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Enhancing Climate Information Services for Sustainable Development Needs and Decision-Making in an Academic Community in Ghana

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Abstract:** This study delves into the critical issue of climate change and its profound implications for sustainable development, with a particular focus on the context of African nations like Ghana. The effective adaptation to climate change hinges on timely access to accurate climate information. However, the successful utilization and adoption of climate data are contingent upon collaborative efforts between providers and users. In this context, we investigate the specific climate information needs within the diverse sections of the University of Energy and Natural Resources (UENR) in Ghana. Conducting an exhaustive survey involving a broad spectrum of stakeholders, our research reveals that respondents within the UENR community possess a sound understanding of climate change. Importantly, they express distinct information requirements related to climate change. Notably, the decisions made by these individuals are significantly influenced by weather and climate information. Moreover, respondents emphasize the importance of climate information that aligns seamlessly with their expectations regarding relevance and precision. This study encompasses diverse segments of the university, including teaching staff, non-teaching staff, and students. Respondents from various departments were selected randomly, and we meticulously gathered primary data through structured questionnaires. Additionally, this research was complemented by a comprehensive review of secondary data from scholarly sources such as books, journals, articles, and reports. This research centers on the utilization and usability of climate information to facilitate climate change adaptation within the framework of climate services to bridge the gap between scientific research and practical application in the realm of development studies. The study also contributes to disseminating best practices, case studies, theories, methods, and data analysis directly relevant to climate services. By highlighting the multidisciplinary and application-oriented nature of climate

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services within specific sectors, this paper provides valuable insights into the pivotal role of climate information in addressing the formidable challenges posed by climate change.

Keywords Climate Information, Climate Change Adaptation, Climate Services, Climate Informational Needs, University of Energy and Natural Resources.

1. INTRODUCTION

West Africa is a very vulnerable part of the world to the impacts of climate change due to a combination of exposure and low adaptive capacity (Ouedraogo *et al*., 2018) In spite of being the least contributor to global warming and having the lowest emissions (about 7%), Africa suffers the most and faces rapid collateral damage due to the low adaptation capacity and high exposure to climate extremes (Nyambane & Ozor, 2018). Due to factors such as poor records of climate observation, poor simulation of inter-annual and decadal climate variability, and limited climate science investments, the provision of seasonal climate predictions and projections continues to be a challenging scientific task in Africa. Many African countries are victims of severe climatic stress, manifested in high incidences of weather-related shocks, including drought, storms, flooding, and extreme temperatures (Nyambane & Ozor, 2018). There have been several studies that confirmed with a high level of confidence that the intensity of the current and future impacts of climate change and the negative effects on Africa's economy will be more due to the fact that, Africa is vulnerable to most of the extreme weather events (Antwi-Agyei et al., 2021; Neville & Anu, 2010; Nyambane & Ozor, 2018). Climate change has already been set into motion, and many African countries like Ghana are experiencing the severe climatic stress, that comes in high incidences of weather-related shocks, including drought, storms, flooding and extreme temperature (Sansa-Otim *et al*., 2022). The negative effect of these shocks on Ghana's economy is further intensified by the widespread poverty thus increasing the vulnerability of a large proportion of the population in Ghana. This is due to the fact that, there are limited climate information available and to some extent, the organizations or individuals (users) do not take the producers of the climate information services serious. The negative impacts of climate change on social, economic and environmental systems have drawn the attention of various stakeholders, including development agencies, scientific institutions and civil society organizations to generate and disseminate appropriate climate information in African countries *(*Antwi-Agyei *et al*., 2021; Singh *et al*., 2018). The climate information service will help individuals and organizations prepare towards a particular weather event throughout the season or daily. This will also help them make decisions concerning activities to undertake and those not to. In most cases where climate information services are introduced, the disconnection between the user and the producer of the climate information seems to undercut largely. The objective of this paper is to examine or assess the climate information needs of the various sections in University of Energy and Natural Resources, Dormaa Campus. The study will analyze the experiences that the various sections have on climate information.

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2. MATERIALS AND METHODS

2.1 Study Area

The Dormaa Municipality as shown in Figure 1, covers a total land area of 1210.28 square kilometers and is situated in the western portion of the Bono Region. It lies within longitudes 3° West and 3° 30' West and latitudes 7° North and 7° 30' North. It is bordered to the north by the Jaman South district, to the east by the Dormaa East district, the South and South-East by the Asunafo and Asutifi districts, the West and South-West by Dormaa West district, and to the West and North-west by La Cote d'Ivoire. Dormaa Ahenkro serves as the municipal capital which is about 80 kilometers to the West of Sunyani, the regional capital. The Dormaa municipality is situated within the wet semi-equatorial climate region with a double maxima rainfall regime. The average yearly rainfall ranges from 125mm to 175mm. The first rainy season starts from May to June; with the heaviest rainfall occurring in June while the second rainy season is from September to October.

