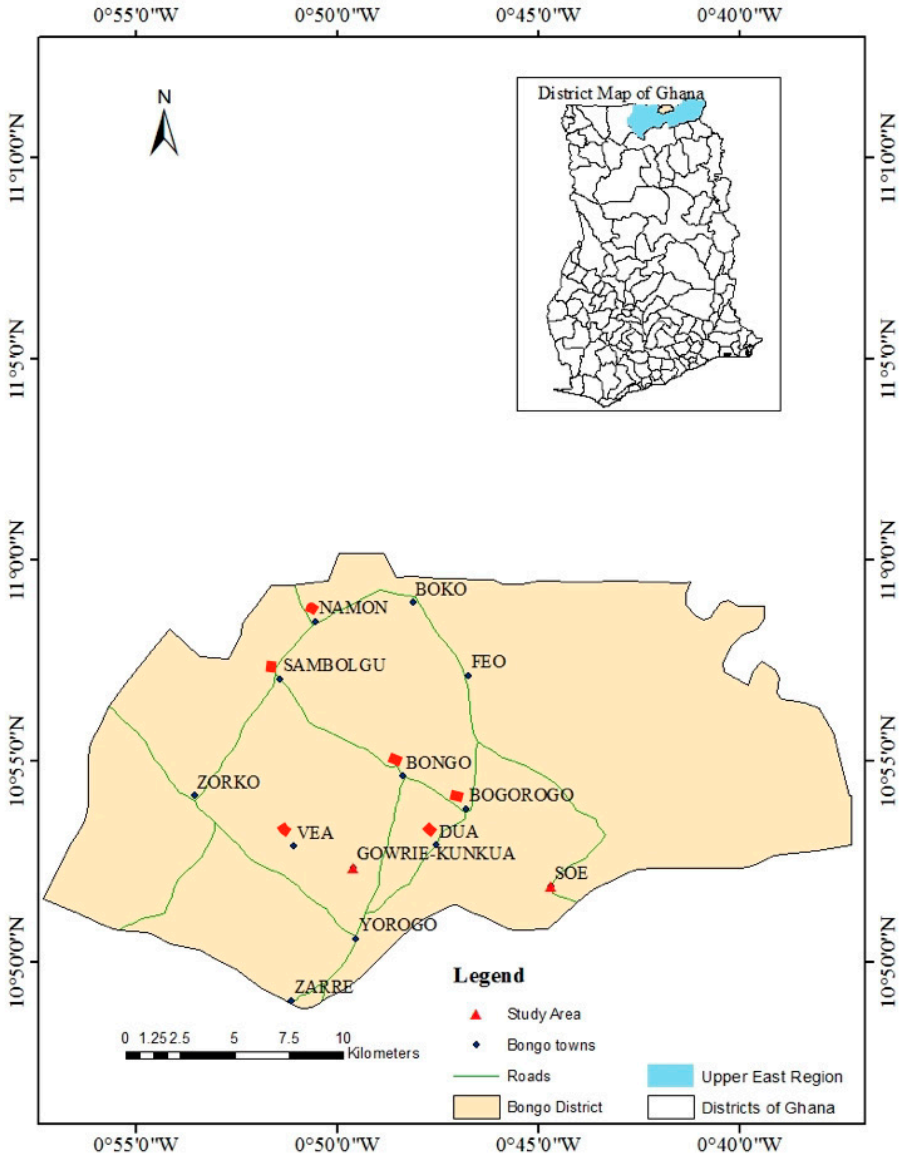

Figure 1. Map of Bongo District Showing Research Sites (UER, Ghana). Map Credit/Source: Philip Aniah (2021).

The climate of the area is marked by a wet and dry season. The wet season marks the period of rainfall activity from April/May to late October. In contrast, the dry season (November–April) is characterised by a period of little or no rainfall. Given that rainfall activity in the area is uni-model, annual rainfall for the district ranges between 600 mm and 1400 mm per annum whilst relative humidity ranges between 92% (wet rainy season) and 15% (dry season) [66]. Alongside the Red Volta River, there are several dams and smaller reservoirs found in the district; amongst which the Vea Irrigation Dam is the biggest. The Bongo District is predominantly rural with a population of more than 84,545 people [67]. More than 70 per cent of the population is engaged in small-scale rain-fed agriculture. The area is marked by a scattered or dispersed pattern of settlement with communities often divided along sections and clans. As in most parts of Northern Ghana, the sections and communities in Bongo often have *tendaamba (pl. earthpriests)* or sectional/sub-chiefs and Chiefs as political heads. The *tendaamba*, who double as political heads and custodians of the land are also responsible for the performance of rituals and sacrifices to the gods [68].

As custodians of the land, they have allodial power and can give consent to anybody who wants to settle or farm in their territory. In particular, reverence is accorded to persons like the *saa-wiira* and *tendaamba*, who mediate and perform rituals to the gods for rain and bountiful harvests respectively during the rainy season [69].

Like many traditional rural African societies, 53.6 per cent of population in Bongo are practicing traditional religion and 28.3 per cent report as Christians (mostly Catholics); whilst the rest are into other religions like Islam [70]. Despite the distinct religious categorisation in the area, most people tend to blend their traditional beliefs and worship with other religions. So it is not uncommon in the area to have people identifying as practicing Christian or Muslims and yet still worship ancestors or perform traditional rituals at the same time [71]. The traditional belief in animism, ancestors and spirits also influence the people's appreciation and use of the environment. As a result, narratives on the causes of disasters, any misfortune, crop failure and general environmental change tend to be associated with sociological explanations. In many instances, any strange sickness, poor rains, floods or bad harvest usually have traditional-spiritual connotations where the *bogro* (soothsayer) is often consulted for direction as to how to address the situation. The *tendaana (singl.)* is also sometimes called upon to offer sacrifices or perform rituals to the gods and ancestors for intervention. It is in this context that this paper delves into the emic perspectives of local farmers on climate/environmental risks and impact in understanding what informs their actions or responses, how this could be considered in shaping climate change adaptation or drought management measures.

2. Research Context and Methodology

The information and data for this paper is drawn largely from the author's PhD research thesis [72], which was conducted within the frame of the large-scale WASCAL (West African Science Service Centre on Climate Change and Adapted Land Use) interdisciplinary research project at the Center for Development Research (ZEF, Bonn-Germany). Informed by an interpretivist paradigm (i.e., reality is complex, distinct and not objective, but shaped largely by individual experiences and the social context) to understanding issues from the subjective perspectives or experiences of local farmers [73], the research was largely based on an ethnographic approach. Data was collected through in-depth and expert interviews, life histories, focused group interviews, participant observation and surveys [74]. Interviews were primarily conducted with local farmers (household heads and members) with the aid of a semi-structured interview guide on issues ranging from: migration, perceptions about climate and environmental change, impacts on agriculture, as well as effects of migration on households and socio-demographic transformation in the study area. In addition, other relevant stakeholders in the community including sub-chiefs and local assembly members, and NGOs in the district were also interviewed to solicit their views on the subject. A total of 5 sets of interview guides were used for the research. Whilst the different interview guides were targeted at the distinct categories of research participants, the questions or topics of discussion did not differ much.

