Public Perception of the Health and Social Risks of Extreme Heat in Northern Ghana

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1.0 Executive summary

The health risks of extreme heat hinge on not only on exposure but also on behavioral related, which are often related to perceived risk. It is clear that risks perceptions vary at multiple scales across the globe taking into account the climatic and the socio-economic variables between the developed and the developing nations. Some populations are seen to be more vulnerable taking into accounts residential status. In northern Ghana, a largely agrarian economy, extreme heat threatens population health, worsens poverty, and exacerbates social disparities. However, there is limited data regarding the perceptions of community dwellers on how extreme heat may threaten population health. We explored the public perceptions of the health and social risk of extreme heat in northern Ghana.

Following a qualitative approaches of focus group discussions (FGDs) and individual interviews we collected data from 28 rural and urban dwellers in the Tamale Metropolis. All interviews and FGDs were recorded digitally and transcribed verbatim. Coding and thematic analysis were used to analyze the data.

This exploratory qualitative study identified that diverse knowledge, awareness and experiences regarding climate change and extreme heat. Participants identified the unpredictability of timing and duration of extreme heat, identified its significant impact on their health and livelihoods. They adopted an array of coping mechanisms and strategies to mitigate the effects of extreme heat. They noted the impact of the nature of their buildings, rooms and settings and how these impact on the severity of the effects of extreme heat on their health and well-being. Aggravated disparities in responses and measures to mitigate the effects of extreme were more pronounced among rural and urban poor people and the elderly.

2. Purpose

Occurrence of extreme heat as a result of global warming constitute a high challenge to human health (USAID, 2022). The health risks of extreme heat hinge on not only on exposure but also on behavioral related, which are often related to perceived risk. It is clear that risks perceptions vary at multiple scales across the globe taking into account the climatic and the socio-economic variables between the developed and the developing nations. Some populations are seen to be more vulnerable taking into accounts residential status (Howe et al., 2019; Smith et al., 2014). Variations in the climate in relation to extreme weathers affect the environment that gives us clean air, food, water, shelter and security. To a large extent, human health is affected by climate change in combination with other natural and man-made health stressors. The effects of climate change (or the environment) on health are huge and significant. For instance, rising temperatures and increasing rainfalls can affect the survival of mosquitoes and hence their potential to transmit malaria parasites. Other health effects of climate change and disruptions in the environment include respiratory diseases, cardiovascular disease, injuries, mental illness and premature deaths associated with extreme weather conditions, variations in the occurrence and distribution of food-and water-borne diseases [1; 2]. In northern Ghana, a largely agrarian economy, extreme heat threatens population health, worsens poverty, and exacerbates social disparities. However, there

is limited data regarding the perceptions of community dwellers on how extreme heat may threaten population health. The current study intends to fill this gap.
Community resilience to the impacts of climate change and extreme heat requires a multidisciplinary, multisectoral collaborative effort that spans education, research, and practical implementation [(1)]. As an initial step towards developing a comprehensive community evaluation and response plan, we propose to conduct a qualitative study to assess public perceptions of the health and social risk of extreme heat in northern Ghana. Our research findings will deepen conversations regarding climate change and extreme heat, incorporate community perspectives into advocacy tools, advance further research, and inform the design of future interventions to increase resilience.
The study provided contextual data on the multi-interactions between individuals, the community and the vital systems of water, food, energy, and housing that will feed into local and national adaptation plans. The findings will deepen conversations regarding climate change and extreme heat, incorporate community perspectives into advocacy tools to advance research and inform the design of future interventions to increase resilience in northern Ghana. We explored the following objectives.

1. To explore awareness, perceived causes and attitude towards climate change and extreme heat among urban and rural dwellers in northern Ghana.
2. To explore public perceptions of the health and social risk of extreme heat in northern Ghana.
3. To explore the coping mechanisms adopted by urban and rural dwellers to reduce the effects of extreme heat.

3.0 Brief Literature review

3.1 Overview

Climate change has become an issue of major concern to humankind, including plants, animals, and the aquatic environment. Therefore, the UN considered it essential to create a key international platform for member countries, known as the Conference of the Parties (COP), to address the issues of climate change. The UN climate agreement was signed in 1992 and member countries have participated in it ever since. Average global temperatures have risen to 1.1 degrees Celsius and are heading toward 1.5 degrees Celsius, according to the Intergovernmental Panel on Climate Change report (2022). Similarly, NASA, estimated that the average temperature of the earth increased by about 1 degree Fahrenheit in the 20th century. It may not seem like a big change, but its impact on our environment has proven otherwise. The effects of this small change in temperature are varied, from long dry spells and heat waves to more aggressive hurricanes. In addition, the increase in the Earth's average temperature caused a variety of problems that left a permanent scar on our environment [(3)].
According to the IPCC report (2022), if temperatures continue to rise and rise, half of the world's population could face life-threatening heat and humidity. To curb the rapid increase in climate change and its associated problems, 194 countries came together and strengthened the previous agreement by signing the Parish Agreement in 2015 and committed to making efforts to reduce

rapid temperature rise. This year, for instance, the UN held its 27th COP27, where world leaders converged in Sharm-el-Sheikh, Egypt to discuss the progress of climate change action taken by the previous meeting COP26, last year and also address emerging issues and challenges faced by IPCC in implementing some of the interventions. Climate change is like new COVID-19 ravaging countries worldwide hence world leaders considered it more than necessary to put their efforts together to save the planet.

3.2. Climate change in Africa

According to the literature, many African climatologists and other scientists have done some research in the quest to find solutions to the ever-growing climate change and its associated problems facing the planet earth but more need to be done. The height of climate change is global warming caused by anthropogenic emissions of carbon dioxide (CO2), methane, and other greenhouse gases. Warming is happening globally, with temperatures rising on the African landmass and surrounding oceans. But Africa is characterized by the combination of climate change impacts. First, there is evidence that Africa is warming faster than the global average, and this is likely to continue. Africa is such a huge landmass, stretching approximately from 35°N to 35°S, the climate impacts vary greatly depending on location within the continent - there is no climate impact across Africa. Some areas of Africa are becoming drier, others wetter, and some regions may reap economic benefits while most will be adversely affected. And since continental Africa is divided into 50 countries, these geographic differences mean not only that some people win while others lose, but that these real locations are essentially between countries. Third, agriculture is the most important sector of the economy in Africa, accounting for around 60 percent of employment and in some countries more than 50 percent of the percent of GDP. Some of this activity is already close to the tolerance level of plants, so climate change will have immediate and direct impacts. Climate change is having a very special impact on Africa. Its climate is likely to be more affected than other regions. This is made worse by the increasing vulnerability of its economy to climate variability.

In contrast to this unusually high exposure to production effects, Africa's role in carbon emissions is unusually small. Its economic activity in the past has not contributed to the global carbon stock, its current activity accounts for a negligible fraction of global emissions, and future projections indicate that it will remain marginal. So, in other regions the key issue is reducing carbon emissions, in Africa, it is about adapting to rapid climate change with its undesirable conditions [(4)].

In Africa, for instance, present-day farmers are uncovered to excessive sunshine, temperature, and wind as in comparison to the past,[(5)], they continue to observe rising temperatures and decreasing rainfall, and their observations correlate primarily with evidence of changes recorded by weather monitoring stations [(6)]. Climate change is a major threat to West Africa, which is already climatically unstable,[(7)]. The effects of climatic changes on Africa would be consequential because of the unfavorable effects on humankind (overly reliance on agriculture), animals, plants, and aquatic environment, and also a high inability to adjust to the changes in the climate. The effects differ broadly across countries in Africa, with some places (e.g. eastern Africa) projected to get high in humidity, but a large swathe of southern Africa increasingly drying and heating. The farm produces would be drastically affected, [(4)].

3.3. Perceptions of climate change, causes and effects

According to studies by Ejembi and Alpha (2012); Haque et al., (2012) regarding the perception of Climate change, people have a clear idea of the changes in heat, cold and precipitation that have happened in the last five to ten years, especially farmers. Local perceptions of climate variability include increased heat, generally warmer winters, less rain, and less flooding, and the impacts of climate variability have been greatly negative on livelihoods, human health, agriculture, and life at large. The constant determination to gauge or comprehensively understands the effects of climate change on Africa is cladded with complexities. While few things are known and are well understood there is still great deal of uncertainty about the key climatic processes. There is also much that is simply unknown. The African weather is decided on the macro-degree via way of means of three main worldwide drivers (the Inter Tropical Convergence Zone, the El Niño-Southern Oscillation (ENSO), and the West African Monsoon), however how they interact and how they're stricken by weather alternate is poorly understood (Collier et al., 2008). Teye *et al.* [6] found out in their study that local farmers associate causes of climate change to economic activities such as cutting down of trees for domestic use and for sale, natural occurrences and curse from the gods due to commissions of sins by the people. Farmers have also acknowledged that temperatures are rising and the rainfall amounts are decreasing, [8]. The effects of climate change cannot be underestimated. In one study, Bunce et al., (2009) found out that climate variability and change are the most severe, attributing them to persistent water scarcity, food shortages, disease (human, agricultural, livestock), declining farms and fisheries, with the human disease being the number one impact among all the impacts identified in the study. Women are also hardly hit by climate change as Louis et al., (2020), demonstrated in their study that, women reported there is a decrease in food production, water scarcity and health problems and they attributed all these to irregular rainfall caused by climate change. Atanga &Tankpa (2021), also identified from their review of climate change, the impacts of climate change in northern Ghana, as events related to extreme weather conditions such as drought, rainfall variability and flooding.

