

Adapting Together, Thriving Tomorrow



Climate Change Rapid Risk Assessment and Adaptation Plan for Wenchi Municipal Assembly, Ghana

Enhancing Multi-Sector
Planning and Capacity
for Effective Adaptation
in Ghana



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List of Abbreviations

Acronym	Expanded Form
AR4	Fourth Assessment Report
AR5	Fifth Assessment Report
CCV	Climate Change Vulnerability
CCRA	Climate Change Risk Assessment
CHPS	Community Health Planning System
CMIPs	Coupled Model Inter-comparison Projects
COP	Conference of the Parties
EPA	Environmental Protection Agency
FNC	Fourth National Communication
GCF	Green Climate Fund
GHG	Green House Gas
GoG	Government of Ghana
GSS	Ghana Statistical Service
I&APs	Interested and Affected Parties
IPCC	Intergovernmental Panel on Climate Change
MESTI	Ministry of Environment, Science, Technology and Innovation
MMDAs	Metropolitan, Municipal, and District Assemblies
MoFA	Ministry of Food and Agriculture
MTDP	Mid-Term Development Plan
NAP	National Adaptation Planning
NCCP	National Climate Change Policy
NDC	Nationally Determined Contribution
PLwD	People Living with Disability
RCP	Representative Concentration Pathway
SSPs	Shared Socioeconomic Pathways
UNFCCC	United Nations Framework Convention on Climate Change
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
VRA	Volta River Authority
WHO	World Health Organisation
WMA	Wenchi Municipal Assembly



EXECUTIVE SUMMARY



Wenchi Municipal Assembly

Climate Change Rapid Risk Vulnerability

The Wenchi Municipality is vulnerable to various climate-related risks. Climate change impacts in the municipality include increased temperatures, changing rainfall patterns, and frequent extreme weather events like floods and droughts. These changes pose significant risks to agriculture, infrastructure, and public health. The climate change rapid risk assessment was guided by the following specific objectives (i) to conduct rapid climate risk assessments in the Wenchi Municipal Assembly, and (ii) to develop a costed adaptation plan for the Wenchi Municipal Assembly. The main goal is to assist local experts and stakeholders in systematically evaluating the district's vulnerability to climate change impacts.

The methodology adopted a structured participatory approach involving a desk review, information synthesis, stakeholder consultation and final revision and validation. The assessment shows that the Wenchi municipality faces significant physical and social and vulnerabilities. The report highlights the key gender-specific vulnerabilities across priority sectors – agriculture, health, energy, agriculture, trade, and forestry. The report indicates that the Wenchi municipality faces a harsh reality of climate extremes. Unpredictable rainfall patterns (leading to both floods and droughts) and temperature fluctuations are already impacting the municipality, with projections indicating further intensification.

Water scarcity is identified as a low-risk hazard in the Wenchi municipal with the risk of river flooding in Wenchi classified as medium. This suggests that while river floods are not as frequent or severe as extreme heat and wildfires, they still pose a significant threat to certain areas within the district. In the Wenchi Municipal, extreme heat presents numerous challenges. The most immediate impact is the heightened incidence of heat-related illnesses, including heatstroke and dehydration, which strain the local healthcare system. Agriculture, a significant part of Wenchi's economy, suffers as crops experience heat stress, reducing yields and threatening food security. Infrastructure deterioration, such as the warping of roads and railways, further complicates transportation and economic activities. Wildfires pose a severe threat to Wenchi Municipal, leading to the destruction of homes, infrastructure, and natural habitats. Additionally, the loss of biodiversity and ecosystem services disrupts the local environment and economy.

Through stakeholder engagements, the report identified the following for Wenchi Municipal Assembly:

- **Improving Monitoring and Supervision:** Adequate resources are needed for effective monitoring and supervision of environmental policies and construction activities to ensure compliance with established regulations.
- **Sensitization and Education:** Regular sensitization sessions are recommended for stakeholders, including gender advocates, NGOs, and the broader community, to ensure widespread understanding and support for climate adaptation measures.
- **Alternative Livelihoods:** The government and non-governmental organizations are urged to provide alternative livelihood opportunities to reduce the community's reliance on climate-vulnerable sectors such as agriculture and to counteract the economic draw of illegal mining activities.

- **Enhanced Disaster Response:** There is a call to establish community-based volunteer groups that can respond swiftly to environmental emergencies and disasters, even without immediate financial incentives.

To reduce the adverse impacts of climate change, the report identifies adaptation actions for Wenchi Municipal. These actions focus on reducing the identified risks and enhancing resilience across key sectors. These strategies include:

- Improving water management systems to enhance storage and conservation of water resources, ensuring availability during dry spells.
- Promoting sustainable agricultural practices such as introducing drought-resistant crops and improving soil health to mitigate the effects of climate variability.
- Strengthening healthcare systems to better manage and prevent outbreaks of climate-related diseases.
- Enhancing infrastructure resilience to withstand severe weather events, particularly focusing on road and bridge construction to manage flood risks effectively.
- Despite the planned adaptation measures, residual risks remain, particularly in areas with limited current adaptation capacity. The strategy emphasizes the need for integrated planning and implementation of adaptation measures within local development agendas to ensure sustainable management and conservation of resources in Wenchi Municipal.

Adaptation Action Plan for the Wenchi Municipal Assembly

Based on the key climate change risks and vulnerabilities identified, an adaptation action plan was developed for the Wenchi Municipality. This is aimed at addressing the municipal's vulnerabilities to climate change while building its resilience towards the attainment of the sustainable development.

Through stakeholder workshops with stakeholders drawn from priority sectors including agriculture, biodiversity, water and sanitation, health, trade, and gender, the identified adaptation actions were prioritized to make informed decisions that lead to effective adaptation and avoid maladaptation. The adaptation actions were evaluated using a Multicriteria Decision Making (MCDM) Analysis. The action plan aligns with the unique socio-economic and environmental characteristics of the Wenchi Municipality. The action provides details on the objectives, key performance indicators, resources requirement and implementing agencies for each adaptation action across agriculture, water resources, energy, health, trade and gender sectors.

MEL in the WMA is designed to achieve several key climate change adaptation objectives:

1. **Enhancing Climate Resilience:** MEL aims to monitor the effectiveness of adaptation strategies in reducing vulnerabilities across sectors such as agriculture, water, and infrastructure. By tracking progress, the Assembly ensures targeted actions improve resilience to climate shocks.
2. **Informed Decision-Making:** MEL provides data-driven insights that support evidence-based decisions, ensuring that adaptation plans address real and emerging climate risks effectively.
3. **Resource Optimization:** By identifying successful adaptation measures, MEL helps allocate financial and human resources to strategies that yield the most significant benefits, avoiding wasteful investments.

4. **Stakeholder Engagement:** MEL encourages collaboration between local communities, governmental agencies, and other stakeholders. Assessing engagement levels ensures inclusive and participatory adaptation processes.
5. **Promoting Sustainability:** Regular monitoring ensures that adaptation initiatives are implemented sustainably, maintaining their relevance and benefits over time while preventing maladaptation.
6. **Building Adaptive Capacity:** Through evaluation and learning, MEL identifies capacity gaps and provides feedback for training and resource provision, equipping stakeholders to manage future climate challenges.
7. **Reporting and Accountability:** MEL ensures transparent reporting on adaptation outcomes to stakeholders, including the government and donors, strengthening accountability and trust in the adaptation process.



1

Introduction

1.1 Background and Context

Climate change continues to dominate global environmental and development discourses. These discussions have intensified over the past few decades, particularly through forums like the United Nations Framework Convention on Climate Change (UNFCCC) and the annual Conference of the Parties (COP) meetings. The Paris Agreement, adopted at COP21 in 2015, marked a significant milestone, with countries committing to limit global warming to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C. These international commitments highlight the collective recognition of climate change as a critical global issue requiring concerted efforts (UNFCCC, 2015).

Ghana is experiencing significant climate change impacts (Asante & Amuakwa-Mensah, 2014). The country's climate has become increasingly unpredictable, with notable changes in rainfall patterns and rising temperatures. These changes pose a substantial threat to economic sectors, particularly agriculture, water resources, energy, health, and infrastructure (Antwi-Agyei et al., 2012; Baffour-Ata et al., 2021). Gender disparity in these sectors also influences the level of exposure and the ability of women, men, youth, and differently abled groups to adapt to climate threats (Antwi-Agyei, Abu, & Okyere-Nyako, 2021).

The Wenchi municipality of Ghana is vulnerable to various climate-related risks. Climate Change impacts in the municipality include increased temperatures, changing rainfall patterns, and frequent extreme weather events like floods and droughts (Adjei-Nsiah & Kermah, 2012). These changes pose significant risks to agriculture, infrastructure, and public health. The municipality's vulnerability is exacerbated by deforestation, land degradation, limited adaptive capacity, and health risks. For instance, the municipality's ability to adapt to climate change is constrained by limited resources, infrastructure, and institutional capacity (Dazé, 2013). Overall, the Wenchi municipal faces significant climate-related risks and vulnerabilities, emphasizing the need for targeted adaptation and resilience-building initiatives.

Addressing these threats requires effective and proactive adaptation planning (Darjee et al., 2023), aimed at building resilience into these economic sectors in a manner that brings equitable relief to vulnerable gender groups. Adaptation involves adjusting practices, processes, and structures to minimize the adverse effects of climate change and take advantage of potential opportunities. For Ghana, this means integrating climate and gender-responsive considerations into national and sectoral development plans, enhancing institutional capacities, and promoting community-based adaptation strategies.

Thus, effective climate adaptation in Ghana necessitates a thorough evaluation of risks and vulnerabilities across various sectors and regions. This knowledge should then be strategically applied to guide adaptation planning at both the national and local levels, particularly in critical climate-sensitive sectors. One critical framework guiding Ghana's adaptation efforts is the National Climate Change Policy (NCCP), which outlines the country's strategic direction in addressing climate change. The policy emphasizes resilience-building across sectors and highlights the importance of sustainable natural resource management, disaster risk reduction, and public awareness campaigns (Ministry of Environment, Science, Technology and Innovation [MESTI], 2021).

Ultimately, adaptation planning and resilience-building against climate impacts should be grounded in developing a deep understanding of climate impact manifestations, associated risks, and vulnerabilities in various sectors and regions (Owen, 2020; Eriksen et al., 2021). This knowledge should also underpin capacity-building processes that ensure effective climate adaptation governance, aimed at enhancing adaptive capacities across sectors, communities, and multiple levels. Ghana's National Adaptation Planning (NAP) process addresses these needs by integrating climate adaptation imperatives into governance at different levels. Incorporating gender inclusive community-based knowledge and indigenous practices in the NAP process can further strengthen adaptation strategies, making them more effective and sustainable.

1.2 Study Aims and Objectives

The Ghanaian government, through the Environmental Protection Agency (EPA) and under the guidance of the Ministry of Environment, Science, Technology, and Innovation (MESTI) secured a grant from the Green Climate Fund (GCF) for a three-year initiative aimed at bolstering the National Adaptation Plan (NAP) process in the country. The United Nations Environment Programme (UNEP) is partnering as the Delivery Partner, overseeing the project's implementation. Titled "Enhancing Multi-Sector Planning and Capacity for Effective Adaptation in Ghana," the project is managed by a dedicated team led by a National Coordinator.