For the data collection, a house was purposively selected with the help of a research assistant to commence with the interviews [73]. Other research participants and respondents were then identified through snowballing. In all, a total of 57 in-depth interviews (40 males, 17 females) and surveys with 120 households (81 males, 39 females) were conducted. Alongside, four focus group interviews with different sets of people were conducted in the communities of Gowrie (mixed males and females), Adaboya (males), Bongo-Soe (females) and Bongo Senior High School (BONSEC—mixed males and females). The reason for the different groups was to get diverse opinions from the people and to give some freedom in view of the sensitivity of the issues that were being discussed. Being present in the communities for the most of parts of a day, over a period of eight months, allowed for participation and observation of key social events, everyday life, farming activities and government departmental meetings [75]. Despite my limited ability to speak fluent Gurune, I could understand whenever I communicated with people in the area. With the support of

my research assistant who comes from the area, I was able to also have extensive informal conversations with people on their farms and during social events in the communities. These informal conversations also provided insights on their worldview, understanding of climate change and farming practices in the area. Despite the complementary household surveys that were conducted, the focus was on other parameters and themes that were being considered as part of the larger research.

With the expressed consent of informants, interviews were audio-recorded with the aid of a digital voice recorder. The recorded interviews were then translated from Gurune where needed and transcribed verbatim. These transcripts were then thoroughly read and manually sorted into an analytical matrix for analysis. Based on the theoretical perspectives in seeking to examine the emic perspectives of local farmers in the study area, an open coding approach was done where inductive codes were derived from the interviews. Given that similar studies have been done in other areas across Africa, axial coding was then done, where connections between deductive codes based on empirical works, theory, analytical memos and inductive codes were derived [76]. For the analysis, a host of different and overlapping codes emerged. The emerging codes were then further categorised into code groups and themes identified. The themes identified were then discussed in relation to theoretical perspectives and research questions. Whilst descriptive statistics are drawn from the surveys as part of the paper, the discussion draws largely on the qualitative data to drill into the aforementioned issues. In discussing the findings, interview quotes are presented in further elaborating the issues. To ensure the anonymity of informants, different names have been assigned in instances where quotes have been presented.

3. Findings

3.1. Climate Change and Drought Perceptions amongst Local Farmers

Across all the 6 ecological zones of Ghana (Sudan Savannah, Guinea Savannah, Transitional, Deciduous Rainforest, Rainforest and Coastal Savannah), climatic events like drought, rainfall, temperature and floods remain important climatic parameters affecting people. But with most people in the Bongo and savannah areas of Northern Ghana engaged in rain-fed agriculture, the critical issues of rainfall variability, as well as drought, remain the most significant climatic parameters or stressors directly affecting their livelihoods.

Most farmers in the rural communities of the study area already had some general perceptions of changing climatic and environmental conditions, as well as some ideas formed from local radio programmes and agricultural extension officers. To ensure some clarity and distinction from general or local generic terminology to environmental change (*korum la teeri*—literally: the past/surrounding/environment has changed) (see also [57]), much explanation was done in asking farmers on their views and perceptions of how the climate has evolved over, at least, the past 30 years.

As may be seen Table 1, for the majority of farmers who alluded to climatic changes in the surveys, the perceived changes basically manifested as irregular and less/no rainfall (drought). A few of the farmers also mentioned the high/warm temperatures being experienced in recent times as being caused by climatic changes. Whilst there seemed to be no distinction in regards to changing weather conditions and climate change, the widespread admission from both the interviews and surveys was that the rainfall pattern had changed (*saa la teeri me*). Farmers pointed to a shift in the onset of rain for the farming season (*sigir)* (see also Roncoli [42] (p. 418)). They explained that the 'normal' seasonal timeline, as experienced over the years, was that the rains started in early April (*dawalega);* with the planting of crops like the early millet and sorghum, already commencing in the beginning of May (*siibedaa)*. But because of the erratic nature of rainfall activity in recent times, one could no longer be sure as to when to prepare plots or even sow for the season.

From the listing of the different perspectives in Table 2, the views of the farmers suggest some changes in the rainfall pattern and temperature in the study area. Local farmers have memories of a 'good' and timely rainfall regime in the past that used to be favourable for their farming activities and wellbeing.

Table 1. Perceptions of Climate Change in the Bongo.

How Has Climate Changed?	Frequency	Percentage (%)
Irregular & less/no rainfall	105	94.59
High/warm temperatures	6	5.41
Total	111	100

Table 2. Views of Farmers on Climate/Environmental Change and Risks.

Parameter/Event.	Perception/Observation
Rainfall	– in the olden days rains were accurate. – nowadays the rains do not come early. – irregular and poor rains—it is not like those days. – it rains less nowadays—in the olden days, July is the time for heavy rains. – rains are unpredictable—but rains heavily & destroy everything when it comes. – nowadays, the wind pattern is rampant. – when it threatens to rain, the rainfall turns to wind. – start of farming season has shifted to July.
Drought	– nowadays it can rain, but when you sow then the rains stop for long time. – less rainfall & so makes the farmland so dry that you have to sow again. – during wet season nowadays, the rains can stop & be dry such that you even feel the heat when you step on the ground. – the riverbeds & Vea dam dries have little or no water even in the wet season.
Temperature	– it is much hotter now than the olden days. – the sun is so hot it kills crops & you cannot even sleep. – more people are dying from meningitis because of the heat.
Agriculture/farming	– harvests were bountiful in the olden days. – intra-seasonal dry spells were not long & so crops used not to die & no need to replant or sow. – crops die off because of little or no rain. – because the rain stops early, the ground becomes hard so difficult to harvest or take out all the groundnuts. – harvest or yields have reduced. – the land is no more fertile.

The issues of less rainfall and drought do not only reflect general views on how environmental and climatic conditions have degenerated, but also the adverse impact on their farming activities and crop yields. These views on climate change and drought across the communities in the Bongo area are well captured in the following responses:

> "(. . .) the rainfall is very poor as compared to the past. In the past 8 years or more, we used to sow in March/April when the rains set in. But now in June and even July, when we used to have abundant rains, you sometimes don't have anything nowadays. You cannot sow crops in time to have good yield, how do you survive or take care of your family?" (Akane. Male Farmer, Age: 47 years, Gowrie-Kunkua)

> "(. . .) in the olden days, it (rain) always started in April. Now, it comes in June and will end in October. Normally, July is supposed to be the time for heavy rains. But we are already in July 15th but no rain! Even when it comes and you sow, the rains can stop for a long time and the crops will not grow well or even die. It can stop for more than a month. This will affect the crops because not all crops will be ready for harvesting. If it rains up until 15 October, then it is okay. But if it stops around 10 October, then it is 2 weeks short. The crops will not do well." (Aduko. Male Janitor/Famer, Age: 36 years, Gowrie-Kansingo)

In expressing their frustrations about the erratic nature of rainfall and effects of drought on their livelihoods, some farmers drew attention to the issue of 'false starts' that could trick one into sowing early. However, the general consensus was that 'false

starts' were familiar occurrences of rainfall activity in the onset of farming seasons. For the farming season of 2012 (also 2015 and 2019), for example, farm plots in the area were prepared awaiting the rains to commence with sowing as early as the beginning of May. Yet, adequate ('real') rains started falling, albeit scantily, in late June. The late onset of rains for farming seasons had culminated in a shift of the cropping calendar in the area. One of the farmers lamented that:

> "The rainfall pattern is unpredictable. Some years, the time you need the rain to come, it will not come. Then at the time all the crops have gone beyond the stage they need more rain, you will now see more rain coming. So the rain pattern here is just unpredictable. Sometimes we will sow late because of the rain. We depend on the rain to do everything. So when the rains delay like this year; we plant late. Around July/August we should have been harvesting but that is not the case because the rains started late. So the rains are changing and it is getting bad every year." (Abagre. Male-Pharmacist, Age: 52 years, Bongo-Nayire)

There were other submissions to the effect that anytime there was a cloud formation to come down as rain, the weather suddenly became windy. As a result, the rain only drizzled for a while with little precipitation amounts. Across most rural communities in Northern Ghana, there is a penchant for some farmers to wait on others to commence with sowing before they also start sowing their seeds. Hence, there is often the tendency to start crop cultivation late across communities. Whilst this delay may be due to the limited numbers or lack of tractors or bullock ploughs to prepare the land in time, some also wait to be sure of the rains before they commence with sowing. Other farmers also delay as a strategy to not overly expose crops to birds and other pests. However, the behaviour or arrival of certain birds, like *koobere* (weaver bird), or flowering of certain trees (*Acacia* and Baobab) used as proxies to predict the nature and start of the wet rainy season have become increasingly unreliable. These proxies and other events are local weather or climatic elements that have become part of the 'schema' or cognitive landscapes of the people over the years. With farmers already conversant with similar occurrences, 'false starts' of rainfall have progressively become part of their mental models of climate change and drought (mostly 'agricultural drought') in the area.