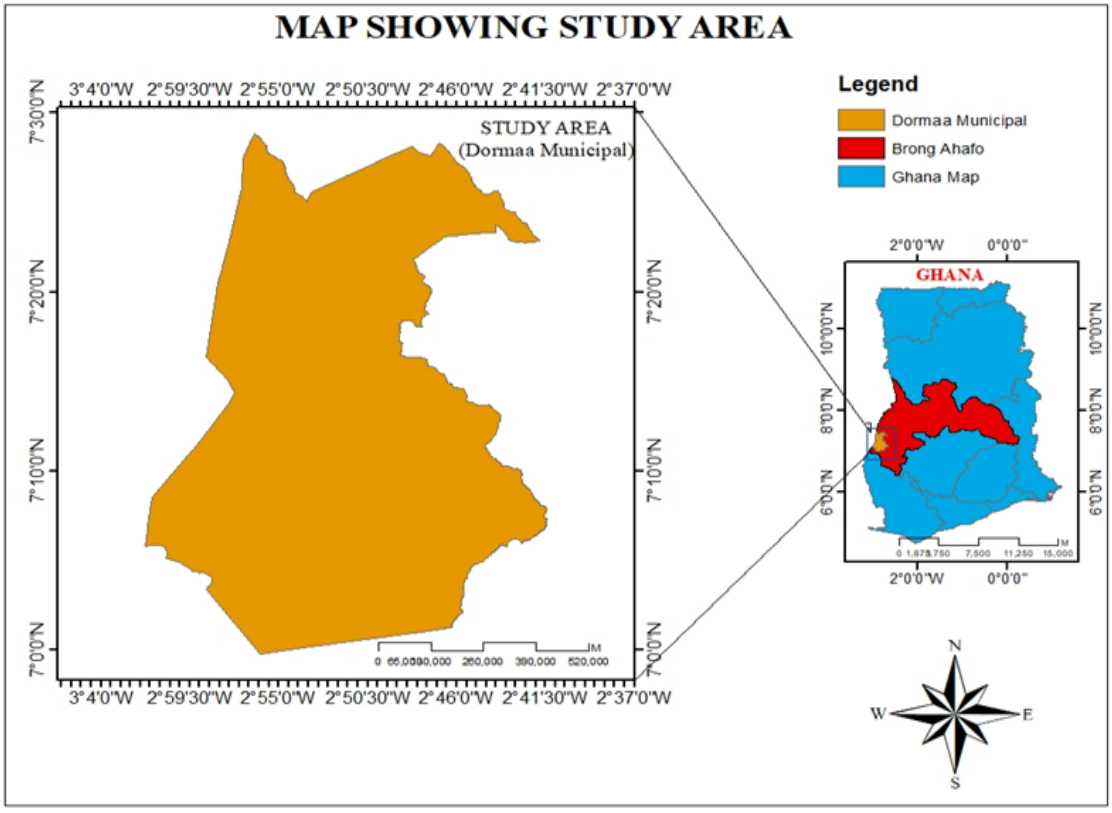

Figure 1. A map of Dormaa Municipality

2.2 Data

In this study, data was collected from the staff (teaching and non-teaching) and students from the various sections or departments in the university through a structural questionnaire. The questionnaire comprised of both open and closed ended questions for the purpose of collecting primary data from the target population. The sampling method used in this study was simple

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random sampling. Every section or department in the university had an equal chance of being chosen for the study without bias using the simple random selection method. Google forms was adopted in this study to help administer questionnaires and the data gathered was analyzed using Microsoft Excel. Permission was sought from every individual before the questionnaires were administered to them.

3. METHODS

3.1. Sampling Strategy

The target population for this study comprises the academic community within the University of Energy and Natural Resources (UENR) in Ghana. This includes teaching staff, non-teaching staff, and students from various departments. A random sampling technique was used to select participants. To ensure representation, a random sample of participants was drawn from each department, with the number of participants from each department proportional to its size.

3.2. Questionnaire Design

Questionnaire Structure: The questionnaire was structured into sections, including demographic information, climate change awareness, climate information sources, utilization of climate information, and preferences for climate information. Most questions were close-ended with options for respondents to choose from. For example, questions on gender, age groups, and department allowed participants to select predefined categories. To assess trust in climate services and the frequency of finding climate information helpful, a Likert scale was used. Respondents could choose from options such as "strongly agree," "agree," "disagree," and "strongly disagree."

Data Collection

In-Person Surveys: Trained research assistants conducted in-person surveys to administer the questionnaires. They explained the purpose of the study, obtained informed consent from respondents, and provided assistance if needed.
Secondary Data Collection: Secondary data was collected from academic sources, including books, research papers, journals, and reports, to provide a contextual background on climate change and climate information services.

Data Analysis

The quantitative data collected from the questionnaires were analyzed using statistical software (e.g., SPSS or Microsoft Excel). The following analyses were conducted: Descriptive statistics, such as means, percentages, and standard deviations. Chi-square tests or analysis of variance (ANOVA) to identify associations or differences between demographic variables and responses. Construction of graphs and charts to visualize the data, such as bar graphs and pie charts.