3.4 Extreme heat verses human and environment health

Extreme heat conditions are defined as weather that is much warmer than average, and sometimes wetter, at a specific time and place. Extreme heat is not just annoying but kills hundreds of Americans each year and makes much more seriously ill. Heat affects everyone, the normal body temperature for adults is around 98.6°F. Some of the most common health effects caused by extreme heat include the following: heat cramps, heat exhaustion, and heat stroke. Extreme heat is particularly dangerous because people may not recognize its symptoms as signs of a more serious condition. For example, symptoms such as sweating or fatigue can appear as normal reactions to a hot day. People may be more at risk if they experience symptoms that interfere with their decision-making, limit their ability to take care of themselves, or make them more vulnerable to accidents. Left untreated, heat-related illnesses can worsen and eventually lead to death. Heat can also contribute to premature death from health effects other than those listed above. Because extreme heat can aggravate chronic diseases such as cardiovascular and respiratory diseases, and diabetes, (US Environmental Protection Agency & Centers for Disease Control and prevention, 2016, p.3). Frimpong *et al.* [9], affirms that heat pressure has great effect on farmers in both their family and farm level. Early studies have warned that heat extremes are

likely to increase and become more frequent in the future due to climate change. In addition to climate change, population size and distribution contribute to overall changes in populations exposed to extreme heat, [10]. Extreme heat results from the rapid climate change the world is experiencing these days, as revealed in one study by Atanga and Tankpa [11], that the impacts of climate change (extreme heat) are extreme weather-related events such as droughts, rainfall variability, and flood events , this evidence shows that the environment will also be badly affected in diverse ways

3.5 Summary

Most of the climate change studies across the globe especially Africa, Ghana focused more on farmers in the local communities [12; 13]. Evidence from literature point to the fact that climate change is real and it affects all the sector of the population and all categories of workers. To provide a long lasting and a formidable solution to climate changes, the views of climate change of all sectors of the population as well as all categories of workers need to be explored. This will help fill the solution gap that exist and also reshape the existing interventions and solutions to make them more integral and functionable. This project when successfully done will contribute to bridging the measures and solutions gaps that prevail in the fight against climate change as it tends to rope in other people's (e.g., students, teachers, nurses, artisans etc.) views of climate change on health, environment and how to reduce the rapid changes in the climate as well as measure their attitudes toward climate change with the Likert scale. It is quite clear from literature in Africa, Ghana that climate change is real and therefore the fight against climate change cannot be delayed any further. There are constant shortages of food, water and astronomic increase in human disease due to climate change or variability.

4.0 Methods

4.1 Study setting and participants

Following a cross-sectional design, we adopted qualitative methods of data collection. The study was conducted in the Tamale metropolis. The Metropolis is located in the central part of the Northern Region and shares boundaries with the Sagnarigu Municipality to the west and north, Mion District to the east, East Gonja to the south and Central Gonja to the south-west. Geographically, the Metropolis lies between latitude 9º16 and 9º 34 North and longitudes 0º 36 and 0º 57 West. There are 115 communities in the Metropolis in which most of the rural communities have a large expanse of land for agricultural activities and serve as the food basket for the Metropolis. Researchers in this study selected participants from the two main densely populated communities in the heart of the metropolis; Moshi-Zongo and Hausa-Zongo, and then two normally populated communities in the outskirt of the metropolis; Zujung and DohuniKukuo. Moshi Zongo and Hausa Zongo are found in the urban Tamale while Zujung and Dohuni Kukuo are in the rural areas of the metropolis. Communities for both rural and urban were selected to ascertain the experience of both rural and urban dwellers on extreme heat. Participants were selected based on purposive sampling. The inclusion criteria were men and women who were 15 years and above and were living in the Tamale metropolis.

4.2 Recruitment and data collection procedures

The research participants were informed to participate in the study by way of community entry. And the interview guide which contained information about the study and informed consent, were read to participants in English or Dagbani as preferred by them to solicit their consent. Participants' consent was acquired either verbally or by way of signing based on the requirements of the institutional review board of the University for Development Studies (UDS). Voluntary participation was encouraged and participants were assured of the confidentiality of their responses. All interviews and focus group discussions were collected using audio recorders, after which participants were given monetary incentives for completing full interviews, the recorded interviews were then transcribed verbatim by the project research assistants for analysis. We recruited twenty-eight (28), at the point of saturation.

4.3 Data collection methods

Data for the project was collected through focus group discussions and individual interviews, supported by interview guides. Four (4) focus groups discussions (Shown in Figure 1) were conducted with twelve (12) individual interviews. The interviews and focus group discussions were conducted for participants who met the inclusion criteria. The interview guide for the study was adapted from those of previous studies and modified into the following sub-headings according to the research objectives: public awareness of climate change, public perceptions of extreme heat on the environment and health, and attitude toward climate change and extreme heat and its possible causes. Participants' perceptions of the effects of extreme heat on the environment and human health was also explored. The interview questions explored the common health conditions in the community, the contributions of climate change to the existing health conditions and its effects on their source of livelihood, mechanisms of reducing the effects of extreme heat and the community perceptions of human-related activities or behaviours that contribute to climate change and extreme heat. We also conducted transect walks through the community to observe the settlement, nature of buildings and windows, drainage systems, and waste disposal sites.

Figure 1: Focus group discussion with elderly women

Pictures were taken during this process. Finally, participants' attitude toward extreme heat was measured on a 5-point Likert scale, ranging from 1-strongly disagree, 2-disagree, 3-uncertain, 2agree and then 5-strongly agree, using a fifteen (15) item questionnaire. The questions ranged from the attitude of research participants towards the role of persons engaged in climate change, through to the effects of climate change on human and environmental health and its awareness, the role of communities in the existing climate change and their role in the combat of its dangers.

4.4 Data Analysis

All sessions were digitally recorded, translated and transcribed into English. The interviewers checked the transcripts for transcription errors in conjunction with the digital recordings. A codebook was developed by consensus among members of the research team. Subsequently, the team members independently coded a sample of the transcripts using NVIVO, and compared coding with each other to ensure agreement. We conducted thematic analysis of the qualitative data, exploring both a priori themes (intersection of extreme heat with social determinants of health, gender-specific impacts, health impacts) and emerging themes.

4.5 Ethical clearance

Ethical clearance for the study was sought from the ethical review board of the University for Development Studies (UDS). The consent process was read in English and Dagbani as preferred by research participants before they were granted an interview. Participants were assured of confidentiality and voluntary participation was encouraged.

5.0 Results and discussion

5.1 General and demographic characteristics of the participants

We recruited 28 participants in which 57.1% (n=16) were females, 64.2% (n=18 had high level of education (i.e., tertiary and SHS).), six had no form of formal education and the rest had vocational (n=1) and low level of education (Primary and JHS). The mean age of the participants was 35.8 years ranging between 20 and 60 years. Except for three participants that were unemployed, the rest were employed as farmers (n=2), traders (n=4) shoemakers, weavers, administrators, accountants, food vendors, welders, tailors and construction workers. Twelve participants were from rural Tamale and the rest from Tamale urban.