The NAP initiative aims to facilitate comprehensive, long-term adaptation planning and budgeting across various sectors in Ghana. It seeks to integrate climate change adaptation considerations into national development strategies and policies. The NAP will strengthen systems for collecting and sharing climate risk and vulnerability data and develop sustainable financing mechanisms for adaptation efforts.

Part of the NAP focuses on generating climate change scenarios and risk assessments for Ghana using advanced techniques and data. These assessments will form the foundation for both national and regional climate change adaptation plans. Effective climate change risk assessments (CCRAs) are critical for understanding climate science, managing uncertainties, analyzing data through diverse methods, and conveying risk impacts in a clear and actionable manner for decision-makers and other stakeholders.

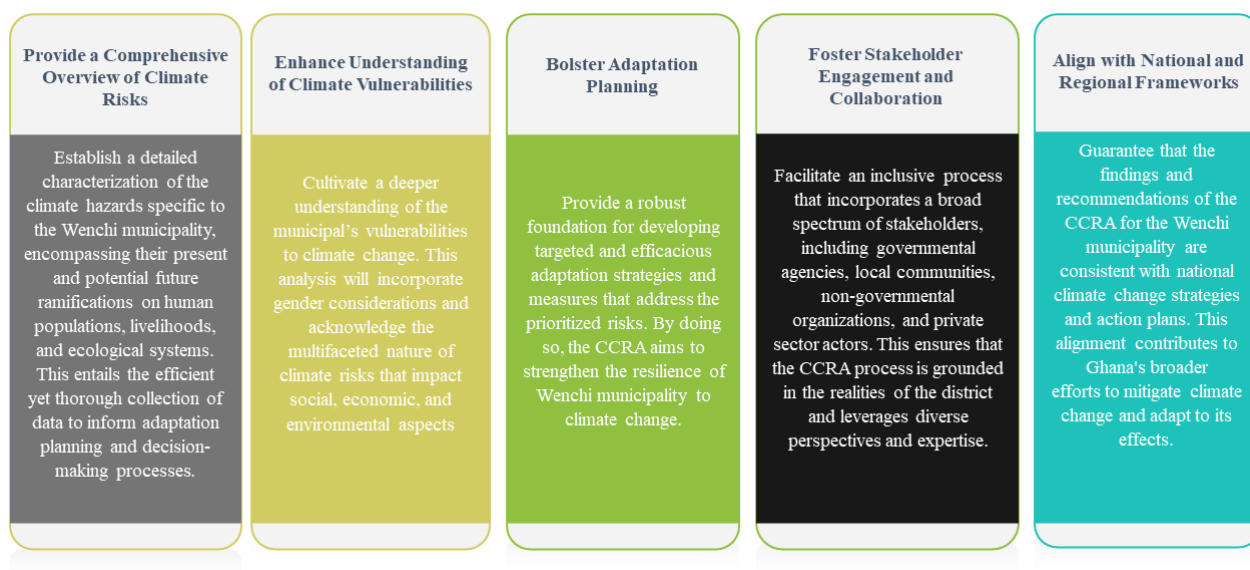
This necessitates a thorough understanding of historical and current climate impacts, projections of future climate impacts with and without climate change, and distinguishing other concurrent changes within the assessment area. The goal is to create a detailed and transparent climate risk narrative for Ghana. The overarching aim of this assignment is to develop a costed district adaptation plan and to build the capacity of the Wenchi Municipal Assembly for the mainstreaming of adaptation considerations in their Mid-Term Development Plan (MTDP) policies and plans. The assessment is guided by the following specific objectives:

- To conduct rapid climate risk assessments in the Wenchi Municipal Assembly.
- To develop a costed adaptation plan for the Wenchi Municipal Assembly.

1.3 Purpose of this Report

This report provides the CCRA for the Wenchi Municipal Assembly (WMA), for up to four first-order (biophysical) risk domains, and up to three second-order (economic sectors) risk domains, developed in collaboration with a range of stakeholders in Wenchi. The main goal of this report is to assist local experts and stakeholders in systematically evaluating the district's vulnerability to climate change impacts, focusing on integrating hazard, exposure, and vulnerability elements based on the Fifth Assessment Report (AR5) framework from the IPCC. Specifically, the CCRA endeavors to achieve the following goals:

Figure 1: A framework of the CCRA goals





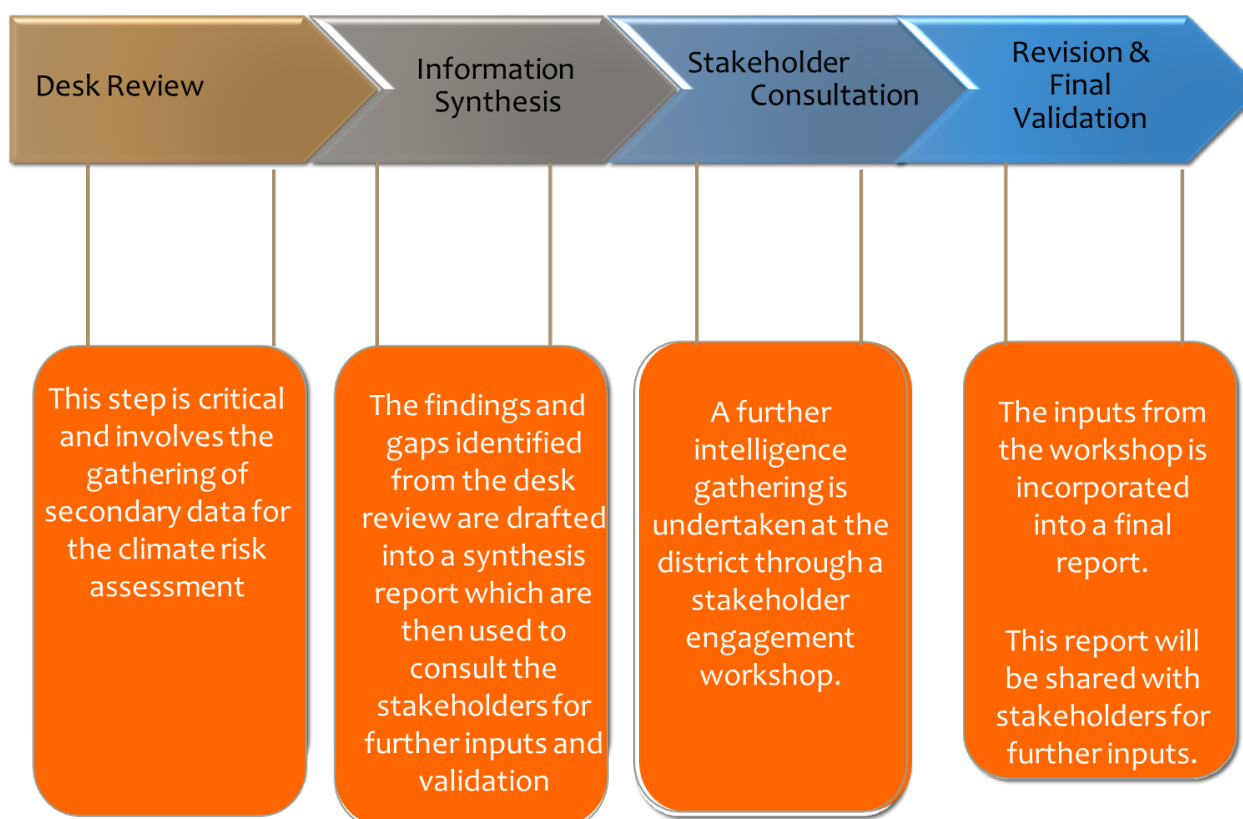
2

Approach and Methodology

2.1 Approach

The assessment method for this Climate Change Risk Assessment for the Wenchi Municipal Assembly is a structured, sequential procedure that comprises the following steps (see Figure 2):

Figure 2: Overall work approach for the Climate Change Risk Assessment for the Wenchi Municipal Assembly



2.1.1 Desk Review

The desk review is the foundational step in the climate risk assessment process. This phase involved the critical task of gathering secondary data, which serves as the bedrock upon which the entire assessment is built. Secondary data refers to information that has already been collected, analyzed, and published by other sources. This could include academic research, government reports, climate models, historical climate data, and case studies from other regions or projects. The primary objective of the desk review was to compile a comprehensive dataset that provided a detailed understanding of the current state of climate risks. This step involved meticulous research and the synthesis of vast amounts of data to ensure

a well-rounded perspective. Analysts must evaluate the reliability and relevance of the sources, cross-referencing data to confirm accuracy and identify any discrepancies or gaps in the existing knowledge.

The gathered data provides insights into various climate-related factors such as temperature changes, precipitation patterns, sea level rise, and the frequency of extreme weather events. Understanding these elements is crucial for identifying vulnerabilities and potential impacts on the environment, economy, and communities. This initial phase sets the stage for more targeted and specific investigations in subsequent steps, ensuring that the assessment is grounded in robust and credible information.

2.1.2 Information Synthesis

Following the desk review, the information synthesis step involved distilling the vast amount of collected data into a coherent and comprehensive synthesis report. This phase was crucial as it translated raw data into actionable insights, highlighting key findings, trends, and gaps identified during the desk review. The synthesis report serves multiple purposes. Firstly, it provides a summarized version of the extensive research conducted in the desk review, making the information more accessible and understandable for stakeholders. This is achieved by organizing the data thematically, identifying patterns, and drawing preliminary conclusions about climate risks.

Secondly, the synthesis report is a tool for engagement and was used to consult with stakeholders, allowing them to provide input and validation. Stakeholders, including local communities, policymakers, scientists, and industry representatives, bring diverse perspectives and expertise, which are invaluable for refining the findings. Their feedback helps to ensure that the assessment is comprehensive and considers all relevant factors.

By identifying gaps in the data, the information synthesis step also sets the agenda for further research and stakeholder consultation. It highlights areas where additional information is needed, guiding subsequent steps in the assessment process. This iterative approach ensures that the climate risk assessment is both thorough and responsive to the needs and concerns of all stakeholders involved.

2.1.3 Stakeholder consultations

The stakeholder consultation step is pivotal in ensuring that the climate risk assessment is inclusive, participatory, and grounded in local realities. This phase involves engaging with a broad range of stakeholders through a district-level engagement workshop, aimed at gathering further intelligence and insights. Stakeholders typically include representatives from local governments, community organizations, businesses, academic institutions, women and youth groups, and other relevant entities. Their involvement is crucial as they possess unique local knowledge, experience, and expertise that can enrich the assessment. Engaging stakeholders in a workshop setting fosters open dialogue, encouraging the sharing of perspectives and the identification of additional risks and opportunities.

During the consultation, the preliminary findings from the synthesis report are presented, and stakeholders are invited to provide feedback. This collaborative approach ensures that the assessment is not only scientifically sound but also socially and culturally relevant. Stakeholders can highlight local vulnerabilities, suggest mitigation strategies, and identify practical adaptation measures that may not have been apparent through secondary data alone.

Furthermore, the consultation process builds trust and ownership among stakeholders. By actively involving them in the assessment, they are more likely to support and contribute to the implementation

of the recommendations. This step highlights the importance of a participatory approach in addressing climate risks, ensuring that the solutions developed are both effective and equitable.