Ethical Considerations

Prior to data collection, respondents were informed about the study's purpose, their rights, and the use of their data. Informed consent was obtained from all participants. Anonymity and

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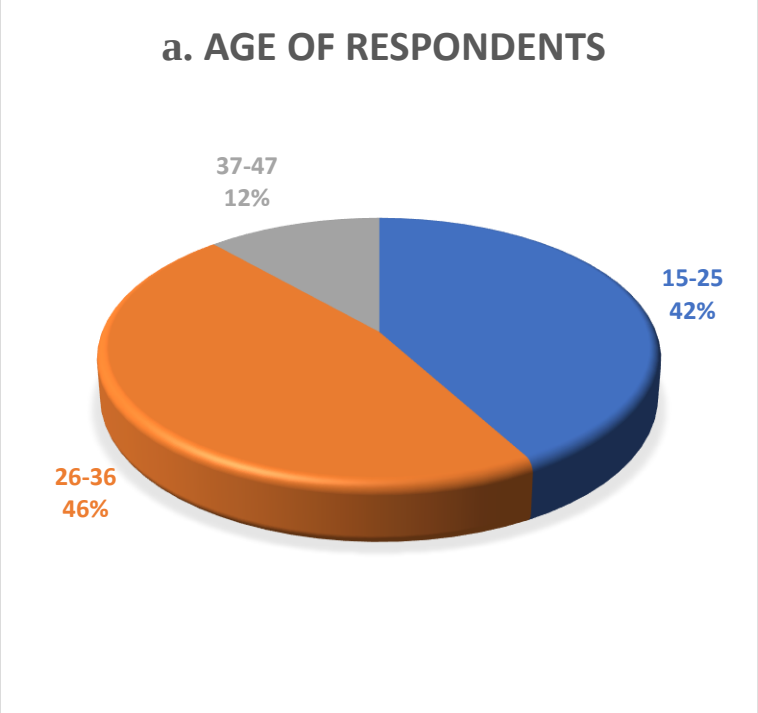
Confidentiality: Respondent data was kept confidential, and no personal identifiers were linked to the responses to ensure anonymity. The research protocol was submitted for ethical review and approval from the university's ethics committee.

4. RESULTS AND DISCUSSION

4.1 Demographic Characteristics of Respondents

From the data collected, majority of the respondents were males with a percentage of 68% while the rest were females also with a percentage of 32% (figure 2b). The age of respondents was categorized into three groups, with the first group which is 15-25years having the second highest percentage of 42%, the second group which is 26-36years having the highest percentage of 46% and the last group which is 37-47years also having the less percentage of 12% (figure 2a). Respondents came from all the five departments of the university that is Department of Atmospheric and Climate Sciences, Department of Agriculture, Department of Geography and Sustainability Sciences, Department of Geospatial Sciences and Department of Agribusiness with percentages of 31.8%, 25%, 22.7%, 11.4% and 9.1% respectively (figure 2c). The number of years respondents have stayed on campus was also categorized into two groups, with the first group being 1-4 years and having a highest percentage of 85% and the second group being 5-7 years also with the lowest percentage of 15% (figure 2d).



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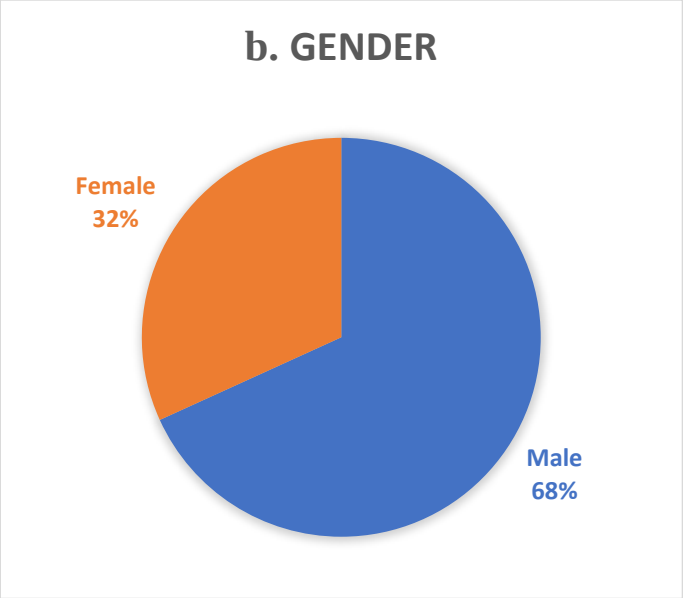