5.2 Perspectives of participants on climate change and extreme heat

Table 1 shows the frequency of participants for each of the perspectives and themes generated from the study

Table 1: Perspectives of participants on climate change and extreme heat

Perspectives	Frequency	Percentage
Signs of climate change		
Believes the climate is changing	8	28.6
Signs of climate change is hot whether	10	35.7
Signs of climate change is cold weather	4	14.3
Signs of climate change is scarcity of water	1	3.6
Signs of climate change erratic rainfall	13	46.4
Effect of climate change		
Poor soils	1	3.6
Drought	3	10.7
Food insecurity and poverty	2	7.1
Extreme heat	8	28.6
Erratic rainfall	6	21.4
Climate change contributes to disease burden	2	7.1
Biggest climate change issue		
Water scarcity	4	14.3
Extreme heat and high temperature	7	25.0
Dust and air pollution	2	7.1
Erratic rainfall patterns change	3	10.7
Causes of climate change		
Bush burning	2	7.1
Industrial activity	2	7.1
Carbon monoxide release from vehicles	2	7.1
Deforestation	2	7.1
Law of nature	1	3.6
Accept responsibility of contributing to climate change	11	39.3
Description/perception of extreme heat		
Very hot whether	13	46.4
Acute cold and flu being common	3	10.7
Extreme heat and health	26	92.9
Ways reducing the effects of extreme heat	12	42.9
Effects of extreme heat on the environment	11	39.3

Negative impact of rooms without windows	14	50.0
Coping mechanisms for extreme heat	16	57.1
Household losses due to extreme heat	10	35.7
Extreme heat affects livelihoods	19	67.9
Sanitation, water and environment		
Sanitation and environmental problems	13	46.4
Inadequate toilet facilities	12	42.9
Varied sources of drinking water	15	53.6

5.2.1 Participants' awareness of global climate change

All participants recognized and had awareness that there is a global climate change. They identified a number of changes in the weather to buttress their assertions. Some of these were erratic rainfall, excessive heat, cold weather, high temperatures, unpredictability of the weather, etc. These sentiments were shared by all age groups including the youth, reproductive age women and the elderly.

Unpredictable rainfalls: Farming, the produce farmers used to get they are no longer getting those returns. Food crops get destroyed by erratic rainfalls. When it gets to the expected time or period of the rainy season, it will rain small and farmers will be lured to start planting their farms thinking the rains will continue to fall, then there will be a sudden drought and the groundnuts and maize will start to die off. Others (Mixed temperature; cold and excess heat combined): when it happens that way and there is cold and heat combined, both children and adult easily fall sick, and you can see that when you go to the hospitals and even at homes. The evidence is often all over the place. **Female, 56 years, Weaver.**

Hmm! like I said because of this climate change it seems the rain pattern too is changing or shifting. I do not know the terms that I should use, mmh! At times you will be experiencing fewer rains in one particular year, at times the rain will come plenty and it will be causing floods and other things. **Male, 47 years, Accountant.**

The way it rained in the past is not the same as today, because at first, the rains use to come with a lot of benefits but now the rains are not that beneficial to us. First as a farmer, even if you don't apply fertilizer, you would still have a good harvest but now even with the fertilizers our returns are small. But in our days, there were so many blessings that came with the rains; we used to get a lot of food and benefits, but now even if you farm a lot what you will get will be something small. So, there is a lot of changes, growing up the harmattan was very strong but now there is no cold, so instead of the cold it is rather getting hotter. Hmm! So, though we are in the harmattan season it is rather hot. So, there is a lot of change. At first, you could not have gone out at this time of the day because of the cold, so you would have to stay indoors, but now the cold is powerless. **Male, 60 years, Tailor and farmer**

For instance, this year the weather has changed. We are supposed to be in the harmattan season so the weather should have been cold but these days it is very hot at night. The heat we experience at night is not easy so this shows that the weather has really changed this year. The changing weather affect our health. **Female, 43 years, Food vendor.**

Concerning the rainfalls and the extreme heat, there are changes. This time of the year is the period of the extreme heat that sets the stage for the rainy season. But currently that is not the case. Now that the harmattan is about to start for the heat to set-in. It has changed. **Female, 30 years, unemployed.**

Yes. As for change it has changed a lot because the way it used to rain it shouldn't have stopped raining at this time but it has stopped raining for a long time now. So, it has changed. We still wanted it but it has stopped. **Female, 70 years, Trader.**

Others also identified that the effects of extreme heat vary across Ghana and it appears to be more intense in the northern sector compared to southern Ghana.

Yes, it is now hotter. Last month I was in Accra and when you compare the heat there and the one here, it's almost the same. It is just that in Accra at night it is not very warm like Tamale. The walls do not absorb much heat there like it is in Tamale. But at first it was not like that. **Female, 38 years, midwife.**

Among young women, they recognized that scarcity of water as a sign of climate change and the occurrence of extreme heat. They added that water bodies dry up too early before the next rainy season sets in. This recognition is not surprising for this age group given that they are usually responsible for fetching water in most families in the study setting.

Scarcity of water. **Female, 20 years, Student**

It has changed through the weather and water crises. **Female, 21 years, administrative assistant**

5.2.2 Source of information

Participants identified varied sources of information regarding climate change. While others indicated that they had information from television, radio, neighbors, family, friends, school, social media and traditional media; others said they have had personal experiences of the effects of climate change such as extreme heat.

We have also seen how it has become. The way it used to rain it doesn't rain that way again. **Female, 30 years, Trader.**

It is no more raining again. It has changed, everything has changed. Yes, in the news (Television). **Female, 32 years, Teacher.**

I have seen it on television and I have also experienced it myself, it is everywhere now, it doesn't rain as much as it used to rain. And the weather has become hotter exposing us the risks of several illnesses. Now if you go to the health facility here you will see a lot of people complaining of skin rushes and other skin related diseases. **Female, 70 years, Trader.**

We hear it on news, we watch it on television and we also experience it as a whole. **Female, 32 years, Trader.**

I have not heard on the TV or radio because I do not have any of these devices. But I do experience the changes and also from the general conversations about the weather changes within our community. **Female, 43 years, Food vendor.**

5.2.3 Perception of the timing and duration of extreme heat

Participants identified the time of the year they usually anticipate extreme heat as well as its duration. They identified that the period to range from October through to April each year. They however, recognized the timing and duration is not predictable and varies from year to year. The unpredictability of when to expect extreme heat is a source of worry and can affect the adoption of measures to mitigate the effects of extreme heat on the health and livelihoods of populations. This could thus serve as a barrier to adopting ways and strategies to reducing the effects of extreme heat.

Because of the change in climate one can never tell when heat or cold comes in. Because of the changes you cannot tell again if not we used to know that sometimes September October is always the heat season but now, we cannot tell again. **Female, 34 years, Trader.**

October to December. Heat comes earlier than it used to as compared to the previous years. **Male, 28 years, welder.**

Ooh! as at now there's heat. Now we don't know when they heat set in because as at now, we're supposed to be in harmattan season and now there is heat so we do not know the month in which there will be heat because we are in the heat. **Female, 42 years, Trader.**

I do not really know the months. Because as at now, we are in Harmattan. And so, after Harmattan comes the heat. **Female, 70 years, Trader.**

The heat season is around, erm! "Kpini or Kpimbila to Nolori-bila" lets say, November, December, January, within these three months. **Male, 32 years, Male.**

As has been said, it happens within the three months, around "Nolorini" the heat becomes extreme and the rains start wanting to fall. **Male, 45 years, Farmer.**

After Christmas. In "Kpini-to-Kpinbila" are the months of extreme heat. **Male, over 60 years, Farmer**

We found that older male participants appeared to describe the timing of extreme heat to be less unpredictable whiles older women found it to be unpredictable. Also, younger people aged between 15-49 years, for both genders, were more specific about the time of the year there is extreme heat and were less likely to describe it as unpredictable.

Normally, in the northern sector, it starts from November to February. **Male, 27 years, student**

Erm! the heat normally starts from February, March and April. **Male, 48 years, 27 years, Artisan**

It starts from November to December to January. **Female, 21 years, unemployed**

From December to January. **Female, 20 years, Student**

From October to February. **Female, 21 years, Weaver.**

5.2.4 Perceived causes of climate change and extreme heat

The participants identified a number of factors they perceived to be causes of climate change. They recognized that the changes they are witnessing was due to bush burning, car emissions, population growth, cutting of tress (deforestation), and emissions from factories.

Sincerely speaking, because there are no longer trees in the area there is no shade or darkness, and when there is no shade or darkness, heat can overwhelm its inhabitants. So, we can understand that, our difficulties are the results of the absence of the shade or darkness the trees use to offer us. **Male, over 60 years, Farmer.**

The change is huge and continue to happen on daily basis because of the increase in human population, my major concern is the population, because our population is now too huge. So, the change we are experiencing today it can only take the intervention of God resolve things. In this household, I have about 12 children and five (5) of them sleep in this small room. The population growth has affected the health of my children especially, during the heat season. **Male, 60 years, unemployed.**

Bush burning and smoke coming out from the factories. **Female, 21 years, student.**

Continuous release of gases from the motor vehicles has contributed to the rise in temperature making the environment very hot during the night making people unable to sleep at night leading to body pain and weakness during the day. **Female, 20 years, weaver,**

Others believed that climate change was as a result of the doings of God as well as the lack of love for others perpetuated by hatred.