What has mostly been acknowledged is that the lack of precipitation and prolonged intra-seasonal dry spells have become frequent and severe in recent times. In the opinion of farmers, the long dry spells and high temperatures that come with the scorching sun often cause the crops to wither and die. They further explained that millet crops in particular normally appear to be growing well after sowing. But at the time the rain is expected to ensure good harvests, it is delayed or never comes. The rain sometimes stops abruptly during the season, although it might have started late. This often results in post-flowering water stress and impact on the yield of relatively climate-sensitive crops like millet and groundnuts. Moreover, the torrential and stormy nature of the downpours tend to destroy the late millet and guinea corn; especially during the flowering stage. The stalks of the millet crop normally bend or break off and fall to the ground due to the intensity of the wind associated with the storms.

> "When I was growing up as a young girl, the rainfall was accurate. There was a time when there was a time the rain stopped for a long time and resulted in severe hunger. We had to sometimes walk to Bolga to queue for wheat that was being distributed. Apart from that time, I was young . . . the rains used to start at the right time. You could actually tell or sense the onset of the rains with the arrival of *koobere* (weaver bird). Because the rains used to be timely, the crop yields were bountiful. I remember some time ago, my family fed on a season's harvest for 3 years. The rain at the time was good but now the rains don't even come. I don't know if the lands are infertile or not. But as for the rain it's very bad, it doesn't rain at the right time." (Mma. Female Farmer/Food Vendor, Age: 63 years, Bongo-Tingre)

The perceptions of farmers are consistent with similar observations of rainfall trends across the region since 1900. Based on their analysis of historical rainfall trends in northern Ghana between 1900–1993, Dietz et al. [77] (p.156) found that periods of seasonal rainfall variability and fluctuations have generally been the pattern of rainfall activity in the area. They observed that from 1900–1915, for example, the study area recorded a 'bad' period of rainfall, marked by severe droughts in 1904 and 1912 [77]. There was, however, an improvement in rainfall activity with good hydrological years recorded from 1915, which gradually peaked in 1917. This period of good rainfall was followed by a drought within the period of 1918–1920. The subsequent years, as shown in their study, illustrate a consistent pattern of alternating 'good' and 'bad' years of rainfall activity.

An appraisal of available mean annual rainfall data from the Ghana Meteorological Agency for the Zuarungu weather station from 1980–2011, and analysis on rainfall departure from the mean between 1976–2016 [78], corroborate the observations of people and findings regarding the rainfall pattern in the study area. From Figure 2, the data depicts fluctuations in precipitation which mark alternating periods of wet and dry hydrological years in the area.

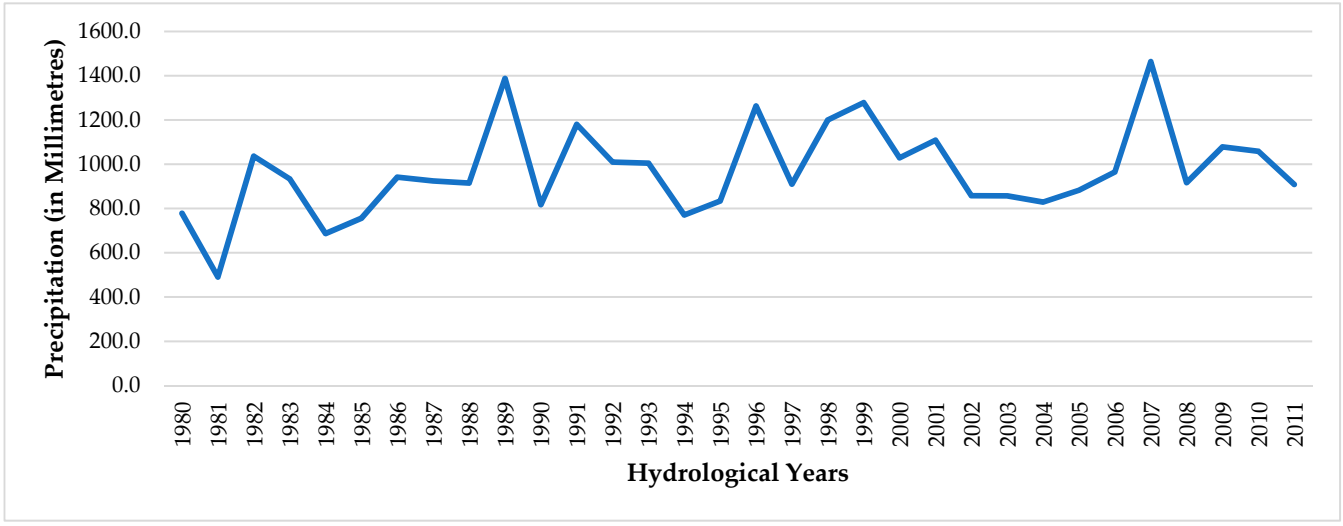

Figure 2. Annual (monthly totals) Precipitation for Zuarungu (UER) (1980–2011). Source: Author (2021).

As can be visualised in Figure 2, the early 1980s, which coincided with the dry years of drought and famine across the Sahel of Africa, recorded lower levels of precipitation that gradually peaked in 1989. This was followed by alternating periods of relatively wet years up until 2007 where the Bongo area, and most parts of Northern Ghana, recorded a considerably wet year with torrential rains, flooding and the subsequent destruction of crops and property. This happened after the area endured a torrid period of extended lack of precipitation at the onset of the rainy season. Following the heavy rains in 2007, the study area has since recorded a rather moderate wet and dry hydrological period of highly variable rainfall, with significant declines in mean annual rainfall. From a fairly stable wet period with ample precipitation between 2008–2010, the area witnessed a considerable decline in rainfall activity which culminated in a shortfall of precipitation for the hydrological years of 2011 and 2012.

In relating these observations to similar findings on the nature of rainfall activity and distribution, specifically for Upper East Region (1976–2016), Ampadu et al. [78] (p. 54) have also alluded to high annual variability and prolonged inter-seasonal dry spells for all the stations considered. Besides their observation of the hydrological years of 2013–2015 as the most recent worst dry period with significant departures from the annual mean, they also found that there had generally been a decline in the distribution of rainfall in the study area and entire country over the last four decades [78,79]. The rainfall departures from the annual mean and negative trend recorded in the study region are indicative of drought

events during the period. These observations have been attributed to the recent aggravation of ENSO across West Africa and hence, the widespread impact of El Nino events within the period. Besides being marked by a uni-modal rainfall pattern, the monthly and seasonal precipitation in the area also varied considerably per each hydrological year. Hence, within the same period of 1976–2016, both inter- and intra-seasonal precipitation also varied considerably; with a significant coefficient of variation in the whole region ranging between 135–630 per cent across the dry period of November to March/April (dry season) as compared to the low variability (25–80%) within the wet months of April–October (farming season) [66] (p. 49–51).