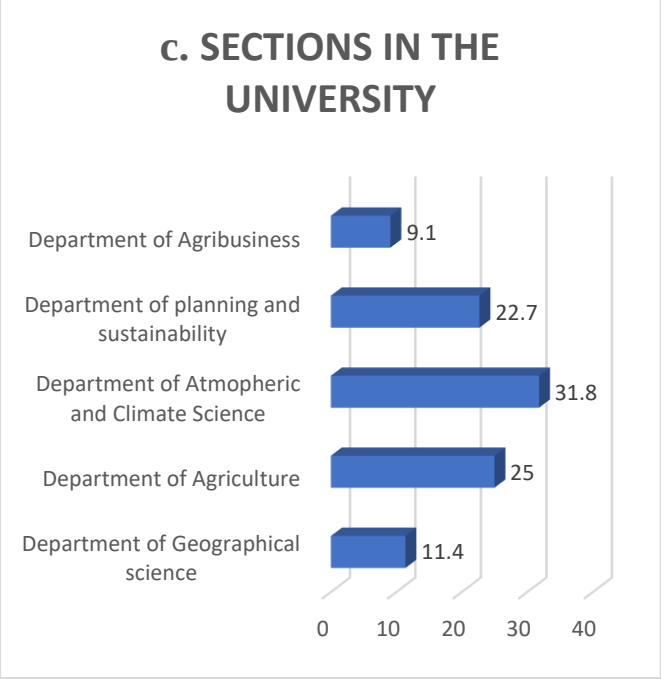

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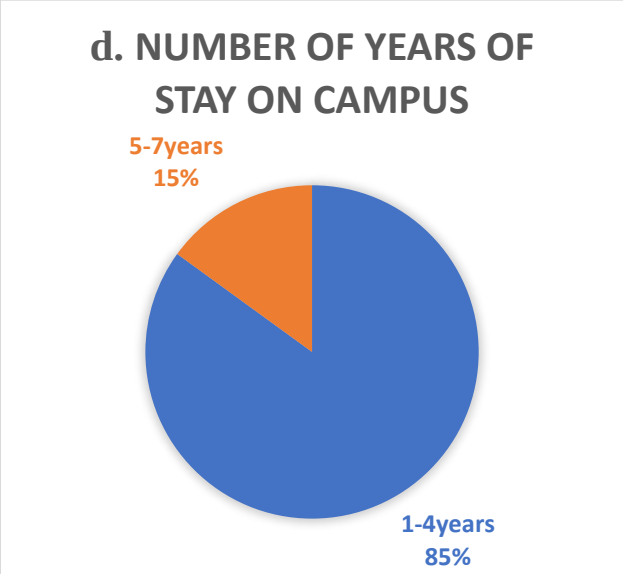

Figure 2. Demographic characteristics of respondents. Note: this figure displays the percentages of the age of respondents (A), respective genders (B), the various sections in the university (C) and the number of years of stay on campus (D).

4.2 Awareness of Climate Change and Climate Information Services

As stated in other literatures, there is strong scientific evidence that the climate is changing more quickly than expected, which will have a negative impact on the socioeconomic progress of developing nations. (Antwi-Agyei et al., 2021). Majority of respondents attested to the fact that the pattern of weather is generally changing and they selected some observed changes or evidences from the options provided to back their claim. The options with their assigned percentages are as follows: temperature/sunshine (47%), decrease in rainfall patterns (19%), drying up of water bodies (20%) and decrease in temperature/sunshine (14%) (Figure 3a). Despite extensive discussions on the cause of climate change, there is a widespread agreement that the planet is changing and that human activity has played a significant role in this process (Wu *et al*., 2016). According to figure 3c, majority of respondents with a percentage of 65 trust climate services while the remaining respondents with a percentage of 35 do not trust climate services. Respondents were asked how often climate services help them on time and the options were categorized into always, most of the time, usually not, and never with percentages of 9.5, 59.5, 21.4 and 9.5 respectively (figure 3b). This data shows that, though climate services do not always help respondents out, most of the time it can be of great help. As stated in other literatures, Climate services is a crucial component of policy making in unstable times (Naab *et al*., 2019). The assumption of projected climate change is that, in addition to changes in mean climate parameters like temperature or precipitation, these changes will also affect the frequency and intensity of extreme weather events (Res *et al*., 2006). Due to changing weather and climate patterns, we may be prone to certain climate hazards and so, respondents were asked to select from options provided which climate hazard they are exposed to and also given the chance to add up incase what they are facing is not in the option. The first option was droughts with a number of 8 respondents, the second was flooding with a number of 26