2.1.4 Revision and Final Validation

The final step in the climate risk assessment process was the revision and final validation phase. This refined the assessment based on the inputs gathered during the stakeholder consultation and ensured that the final report was accurate, comprehensive, and actionable. The inputs from the stakeholder workshop were meticulously reviewed and incorporated into the final report. This involved updating data, revising findings, and adding new information or perspectives that were brought to light during the stakeholders' consultations. The goal was to produce a document that accurately reflects the collective knowledge and insights of all participants, providing a robust basis for decision-making.

Once the revisions are made, the final report undergoes a validation process. This involves sharing the revised document with stakeholders for final review and approval. Their validation ensures that the report is not only technically sound but also aligned with the expectations and needs of the stakeholders. This step is crucial for building consensus and ensuring that the recommendations are feasible and supported by all involved.

The final report serves as a strategic tool for policymakers, planners, and other stakeholders, providing a clear roadmap for addressing climate change risks. It includes detailed recommendations for mitigation and adaptation measures, prioritizing actions based on the identified vulnerabilities and risks. By incorporating stakeholder inputs and undergoing rigorous validation, the final report becomes a credible and authoritative guide for climate risk management, setting the stage for effective implementation and long-term resilience building.

Plate 1: Group picture of the sector stakeholders at the revision and final validation workshop



2.2 Methodology

The Climate Change Risk Assessment (CCRA) for the Wenchi municipal adapted methodology similar to Norman et al. (2014). This methodology is a structured approach divided into three primary stages, each with its specific focus and activities (see **Figure 3**). The adapted approach integrates gender dimensions which will help the district reduce its climate change and gender vulnerabilities.:

Stage 1: Risk Identification

The first step in the risk identification for Wenchi was establishing the context. This stage involved defining the parameters that influence the climate risk management process in the Wenchi Municipal. This involved desk reviews to gather relevant information. These reviews involved examining existing documentation, reports, and data to gain a comprehensive understanding of the municipal's unique environmental, socio-cultural, and socio-economic attributes. By analyzing historical data, trends, and previous risk assessments, the team identified patterns and factors that may influence future climatic risks. This step is essential as it lays the foundation for identifying and analyzing climate change-related risks. Once the context was established, the next step was to identify relevant climate change-related risks. This involved recognizing and documenting potential risks that may arise due to climate change and could impact the municipality. These risks were varied and may have included physical risks (such as extreme weather events).

Stage 2: Risk Assessment

The second stage in climate change risk management is risk assessment. This stage involved analyzing the identified risks to evaluate their potential impacts and likelihood. This stage was essential for understanding the significance of identified risks and determining appropriate actions to address them. The risk assessment began with the analysis of past, current, and future risks. This involved evaluating how historical events and current trends can influence future risks. By examining past data, the consultants identified patterns and understood how similar risks may have impacted the municipality in the past. Desk reviews and stakeholder engagement are key activities in this step. Insights from desk reviews involved analyzing historical data, scientific reports, and case studies to understand the nature and impact of past risks. Stakeholder engagement ensured that the analysis was comprehensive and considered diverse perspectives. The results of the risk evaluation feed into the risk management documentation. This documentation provides a detailed analysis of the potential risks, their impact, and likelihood. It serves as a critical input for decision-making regarding risk acceptance and treatment.

The results of this stage are meticulously documented in Chapter 8 of the assessment, which examined and prioritized hazards based on their potential consequences and probability. Following the entire assessment, a decision point was reached at which risks were either approved for further action or denied based on preset criteria. These factors included the severity of the impact, the effect on vulnerable groups, the financial costs of adaptation, and the municipal's ability to effectively manage the risks. This decision-making process was critical in determining the direction and focus of the subsequent Municipal Adaptation Action Plan.

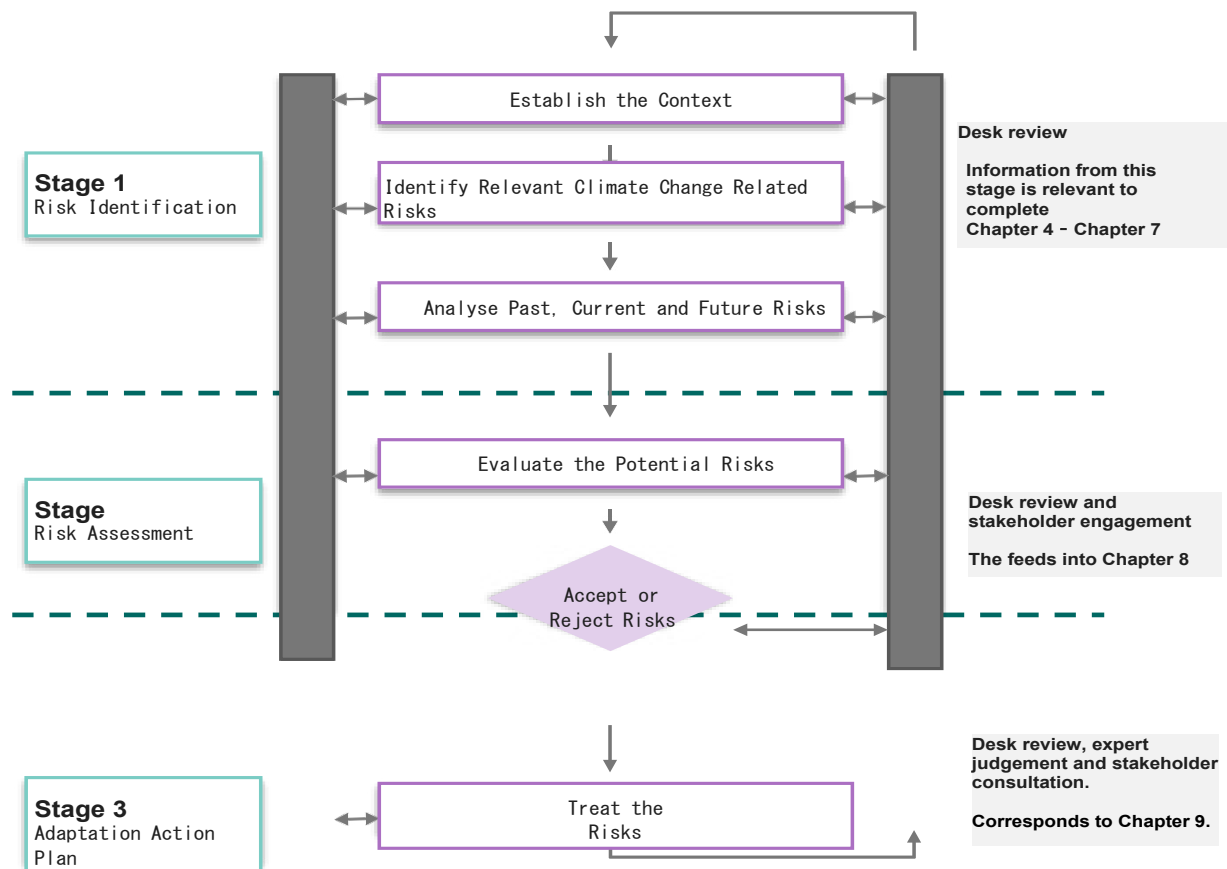
Stage 3: Adaptation Action Plan

This final stage involved the formulation and implementation of an Adaptation Action Plan to the identified risks. The objective of the adaptation action plan is to ensure that the Wenchi Municipal Assembly is resilient to the impacts of climate change and can continue to operate effectively in the face of the identified risks. Treating the risks involves developing and implementing strategies to manage or mitigate the identified risks. The adaptation action plan is the final stage in climate change risk management.

The adaptation action plan is a detailed document that outlines the strategies and actions to be implemented to manage and mitigate identified risks. It includes specific actions, timelines, responsibilities, and resources required for implementation. The plan also includes monitoring and evaluation mechanisms to assess the effectiveness of the implemented strategies and make necessary adjustments.

The methodology emphasizes a collaborative approach, incorporating diverse perspectives and expertise to shape the assessment and subsequent action plan. This process is crucial for creating a strong, contextually tailored strategy for climate change adaptation in the Wenchi municipality.

Figure 3: Methodology for Climate Change Risk Assessment (CCRA) for the Wenchi municipal



Source: Adapted from (Norman, et al., 2014)



3

Overview of the Wenchi Municipal Assembly

This section provides a high-level overview of the Wenchi Municipal Assembly (WMA).

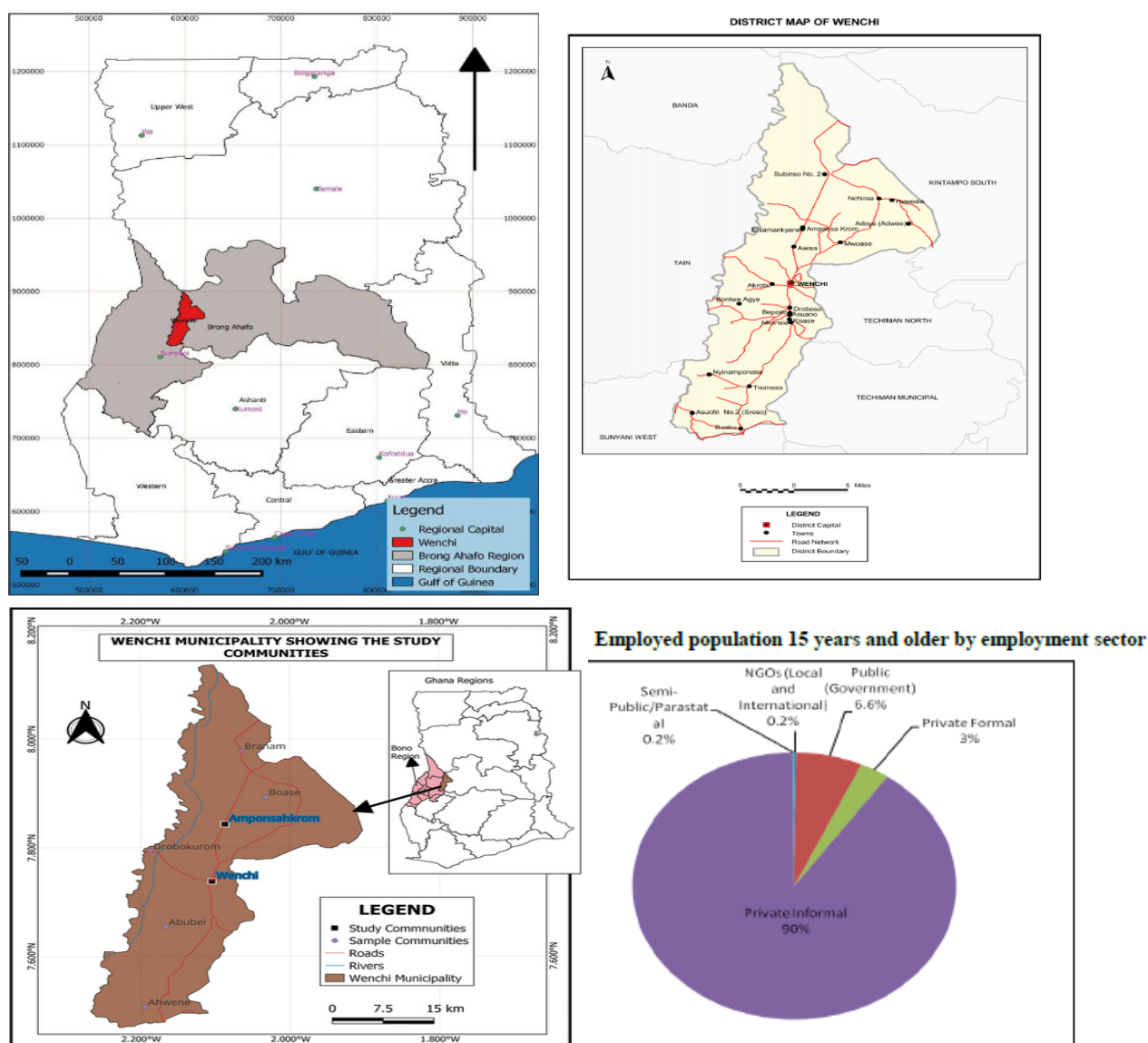
Figure 4: Aerial overview of the Wenchi Municipal



3.1 Geographical location and Demographics

The Wenchi Municipality is situated in the Western part of the Bono Region, which was created in 2019. It is located at the northeast of the Bono Regional capital, Sunyani (see Figure 5). To the west, the municipality shares a boundary with the Techiman Municipality and the newly created Bono East Region. The Wenchi municipality also shares boundaries with the Kintampo North Municipality to the northwest, the Tain District to the east, and the Sunyani Municipality to the south. The municipality lies within latitudes 7°30' and 8°05' North and longitudes 2°15' West and 1°55' East.