The heat we are facing nowadays is a mind-blowing experience to all of us, even though there was heat in the past, they were few instances that we experienced them, and that can never be

compared to the heat in recent times, what we have now is extreme. But I think it is the doing of God. **Male, over 60 years, Farmer.**

…You see, at first there was love and communal support, but now there is a lot of stress and hate. So, we donnot get the rain like we did in the past, even when it rains it is less beneficial. We have less rains now because of our attitude, because at first, farmers use to help others with food but now not even a bowl of your farm proceeds will be given to someone especially the poor. Now farmers get indebted because at first, we use not to apply fertilizer yet we use to have bumper harvest. But now we farm a lot with huge losses, we donnot help each other again so even if you farm you will not get the full benefit of the farming. **Male, 47 years, Tailor and Farmer.**

Others opined that it was as a result of climate change but others discussed that it was due to the bad attitude nature of individuals in relating to one another. There is lack of communal spirit and support for one another in the society.

I was born in this house. Though the weather has now become too hot, we are used to it, our problems are the diseases. The extreme heat is caused by our attitude. Because at first when you farm you get a lot of food to harvest but now even if you get the food, it will not be beneficial to us, why so? Because of our attitude. Our bad attitude, so even when you do something it will not receive the blessings it deserves. Now we are full of bad attitudes, and that is consuming us. There is no love again, we lie against each other. So, we will not get our heart desires, unless we love each other, and support one another, that way the blessings will come upon us. **Male, 60 years, Tailor and Farmer.**

It is worth noting that the factors identified by the participants regards the possible causes of climate change is consistent with the scientific literature. It is recognized that bush burning, deforestations and emissions from vehicles as significant contributors to rising temperatures and unpredictability of the weather.
Participants ascribing the perceived causes of climate change to be related to the ways of God, lack of communal spirit, and God's way of punishing humanity for their deeds is not uncommon and has been reported in previous studies [(14)]. These perceptions were expressed by both rural and urban dwellers. There is thus the need to design interventions to create awareness and increase knowledge around climate change among urban and rural dwellers as these barriers may affect their adoption of climate change mitigation strategies.

5.2.5 Attitude towards climate change and extreme heat

Table 1 shows participants reported attitude towards climate change and extreme heat. Interestingly, most (n= 15, 57.7%) of the participants agreed that persons engaged in climate change work are making a big deal of nothing. However, all participants recognized that climate change affects their community; 77% noted that they had contributed to global climate change; 85% said they could do something about climate change. Almost all participants demonstrated that said they will benefit from receiving further information on climate change and such training should be extended to children. Also, all of them recognized that extreme heat (higher temperatures) was due to climate change. These findings demonstrate the positive attitudes of

participants towards climate change and it is pleasing that they have recognized that they have contributed to climate change and are willing to take measures to curb it. These findings are similar to those of previous studies [14; 15].

Table 2: Attitude towards climate change and extreme heat

Variable	Agree (%)	Neutral (%)	Disagree (%)
Persons engaged in climate change work are making a big deal of nothing	15 (57.7)	1 (3.8)	10 (38.5
Climate change is no affecting us in our community	0	0	26 (100)
My community is not responsible for causing global climate change	5 (19.2)	1 (3.8)	20 (77)
We are too small to do anything about climate change	3 (11.5)	1 (3.8)	22 (84.6)
People need more information on climate change	23 (88.5)	0	3 (11.5)
Children should be taught about climate change in school	25 (96.2)	1 (3.8)	0
Climate change leads to stronger storms	23 (88.5)	2 (7.7)	1 (3.8)
Climate change leads to loss of different types of plants animals	23 (88.5)	2 (7.7)	1 (3.8)
Climate change leads to higher temperatures	26 (100)	0	0
Climate change leads to drought	25 (96.2)	1 (3.8)	0
Climate change leads to earthquakes	17 (65.4)	6 (23.1)	3 (11.5)
Climate change leads to more diseases	26 (100)	0	0
Climate leads to loss of buildings close to the sea	20 (77)	2 (7.7)	4 (15.4)
Climate change leads to loss of food crops	25 (96.2)	1 (3.8)	0
Climate change leads to flooding	21 (80.8)	2 (7.7)	3 (11.5)

In relation to attitudes, participants also recognized that they had contributed to global climate change leading to rising temperatures and extreme heat. These actions and inactions include burning of the bush for hunting and agricultural purposes; cutting down trees for fuelwood, construction and agricultural and building purposes, and the use of vehicles that are not regularly maintained.

People prefer to burn their rubbish to disposing them at the dumping site. Like my colleague said when they are building sometimes, they cut down trees. **Female, 21 years, administrative assistant.**

Yes, we are also part of it because though we are not having many trees in our communities. The few that we have in the forest we are cutting them for charcoal. We are burning the bushes and adding more chemicals to the land. **Female, 38 years, Midwife.**

Because of the ignorance, sorry to say, they donnot maintain their vehicles, and these vehicles continue to release smoke into the air, when they are building, they cut down trees also and this contribute to climate change. **Female, 20 years, student.**

Yes, most of them like the youth, most of them normally go for hunting so they normally burn the bush anyhow and most of them normally cut down the trees for firewood and those sorts of things. **Male, 21 years, administrative assistant**

Yes. We're all involved. Some earn a living from deforestation. There's no work, no business. Unless the person cut down trees to sell as firewood to earn a living. Yes we all are contributing factors but we have no option. **Female, 70 years, Trader**

Yes, human beings contribute to climate change because we won't stop deforestation. And when we cut down trees definitely it will lead us to excessive heat. **Female, 34 years, Trader.**

Others also opined that they have contributed to climate change through population growth in which it here is increased use of firewood for food preparation which contributes to the production of smoke that ends up polluting the atmosphere and increased heat.

It is the population. Assuming the house here sets fire and all the houses does same, it will generate heat. So that also contributes to it because our population is huge, but when we were few in the community, we use not to experience extreme heat. The population also contribute to the fewer rainfalls, due to our population, we have cleared all our forest reserves, there are now desserts. But the rains do well in forested areas, areas where there are trees, the trees create the atmosphere for rains. So, rains don't fall haphazardly unless we are in the depth of a rainy season. But because of our population we go about cutting down the trees. **Male, 60 years, unemployed.**

Others also identified that it is God's way of punishing society for the bad deeds of others. We found that older participants, both male and female alike were most likely to ascribe the changes in the climate to ways of God but not human.

No please. I consider all of that as the doings of God. It is from God and not human, it is God who created us so He choose to do what He want to do. **Female, 56 years, Weaver.**

People now behave like madmen; the reason things are getting much tough for us. When you do a bad deed God will not punish you alone, He punishes the entire population with some calamities that can plunge the population into hardship. **Male, over 60 years, Farmer**

Although almost all participants agreed that they contributed to the global change, a few disagreed and intimated that climate change is seasonal, which they do not control but God.

No. there is a season for everything, so when it is a hot season, the weather will come, so the seasons are there likewise the hot season. So, one cannot cause heat unless he decides to set fire in his room. So, it is God who is making it seasonal. **Male, 32 years, unemployed.**

Others were unsure if the climate will continue to change in the future as well as the any effects.

I am not too sure about that. It could be better or get worse. Only God knows so as the years go by, we will get to know. **Female, 43 years, Food vendor.**

You see, the change goes with our attitude, cause the time we find ourselves, if we are united with one another and support one another, things would have been going in our favour. So, all the difficulties we are going through, all the struggles are the results of our deeds. Look at our gutters outside, they're full but we cannot unite or organize a communal labour to desilt the gutters, that unity is lacking. So, its associate diseases will come upon us all. If we were united, we would have come together to work on our getters for the benefit of our health, but nobody cares. As a community we are supposed to be united to be able to take communal duties such as cleaning, but that is lacking in the community, everybody does what he wants, when you see the gutter, it is heart breaking, it is full of dirt and this goes with diseases, if we were united, we would have worked on it together. So how can we advance as a people? It is only possible with unity. **Male, 60 years, Tailor and farmer**

5.2.6 Perception of extreme heat

Participants expressed their opinions, understanding and experiences of extreme heat. They described that extreme heat occurs when they begin to feel that the whether is hot, when the temperature begin to rise, expansion of metals, when the fans in their rooms blow hot air instead of making the rooms cool, when they begin to sleep in their compounds instead of being in the room, and among others.