The findings from historical rainfall data and general climatic models give the impression of high rainfall variability as characteristic of the area. However, a critical examination of the convictions of local farmers on changes in the rainfall pattern, and shortfall in precipitation levels, seem to be informed and shaped by their accumulated knowledge based on past experiences and current environmental happenings. This is more likely the case because people often try to "predict the future on the basis of more or less incomplete information and experience regarding the past and present, which are largely embedded in traditional knowledge" [59] (p. 27) (emphasis by the author). The experiences and personal observations of the rural farmers, in their continuous interaction with the environment, have created some mental models of changing local climatic conditions and associated environmental risks. The general views of people interviewed in the communities suggests that the current climatic (weather) conditions tend to vary significantly from a purported 'utopian' past when everything was fairly good. On the other hand, explanations of the underlying causes of the changes in the area tend to translate as models of blame, which seem to establish some causal chain of events by apportioning blame. An examination of the various causes in the next section will give a background to the culturally-embedded responses employed to address the effects of rainfall variability, drought and environmental risks in the study communities.

3.2. Local Models of Blame: Explaining the Causes of 'Climate/Environmental Change' and Drought

General local accounts relating to the occasional invasion of locusts and widespread destruction of crops, as well as human deaths and loss of livestock due to certain diseases, were designated as some form of punishment from the gods for misdeeds of a kind. This notwithstanding, the climate and weather narratives that emerged during the research gave the impression of a timely and copious rainfall regime with positive outcomes for agricultural production in the past. According to research participants, this 'good' past coincided with the period where there was respect for customs and resort to the gods and ancestors for blessings and protection.

The belief amongst people in the study area is that God controls and sanctions everything in the world, including environmental events. These religious beliefs and practices also tend to be integral in agricultural activities and social life. Der [80] (p. 173), in writing about religion in the study area observed that the belief amongst people was that "[. . .] God gave the necessary rain for cultivation. Thus, just before the onset of the wet or rainy season, sacrifices were normally made to God either directly or indirectly through the ancestors in order to obtain rain. Similarly, sacrifices were offered to God after the harvest in thanksgiving ceremonies." In similarity to views of God being the ultimate steward of nature in the case of watermen in the Chesapeake Bay [53], for example, people in the study area are also of the belief that God controls everything in life. So, inasmuch as one could get favours and blessings from God, one could also get sanctioned through sickness and agricultural adversity for any abomination or disobedience towards the gods or ancestors; which serve as intermediaries to the supreme God. Hence traditional rain-makers, fetish priests and witch doctors play vital roles as intermediaries in ensuring a good relationship with the gods and ancestors in order to obtain good rains and harvests.

3.2.1. Local Scientific-Related Models of Blame

Akin to scientific views on the role of human activities in contributing to ongoing changes in global environmental and climatic systems, research participants mentioned the indiscriminate cutting of trees and loss of forest vegetation as causes of rainfall variability, droughts and environmental deterioration in the area. Three-quarters (75%) of research participants were unequivocal about the fact that the cutting down of trees, most especially shea, for charcoal and fuelwood was to blame for the observed changes.

> "(. . .) it is the cutting of trees, because they weren't cutting trees like this. But nowadays, they cut trees for firewood, charcoal and all those things. It is making the wind pattern very rampant. So when it is threatening to rain, you see that it will turn into something different. The weather suddenly becomes windy and as a result the rain only drizzles for a while and stops. So it is due to the cutting down of trees." (Ayinpoka. Female Farmer, Age: 68 years, Bongo-Dua)

As shown in Figure 3, more than half of the survey respondents (63%) similarly alluded to the loss of forest cover and vegetation as one of the reasons accounting for the changes being observed in the rainfall pattern.

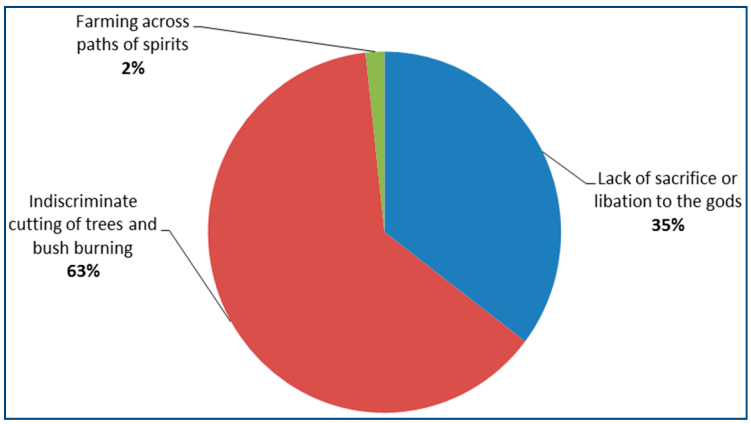

Figure 3. Reasons for Perceived Changes in the Rainfall Pattern. Source: Author's construct based on field survey results (2016).

People in the study area intimated that trees mostly provide shade and help release some moisture into the atmosphere, which helps to create clouds and come down as rain. For them, the trees or forest cover serve as viable obstacles or brakes to prevent precipitation from turning into wind or storms, and from destroying their crops and houses. The hot temperatures and immense heat in the area are not only attributed to the scorching sun and lack of precipitation, but also the lack of forest cover to blow cool air and absorb the heat. These widely-held views resonate with similar findings in the area by Eguavoen [57], where people also identified the loss of forest vegetation and heat as accounting for the changes observed in the climate and environment. In her study, people in the area were a bit more measured in admitting that it was not a good thing to be cutting trees anyhow as they contributed to rain formation. Whilst local farmers in her study explained that felling a tree was like symbolically evicting someone from your home, the general consensus was that bush burning and felling of trees were to blame for the recent changes in the weather and rainfall pattern.

In contrast to scientific-related explanations, many other farmers in the study communities subscribed to cultural models of blame in explaining rainfall variability and recurring periods of drought. These cultural explanations are somewhat shaped by the cultural schemas that people share based on their accumulated culturally-embedded experiences and interpretations of the environment and climate risks.

3.2.2. Cultural Models of Blame

More than a quarter of the informants interviewed (37%) attributed the changes in the rainfall pattern and drought conditions to religious reasons and attitudinal change on the part of people in recent times. An old man in expressing his discontent about the development noted that:

> "This generation is very different. Looking at things, this generation is deviating very much from the customs. (. . .) our time it wasn't like this. When you look at things in general, we used to respect elders in our days. In our days, growing up, respect was very high. But as at now, the situation is that you will gain respect only when you are rich, which was not the case. Now, the children do not even follow traditions and customary practices; why won't we face difficulties? Pouring of libation like this, it has changed. Because, initially this Catholic church was in existence, but people at the time still followed the customs accordingly, in respect to the gods. But as at now, it is not like the way we used to pour libation. Now they do it once in a while. I think it is the White men who brought this. Before they came, everything was perfect. But after they came, everything has now changed for the worse. The rain pattern, at this time (August) it should not be like this. It should be raining heavily. If it were our time, houses like this type with mud will be falling down because of the excessive rains." (Baba Anafo. Old Man, Age: 78 years, Bongo-Balungu)

In particular, the disregard of people in farming across the 'paths' of spirits was identified as another problem in the area. As explained during the research, there are certain 'spaces' or 'paths' on farm plots that should normally be left uncultivated for the free movement of spirits in the night. However, it was disclosed that many people have ignored this customary practice and tended to farm across these 'spaces' and 'paths'. In similarity to the Tonga in Northern Rhodesia (today part of Zambia) where *basangu* or *mizimu* (ancestral spirit (or that of *ulayinka* (former leader)) spirits could punish communities with drought, epidemics, or any other disaster of a kind [81], farming across these 'paths', according to local farmers, hampered the free movement of the spirits at night and hence, has consequences. It was recounted during the research that there was, for example, an extended period of drought in the 2010 farming season. In response, a soothsayer (*bogro*) was consulted as to the cause of the drought. It was subsequently revealed that there were some crop farm plots blocking certain 'paths' of the spirits. In response, the chief ordered the clearing of these areas as paths for the spirits. After clearing the crops to make way for the 'paths', the rains started falling for the season.