Figure 5: Wenchi Municipal Data, 2022



The Wenchi Municipality covers a land area of 3,494 km² and happens to be the largest of all the districts in the Bono Region (Wenchi Municipal Assembly [WMA], 2023). Wenchi town which is the capital of the municipality is about 56km from the regional capital Sunyani and about 29km from Techiman, the regional capital of the Bono East Region. This makes the Wenchi municipality strategically positioned due to its proximity to Techiman, which is an important national market. This presents the municipality with enormous opportunities in the areas of agricultural production, and agro-processing (Ministry of Food and Agriculture [MoFA], 2023).

3.2 Topography and Climate

The Wenchi municipality has two main seasons, i.e., rainy and dry seasons. The municipality is characterized by generally high temperatures averaging about 24.5°C with average maximum and minimum temperatures being 30.9°C and 21.2°C respectively (Ghana Statistical Service [GSS], 2014). The hottest periods in the municipality are experienced from February to April. Additionally, the periods between November and February are considered the dry season also known as harmattan. This is a long period of dryness which makes the municipality vulnerable to frequent bushfire outbreaks (GSS, 2014). The rainy season of the municipality

occurs between April and October with a brief dry spell in August. The municipality experiences an average annual rainfall of about 1,140 mm to 1270 mm (GSS, 2014).

A large section of the soil in the municipality is of the savannah ochrosol type with other sections being lithosols. These soils have a relatively good level of nutrients suitable for the cultivation of tuber crops such as cassava, yam, and cocoyam as well as maize. The Wenchi municipality lies within the moist-semi-deciduous forest and the Guinea Savannah woodland vegetation zone (GSS, 2014). The original forest vegetation of the area has undergone several years of depletion through a host of human activities such as bushfires, slash-and-burn agriculture, and logging among others. Common tree species found within the municipality are Odum, Sapele, Wawa, and Mahogany. Residents of the municipality utilize the forest resources through logging and felling of trees for timber and fuelwood.

The municipality is well drained with its northern boundary being marked by the Black Volta. Rivers such as Tain, Subin, Kyiridi, Trome, and Yoyo are the major rivers that serve communities within the municipality. Although some rivers/streams sometimes get dried up during the dry season, major ones like the Black Volta, Tain, and Subin continue to flow throughout the year. Such rivers present the opportunity to support agricultural production throughout the year.

Table 1: Summary of geographic characteristics of the Wenchi Municipal Assembly

Theme	Characteristics
Topography	Wenchi is characterized by a mix of low-lying plains and rolling hills, with elevations ranging from 150 to 300 meters above sea level. This varied landscape supports diverse agricultural activities.
Geology	The geology of Wenchi is dominated by Precambrian rocks, primarily granites and metamorphic rocks. These geological formations provide a stable foundation for construction and influence soil properties.
Soil Composition	A large section of the soils in the municipality is of the savannah ochrosol type with other sections being lithosols. The soils in Wenchi are predominantly sandy loams and clay loams. These soils are fertile and suitable for a variety of crops, including maize, yam, cassava, and groundnuts.
Agriculture	Agriculture is the backbone of Wenchi's economy, with major crops including cashew, maize, yam, cassava, and vegetables. The municipality also engages in livestock farming, with poultry, cattle, and goats being common. Farming is mostly small-scale and subsistence-based.
Climate	Wenchi experiences a tropical savanna climate with distinct wet and dry seasons. The wet season typically occurs from April to October, while the dry season lasts from November to March.
Temperature	The average annual temperature in Wenchi ranges from 24°C to 30°C. During the hottest months (March and April), temperatures can rise to around 32°C, while the coolest months (August and September) see temperatures around 22°C to 25°C.
Humidity	Humidity levels in Wenchi vary with the seasons. During the wet season, humidity can be as high as 85% to 90%, while in the dry season, it can drop to around 60% to 70%.

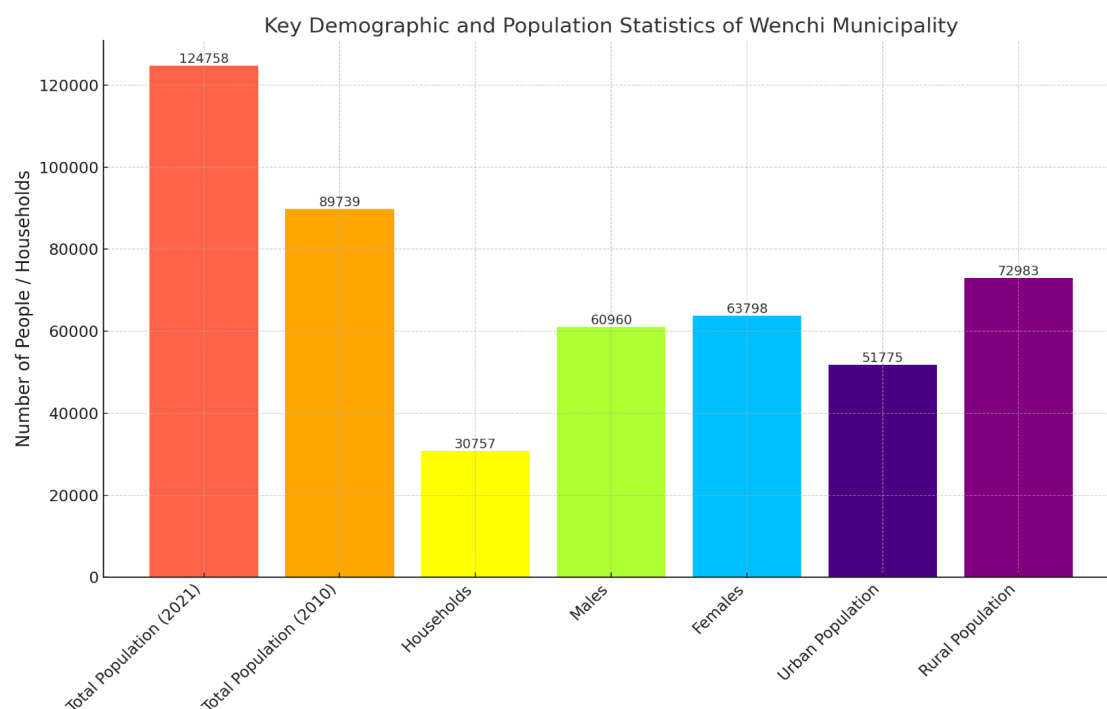
Source: GSS, 2014

3.3 Demographic Characteristics

Recent estimates from the 2021 Population and Housing Census put the overall population of the municipality at about 124,758 (GSS, 2021), which is about 35,019 (an increase of 39 percent) more than the population (89,739) recorded in the 2010 Population and Housing Census (GSS, 2014). The population of the Wenchi municipality constitutes 10.3 percent (i.e., the third largest after Sunyani municipality and Sunyani West municipality) of the population of the Bono Region. The municipality has a total of 30,757 households with an average household size of 4 and a population density of 116.9 persons per square kilometer (GSS, 2021). In terms of population composition, the municipality has 60,960 (i.e., 48.9 percent) persons being males and

63,798 (i.e., 51.1 percent) persons being females. Using the definitions of rural location i.e., localities without urban infrastructure, and urban locations i.e., localities with urban infrastructure and a population of 5,000 and more, majority of the municipality's population reside in rural areas compared to urban areas. In comparison to the regional average of 55.9 percent urban and 44.1 rural populations, the Wenchi municipality has 41.5 percent of its population in urban areas and 58.5 percent of its population in rural localities (GSS, 2021).

Figure 6: Key demographic and population statistics of Wenchi Municipal



Source: GSS, 2021

3.4 Key Economic Sectors

Agriculture is the mainstay of the municipality's economy. About 65 percent of households in the municipality are engaged in agriculture (GSS, 2014). This percentage of households in the rural part of the municipality engaged in agriculture is as high as 84 percent (GSS, 2014). Agriculture production in the municipality mainly centers on the production of crops such as maize, sorghum, cassava, yam, cocoyam, plantain, groundnut, cowpea, tomato, pepper, okra, and cashew. Women generally cultivate food crops such as cowpea, tomatoes, pepper, okra, and cassava while the men cultivate cash crops like cashews (Duncan, 2004). There are two main markets namely Wenchi and Subinso with Nchiraa and Botenso being minor ones. There are roughly 120 km of paved roads. Of the feeder roads, 20.8 km are partially constructed, and 139.3 km are engineered roads. Three (3) water systems in the municipality serve the urban areas of Wenchi, Nchiraa, and Awisa.

Commerce and trade are central to Wenchi's economy, facilitated by its strategic location as a regional market hub. The Wenchi Central Market is a bustling center where traders from surrounding areas converge to sell and buy goods. The market features a wide range of products including textiles, electronics, household items, and foodstuffs. The markets operate daily, with peak activity on Wednesdays and Saturdays. Wenchi's healthcare sector includes hospitals, clinics, and pharmacies that serve the town and neighboring areas.

The Wenchi Methodist Hospital is the largest healthcare facility in the area, providing a range of medical services. Wenchi has fifteen medical facilities. Six health centers, one private clinic, five Community Health Planning System (CHPS) compounds, one maternity home, and two hospitals. Transportation is a crucial

sector in Wenchi, facilitating the movement of people and goods within the region. The sector includes public transport services such as taxis, minibusses (trotros), and motorbikes, as well as freight services. There are over 200 registered public transport operators in Wenchi. On average, around 5,000 people use public transport daily within and around Wenchi (GSS, 2021).

3.5 Water and Electricity Supply

The water supply in Wenchi is primarily managed by the Ghana Water Company Limited (GWCL). The primary sources of water for Wenchi are boreholes, rivers, and streams. The Tain River is a significant source of surface water, while numerous boreholes supplement the supply. Approximately 60% of households in Wenchi have access to piped water, either directly to their homes or through communal standpipes.