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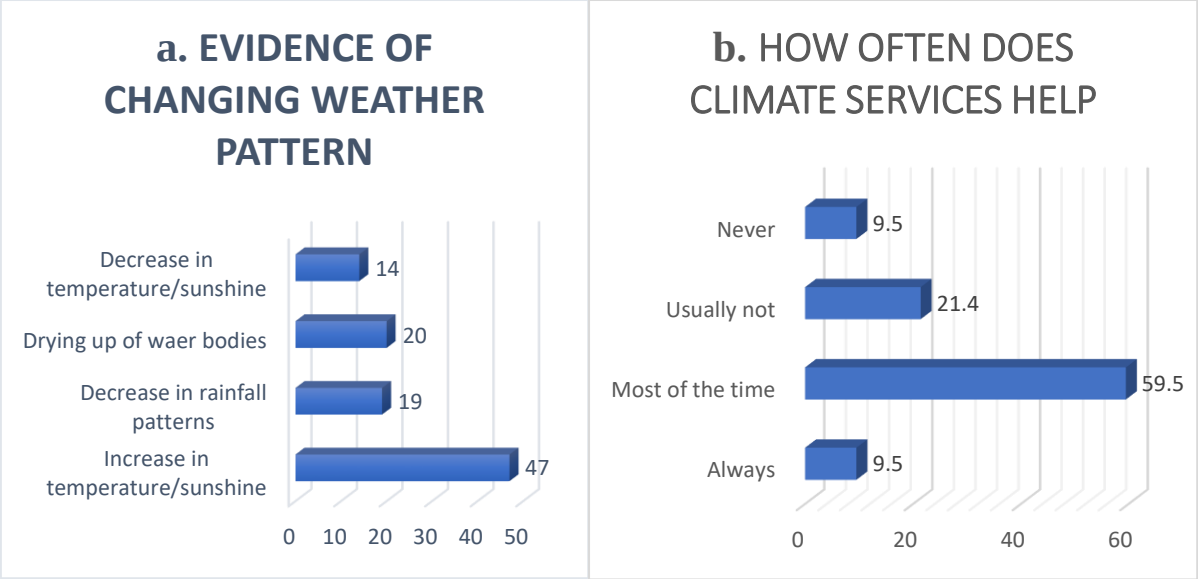
respondents, the third was increase in disease epidemics with 0 respondents and the fourth option was famine also with 4 respondents. The other options provided were also from 4 respondents and they were: cold spells, rising temperatures, food insecurity and heatwaves (figure 3d). From this data, flooding came out with the highest number of respondents and this means majority of respondents are at risk to flooding. Changes in climate (example temperature rise, sea level rise, increased risks of floods and droughts) may increase the likelihood of sudden and non-linear changes in many ecosystems, which would influence their composition, function, biodiversity and productivity (Cardoso *et al*., 2008).



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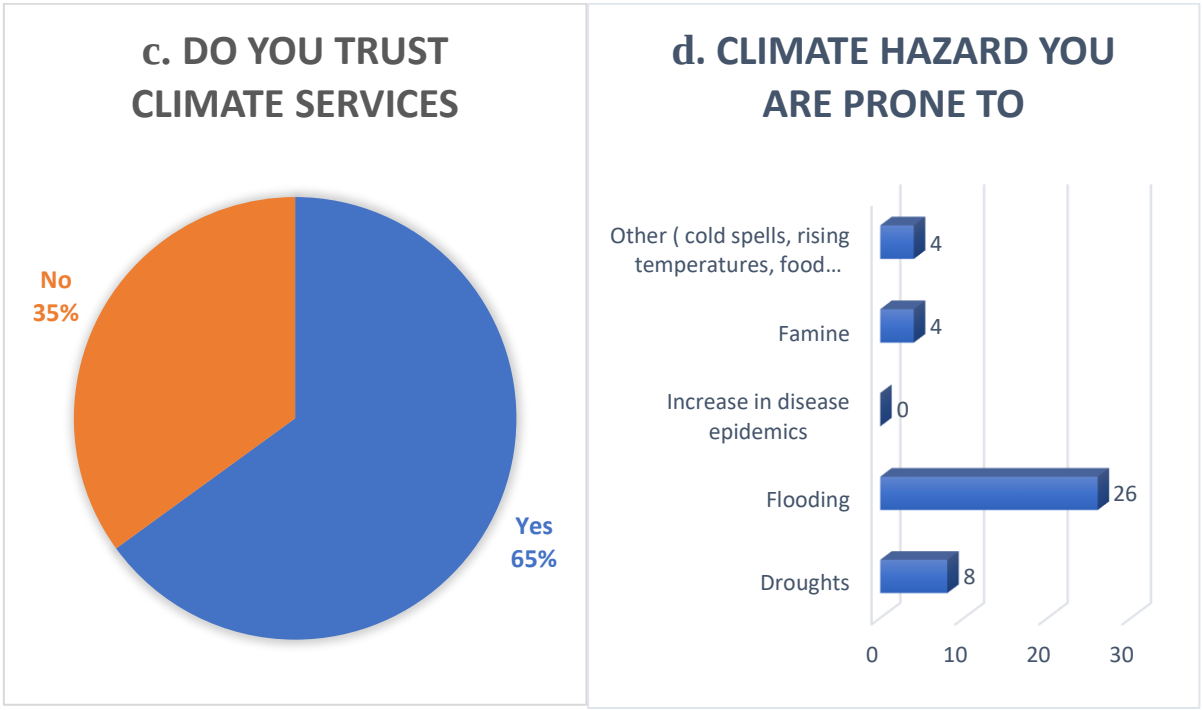

Figure 3. Awareness of climate change and climate information services. Note: this figure displays the percentages of some of the evidences of changing weather pattern (A), how often climate services help respondents (B), how well respondents trust climate services (C) and some possible climate hazards respondents are prone to (D).