Extreme heat is like you will be there and just be feeling the heat within. It's as if they are pouring something very hot on you, especially at night. Even when you put on the fan, it's full of heat.
And when you go outside you don't even feel the wind blowing. You feel the sun very hot and it will be burning you. **Female, 38 years, Midwife**

No idea. My family don't normally fall sick, but when it comes to the extreme heat period, they develop boils or rashes and other things develop on them, then you will know there is heat. Or when there is catarrh, but that is in the harmattan where flu becomes common. **Male, 47 years, Accountant.**

The weather would be very hot and there will be excessive heat. **Female, 20 years administrative assistant.**

Others opined that the wind do not usually blow, they do not find shade to sit under and they find it difficult to sleep at night.

When heat sets in, even wind doesn't blow again. I can't even sleep at night when the heat comes erhn. When heat sets in no one would even tell you there's heat. When the tress has shade during rainy season, there's no shade during heat, there's no fresh air. Even when the wind blows it comes with heat. **Female, 42 years, Trader.**

Yes. So, as it happens that way you don't need anyone to tell you that we're experiencing heat. That is what we use to tell. Everywhere gets hot, dried and even when the wind is blowing it blows hot air. You don't feel any fresh breezes in the air. **Female, 32 years, Trader.**

When the weather becomes hot and one cannot sleep indoor. For instance, the season we find ourselves now, you can be indoor at 8pm but in the hot season even at 12midnight one may not be able to sleep indoor because of the heat. One can sleep outdoor throughout the night, mhuh, that is the time we say there is extreme heat. **Male, 32 years, unemployed.**

Others recognize changes in the environment in relation to the land drying as well as vegetation.

The land is dry, the grasses and trees get dried during the heat season. **Male, 25 years, Teacher.**

Another opined that the period of extreme heat usually comes before the rain sets and its occurrence demonstrate that the rainy season is nearby.

When it gets to the hot season, you will see that the temperature will become very hot, you can't enter your room unless you have a fan, but we are in the harmattan season now so the temperature is better. But after January and February, the rain will be preparing to set-in. So, the harmattan starts in about two months after the rainy season, then going to January, the harmattan disappears for the heat to set-in. **Male, 60 years, Tailor and farmer.**

Extreme heat is associated with rain, so when it becomes very hot, and the dust clears off the atmosphere for the sun to shine, that is an indication the rainy season is just by the corner. At that time the heat becomes extreme. **Male, 60 years, not actively working.**

These findings as expressed by the participants demonstrate that they are able to identify the signs of extreme heat and recognize its occurrence. They also show an appreciation of the risk associated with extreme heat and this could greatly influence the acceptance and adoption of coping strategies.

5.2.7 Perception of extreme heat on health

Participants intimated that extreme heat impacts negatively on their health. They discussed that certain diseases are usually common during the period of extreme heat. These are skin rashes, headaches, boils, body pains, malaria, neck pains, cerebrospinal meningitis (CSM), etc. They also opined there is increased in visitation to health facilities thereby increasing household health cost. They further discussed that they usually use the occurrence of these diseases to recognize that the period of extreme heat has set in.

When the heat becomes extreme, you will see maybe some boils, boils, erm! children will be experiencing some boils in the parts of their bodies. Erm! What is this thing? "Nangwadwagu" what do they call it? Erm! Some erm! Ooo! I have forgotten the name… mhuh the Nangwadwagu

is CSM, the extreme heat is the period we experience CSM (Cerebrospinal meningitis). **Male, 47 years, Accountant**

When the extreme heat season is drawing closer, at night one begins to sweat and feel some discomfort in your body e.g., itchy skin and a general increase in body temperature at times, and the room becomes very hot and impossible to sleep in. **Males, over 60 years, Farmer.**

There will be catarrh and cold. **Male, 20 years, Student.**

During the heat period, you can see people developing boils, rashes and other things on their body. **Male, 48 years, artisan**

Heat reduces efficiency at work. You can't work well or properly because the work itself is heat. I do sweat. **Male, 28 years, Welder.**

It's the heat…. That is the only way I have experience it. You can't sleep at night because of the heat or when you are going out, especially in the afternoon you have to think about how you will protect yourself and go and finish what you have to do and come back. So, it disturbs my sleep at night and also distracts how I go out to carry out my activities. **Female, 38 years, Midwife.**

I would say we need heat but its excessiveness is the problem. For example, the rashes it causes, it is a challenge, a big challenge. Now and then you need to visit the hospital and if you don't have money, what do you do? So, it is a challenge. **Male, 25 years, Teacher.**

You see that at that heat period, small, small babies and also children suffer a lot, people spend much of time or a lot of money on drugs, visiting hospital often. **Male, 28 years, Student.**

The temperature now has increased. It is because of the extreme heat. The sun is very hot and that causes the high heat these days. **Female, 20 years, Shopkeeper.**

When there is excessive heat, it can lead us to CSM and when there is excessive cold it can give us catarrh and all the other diseases like malaria and cold. **Female, 34 years, Trader.**

That is what we're talking about during heat that whole season is full of sickness. Rainy season is even better. During heat we get malaria, sickness relating to the neck and skin diseases. Because some people skins are very sensitive to heat. **Female, 42 years, Trader.**

During heat some people cannot even sit. Unless they bath throughout the day. The water is even scarce. So, there's no water how then do you even bath? So, because of that there is suffering during this period. **Female, 70 years, Trader.**

Oo! I it comes with a lot of problems. It comes with sankpang, neck sickness, children fall sick a lot during that period and everyone everywhere fall sick. This is caused by the heat. It leads to CSM and malaria and difficulty in sleeping. **Female, 30 years, Trader.**

Because of the global climate change, there is a huge outburst of diseases to the extent that humanity have lost count of their number. So, when you are infected by these diseases the causes are mostly unknown, so that is the cause. Because, some people are not heat loving and some are also not cold loving, so when they are hit by a lot of cold, they can fall sick, also when they are hit by a lot of heat, they can also fall sick, so that is how it is. **Male, over 60 years, Farmer.**

Erm! When the season is changing, people react differently to it. There was one apprentice in my shop I trained to weave some time ago, when it comes to this time of the season, she virtually bath whilst walking. She cannot just sit down because of the heat, and even when you sit closer to her you cannot stand it, she smells bad. So, at all times she cannot do without water, she walks arounds with pure water to calm her temperature, so she is not cool with the harmattan and hot season at all. **Female, 56 years, Weaver**.

Participants recognized that the aged are the most vulnerable to the effects of extreme heat on their health.

Because despite the heat we have now in the next moment you will experience a lot of wind, and people of all age groups will begin to feel the extreme cool and dust. The extreme dust will make it difficult for people to see, hence putting the health of all in danger. The cold will become extreme and paralyzing, hence making people inactive especially the aged until the sun sets in. so, we the elderly ones are the most vulnerable to the perils of the change. **Male, 60 years, Farmer.**

The extreme heat we are talking about is even more consequential on the aged or people with advance age compared to the youth. When an elderly person gets a lot of heat overnight, he or she will begin to feel malaise the following day and unable to work. The heat may not instantly take away your life, but it can constantly subject you to discomfort and lack of well-being. **Male, over 60 years old, Farmer.**

Extreme heat has also impacted on quality of maternal care and negatively impacting the stress pregnant women go through during labour.

Considering my work as a midwife, when the women come and they are in labour, they continue to sweat a lot and you have to help them to shower to reduce the stress. When the person is in labour pains and the heat too adds up the person will be stressed and she will not even cooperate with you. Also, if a person is a BP patient and you administer drugs, they have to rest but because the place is hot you have to continue fanning them and the number of people in each room too makes the situation worse because the rooms are few. **Female, 38 years, Midwife**

Others lamented that there is almost a situation of helplessness during the extreme heat periods as they rooms are hot for them sleep but mosquitoes will bite them and increased their risk of getting malaria if they sleep outside in their compounds. They opined that their situation is

usually made worst during extreme heat period due to frequent power outages at nights making it impossible for them to use their fans to at least cool the rooms for them to sleep in.

Yes, it has because you don't know what to do with your body because today there's heat tomorrow there will be cold. Nowadays they put off the lights almost all the time. and then if you are to sleep outside mosquitoes are biting which causes malaria. and nowadays the food stuff is filled with condemn (a weedicide used to control weeds). They have put condemn in every food or every food stuff after eating you get pains in your legs and waist. **Female, 70 years, Trader.**

During heat when you even put on the fun it doesn't serve its purpose. We'll come out to sleep in the compound. And the mosquitoes too will be biting us. As for the heat it is going to be that way because we don't know what we'll do to reduce it. **Female, 42 years, Trader**

Others opined that the period of extreme heat causes illnesses that could not be cured through the conventional medicine that is seeking care from hospitals.