Nearly 90% of households in urban Wenchi have access to electricity. This high coverage rate supports domestic, commercial, and industrial activities.



4

Climate Change Vulnerability in the Wenchi Municipal Assembly

4.1 Defining Climate Change Risk and Vulnerability

The concept of climate change risk and vulnerability is interpreted through various lenses by international organizations, each adding nuances to these foundational elements of climate science. The Intergovernmental Panel on Climate Change (IPCC) provides a comprehensive framework for understanding climate change risk and vulnerability, crucial for developing effective adaptation and mitigation strategies. Drawing on the Intergovernmental Platform of Climate Change (IPCC), Climate Change Risk refers to the potential for adverse consequences or damage resulting from the interaction of climate-related hazards with the vulnerability and exposure of human and natural systems. The IPCC defined climate change risk by the interaction of three primary components: hazard, exposure, and vulnerability. Hazards are the physical manifestations of climate change, such as extreme weather events, rising sea levels, and shifting temperature patterns. Exposure refers to the presence of people, assets, and ecosystems in places that could be adversely affected by these hazards. Vulnerability, a multifaceted concept, encompasses the susceptibility of these exposed elements to harm, influenced by social, economic, and environmental factors. The IPCC emphasizes that vulnerability is not static; it varies across different communities and over time, shaped by factors such as governance, socioeconomic conditions, and adaptive capacities. By dissecting these components, the IPCC highlights the complex and interconnected nature of climate change impacts, advocating for an integrated approach that addresses all aspects of risk to enhance resilience and reduce overall vulnerability. This nuanced understanding is critical for policymakers, enabling targeted actions that can safeguard both human and natural systems against the escalating threats of climate change.

The diagram below provided by the IPCC outlines a conceptual framework for understanding climate change risk, emphasizing the interplay between climate factors, socioeconomic processes, emissions, and land-use change. Applying this model to the Wenchi Municipal Assembly allows for a localized analysis of climate change impacts and the formulation of targeted strategies for adaptation.

Vulnerability in the context of climate change is the propensity or predisposition to be adversely affected. It includes a variety of factors such as sensitivity or susceptibility to harm and lack of capacity to cope and adapt. Vulnerability is a multi-dimensional concept, often dependent on social, economic, environmental, and cultural factors. It reflects not just the potential impact of climate change, but also the adaptive capacity of the system or community at risk.

In the context of the Wenchi Municipal Assembly, the climate risk framework, as delineated by the IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX) and the WGII AR5, provides a comprehensive approach to understanding the potential impacts of climate change on the district (**Figure 9**).

Figure 7: Risk assessment framework for evaluating climate change risks



The framework considers ‘**climate**’ as the foundational element, encompassing both the natural variability and the additional stresses from anthropogenic climate change, which in turn inform the types of ‘Hazards’ the district may face. These hazards could range from extreme weather events to gradual climatic shifts, each carrying the potential to disrupt the district’s socio-economic and environmental landscape.

‘**Exposure**’ within the Wenchi municipal is characterized by the presence of communities, ecosystems, and infrastructural assets that stand to be affected by climate hazards. The district’s ‘Vulnerability’—its susceptibility to harm from these hazards—is shaped by a variety of factors including socio-economic status, gender aspects, public health, local environmental conditions, and the capacity of individuals (particularly vulnerable women, men, youth and differently abled persons) and systems to adapt to climatic changes.

The ‘**risk**’ is then a product of these hazards encountering the exposed and vulnerable systems within the municipality. It represents the likelihood of experiencing adverse consequences, which can range from threats to human life and well-being to damage to property and infrastructure, and degradation of the environment and biodiversity.

The ‘**Impacts**’ of climate change are felt across the natural and human systems in the district. They are influenced by the intersection of climate risk with ‘Socio-economic Processes’ such as development pathways, adaptive practices, and the efficacy of governance structures in place to manage and respond to these risks. They are also influenced by socio-cultural practices which tend to intensify the impact of women and other vulnerable groups.

For the Wenchi Municipal Assembly, recognizing this interplay is crucial for advancing climate change adaptation strategies. The district’s adaptation efforts must therefore be rooted in a deep understanding of local climate risks, informed by both scientific knowledge and socio-economic dynamics, to ensure resilience and sustainable development in the face of climate change.

The sensitivity of the sectors and the ability of the systems and residents in the municipality to withstand shocks (i.e., adaptive capacity) determines how vulnerable the Wenchi municipal is to potential climate change impacts. The current level of vulnerability within the municipality is characterized by both the prevailing socio-cultural and socio-economic conditions and the institutional capacity to manage and mitigate the potential for increasing climate change related risks. The current socio-economic conditions of the municipality are one of a high degree of dependence on high-risk sectors such as agriculture. Within the high-risk sectors, the vulnerability of differently abled, women and other vulnerable groups is further impacted by factors such as inadequate access to resources that will enable them to adapt. Future levels of vulnerability will depend on gender-equitable socio-economic development pathways that may unfold in the future.

4.2 Current vulnerability (sensitivity and adaptive capacity)

Climate change coupled with an increasing population and slow infrastructure development poses significant challenges for communities in the Wenchi municipality. With over 80 percent of rural households engaged in agriculture, recent experiences of longer dry seasons, and unpredictable rainfall patterns make a large share of the municipality's population vulnerable to climate risks. This is because agriculture which is the mainstay of the rural economy is rainfall-dependent and therefore any unfavorable patterns of rainfall lead to the disruption of the local economy. Given the numerous rivers and streams, communities along the banks of such river bodies are vulnerable to flooding in the rainy season especially since the intensity of rainfall has been increasing over the years. Higher rainfall intensity also presents a challenge for farming households who are faced with the possibility of their farmlands being flooded. Moreover, the municipality lacks larger drains to forestall any potential flooding, especially in the urban centers which may result from heavy rainfall events. Urban centers are therefore at risk of flooding due to the increasing level of urbanization that has significantly changed the land use of the municipality.

4.2.1 Economic vulnerability

The vulnerability of the Wenchi municipality is mainly due to its economic mainstay. The majority of residents in the municipality are engaged in subsistent agriculture which is largely rain dependent. This renders the economic activity of over 60 percent of the residents in the municipality highly susceptible to variations in the weather. This will have a significant impact on food security in the area and beyond as the municipality supplies food to other communities that access the Techiman market. The municipality is also known for its contribution to tree crops such as cashew and mango as such the climate variability leading to long dry spells poses a challenge to this subsector of the municipal's economy. This is because cashew and mango plantations face the possibility of wildfire which is a regular occurrence during the dry seasons. Additionally, the municipality is endowed with other natural resources such as granite and sand deposits, forest reserves, streams, and rivers as well as clay deposits (GSS, 2014) which are utilized for their economic purposes. However, successfully harnessing these resources is impacted by climate change. This therefore affects the economic opportunities available to residents of the municipality and makes their utilization difficult given the unpredictable nature of the climate in recent times.

4.2.2 Physical/Environmental Vulnerability

Wenchi geo-climatically represents the transitional agro-climatic zone of Ghana. Wenchi and for that matter, the transition zone is an ecologically fragile zone that lies between the rainforest and the northern savanna zones of Ghana. Wenchi, like most parts of the transition zone, is experiencing high-temperature levels leading to detrimental impacts on the environment (Yamba et al., 2023). As a result, the area is taking on more characteristics of the Guinea Savanna zone. By implication, there is now more stress on the sources of water as the rising temperatures mean a higher rate of evaporation and reduced levels of

underground water. There is therefore an increasing likelihood of water insecurity in the enclave. This will have an immense impact on the agriculture sector of the municipality's economy especially since it is the mainstay of most residents. In addition, women and other vulnerable groups who do not have access to arable lands close to water bodies will be highly impacted. There is also likely to be an increase in water conflict with time as water will become very scarce soon.

The increased intensity of rainfall also has implications for the municipality. To begin with, the increased intensity of rain has an impact on the soil in the municipality. The intensity of rainfall coupled with its volumes has led to increased levels of soil erosion. The ever-increasing runoff water from such intense rainfall continues to wash away the topsoil rendering previously fertile lands infertile. This has a detrimental impact on the agricultural activities in the municipality. Again, the intense rainfall and its resulting erosion leads to silting of the existing water resources in the municipality. This further reduces the quality of water resources available to residents of the municipality. Additionally, communities in the municipality are susceptible to being flooded due to the numerous streams and rivers. Besides flooding and damaging farmlands, such intense rainfall also puts pressure on the physical infrastructure such as drainage systems within the municipality.

Figure 8: A heavy downpour of rain coupled with strong winds rendered some residents homeless in Wenchi in October 2017



Source: <https://www.ghanaweb.com/GhanaHomePage/NewsArchive/Over-200-people-rendered-homeless-in-Wenchi-after-rain-storm-592516>

Figure 9: A section of flooded road in Tainso, a farming community near Wenchi



4.2.3 Social vulnerability

The population of the municipality has increased by about 39 percent over the decade with little increase in the infrastructure of the municipality. This mismatch in the increase in population vis-à-vis infrastructure means an ever-increasing pressure on available infrastructure. Moreover, agriculture is also impacted due to the rising population with its associated need for more residential units. This means that most of the previously agricultural lands are being converted to provide residential units to meet the rising demand. This is further exacerbated by the high levels of climate change-induced land degradation.

In line with national trends, the Wenchi municipality is also witnessing an increasing level of urbanization, and as a result, more people are vulnerable to the impacts of climate change especially as these new urban settlements are not furnished with the right and adequate infrastructure needed to withstand climate extreme events. With most of these urban centers not being properly planned, they are highly vulnerable to climate events such as flooding.

Figure 10: Residents of Buasu Kwame Pinsang Electoral Area sharing a water source with animals.



4.2.4 Gender Vulnerabilities

Table 2 below illustrates gender vulnerabilities across identified sectors in the Wenchi Municipality. This table includes the vulnerability, and impact on women, youth, and PLwD individuals, along with specific examples from the Wenchi Municipality.

Table 2: Gender-specific vulnerabilities across priority sectors in the Wenchi Municipal Assembly

Sector	Vulnerability	Impact on Women	Impact on Youth	Impact on PLwD	Specific Examples
Agriculture	Limited access to resources and land	Women often have less access to arable land and credit	Youth face challenges in securing agricultural employment	PLwD has limited physical capacity for farming	In Wenchi, women represent 55% of the agricultural workforce but own only 20% of the land.
Water Resources	Poor access to clean water and sanitation facilities	Women spend significant time fetching water	Youth face health risks due to poor sanitation	Inaccessible sanitation facilities	In Wenchi, only 60% of households have access to piped water, burdening women with water collection. In communities like Adeammra access to clean and safe water is a challenge.
Biodiversity	Loss of biodiversity affects livelihoods	Women dependent on natural resources for livelihoods like firewood for cooking will face difficulty fulfilling this role	Youth employment opportunities in eco-tourism are limited	Limited mobility restricts involvement in conservation efforts	Wenchi's deforestation rates have increased by 25% over the past decade, affecting local herbal medicine.