4.3 Climate Informational Needs and Decision Making

In this section, we wanted to find out if respondents use weather and climate information. From the data gathered, it was evident that majority of respondents with a percentage of 81 use weather and climate information and the remaining percentage of 19 do not use weather and climate information (figure 4c). Lead time for receiving climate forecast were categorized into one month with the highest percentage of 57, two months with a percentage of 25, three months with a percentage of 11, four months with a percentage of 2 and five months also with a percentage of 5 (figure 4a). From this data gathered, it clearly shows that majority of respondent prefer a one-month lead time of receiving climate forecast since it will be a sufficient lead for them to plan their activities. The timely provision and use of climate information services is a crucial step toward enhancing management of hazards associated to climate change (Baffour-Ata *et al*., 2022). Data was also gathered on what a sufficient lead time will enable respondents do and 86.3 percent of the respondents said it will help them prepare fully for the season with its consequences, 11.7 percent said it will improve their service levels and 2.3 percent also said it will thrive their safety stock (figure 4b). Data was also collected on how much respondents agree or disagree to trusting climate information and using it for decision making. Scholars have shown that the degree of interaction or cooperation of scientific knowledge and decision making between information provider and users significantly influences the rate of usage of climate information(Carmen *et al*., 2012). From the data collected, we had 61.3 percent agreeing, 19.4 percent strongly agreeing, 3.2 percent disagreeing and 16.1 percent strongly

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disagreeing (figure 4d). This shows majority of respondent agree to trusting and using climate information. (Carmen *et al*., 2012) argue that information is only useful if users believe it to be relevant, trustworthy, and legitimate.

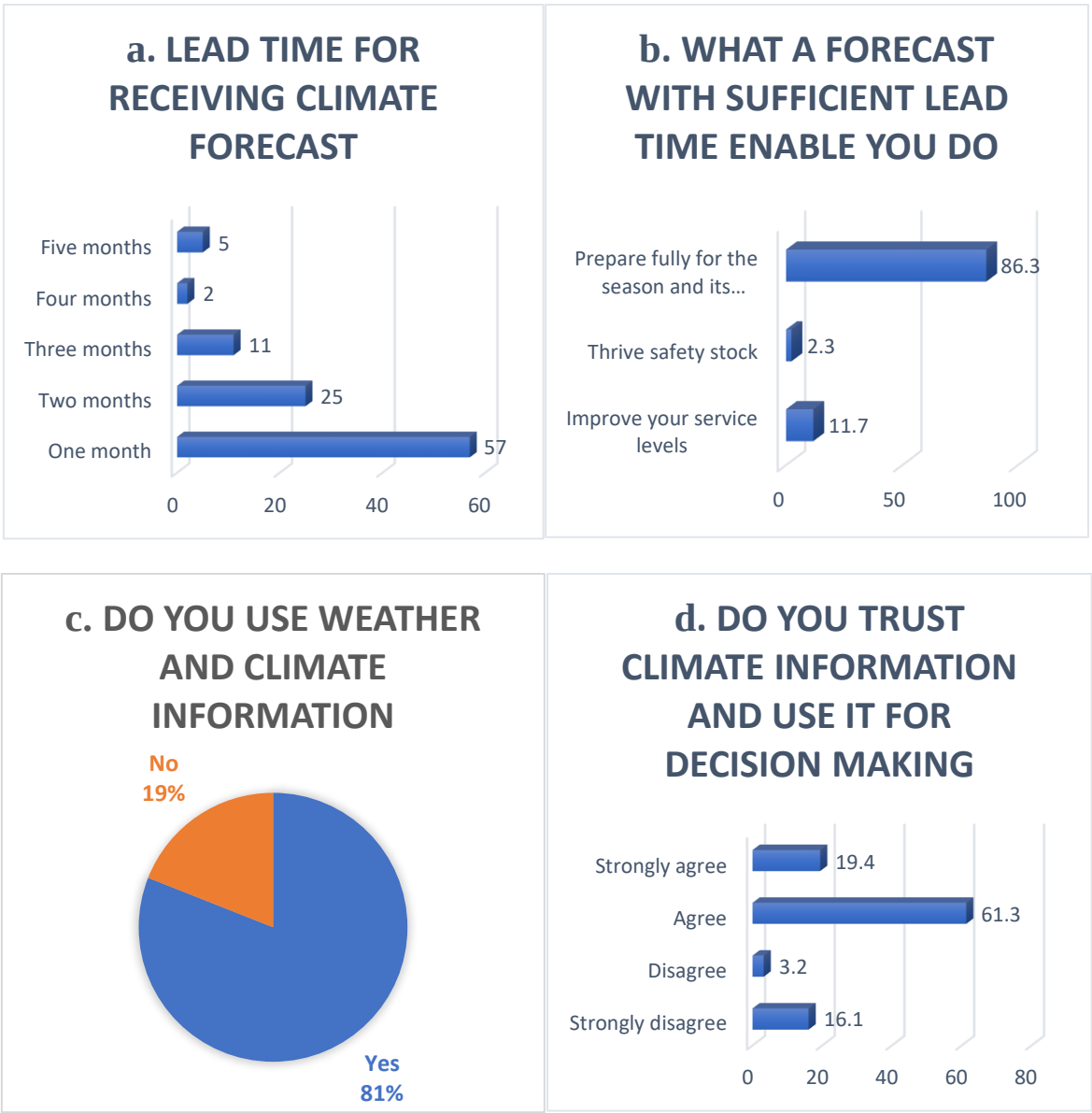

Figure 4. Climate informational needs and decision making. Note: this figure displays the percentages of the lead time for receiving climate forecast (A), what a forecast with sufficient lead time enables respondents do (B), whether or not respondents use weather or climate information (C) and the level at which respondents trust and use climate information for decision making (D).