> "(. . .) Like traditionally, the sacrifices . . . it is there. What I know is that; you know during every year people will normally farm and leave a certain space on the farm. That is the place to serve as the path for the spirits. It is for the spirits that pass through these spaces. But now, people farm virtually every place. So they farm and then block all these places. You see that they go and do consultations with the *bogro* and then they will realise that the gods are not happy because of the lack of zeal to allow these spaces. So, they go and make sacrifice to rivers and then clear all those areas for that place to be free for the spirits to pass through." (Abire. Male Farmer, Age: 27 years, Bongo-Vea)

Essentially, the local farmers see themselves as victims of the 'irresponsibility' of some people in the area. On the other hand, the views of traditional authorities like the *tendaana* and *saa-wiira* suggest that the people in the communities are the cause of their own suffering due to their negligence and misdeeds. A *tendaana*, who is also a farmer, bemoaned the distasteful attitudes and bad deeds of people as partly accounting for the lack of rain and poor yields in Bongo and its environs. The *tendaana*, who was visibly irritated when the issue of lack of rain came up, explained that:

> "(. . .) in the past, before or even when you cultivate your crops and you have raised animals, fowls, guinea fowls and goats; at the end of the season when

> you harvest, you prepare food, pito, and sacrifice some of the animals. You do this to thank the gods, your ancestors and the spirits who have protected and helped you throughout the rainy season. But today everything has changed; people do not honour that again. Nowadays when people harvest at the end of the season, they just bring someone from nowhere to come and buy or catch (sell) animals anyhow. They send the produce to the market and sell everything without thanking your late father whose spirit has guided you throughout the year and given you a bumper harvest. So, why will the gods and spirits give us rain? The pouring of libation and sacrifices has changed. Just imagine that you have children in the house and they have completed school and they do not even know that it is because of the libation that they have been able to come this far. They keep asking why you have killed and wasted the biggest animal to sacrifice to the gods but not rather sell it to get money and pay their fees. Sometimes they refuse to eat the food and animals sacrificed to the gods all in the name of Christianity. So this sometimes discourages me from making sacrifices and as such making us suffer the consequences; which are often the poor rains and bad harvests." (*tendaana*. Male, Age; 36 years, Gowrie-Kunkua)

The *tendaana* stressed the fact that pouring libation was necessary for good rains, health and a bumper harvest. He attributed the changes to the general disregard for customs and social change brought about by western education and Christianity and hence, the underlying cause of the suffering people were going through in the area. In another interview with a rain-maker (*saa-wiira*), he also complained about people no longer coming to consult for rain. He revealed that people do not even come to make sacrifices to enable him command rain for the community. For him, this was the reason why the place was so dry and hot without rain, even though it was in the wet farming season. When asked why he was not commanding the rain for himself since he needed it for his crops, he retorted that he was not going to do so until people begun to realise that there was the need to appease the gods. Besides, he stressed that whether it rained or not he was still going to be able to feed himself. So he was not going to command rain until people resolved to conform to customs.

> "(. . .) I am the one who command rain here. People no longer come to make sacrifices for rain like used to. As for the rain people think you just get rain without sacrificing to the gods. If you don't bring your thing (animal) for sacrifice, it is more like a cheat or something like that. [. . . .] me I don't need the rain. You see, whether I farm or not I will still eat. The fact that they don't come to me to make sacrifice, they will not be able to harvest their groundnuts. The rice, they will not harvest and there is no way I will command it (rain). If I want it to come today, it will come. But I will not command." (*saa-wiira*. Male, Age: 76 years, Namoo)

The views of the *tendaana* and *saa-wiira* also show that rain and environmental management in traditional African societies also reflect some dynamics of power. Bourdieu [82], in his views on the concept of 'field' as a social setting or structure, describes it as encompassing the rules, norms and interactions between people in a social setting. Each 'field' in this sense defines the values, what is acceptable behaviour and capital; and lastly, what generates power for a person in a relationship. These shared expectations in the 'field' (society) allows for recognition of the resulting power relations and relevance of rain-makers as important actors in ensuring a harmonious relationship between the environment and collective society. Against this background, it is important and justified to know that the *tendaana* and *saa-wiira* in many rural communities of Northern Ghana wield enormous political power.

As elaborated by Sanders [83] in rural Tanzania, for example, Ihanzu rain-makers, like the *saa-wiira*, have spiritual super power and traditional authority. They command rain and are indeed very important stakeholders in decision-making in the society. Ihanzu rain-makers, wield much power in the society and are still very much recognised in

contemporary times. In the case of the Bongo area, however, the perceived laxity of people to adhere to traditional/customary demands and practices tend to translate as challenges or threats to the authority and relevance of persons like *saa-wiira* and *tendaamba*. In similar instances of non-adherence to rain-rituals or disregard for rain shrines amongst the Tonga of Northern Rhodesia, for example, the reverence for rain shrines (be it the *malende* or *kaanda*) and adherence to rituals for the betterment of the larger society was a collective responsibility [81]. Despite describing the Tonga as culturally a 'have-not' group that has never been organised as a State, Colson [81] clarifies that persons who flout the shared rules on good behaviour and peace before the rituals, or are found to have desecrated any of the shrines, are severely sanctioned by the elders for their misdeeds. But in contrast to the study area, the frustrations of traditional rain-makers and earthpriests, such as the *saa-wira* and *tendaana*, gives the impression of subtle challenges to their authority or perhaps waning relevance in the society. It also highlights the evolution of blame regarding changes in the rainfall pattern and environment.

Whereas the call for people to adhere or conform to religious practices or customs was emphatic, certain spiritually powerful persons are also reckoned to sometimes withhold or prevent rainfall in the communities out of sheer greed or show-off. Although claims about these abilities cannot be scientifically proven, such persons are believed to be present and common in the study area and many parts of Africa. As exemplified in an incident recounted by one of my interlocutors, a person was supposedly summoned before the Chief of the area for preventing the rain from falling to the displeasure of members of the community.

> "(. . .) I think it was five or six years ago; someone from Dua community who was believed to have the power to command or withhold rain, actually held it for some time. The land and crops were so dry that if you even set fire it will burn the crops. So, the elders had to make sacrifices and consultations with soothsayers. It was then revealed that this particular man was behind the lack of rainfall activity in the community. So, he was summoned to the chief's palace. Actually, chief threatened and asked him to let it rain or else he will also deal well with him accordingly. Upon persistent persuasion he confessed and agreed to release the rain. Actually, he went home that day and it rained massively. So some of these things they are spiritual things. You see it; very hard to believe. So these things they happen." (Ayine. Male Farmer, Age: 29 years, Bongo-Adaboribisi)

An account such as this could not be independently verified. However, informal discussions with people in the rural communities seemed to acknowledge and corroborate not only this account, but also the existence of such persons and the super natural powers they possess. These shared perceptions on the deterioration of things in general, and the differing mental models of blame, may be seen to reflect what has become part of the totality of the communities cognitive impressions (cognised models) of their changing social and physical environment. But, in recognising also that agriculture in the study area is largely rain-fed, the observed events relating to the erratic nature of rainfall activity and effects of both 'meteorological' and 'agricultural' droughts have continuously threatened livelihoods and food insecurity in the Bongo area.