The hot season is associated with fever, headaches, and bontora (boils) that make people feverish. So, when you develop a fever, some of these fevers can only be treated locally, but some of these cases are sometimes sent for medical care where the patient dies upon the reception of an injection, because of the very high temperature. That fever is caused by an organism called "Nantoo" this organism actively moves around during the hot season, and when it urinates on you, you can develop a fever. If that fever is sent for medical care, and unfortunately you are injected you will die. But in the Dagomba culture, you can be given an herbal preparation to drink and bath so that when you are infected it will be less severe. **Male, 45 years, Farmer.**

A healthcare provider identified extreme heat could have significant impact on individuals who are managing non-communicable diseases such as hypertension affecting their ability to control the condition.

For instance, if you have BP and you are told to rest but because of the excessive heat at night you are not able to rest it will affect you. And when you go out during the day to do some things for yourself the way it is hot it can have an impact on you. For example, it can affect our skin and our eyes so it can lead to skin diseases and eye problems. So, during the heat season some people prefer to stay indoors. **Female, 38 years, Midwife.**

Quite a few discussed that extreme heat is not associated with any health conditions.

As for me, the hot season is ok, it has no health problems, it is the harmattan that has a lot of health challenges. The rainy season normally set-in immediately after the hot season. **Male, 60 years, Tailor and farmer.**

5.2.8 Impact of extreme heat on livelihoods

Participants discussed that extreme heat has enormous impact on their livelihoods such as farming, processing of farm produce, and among others.

As it is now, when the hot season sets in and you try to process cassava, it will damage the cassava. The reason been that the cassava will not be able to dry properly. But in the harmattan season where there are wins, that is the rice processing season, you will see that when you are winnowing your rice it works better and when you are also processing cassava it dries properly. But when the weather is hot it will damage the cassava, mhuh!. **Males, 32 years, unemployed.**

As a farmer, when we have the kind of mixed weather we have now, and you want to process your grains it becomes difficult to winnow your produce. **Male, 45 years, Farmer**

Everything has its timing, thus the seasons. So, the hot weather has its purpose likewise the harmattan or wind season. So, currently we are in the harmattan season where the wind is the instrument of purpose, so when you harvest your maize for a machine to thresh, it is the wind that takes the chaff from the grains. If you are processing rice, whether manually or by a machine in either case, it is the wind that will take the chaff from the grains. When you are processing cassava, it is the wind that can make them dry properly, but when there is so much heat, the cassava will stick together and turn red. So, everything goes according to season. So, as you can see, the Kapok tree has shed off its leaves, that is what we call "Bontira saa", it is associated with mixed temperature (hot and cool combined), hence causing an increase in general body temperature. **Male, 60 years, unemployed.**

I sometimes do small farming. As for accounts side no, climate change I don't think. But at times when you are in the office, during the harmattan you will be feeling cold we at time shut, or we will not even open the fan. But dry season you have to open the fan and windows, erhuh! So, at times it affects us, you will be feeling uncomfortable in your office. As a smallholder farmer, it only affects us when the rains don't flow as expected or at times it will over rain, so at times it causes flooding, and sometimes destroy your vegetables or your crops. **Male, 47 years, Accountant.**

They added that the dryness of the land and vegetation negatively impacts agricultural activities which is their sole source of livelihood.

Like we said before the land gets dry, grasses are dried, trees get dried and it also affect our agricultural sector in the nation, because of the reduction of the rainfall, some of the crops fall back as a result of shortage in rain yeah. **Male, 25 years, Teacher.**

It is worrying to all of us, because what affects us seems to also affect our environment, because the yield we use to get from our lands have reduced. The trees that use to serve important purpose have also started dying and have reduced in number. **Male, 32 years, unemployed.**

Ok. Our area was not as large as it is today, so we use to farm around our homes, and the trees that were around gave us some shade. So, even in the hot season the temperature of the area was cool. But now because the environment is too clear, the heat gets its way in to the community. So, we have no option now than to rely on God. It could be God's punishment to humanity because

of our hatred for one another. So, it could be God's intended punish to register His displeasure of the hatred among as. Male, elder. **Male, 45 years, Farmer.**

Others recognized that frequent bush fires have led to their harvest being burned.

The sun goes with bushfire, two days ago our 50 acres maize farm got burnt, it is not up to two (2) weeks as I talk to you, so with the current issue only God can solve them for us. **Male, 60 years, Tailor and a farmer**

Yes, some of my family members, do not harvest early as a result bush fires normally burn their crops. **Female, 21 years, administrative assistant.**

Some of the participants opined that climate change through extreme heat has led to increased in goods and cost of living and unbearing economic hardships.

It has really affected us. It has increased the prices of goods. A bag of maize is now sold at ghc600.00. But we used not to buy it even at ghc200.00. **Female, 42 years, Trader.**

Because of the limited rainfall, it has made food costly. **Female, Trader, 42 years**

Interestingly one participant, a welder, identified that extreme heat does not affect his work but the rains do. He explains that the rains caused him to get mild electrocutions during work.

For the heat it does not have so much effect on my work but during the rainy season, I do experience electric shocks when working especially when the place gets wet. Because the machine uses electricity, I experience shocks. **Male, 28 years, Welder.**

5.2.9 Nature of rooms and extreme heat

The participants recognized that the nature of their rooms especially those with tiny windows contribute to their experiences of extreme heat.

If it has to do with the mixed weather we have now, when you enter your room and it is very hot, we often open out doors and window for some fresh air to come in. And when the room is well ventilated, we close them again. But when the weather is too cold or windy, we close our doors from the cold and dust of the atmosphere. **Male, 32 years, unemployed.**

The nature of our buildings can also contribute to the extreme heat, because we use to build and stay in thatch houses. And with the thatch house even when the raining is falling you would not hear the noise of the rain drops, but today because we roof with zinc, when you are staying in a zinc roofed room or building without a fan can you sleep inside it? Erm! this thing, if there is no air condition in a zinc roofed room can you sleep inside it? One cannot sleep in the room due to the extreme heat. you will be in serious heat the little water in your body will call come out. You will sweat like they have pour water on your body. This make more people to be dehydrated during the period., so that is what I can say… **Male, 45 years, Farmer.**

I mentioned the cutting down of trees, erm! erm!. indiscriminate erm!. maybe defecating around, the way we build; because some buildings they are erm!, the windows that we use are small and in some cases no window at all. small and nowadays they now use, turn to be using erm! well, how do they call them, the slide door with windows, ahuh! It always makes the rooms very very hot or heat. **Male, 47 years, Accountant.**

It depends on where the window is situated, at times when it is, there are some particular erm, erh! side when your window is there, there wouldn't be fresh air coming in. So, in that case it will be hot, the room will be hot. Hmm! So, my room is hot, it is hot. I can only feel it with the children, when you see some rashes in their body or some boils, you will see that the heat has set-in. **Male, 47 years, Accountant.**

My room is hot, it is very hot in such a way that even if you turn on the fan it does not look like there is one in the room. **Male, 32 years, unemployed**

Oo! *The room will be as hot as something else, I would have to sit to around 1 Oclock for some fresh air to begin to blow around before I can be able to sleep, else I may sit all night. In some instances, I sleep outside and expose myself to mosquitoes leading to constant malaria.* **Male, 60 years, not actively employed.**

Others strangely others discussed that burglaries rates reduces during the heat seasons due to people staying awake during the night because they are unable to sleep due to the extreme heat.

Oo! In the hot season my room gets hotter, it gets too hot. And when it happens that way, one cannot be able to sleep, you will stay awake over the night. So, in the hot season, it becomes difficult for thieves to operate because they are prone to easy arrest. **Male, over 60 years, farmer**

Others recognized that thatch roofed rooms seem much cooler than those with aluminum roofing sheets.

I've never slept in that kind of room. Even the thatched hoses have windows. It's even cooler that the ones with zinc. **Female, 50 years and older**

The ground will be cool when you sweep and mop inside the thatched house. But houses that are roofed with zinc, you will still clean and be bathing more often alongside. **Female, 50 years and older**

Others bemoaned the negative consequences of sleeping in rooms without windows.

Sleeping in a room without a window is just like been in the grave and no one will wish to sleep in such a room. **Female, 32 years, Trader**

Even in my room there is heat, if you compare it to the room without windows the heat will be excessive. **Males, 26 years, unemployed.**

Participants recognized that the nature of their rooms have contributed to the negative effects of extreme heat they experience. They recognize that there is a need to have bigger windows instead of the smaller ones.

There are windows, but they are the small ones. That can also be the cause of the poor ventilation in the room. **Male, 25 years, Teacher.**

As for me, my window is the very small type, I am yet to create a window. So, I will say there is no window because it is the very small type. **Male, over 60 years, Farmer.**

Participants recognized that they should build rooms with bigger windows to help cope with the effects of extreme heat.