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4.4 Consequences of Climate Information Failure and Types of Climate Information

Types of climate information may vary from one person to the other depending on the kinds of decisions each person would want to make. Data on temperature, precipitation, wind, humidity, sunshine hours, and other factors are described in terms of climate information (Nyambane & Ozor, 2018) Climate data can be coupled with a variety of services to assist people in understanding and utilizing the data to improve their quality of life in areas including health, agriculture, energy, and water (Kotamarthi *et al*., 2016). Respondents were asked the type of climate information they will need for their decision making and were asked to rank from 1-5 where very important information was ranked 5 and less important 1. The types of climate information included rainfall onset which can be described as the possible start of rainfall in a year and was ranked the highest, rainfall cessation which is also a period that is characterized by the end of rainfall in a year and was ranked the fifth highest, total rainfall amount which is the depth of water reaching the ground, typically in inches or millimeters and was ranked the fourth highest, degree of hotness (temperature) which is also the extent to which temperature increases and was ranked the second highest and likelihood of water deficits which describes the cumulative difference between potential evapotranspiration and precipitation during a certain period in which the precipitation is the smaller of the two and was ranked the third highest. This shows that even though respondents find all the climate information very important, majority of find rainfall onset very important (figure 5c). We also wanted to find out from respondents some of the consequences they face when a climate information fails. After the data was gathered, 40.5 percent of respondents stated insufficient food, 28.1 percent stated extreme heat, 28.1 percent also stated flood and 3.1 also said its affect decision making (figure 5a). Looking at these results, it clearly shows that majority of respondents face problems of insufficient food when climate information fails. As stated in other literatures, over 26% of people worldwide experienced moderate or severe food insecurity in 2018 (Backer & Billing, 2021). Information was also gathered from respondents on what a good forecast will do to their area and at the end majority of respondents with a percentage of 55.8 stated high yield, 18.6 percent also stated proper wearing of clothes to suit the weather, 9.3 percent stated prevent extreme heat, another 9.3 percent also stated control and reduce flood and 6.9 percent stated appropriate water management (figure 5b). From the results derived, it shows that greater number of respondents are saying that a good forecast will help in a high yield. Four statements were provided for the respondents to find out how much they agree to them. Options were categorized into strongly disagree, disagree, agree and strongly agree. The statements were information about weather or climate influences your decisions, you consider seasonal climate prediction relevant, you prefer less accurate forecast with sufficient lead time and you prefer highly accurate forecast with insufficient lead time. According to figure 5d, you find majority of respondents agreeing to the statements, information about weather or climate influences your decisions and you consider climate prediction relevant. This clearly shows that there are people who value and use weather and climate information and therefore their decisions maybe influenced depending on how accurate or inaccurate the climate information is. The rest of the respondents also agreed to the other two statements, you prefer less accurate forecast with sufficient lead time and you prefer highly accurate forecast with insufficient lead time.

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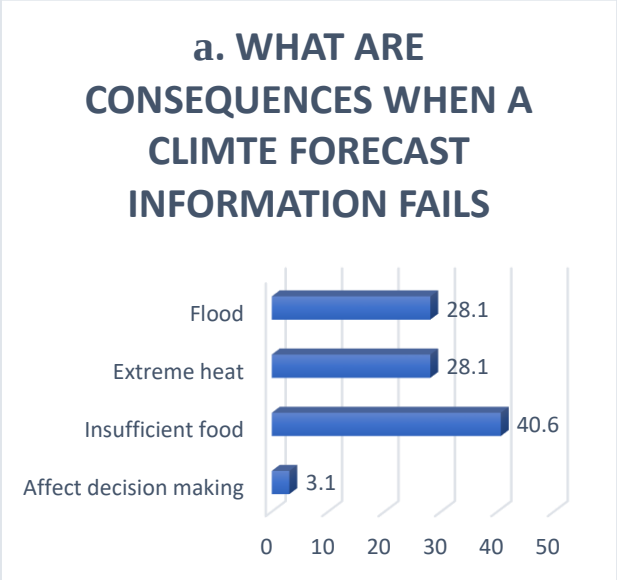