3.3. Exposure to Climate Risks: Effect of Rainfall Variability and Drought on Agriculture

The national government, in collaboration with other agencies, have introduced newly improved and drought tolerant sorghum and early maturing varieties, as well as crop improvement programmes in the study area [84]. These interventions have been geared at improving agricultural productivity. Despite the ongoing efforts, local farmers have pointed to a consistent decline in yields since the droughts and famine that struck the Sahel in the early 1980s. Close to half of the farmers (41.03%), who were mainly into compound farming (farming or cultivating crops on fields around the homestead), 21 reported that on the average, they harvested 1–2 bags (50 kg) for each of the major staples (late and early millet, maize, groundnuts and sorghum) in a season (Figure 4).

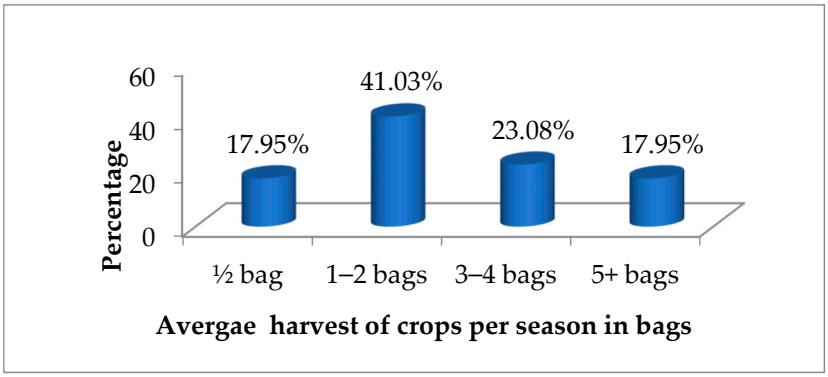

Figure 4. Average Harvest (per season) of Major Staples (in bags of 50 kg). Source: Composed from Field Survey Data (2016).

More than a quarter of the farmers surveyed also reported getting only half a bag or less of crops harvested, depending on how 'bad' the season was in terms of precipitation and yields. For farmers who indicated that they harvested between 3–5+ bags, they were mostly those who had additional 'bush' farms or were into irrigation farming around the Vea Irrigation Dam. The reports of farmers largely converge with yield estimates of selected crops in the Bongo District from 1995–2019 which have consistently shown a decline in yields for staples like millet, sorghum and guinea over the years. As shown in Figure 5, the yield estimates for millet as the main staple, for instance, consistently declined from 1.06 t/ha in 1995 to an all-time low of 0.33 t/ha in 2007. The year 2007 in particular, witnessed an uncharacteristic long dry spell in the wet season. This was subsequently followed by heavy torrential rainfall and flooding that ravaged and destroyed crops and property in the whole of Northern Ghana. Millet production received a boost with an increase to 0.86 t/ha in 2008. Yet, this increment in yields has not been sustainable as there have been subsequent dips and marginal increases between 2009–2015; which coincided with the occurrence of droughts, poor rainfall and late starts recorded within the period (Figure 2).

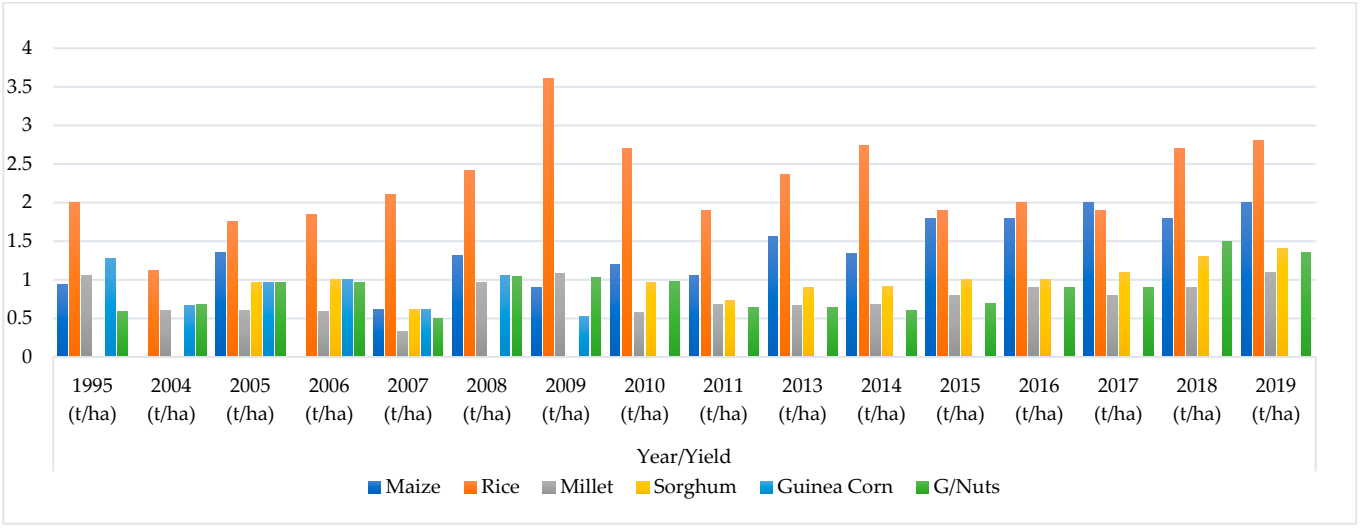

Figure 5. Yield Estimates of Selected Crops in the Bongo District, UER. Source: Statistics, Research and Information Directorate (SRID), Ministry of Food and Agriculture (MOFA) (2020), Bolgatanga.

Apart from rice, similar observations of relatively poor yields could be made for sorghum, guinea corn, maize and groundnuts. Whilst the yield performance of sorghum witnessed some relative improvement over the years, the perceived yield increment has been marginal. Nevertheless, the somewhat better performance of sorghum could be

attributed to the fact that it is a highly drought-tolerant crop [85]. Also, many parts of the region are witnessing a gradual transition from the cultivation of traditional staple crops like millet to other market driven crops like maize, groundnut and rice. According to Kasanga et al. [86], the gradual transition to market-oriented crops in the Northern Savannah may be attributed to technical, economic, as well ecological and climatic factors. Hence, aside from the use of tractors that may have resulted in a transformation of land preparation dynamics, the tolerance of sorghum to drought alongside the introduction of new varieties may explain the observed marginal increases in yield over the period [86]. Comparatively, rice production in the area has been fairly better. The commercial production of rice around the Vea Irrigation Dam may account for the relatively good rice production. This notwithstanding, the use of agricultural inputs and labour-intensive methods give a better explanation for the relatively good rice production. Although a host of institutional-structural factors (37.9%), economic hardship (6.8%), poor soil fertility (27.2%), high cost of input-fertiliser (4.9%), as well as inadequate land/fragmentation (23.3%) have generally been implicated in accounting for the poor yields, it was widely agreed amongst research participants that the lack of rain or drought occurrence was to blame for the poor yields.

> "Mostly, with the growth of our guinea corn and late millet; when we have early rains, maybe we can have good yields. But when there is drought or a break in the rains for about 2 weeks or more, it affects the crops. With that too, when the millet is about flowering, you have ants, birds and insects that destroy the farm. Poor rains too make the crops not to have a good yield." (Akugre. Male Farmer, Age: 62 years, Bongo-Vea)

With agricultural production mainly aimed at household consumption, more than half of the farmers interviewed (68.13%) lamented that feeding the household was challenging because of the poor crop yields. The inability of people to adequately produce or command enough food as part of their 'entitlement bundle' needed for sustenance had exposed them to hunger as a result of food scarcity. The shock that comes with climatic uncertainties or risks tends to undermine the resilience or capacities of people to be able to cope. Whilst people's livelihoods are sometimes overwhelmed by the impact of climate change events, the social support systems are also dying out. As such, most families are often faced with precarious situations with no food for sustenance.