Trade	Barriers to market access and financial services	Women entrepreneurs face financial exclusion	Youth face high unemployment rates	Limited opportunities for entrepreneurial activities	Women in Wenchi make up most of the market vendors but have limited access to credit facilities
Energy	Unreliable electricity supply	Women's domestic and economic activities are disrupted	Youth education is affected by power outages	Limited ability to use energy-dependent assistive devices.	Frequent power outages in Wenchi disrupt evening study time for students, home-based businesses, and cold stores in the major markets.
Health	Increased exposure to vector-borne diseases and waterborne illnesses.	Higher maternal mortality rates and health risks. Increased caregiving burdens impact women's well-being.	Health risks from environmental exposure impact youth's long-term health.	Health services may be less accessible or inadequate for specific needs, increasing health risks.	Wenchi has one major hospital, which struggles to cater to the growing population, impacting maternal health.
Infrastructure	Insufficient urban infrastructure and housing	Disproportionate impact on women in securing family safety and rebuilding communities.	Limited involvement in planning and recovery efforts reduces youth's influence on future resilience.	High susceptibility to injuries during disasters due to inadequate evacuation plans or facilities.	Wenchi's urban areas have a housing deficit, with some of the population living in substandard conditions.

Source: Stakeholder workshop, 2024



5

Observed Climate and Trends at the Wenchi Municipal Assembly

5.1 Local Level Climate and Trends

The mean annual temperature in Wenchi Municipal Assembly is approximately 26.1°C, with an average maximum temperature of 30.9°C and a minimum of 21.2°C. Figure 14 shows the mean yearly temperature in Wenchi from 1979 to 2023. The purple line represents the actual yearly mean temperature data points. The blue dashed line represents the linear trend over the period, indicating a general increase in mean temperature. Each stripe represents an annual temperature anomaly, with colors ranging from blue (cooler than average) to red (warmer than average). The shift from predominantly blue stripes (cooler anomalies) in the earlier years to more red stripes (warmer anomalies) in recent years aligns with the observed warming trend.

The mean annual rainfall in Wenchi is around 1,140-1,270 mm, with a significant seasonal pattern. The rainy season occurs between April and October, with a short dry spell in August. The dry season, also known as the harmattan, occurs between November and February and is characterized by a long period of dryness and is vulnerable to bushfires. Figure 15 represents the mean annual precipitation from 1979 to 2023. The purple line represents the actual yearly mean precipitation data points, and the blue dashed line shows the linear trend over the period, indicating a general decrease in mean precipitation. Each stripe represents an annual precipitation anomaly, with colors ranging from green (wetter than average) to brown (drier than average). The transition from predominantly green stripes (wetter anomalies) in earlier years to more brown stripes (drier anomalies) in recent years corresponds with the observed decrease in precipitation. In summary, these graphs illustrate a warming trend in mean yearly temperatures and a decreasing trend in mean yearly precipitation for Wenchi over the past four decades.

Figure 11: Mean annual temperature, trend, and anomaly in WMA 1979-2023

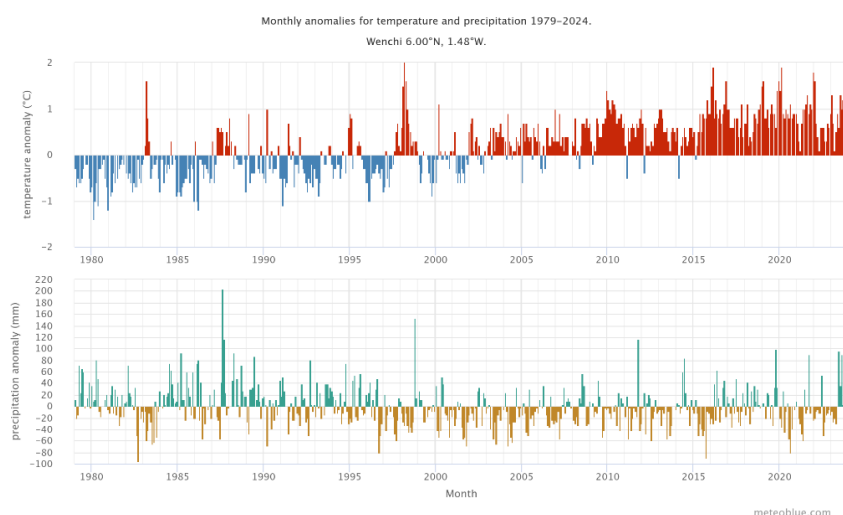


Figure 12: Mean annual precipitation, trend, and anomaly in WMA, 1979-2023

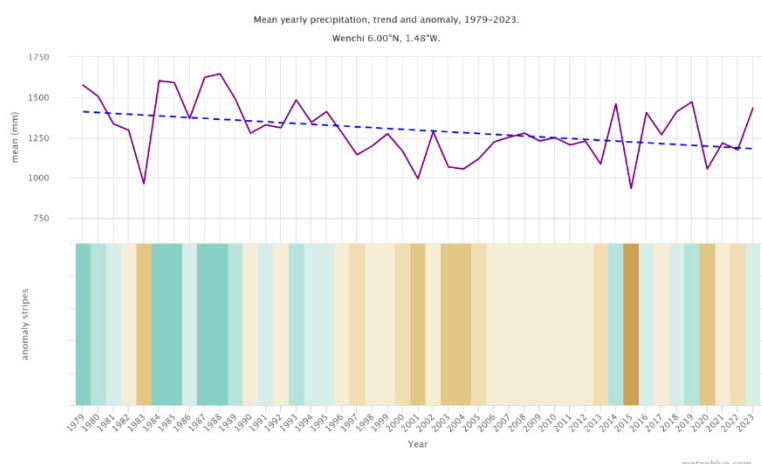
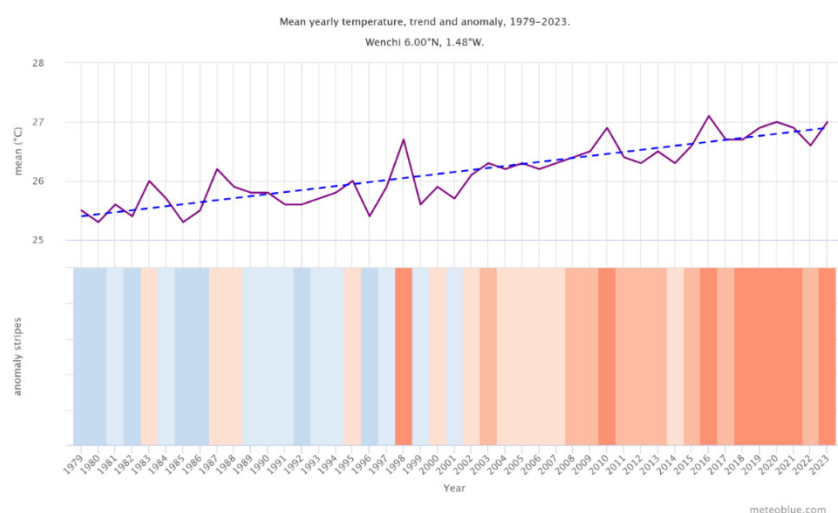


Figure 13: Monthly anomalies for temperature and precipitation in WMA, 1979-2023



Figures 19 and 20 represent the temperature and precipitation anomalies between 1979 and 2023. Each vertical stripe represents an annual precipitation anomaly. The colors range from green to brown. The green stripes indicate years with higher than average precipitation (wetter than average) and the brown stripes indicate years with lower than average precipitation (drier than average). The earlier years (1979 to 1999) exhibit a mix of green and brown stripes, showing variability with both wetter and drier years. The earlier part of this period has predominantly green stripes indicating wetter years, transitioning into mixed anomalies by the late 1990s. The later years (2000 to 2023) display predominantly brown stripes, indicating a trend towards drier conditions.

Notably, the stripes from around 2000 to 2015 are mostly brown, signifying a period of consistently below-average precipitation. Some variability returns in the most recent years (2016-2023), with a mix of green and brown stripes, indicating fluctuations between wetter and drier years. This illustrates a decreasing trend in mean yearly precipitation for Wenchi over the observed period, with a notable shift toward drier conditions in recent decades. This is evidenced by the prevalence of brown stripes in the anomaly section and the downward trend line in the precipitation data.

Table 3: Recent climate hazard events identified in WMA and surrounding areas

Date	Event	Location	Impact	Reference
March 2015	Severe Drought	Wenchi Municipal	Significant crop failure, water scarcity, food insecurity, economic loss for farmers	Local Government Report 2015
June 2016	Flooding	Wenchi Town	Infrastructure damage, displacement of residents, disruption of transportation	National Disaster Management Organization (NADMO) Report 2016
October 2017	Windstorm	Wenchi	Damage to buildings and power lines, over 200 residents were displaced, and a casualty was recorded	Techiman Municipal Report 2017
April 2018	Heatwave	Wenchi Municipal	Health issues such as heatstroke, increased energy consumption	Ghana Meteorological Agency (GMet) Report 2018
August 2019	Flash Floods	Subinso	Crop destruction, water contamination, temporary relocation of families	NADMO Report 2019
November 2020	Prolonged Drought	Wenchi Municipal	Severe impact on agriculture, water shortages, heightened food insecurity	Local Government Report 2020
January 2022	Hailstorm	Buoku	Damage to crops and property, disruption of local markets	Wenchi Municipal Assembly Report 2022
September 2023	Torrential Rain	Wenchi Town	Road damage, flooding of low-lying areas, increased cases of waterborne diseases	GMet Report

5.2 Projected Mean Surface Air Temperature and Precipitation for Brong Ahafo and Wenchi Municipal

The images below delineate the projected average mean surface air temperature for Brong Ahafo, Ghana. The historical reference period (1950-2014) reveals a gradual increase in temperature, consistent with global warming trends observed worldwide. However, future projections under various SSPs illustrate divergent pathways depending on the emission scenarios adopted. The black line representing historical data shows a steady temperature rise, highlighting the baseline warming that has already occurred due to anthropogenic activities.

- **SSP1-1.9 and SSP1-2.6 (Light Blue and Blue Lines):** These pathways assume robust climate policies aimed at limiting global warming to below 2°C. As a result, temperature increases in Brong Ahafo are relatively moderate, reflecting the effectiveness of stringent mitigation measures.
- **SSP2-4.5 (Orange Line):** This pathway represents an intermediate scenario where some mitigation efforts are made, leading to moderate temperature increases.
- **SSP3-7.0 and SSP5-8.5 (Red and Dark Red Lines):** These pathways envision high-emission futures with minimal climate policies, resulting in substantial temperature rises. By 2100, temperatures could exceed 34°C, posing severe challenges for agriculture, water resources, and human health.

Unlike temperature, precipitation projections show significant variability and uncertainty, especially under higher emission scenarios. Historical data (black line) indicates fluctuations around an average of approximately 1000 mm per year, reflecting the region's inherent variability in rainfall patterns.

- SSP1-1.9 and SSP1-2.6 (Light Blue and Blue Lines): These scenarios suggest relatively stable precipitation patterns with slight variations, indicating that strong climate policies could help maintain current rainfall levels.
- SSP2-4.5 (Orange Line): This intermediate scenario shows a slight increase in variability but does not indicate a significant deviation from historical averages.
- SSP3-7.0 and SSP5-8.5 (Red and Dark Red Lines): These high-emission scenarios reveal considerable variability and uncertainty, with projections indicating potential increases or decreases in annual precipitation. This heightened unpredictability could exacerbate challenges related to water resource management, agriculture, and flood risk.