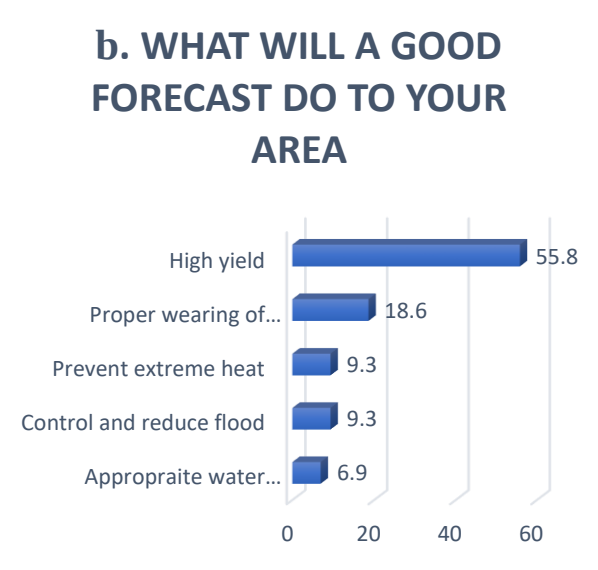

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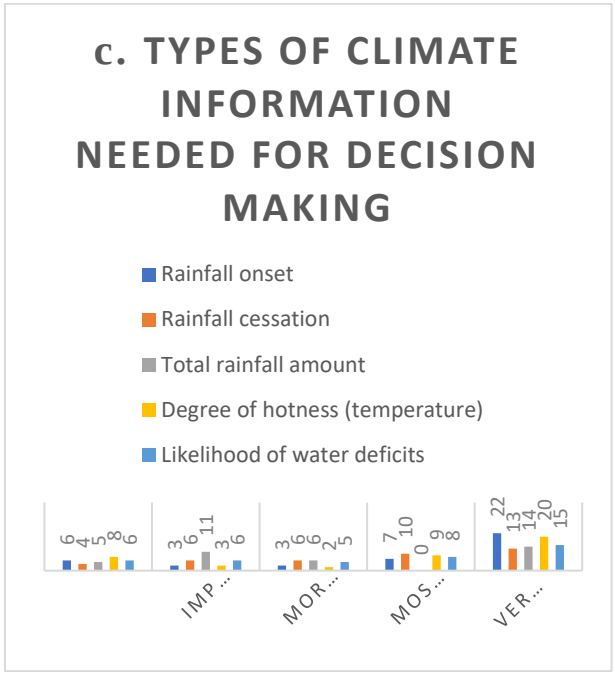

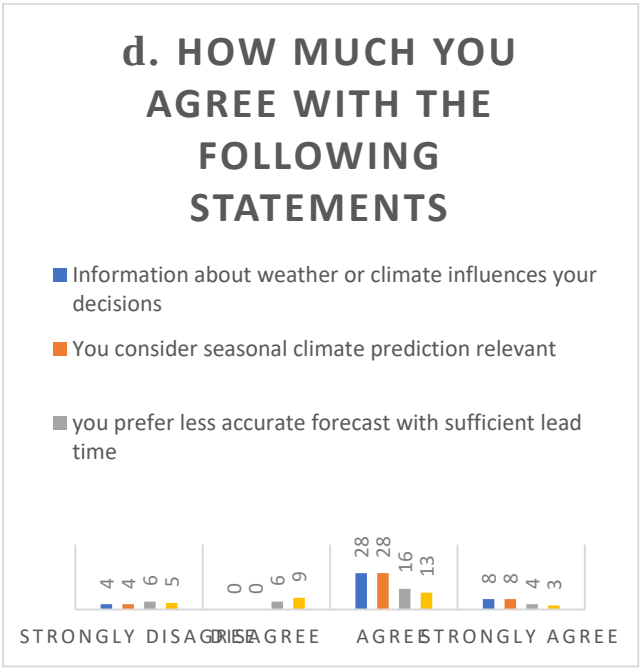

Figure 5. Consequences of climate information failure and types of climate information. Note: this figure displays the percentages of some of the consequences associated with the failure of climate forecast (A), benefits of a good forecast to your area (B), the types of climate information needed for decision making ranked according to the level of importance to respondents (C) and how much respondents agree to statements like how climate information influences decision making, how relevant is seasonal climate prediction, and how one prefers his or her forecast (D).

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5. CONCLUSION AND RECOMMENDATIONS

This study was carried out to assess the climate information needs of the various sections in University of Energy and Natural Resources, Dormaa Campus. we found out that majority of the respondents had a fair knowledge on climate change and climate information services. Respondents pointed out some evidences to back their claim. You could also tell from the study that majority of respondents have access to weather and climate information and use it for their decision making. Although some of the respondents noted that weather and climate forecast are good and helps them out most of the time, other respondents also noted that there could be more room for improvement. Uncertainty about the accuracy of weather and climate information and the information not meeting specific needs of users are barriers to people willingness to use it. I advocate for enhanced cooperation between Ghana Meteorological Service and other sectors to improve weather and climate information access and needs and also adopt innovative approaches that will enable improved understanding and utilization of weather and climate products. There is therefore the need to invest more in the Meteorological Agencies so that they can be well equipped to help in the proper and efficient dissemination of climate information to users. I would therefore like to recommend future researchers to look into other sectors like the agricultural and health and also assess the climate information needs of these sectors to enhance proper adaptation and mitigation of climate risks.

Declaration of Competing Interest
The authors declare no conflicts of interest regarding the publication of this paper.

Authors' Contributions
All the Authors contributed equally to this study

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Data Availability
The data is available upon request

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