Stop building congested houses and also provide bigger windows to prevent these diseases. **Female, 32 years, Trader.**

Transect walks and field observations of the study setting showed most of the rooms had small, tiny windows and some even had no windows (Figures 3). Obvisously these kinds of windows do not allow for proper ventilation and the rooms will have unbearable heat during the heat seasons.

Figure 2: A room without windows (front and back view).

In order to cope with the extreme heat, participants reportedly slept outside their rooms in their compounds and verandas. But this comes with the risk of having mosquito bites that could increase their risk of getting malaria.

Yes, we have windows but they are the small ones as you can see. **Male, 60 years, Tailor and farmer**

People choose to sleep outside their rooms, in the open compound because of the heat so that they can get some fresh air. **Male, 28 years, Welder.**

As shown in Figure 3, this window is continuously covered which does not allow for effective circulation of air in and out of the room there by increasing the effect of extreme heat on the inhabitants of the room.

Figure 3: Window covered with a waste cement bag.

Others offered tips of how items in a room should be arranged to allow for effective ventilation through the windows.

With the heat, you have to arrange your room to allow some ventilation in your room and sleeping places. Don't crowd your sleeping room with a lot of stuff, that way your room will become too hot. Some people overcrowd their rooms with bags of food and also by always locking the rooms. **Female, 56 years, Weaver.**

As can be seen in this Figure 4, this is a window that is small and half of it is covered with polythene.

Figure 4: Window covered with polythene.

Participants also noted that people respond to heat differently. As shown by a 56-year-old weaver, her husband is not able to comprehend cold while she does. Whiles the husband is able to handle heat but she is not able.

Yes, when it changes and your system is not cool with it you react to it. I live in the same room with Alhaji, I am the kind who is ok with the cold weather but Alhaji is not comfortable with it. So, when we switch on the fan, he suffers it but I will be ok, because our systems are not the same. During when the weather is hot, I sweat a lot and cannot sleep until I take a bath. My only challenge is just the sweating. **Female, 56 years, Weaver.**

In the hot season I often have to get up and bath. Even with two windows when it is hot and the fan is not supportive enough or when I am unable to use the fan because my husband is not cool with it, I have nothing to do. My husband is ok with the heat. **Female, 56 years, Weaver.**

Some of the houses that had quite bigger windows (Figure 5), had the windows covered with polythene making it difficult for effective ventilation. The window also has another shading cover further affecting its ability to provide effective ventilation. Apparently, participants explained that the polythene covering is to prevent water from entering their rooms during the rainy season.

Figure 5: A window with a cover

Figure 6: A window completely covered with polythene

These findings as expressed by the participants demonstrate that both rural and urban dwellers recognize that the nature of their buildings relating to the size of the windows contribute to the severity of the effects of extreme heat on their health and how they are able handle to handle its effects. However, participants are constrained by economic challenges in order to be able build rooms with big windows. Also, given that there are some seasons in which the weather becomes cold, it is also challenging for them to build rooms with large rooms or the recommended size of windows.

5.2.10 Coping mechanisms extreme heat/climate change

Participants adopted a wide range of coping mechanisms to reduce the impact of extreme heat on them. Some said they opened their windows at night to allow for ventilation. Those who have fans and electricity put on their fans and the very few who have air conditioners use them while others said they slept outside in their compounds and verandas, etc.

We open the windows and sometimes too we use the fan. We also take cold baths to help with the heat at night. **Female, 43 years, Food vendor**

It has, because you will need something that, let just say you need air-condition that is also a cost so it affects us in financial situation because you need to get money to buy those things to make the room cooler. **Male, 28 years, Student.**

In the office you have to open fan, if there is no light you open the louvres and be managing, so you cannot do otherwise, you have to accept it like that. Or you can't take your books and go and be sitting under the tree to work.
As for the farm side sometimes I don't directly involve, I sometimes provide financial aspect to the farmers to do. So erm! when there is flood at times maybe they sometimes create farm belts ahuh, to protect the farm, so as to redirect maybe at time the water, excess water to other areas.
Male, 47 years, Accountant

If the heat will reduce for us, one will need a fan or will have to sit under a tree, if not, one will not be able to enter his or her room. They are no trees in the area, but they were many trees here, but now there are no trees. At the time we settled in this area the houses were not up to twenty (20) or twenty-four (24), but now because of the construction of houses, all the trees have been cut down. So now they are no trees. But the trees would have helped. It may be reasonable to plant trees now, but where is the land to do so? Trees are very beneficial. The cutting of the trees has given as so many challenges, because at first when the trees were there, they helped a lot and we had good health, especially during the harmattan season, our roofs were in good shape, without the trees when there is storm it can rip off our roofs and get us into troubles. The trees use to protect our homes, but now without the trees the storms rip off our zinc. **Male, 60 years, Tailor and farmer.**

Others also opined that they drink a lot of water during the extreme heat period. This is however also affected the problem of inadequate access to clean water especially during that period when the water situation becomes precarious. Some described that they choose cotton cloths to wear to protect their skin and reduce the effect of the heat. Others also wear sun glasses to prevent the heat from getting to their eyes.

You have to drink a lot of water. When going out in the sun you have to wear cotton dresses to cover your body and use sunglasses too.

However, rural folks and urban poor people will be unable to do any of these due to poor income levels. They struggle to feed and on a scale of preference will rather spend their income on food and other essentials instead cloths that will be suitable for extreme heat conditions. They will thus be the most impacted from the effects of extreme heat.

5.2.11 Water crisis

Participants also noted that access to clean potable water was a challenge especially during the period of extreme heat. Although water challenges are endemic in the Tamale metropolis, the situation becomes more precarious during the period of extreme heat as it is a period that there are no rains and other sources of water such as dams, ponds and rivers are usually dry. It is thus not surprising that water crises were identified as one of the biggest climate change issues in the study setting. Inhabitants will usually have to resort to buying water sold by water tankers or through the use of tricycles referred in the local palance as 'Motor King'.

They fetch from town and sell to us at 2cedes per barrel. There's also a dam but there is a lot of rubbish or dirt in it. But we still fetch from it to wash our clothes. **Female, 30 years, Trader.**

In some communities, participants reportedly had access to water from the dam which is not clean for drinking and will have to depend on water sold to them by private water tankers.

You have to buy pipe water. Because the dam here is not good for drinking. **Female, 32 years, Trader.**

Some had taps but these were not frequently flowing. The also rely on rain water but the rains have stopped.

Among those from rural Tamale, they drink water from the dam.

We fetch from the community dam, because our taps are not flowing. We also buy, as you can see the yellow gallons, so we either buy or fetch from the dam and that can cause diseases. **Male, 32 years, unemployed.**

Hmm! We drink from the dam. In the past we use to get infested by guinea worm by drinking from the dams, but due to advancement in health we are now protected. Those days, from now into the hot season, people who drunk from the dam were down by guinea worm infested blisters. Due to the discovery of guinea worm infestation from drinking from the dam, pipes were laid in the area to supply us with pipe borne water, but up to date these pipes are still dry without water, and people continue to drink from the dam. So, what happens when the dam dries up? What will be our next option of drinking water? Because it is a small dam and the population of the community outnumber its supply capacity. **Male, 45 years, farmer.**

We don't have a source of drinking water we buy. So, imagine if you have to buy water on daily basis at Gh 2.00 per a yellow can from the motor king water suppliers and still give your children daily school feeding fees, no matter the amount of money you think the money will continue to me there for you? So God will see us through, and grant you people jobs, so you can continue to support the younger ones. **Male, 60 years, not actively employed**.

Hmm! As for the water, hmm! The rains stopped for barely two (2) months now, but we are already faced with water shortages, so in about three-to-four months' time it will be a very big

problem. So that is one of our major challenges. So, our drinking water is from the dam, but we are so much aware the dam will dry up in the shortest possible time, because its consumers are too many, hmm!. **Male, over 60 years, Farmer**

The water scarcity increases participants risk to contracting water-borne and water WASH diseases. There is the possibility of the reemergence of Guinea worm that was eradicated several years [16].

5.2.12 Common diseases in the community

Participants discussed diseases that were common in their community. These diseases were malaria, headaches, skin rashes and boils. Interestingly participants also described noncommunicable diseases such as stroke that hitherto where uncommon in their communities are now almost endemic. They are attribute these changes in morbidity to effects of extreme heat and change in dietary habits.