The divergent trajectories depicted in these projections highlight the critical importance of climate policy decisions made today. For Brong Ahafo, Ghana, the potential rise in average mean surface air temperature, especially under high-emission scenarios, could lead to severe heat stress, impacting human health, agricultural productivity, and biodiversity. The variability and uncertainty in precipitation projections further complicate the region's climate resilience efforts, as both droughts and excessive rainfall could become more common. Adopting robust climate policies, as reflected in SSP1-1.9 and SSP1-2.6, offers a pathway to mitigate these adverse effects by limiting temperature rise and stabilizing precipitation patterns. Conversely, the absence of such measures, indicated by SSP3-7.0 and SSP5-8.5, portends a future with extreme temperatures and unpredictable rainfall, challenging the region's socio-economic development and environmental sustainability.

Figure 14: Projected precipitation patterns for the Brong Ahafo region

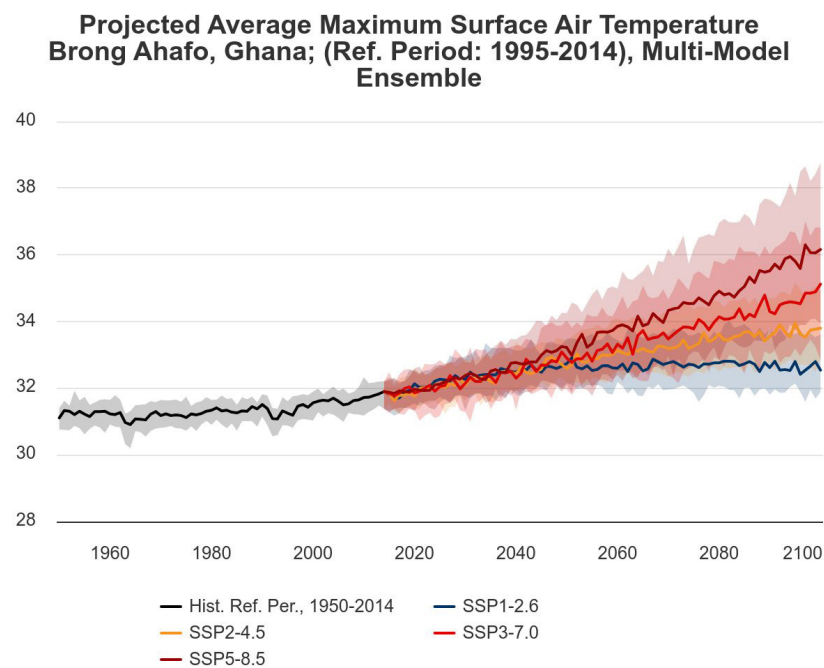
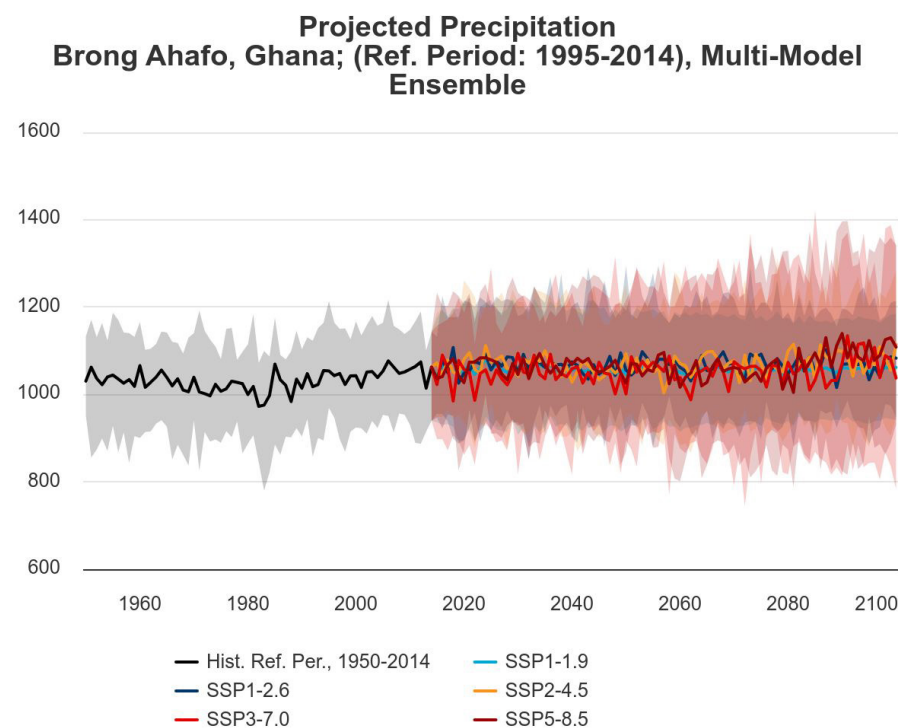


Figure 15: Projected average maximum surface air temperature for the Brong Ahafo region





6

Potential Impacts for Priority Risk Domains

6.1 Initial Assessment of Critical Climate-Related Hazards

The preliminary critical climate-related risks can be assessed using a tool like the Think Hazard! Tool. Wenchi municipality assessed several climate-related threats using data from the ThinkHazard! Tool. These hazard levels from the ThinkHazard! report is supported by the experiences of local stakeholders who participated in district workshops. Their observations and experiences add significant ground truth to the simulated data, showing the real-world consequences of these climate-related risks for the Wenchi municipality. Below is a comprehensive analysis of each hazard category as presented in **Table 2**.

Table 4: Summary of critical climate-related hazards for Wenchi Municipal Assembly

District	Hazard				
	Extreme heat	Wildfire	River flood	Water scarcity	Urban flood
Wenchi	High	High	Medium	Low	Low

Source: ThinkHazard! (Global Facility for Disaster Reduction and Recovery (GFDRR), 2022)

- **Extreme Heat:** Extreme heat is marked as a high-risk hazard for the Wenchi district. This implies that the district experiences significant temperatures that can have detrimental effects on both the population and the environment. The high risk associated with extreme heat necessitates immediate attention and the implementation of heat mitigation strategies. These might include creating cooling centers, ensuring adequate water supply, and promoting heat safety awareness among the residents. Moreover, the high heat risk could potentially exacerbate other hazards, such as increasing the likelihood of wildfires and impacting water scarcity.
- **Wildfire:** Wildfires are also categorized as a high-risk hazard in Wenchi. This high risk indicates that the district is prone to frequent and severe wildfires, which could be due to the combination of climatic conditions, vegetation types, and land use practices. The high risk of wildfires demands robust fire management strategies, including controlled burns, the establishment of firebreaks, and community education on fire prevention. Wildfires can cause extensive damage to property, wildlife, and human life, making it essential for the district to invest in effective firefighting resources and emergency response plans.

Figure 16: Fire destroys house at Akrobi, Wench



Source: Adomonlinefm, 2024 <https://www.adomonline.com/fire-guts-5-bedroom-house-at-akrobi/>

- **River Flood:** The risk of river flooding in Wench is classified as medium. This suggests that while river floods are not as frequent or severe as extreme heat and wildfires, they still pose a significant threat to certain areas within the district. River flooding can result in substantial economic losses, damage to infrastructure, and displacement of communities. The medium risk level calls for the implementation of flood management systems such as levees, floodwalls, and proper drainage systems. Additionally, early warning systems and gender-responsive flood preparedness plans can help minimize the impact on the population.
- **Water Scarcity:** Water scarcity is identified as a low-risk hazard in the Wench district. This indicates that the district generally has an adequate supply of water to meet the needs of its population and environment. However, the low-risk classification does not mean that water scarcity can be completely ignored. Gender-inclusive sustainable water management practices should still be promoted to ensure long-term water security. This includes efficient water use, protection of water sources, and infrastructure improvements to prevent future scarcity issues that could arise due to climate change or population growth.

Figure 17: Residents of Adeammra, Wenchi heavily dependant on unwholesome water from streams



Source: Joyonline, 2021 <https://www.myjoyonline.com/access-to-safe-drinking-water-in-the-wenchi-municipality-remains-a-challenge/>

- **Urban Flood:** Urban flooding is also considered a low-risk hazard for Wenchi. Urban floods, often caused by heavy rainfall and overwhelming drainage systems, can lead to temporary waterlogging and disruption in urban areas. The low-risk level suggests that urban flooding events are infrequent or have minor impacts. Nonetheless, maintaining and upgrading urban drainage systems, implementing green infrastructure, and ensuring proper land use planning are essential to prevent potential urban flooding issues. Gender-sensitive public awareness campaigns on flood preparedness and response can further mitigate the effects of occasional urban floods.

Figure 18: Road flood on the Wenchi Sampa road



6.2 Stakeholder Engagement

An effective climate risk assessment requires a participatory process that considers the perspectives of various groups, including those from different genders, young people, and potentially vulnerable populations like Indigenous communities. To achieve this, all interested and affected parties (I&APs), particularly local community members, should be involved throughout the assessment. The level of engagement can be adjusted based on the study's goals, scope, time constraints, and chosen methods. A project team conducted a site visit to Wenchi Municipal Assembly on March 27, 2024, to gather input for the climate risk assessment. This trip aimed to engage key stakeholders at the local level by:

- Introducing the National Adaptation Plan (NAP) project and its process.
- Providing an overview of climate change, its potential impacts, and the various aspects to be evaluated in the risk assessment to the key stakeholders.
- Identifying important climate-related risks and gather data and anecdotal evidence in order to gain a deeper understanding of these risks, their effects, and the ability of local communities to adapt.
- Capture additional information on critical climate risks and adaptive capacity.
- Offer training on conducting local-level climate risk assessments.

Plate 2: Stakeholder engagement session and participants in sector-specific group exercises at Wenchi



The Wenchi session was coordinated through the Wenchi Planning Department under the Wenchi Municipal Assembly. The stakeholder session on March 27, 2024, brought together various Municipal departments alongside public and private sector representatives. A total of 37 participants (excluding the project team) contributed valuable insights, enriching both the top-down and bottom-up approaches to risk assessment (participant list included in Appendix). The participant roster for the Wenchi municipal stakeholder workshop highlights a diverse assembly from various sectors, highlighting a broad engagement strategy essential for extensive community involvement in climate resilience planning. Attendees included representatives from national and local government agencies like the Ghana National Fire Service and Ghana Meteorological Agency, alongside the local chief and delegates from the People Living with Disability (PLwD) Group (see Appendix for the List of Participants). Community perspectives were well-represented by leaders of women's groups, local farmers, and community media personnel. The opening session was pivotal in establishing the context and objectives of the workshop.

During this session, sector groups engaged in participatory activities such as physical/resource and hazard mapping. They identified the most vulnerable and at-risk areas within the municipality, pinpointing geographical locations susceptible to climate impacts and critical resources that might be affected by these hazards. Concurrently, other sector groups focused on identifying climate hazards, scoring vulnerability assessments for various hazards of climate events the community has faced or might encounter. This fostered a shared understanding of the district's climate patterns and anomalies.