3.4. Local Responses to Drought and Climate Risks

The kind of strategies often deployed to address risks are influenced by culturally-laced perceptions as to whether it is 'official' or 'unofficial' risk [87]. 'Official risk' refers to the threats that are mostly the focus of formal planning or measures instituted by governments and institutions. 'Unofficial risk', on the other hand, relates more specifically to the socio-cultural perspectives where threats to the wellbeing of humans cannot be scientifically explained.

The research showed that both cultural and scientific models of blame tended to dominate the climate/environmental change and risk narratives in the study area. Yet, the recognition given on the part of government and aid agencies to 'official risks' in the area had given rise to responses associated more with scientific models of blame than cultural explanations to environmental risks. The views and responses of people interviewed across the communities straddled the scientific and cultural models of blame. As a coping strategy, local farmers alluded to the sale of livestock and personal assets during periods of food deficit. Although this strategy provided some reprieve, it further served to deplete the asset base of households which also provide some insurance cover in times of distress. A farmer noted that:

> "We rear the fowls and animals so that we can sell to support the family when there is food problem or you are sick . . . even to pay school fees for the children. Our fathers used to rear and keep a lot of cows. All these cows have been sold and there is nothing left. So, if you continue to sell the animals like this every

> year because you did not get much from the farming, nothing will be left. If you are not lucky and they die because of diseases, and you don't get the veterinary people to come in time, it becomes a big problem. Last time like this, it was not good at all. I had a motorbike. I had to sell it to buy food for the family to manage small-small. This is how we manage." (Male Farmer, Age: 47 years, Balungu-Duoni)

The depletion of family assets to gain some income to buy grains, further impoverishes families and undermines their resilience or capacity to cope with drought and climate change impact on their livelihoods. Aniah et al. [56], for example, lend some credence to this observation as they found that about 80% of the farmers they interviewed in Bongo, who sold their key assets as a response, failed to recover or restock their assets after the catastrophe (drought, food shortfall) was over. They noted that the situation had significantly affected and eroded the coping capacities of smallholders, as well as endangered future food production and availability in the communities.

For families faced with food shortages without other sources of income, they intimated resorting to strategic management of grain stocks by rationing consumption within the household. In addition to reducing the number of mouths through migration, the much older members of the household sometimes forfeit food consumption for the younger ones or children. Alternatively, household members resort to eating once a day or the consumption of undesired foods like vegetables, seeds of Kenaf (*Hibiscus cannabinus* L.) or Baobab. Whilst the impact of climatic changes on declining crop yields, food insecurity and changes in dietary patterns have undoubtedly translated into adverse implications for the nutritional status of people (particularly women and children) in the Bongo area [88], research participants also alluded to drawing on the support of other family members as another coping strategy. Although there were general complaints that the social support from familial relations and social networks had considerably waned in recent times, they still remained important in times of agricultural adversity and food shortage.

In line with the general acknowledgement of mistrust and wicked persons who had the potential to withhold rain or spiritually destroy one's farm crops, some farmers alluded to consulting local soothsayers or soliciting protection for their farms from witch-doctors or specially prepared amulets. Aside from making the effort to consult and perform the necessary traditional rites and sacrifice before the commencement of each farming season for good rains and harvest, the protection provided by the charm amulets (*dubula banga*) and concoctions, in the view of some farmers, also limit the abilities of wicked people to bring misfortune to their farms.

> "Last season like this, before I started the season I did consultation and was directed to perform some sacrifices. Although, the rain was not good, I still managed to get something small. Because I also put up a charm amulet on my farm, nobody ventured to steal or could spiritual harm my maize farm. I didn't really get much; but at least it was better than the previous year. This year, I will do the same before I start sowing for the season." (Asaah. Male Farmer, 53 years, Gowrie-Kansingo)

Although the effect of these spiritual consultations and ability of charms to address climate anomalies or enhance agricultural productivity cannot be scientifically proven, their use or patronage is quite common in most rural areas across Northern Ghana. Grindal [89] in his study of the neighbouring Sissala to the north-west of the study area, for example, acknowledges the fear of witchcraft amongst villagers who believe that some 'crop collectors' had the power to spiritually remove crop stalks from another's farm and then transfer them to their own farms. With this common belief, many farmers who wish to guard against these attacks protect themselves and their farms by installing cults or performing rituals on their farms [90]. It was thus common in the communities to see spiritual cults or charms erected on farms to drive away bad omens and deter thieves who may want to steal from the farm. Even though this particular observation was mostly the case for groundnut and

maize farms, many others alluded to consulting soothsayers or getting the rain-makers to offer sacrifices in instances where there was no rain.

Despite not being considered a main staple, many farmers also indicated paying more attention to the cultivation of maize as a response to drought and the decreasing number of rain days, as well as to complement the decline in millet yields. Some of the farmers also advocated for the introduction of drip irrigation to complement their farming activities. For the farmers that have small plots around the Vea Dam catchment, they enhance their farming activities by actively engaging in vegetable gardening, rice and tomato production. Many others undertake shallow groundwater irrigation by drawing on water from small dug-outs in dry riverbeds. However, the lower levels of water and scarcity due to limited precipitation and droughts have remained challenges to farmers.

It was widely proposed that drip irrigation could greatly enhance the capacity of people to cope with drought impact on agricultural activities in the face of increasing frequency and intensity of dry spells in the area. For example, the introduction of drip irrigation by 'World Vision International' in the pilot communities of Gorugu and Dua [91] had brought some relief in enhancing the farming activities and welfare of people [92]. Many other farmers called for such interventions to be extended to other communities within the Bongo District as this could help address the effect of high rainfall variability and recurring droughts on agricultural production in the area [93].

Although the suggestion to stop bush burning and the cutting of trees was widely endorsed by research participants in the communities, the views expressed in one of the focus group interviews in the Adaboya community indicated that the prospect of stopping or reducing the rate at which trees were being felled was bleak. For those who did not appear to identify with an ongoing campaign to stop cutting tress in area, they suggested that the trees did not only limit the space available for farming in the wake of land scarcity, but also served as hideouts for birds and insects to invade, feed and destroy their crops. One of the farmers explained in an interview that:

> "(. . .) although the fertility of the soil has declined, the birds have also increased in their numbers as compared to the past. At the time, you could not find insects and birds destroying the farms like you see today. Besides, we have been asked not to cut down the trees and that we should plant more trees; we have planted and left the trees all over and now the birds have taken the trees as their humble abode. They perch and nest there, and come down to take all our millet away and we suffer?" (Akugre. Male Farmer, Age: 62 years, Bongo-Vea)

As elaborated in the interview above, some of the farmers are not impressed with the call to plant more trees as they serve to provide hideouts for birds and insects to destroy their crops. For these farmers, the prospect of encouraging them to refrain from cutting down trees is bleak. Moreover, in the face of economic hardship and poverty in the area, the hope that people will utilise other sources of sustainable energy other than fuelwood does not look likely. What this means is that, more people will continue to depend on fuelwood, while others will basically see the production of charcoal and the sale of wood as alternative sources of income.

4. Discussion and Conclusions

The study has shown that farmers' perception or understanding of climate change in the study communities relate to the limited and erratic nature of rainfall activity, as well as the increase in frequency and severity of (agricultural) drought—as in the 'unusual' delay in the onset of rainfall activity, or prolonged periods of intra-seasonal dry spells in the area. This understanding is largely informed by the fact that these climatic parameters directly affect their agricultural livelihoods.