Like we said there are a lot of changes, our fathers have told us that some of the diseases of late were not known in their days but now because of the change those diseases such as stroke are now setting-in. In fact, growing up as a child we use not to see stroke, malaria was not that common, headaches were not that common, but now there is a drastic change. **Male, 60 years and Farmer**

I have observed with sharp contrast some of the things we eat nowadays with what we use to eat. Our fourth fathers used to prepare their food with what do they call it? Dawadawa and kapok seed; they use to harvest these things to prepare soup. During those days we didn't know stroke, we didn't know what stroke was. But nowadays every little farming you do you are required to spray with chemicals, all of these brings about the stroke. **Male, 60 years and unemployed.**

Hmm, it is a very difficult issue, because as we have already discussed the hot season, you can sleep in you compound and open the doors of your room in the hot season for thieves to evade and cause you some losses. As was discussed I hope you can experience the sudden change in weather, we have air blowing along with heat, this combination of cold and hot air is the cause of the generally increase in our body temperature. And when you have temperature, if you have malaria it will show, if you have Kpagu doro (...), and when you have high blood pressure or stroke it will show. But the stroke is a new disease but it was there some years ago, but use to affect only those who ate to their fill and had money to feed voraciously (sweet foods) in society, but today it has no target group, as slim and emaciated as I am, I can even develop a stroke now and before you realize it I am paralyzed to the ground. May God grant as favour.

Others also believed that the increase in the incidence of NCDs such as stroke is due to the work of the devil and the work of the enemies.

The devil can use people to accomplish his aims. You see stroke, people can strike you spiritually with stroke, a deed that displeases God. You see for example headaces, people can strike you spiritually with it, another example is malaria, people can strike you spiritually with it, so when humanity continue doing things against the will of God what would you expect Him to do? He will send us some calamities in the form of challenges, air in other to punish us. **Male, 60 years and older, Farmer.**

Malaria. Erm! Nowadays we hear about stroke and so on and hypertensions. **Male, 49 years, Mason**

Common illness identified by the elderly related to waist pains and joint pains. This is understandable given that these are the common reported health problems in this age group.

Waist and leg pains (Bodily pains), malaria is for the children. **Male, 60 years, Tailor and farmer**.

5.2.13 Environmental health issues

Participants identified rampant indiscriminate disposal of waste in the environment. They recognize that they lacked dustbins for the collection of waste.

Sometimes there are choked gutters making the environment dirty and also there is a lot of dust. **Female, 20 years, Shopkeeper.**

Figure 6 shows a refuse dump that can be found near most homes in the community. This provides breeding grounds for disease causing flies and mosquitoes.

Figure 6: Refuse dump near homes.

Participants also identified their lack of access to toilets and majority of them resort to open defecation. They bemoaned the consequences of these activities which could lead to their water bodies get polluted and increasing their risk of getting water-borne diseases.

Our problem is water, we don't have water. The entire community has no water, erm! and also a public toilet, so, you know, when you don't have a toilet facility in your house and there is a

public facility in the vicinity that is far better than squatting in the bush. The bush squatting, when the bushes are cleared, we turn to defecate around our homes. These are some of the practices that gets us infected by diseases. The faecal matter also gets washed into our water bodies (dams) and we go back to drink from these contaminated sources, because our pipes are not flowing. As it stands now, a yellow can of water is Gh 2.00, so our main problem is the water, public toilets and road, our roads are not in good shape. **Male, 32 years, unemployed.**

We don't have toilet. We free ourselves in the bushes. **Female, 30 years, Trader**

No toilet facility. We defecate in the bush. **Male, over 60 years, Farmer** Others identified that they make use of public toilets.

Figure 7: A choked gutter.

6.0 Strengths and limitations

This is one of the first step in northern Ghana to explore the perceptions and social risks of extreme heat among rural and urban folks in northern Ghana. The evidence generated will serve as a stepping stone for the design and conduct of future studies into this subject matter. It will also provide evidence that will support the design of interventions to support communities mitigate the effect of extreme heat on their health and livelihoods. We adopted a qualitative approach that is strong at generating new unique ideas and perceptions that context specific. However, the study is not without limitations. We adopted a cross-sectional design that does not

establish causality. We adopted interviews and focus group discussions that rely on self-reports that may be liable to social desirability bias. These were however minimized by through the use of transect walk and field observations to complement the interviews and focus group discussions.

7.0 Conclusions

Participants had awareness that there is global climate. Participants generally had positive attitudes towards climate change and recognized that they action and inactions have contributed to global climate change. Notwithstanding the high level of awareness and sense of recognition of climate change they are significant others who believed that the effects of climate change are by the actions of God or the wrong doings of others.

Extreme heat has been described by these rural and urban folks as one of their biggest climate change issues through their personal experiences and its effects on their health and livelihoods. They are very much aware of the coping mechanisms to overcome the effects of extreme heat and have demonstrated an adoption of some of those strategies. There are also structural and economic barriers that prevent the adoption of other coping mechanisms such as having access to cooling fans, air conditioners and regular supply power. These barriers become more aggravated especially among urban and rural poor people and the elderly making them more vulnerable to the effects of extreme heat.

Nature and design of buildings and windows were identified as key contributors to community dweller's response and ability to withstand the effects of extreme heat.

Access to adequate and portable water was identified as a major climate change issue which becomes more devastating especially for the urban and rural poor during the period of extreme heat when most water sources have dried up.

Access to toilet facilities was identified as a challenge as a good proportion of the participants reported that they resort to open defecation, a practice that aggravates water, sanitation and hygiene (WASH) issues.

8.0 Recommendations

1. Future quantitative surveys should be conducted using a large sample size to estimate the knowledge and practices around extreme heat as well as the beliefs, attitudes and perceptions about the frequency, severity and duration of extreme heat periods in northern Ghana.
2. Future studies should also assess the vulnerability to extreme heat taking into considerations income levels, geographical locations and demographic factors.
3. Public health departments should develop and promote educational resources and campaigns regarding coping strategies and mechanisms and to improve public response to extreme heat. This should be a collaborative approach involving the town and country planning, forestry commission, the Ghana Health Service and among others to support the revamping of infrastructure, increasing knowledge of risks factors and improving protective measures.

9.0 References

1. Hasan F, Marsia S, Patel K *et al.* (2021) Effective community-based interventions for the prevention and management of heat-related illnesses: a scoping review. *International journal of environmental research* **18**, 8362.
2. Watts N, Amann M, Arnell N *et al.* (2019) The 2019 report of The Lancet Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate. *The Lancet* **394**, 1836-1878.
3. Hardy JT (2003) *Climate change: causes, effects, and solutions*: John Wiley & Sons.
4. Collier P, Conway G, Venables T (2008) Climate change and Africa. *Oxford Review of Economic Policy* **24**, 337-353.
5. File DJM, Derbile EK (2020) Sunshine, temperature and wind. *International Journal of Climate Change Strategies and Management* **12**, 22-38.
6. Teye JK, Yaro JA, Bawakyillenuo S (2015) Local farmers' experiences and perceptions of climate change in the Northern Savannah zone of Ghana. *International Journal of Climate Change Strategies and Management* **7**, 327-347.
7. Callo-Concha D (2018) Farmer perceptions and climate change adaptation in the West Africa Sudan Savannah: reality check in Dassari, Benin, and Dano, Burkina Faso. *Climate* **6**, 44.
8. Daba M (2018) Assessing local community perceptions on climate change and variability and its effects on crop production in selected districts of western Oromia, Ethiopia. *J Climatol Weather Forecasting* **6**, 216.
9. Frimpong K, Odonkor ST, Kuranchie FA *et al.* (2020) Evaluation of heat stress impacts and adaptations: perspectives from smallholder rural farmers in Bawku East of Northern Ghana. *Heliyon* **6**, e03679.
10. Iyakaremye V, Zeng G, Yang X *et al.* (2021) Increased high-temperature extremes and associated population exposure in Africa by the mid-21st century. *Science of The Total Environment* **790**, 148162.
11. Atanga RA, Tankpa V (2021) Climate Change, Flood Disaster Risk and Food Security Nexus in Northern Ghana. *Frontiers in Sustainable Food Systems* **5**.
12. Ejembi E, Alfa G (2012) Perceptions of climate change in Africa: regional agricultural perspectives. *Research on Humanities and Social Sciences* **2**, 1-10.
13. Haque MA, Yamamoto SS, Malik AA *et al.* (2012) Households' perception of climate change and human health risks: A community perspective. *Environmental Health* **11**, 1-12.
14. Odonkor ST, Dei EN, Sallar AM (2020) Knowledge, Attitude, and Adaptation to Climate Change in Ghana. *The Scientific World Journal* **2020**.
15. Frimpong K, Odonkor ST, Kuranchie FA *et al.* (2020) Evaluation of heat stress impacts and adaptations: perspectives from smallholder rural farmers in Bawku East of Northern Ghana. *Heliyon* **6**, e03679.
16. WHO (2015) WHO certifies Ghana free of dracunculiasis. https://www.who.int/news/item/16-012015-who-certifies-ghana-free-of-dracunculiasis