A comparison of the views of research participants with available data on trends of rainfall activity and temperature in the study area, also point to high rainfall variability marked by alternating periods of 'good' and 'bad' hydrological years and increasing temperatures. Despite recent projections of regional climate models for West Africa suggesting

the recovery of rainfall from the previous drought episodes of the 1970s and 1980s, it is noted that the timing and spatial distribution of precipitation have continued to vary significantly. The high rainfall variability is coupled with intra-seasonal dry spells (agricultural and meteorological drought), which have become frequent, prolonged and severe.

For rural communities in the study area, and most parts of the West African Sahel, the effects of high rainfall variability and drought are already manifesting by way of increasing crop failure, food insecurity and economic hardship. Besides the impact on agricultural productivity of major staples in the area, there have also been increases in fatalities due to the resurgence of cerebro-spinal meningitis (CSM). The growing levels of malnutrition due to climate change-induced food scarcity in the area raises concerns about the likelihood for the public health system to be overburdened. As exemplified by the 2008 riots [94], which were instigated by climate-induced rice shortage and food price hikes in Senegal [95], another ramification of climate change-induced food scarcity in the study area is also the potential for food riots to degenerate into civil unrest and conflict [96]. These observations likely hold for most parts of West Africa.

The local narratives in the communities, somewhat give an indication of some awareness on the contribution of global warming and anthropogenic activities—relating to the loss of tree vegetation and unfavourable farming practices as causes of the observed climatic changes and failing agriculture. People's resort to culturally defined remedies of pouring libation, using charms or offering sacrifices reflects not only the shared cultural schemas, but follows Hulme's [31] argumentation that climate, as it is envisioned and the related actions, must be understood culturally. What this implies, in terms of enhancing climate change adaptation, drought preparedness and management for vulnerable rural communities, is that ongoing efforts at international, regional and national levels must take into account the context-specific circumstances and socio-cultural dynamics in the design and deployment of climate change adaptation measures.

As observed in the case of most climate and development policy processes, there is often the tendency to develop good policy interventions that will still fail to achieve the desired impact [97]. If there are, for instance, knowledge gaps, lack of consideration for shared culture or different viewpoints on the underlying causes and consequences of climate change and impacts [38,97,98], any efforts to enhance local adaptive capacities may not achieve the desired results [37]. A host of complex factors act to constrain the effective implementation of adaptation programmes at the local level. Nevertheless, typical issues relating to narrow framing in planned, 'top-down' adaptation or climate action, and the tendency to gloss over distinct context-specific socio-cultural and economic dimensions, remain veritable pitfalls in adaptation research and policy planning [52,99].

With reference to the study area, both governmental and non-governmental climate change adaptation programmes have generally revolved around the introduction of early maturing seed varieties, drip irrigation, agro-forestry campaigns and distribution of food grains to communities. These interventions have undoubtedly brought some respite to rural households in the interim. However, like many rural development projects, climate change adaptation interventions or programmes in many parts of Northern Ghana have often failed to achieve the intended long-term impact. As shown by Samaddar et al. [46] and Gedzi et al. [47], the recognition is that community participation and consideration for local culture and worldview of people across communities remain critical to the effective implementation of climate change adaptation programmes or rural development projects in the study area.

For people in these rural communities, navigating everyday life is not only about negotiating climate risks and environmental fragility in the area alone, but also confronting social change and moral decadence as critical elements in maintaining a harmonious relationship with the supernatural and physical environment. Hence, a consideration of the complexity, different actors and context (socio-cultural, institutional and power structures) of climate change and drought impact in rural communities will significantly contribute to sustainable adaptation and mitigation measures in vulnerable rural communities. If many

of the people living in the communities, for example, believe that planting more trees will provide the means for birds to nest and come down and destroy their millet crops, then people will continue to cut down trees. This will mean that any efforts at promoting agroforestry as a sustainable land management strategy to stemming degradation and drought impact would be undermined. On the other hand, if people consider offering sacrifices or pouring libation as key to improving agricultural productivity and environmental conditions, then the possibility for local farmers to, for instance, wholeheartedly accept any improved or early maturing seed varieties may be bleak.

Unlike in the case of state-sanctioned witch-hunting and imprisonment campaigns that were launched in the Republic of Benin in the 1970s–1980s to rid the country of these so called 'backward' and 'retrogressive' actors, as a way to advance the government's modernisation projects [100], the state cannot force people to abandon their beliefs or possibly arrest any persons who may be perceived to be possessing certain magical powers which are being used to derail progress. Whilst the national government could impose or design programmes to help address issues of climate change impact and environmental deterioration, it cannot force people to adhere or change their perceptions or beliefs on the environment. People have the legal right and freedom to practice or subscribe to any beliefs or religion. It is equally important to note that the risk perceptions and preferences of farmers in the choice of risk management strategies are also critical in informing the design of appropriate policies in the area [101]. There is thus the need for government and non-governmental actors to engage and consider the worldview and specific challenges of local farmers in understanding what informs their understanding and actions in terms of responses to climate change and drought risks.

As important actors that still command immense respect and wield traditional and political power in the rural communities, local sub/sectional chiefs (*kanbonaba*), *tendaamba* (as earth priests and custodians of the land) and chiefs should be engaged in disseminating information and facilitating planned adaptation programmes. In addition to empowering and resourcing agricultural extension officers as actors who play a crucial role in transmitting knowledge and strategies to local farmers [101], government should actively involve these influential local authorities in educating and raising awareness as to the adoption of sustainable land management practices and climate smart agriculture in promoting healthy land and drought resilience. From the success story of the World Bank's Community Action Program (PAC) on reforestation and land restoration in Koné Béri (Niger) [102], for example, ongoing reforestation projects in the Bongo district could also adopt a farmer-managed natural regeneration approach (FMNR) [103]. Alongside the integration of traditional methods to growing trees that come with FMNR, the provision of 'juicy' incentives or the potential for land-based jobs and revenues from carbon credits could serve to motivate local farmers to protect trees rather than cutting them down to stop birds from nesting on them and destroying their crops.

Additionally, the meteorological agency could also consider involving rain-makers as local experts in the forecast and dissemination of climate information to local farmers—for example: on predictions relating to the onset of rainfall or the potential for a prolonged intra-seasonal dry spell in a particular season. With most people owning cell phones in the communities, climate/weather information could also be sent periodically as voice messaging in the local language. As proven by the ITIKI (Information Technology and Indigenous Knowledge) mobile app [104], where meteorological data is combined with traditional knowledge to send drought forecasts to farmers via the app or SMS messages in South Africa, Kenya and Mozambique, the national government or relevant actors could also consider this proactive approach in bridging local perspectives and science to enhance preparedness and adaptation to drought and climate related risks.

Funding: This research was funded by the German Federal Ministry of Education and Research (BMBF) in the context of the large-scale multidisciplinary WASCAL (West African Science Service Centre for Climate Change and Adapted Land Use) research project (https://wascal.org/category/project/, accessed on 28 November 2020).

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee of Center for Development Research (ZEF, Bonn—Germany).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data sharing is not applicable to this article.

Acknowledgments: Thanks to the Upper East Regional office of the Ministry of Food and Agriculture (MOFA), Bolgatanga, Ghana for sharing their data with me for this research and also readily responding to some follow up queries despite the challenges imposed by the COVI-19 pandemic. Thanks also to the Centre for Development Research (ZEF, Bonn) and Population Research Centre (Faculty of Spatial Sciences, University of Groningen) for the support. My appreciation also goes to Philip Aniah for the quick response in sharing the map of the study area.

Conflicts of Interest: The author declares no conflict of interest.

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