Building on these activities, the sector groups worked meticulously to develop a sector-specific vulnerability and adaptation matrix. They assessed and prioritized each identified vulnerability, considering the severity of impact and likelihood of occurrence. This systematic approach aided in quantifying relative risks and shaping targeted adaptation strategies. Additionally, gender-specific discussions on climate impacts and adaptation were held, ensuring that the workshop addressed the different effects of climate change on women, children, the elderly, and people living with a disability. These discussions highlighted unique challenges faced by different gender groups and promoted strategies that incorporate gender-specific needs and perspectives.

By combining climate projections, existing studies on potential climate impacts in Wenchi, and the key findings from these interactive sessions and additional data collection, the project team was well-equipped to proceed with the local-level risk assessments.

Plate 3: Sectoral presentation by some key stakeholders



6.3 Overview of Impact Chain Analysis

In the Wenchi Municipal, extreme heat presents numerous challenges. The most immediate impact is the heightened incidence of heat-related illnesses, including heatstroke and dehydration, which strain the local healthcare system. Agriculture, a significant part of Wenchi's economy, suffers as crops experience heat stress, reducing yields and threatening food security. Infrastructure deterioration, such as the warping of roads and railways, further complicates transportation and economic activities. The urban population of Wenchi, particularly in densely populated areas, is highly exposed to extreme heat. Outdoor workers, including those in construction and agriculture, are at significant risk due to prolonged exposure to high temperatures. Vulnerable groups, such as the elderly, young children, and individuals with pre-existing health conditions, are especially susceptible to the adverse effects of extreme heat.

Several factors exacerbate Wenchi's vulnerability to extreme heat. Many residents lack access to air conditioning or cooling centers, making it difficult to find relief during heatwaves. Poor housing conditions often trap heat, intensifying indoor temperatures. Limited green spaces and the urban heat island effect further elevate local temperatures. Additionally, socio-economic disparities affect access to healthcare and cooling resources, leaving lower-income populations more vulnerable. Economic losses arise from reduced agricultural productivity, healthcare costs, and infrastructure damage. Power outages disrupt daily life and business operations, exacerbating the economic impact. Decreased food security due to lower crop yields poses a significant risk to the local population.

Wildfires pose a severe threat to Wenchi Municipal, leading to the destruction of homes, infrastructure, and natural habitats. The smoke generated by wildfires causes air pollution, contributing to respiratory health issues among the population. Wildfires can displace communities, creating immediate humanitarian concerns. Additionally, the loss of biodiversity and ecosystem services disrupts the local environment and economy. Communities located near forested or grassland areas in Wenchi are particularly exposed to the risk of wildfires. Properties in the wildland-urban interface, where human development meets natural landscapes, are highly vulnerable. Firefighters and first responders face direct exposure to wildfire hazards.

Several factors contribute to Wenchi's vulnerability to wildfires. Poor land management practices, such as the accumulation of dry vegetation, increase the risk of fire outbreaks. Limited access to firefighting resources and equipment hampers effective response efforts. Inadequate building codes and the use of flammable construction materials exacerbate the damage caused by wildfires. Climate change, which increases the frequency and intensity of wildfires, further heightens this vulnerability. The risks resulting from wildfires in Wenchi include loss of life and property, with significant economic costs associated with rebuilding and recovery. Long-term health problems due to smoke inhalation affect the well-being of residents. Ecological damage leads to the loss of wildlife and degradation of natural resources, impacting local biodiversity and ecosystem services.

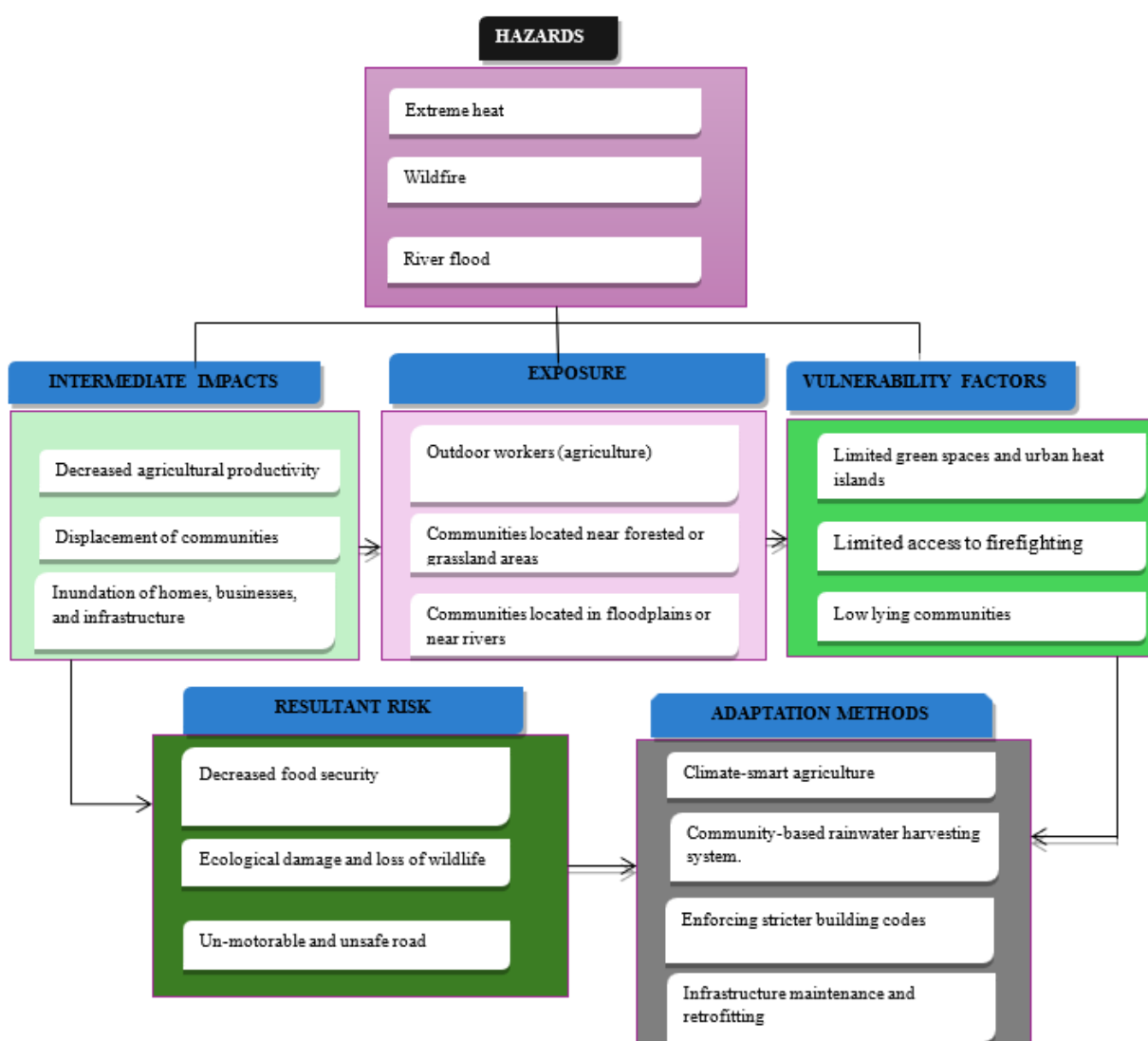
River floods in Wenchi Municipal lead to the inundation of homes, businesses, and infrastructure, causing widespread damage. Floodwater can contaminate drinking water supplies, spreading waterborne diseases. The disruption of transportation networks and supply chains hinders economic activities and access to essential services. Additionally, soil erosion and the loss of agricultural land threaten food security and livelihoods. Communities located in floodplains or near rivers are most exposed to the risk of river floods in Wenchi. Agricultural lands and rural areas, which rely heavily on river water, are vulnerable to flood damage. Urban areas with inadequate drainage systems face significant exposure. Critical infrastructure, such as bridges, roads, and hospitals, are also at risk of flooding.

Poor urban planning and development in flood-prone areas increase Wenchi's vulnerability to river floods. Insufficient flood defense infrastructure, such as levees and dams, exacerbates the impact of flooding.

Degraded natural buffers, like wetlands and riverbanks, reduce the landscape's ability to mitigate floodwaters. Socioeconomic factors, including limited access to insurance and recovery funds, further heighten vulnerability. The resultant risks from river floods in Wenchi include the loss of life and displacement of communities. Economic losses due to property damage and business interruption are significant.

To adapt to river flood risks, Wenchi Municipal can invest in constructing and maintaining flood defenses, such as levees and flood walls. Restoring natural buffers, including wetlands and riparian zones, enhances the landscape's flood mitigation capacity. Implementing floodplain zoning and land use planning can prevent development in high-risk areas. Enhancing gender-responsive early warning systems and emergency response plans ensures that communities, including the gender vulnerable, are better prepared to respond to flood events.

Figure 19: Impact chain analyses of Wenchi municipal



Based on a thorough understanding of Wenchi municipal climate change vulnerability, including socioeconomic conditions, environmental problems, and infrastructural limits, it is critical to identify and prioritize risk areas to improve resilience and adaptation activities. Understanding the possible climate change impact on selected priority locations is critical for numerous reasons. The potential impact of climate change on the priority risk

domains of the Wenchi municipality of Ghana is described in the sections below. The impacts are described for major domains such as

6.4 Agriculture

Like most municipalities in Ghana, the economy of the Wenchi municipality is mainly dominated by agricultural activities. It is estimated that about 65 percent of all households in the municipality are engaged in agriculture (GSS, 2014). In terms of proportions, it is estimated that about 84 percent (i.e., 8 out of every ten) of rural households are engaged in agriculture while about 40 percent (i.e., 4 out of every ten) urban households are engaged in agriculture (GSS, 2014). Major crops grown in the municipality include food crops like yam, maize, cassava, cocoyam, and plantain; vegetables such as tomatoes, garden eggs, onions, and okra; and tree crops particularly cashew and mangoes (Ministry of Food and Agriculture [MoFA], 2023).

Agriculture in the municipality like in most parts of Ghana is rainfall-dependent, hence it is highly susceptible to the changing climate (Abdoulaye et al., 2017). The increasing variability of rainfall will continue to impact crop yields across all the agroecological zones of Ghana. For example, the yield of maize which is a staple crop is estimated to decline by about 65 percent given a 1°C increase in temperature (Lobell et al., 2011). This will spell doom for households that depend solely on agriculture for their livelihoods. With the majority of households in rural Wenchi being engaged in agriculture, it is expected that the climate changes that impact the yield of crops will further deepen their poverty status. Further studies indicate that despite efforts to curtail the impact of climate change on agriculture, these attempts have not been successful especially in the Wenchi municipality due to farmers' lack of access to credit, lack of ready market for agricultural produce, and poor access to extension services (Adu et al., 2019). When compared with other municipalities with similar characteristics, farmers in the Wenchi municipality are more vulnerable to climate change and weather variability (Adu et al., 2018).

A study on climate impacts on crop production across Ghana indicates changing crop suitability in the transitional zone of Ghana which is represented by Wenchi (see Figure 7). The estimations show that the suitability of groundnut production in the Wenchi area is expected to decrease under both the RCP2.6 and RCP8.5 scenarios. On the contrary, the suitability of sorghum production is expected to increase under both scenarios indicating that the rising temperatures in Wenchi will make the zone more suitable for the cultivation of sorghum.

Climate change's impact on agriculture will be in several folds. The prolonged periods of drought experienced in the municipality will have a wide range of impacts on the agriculture sector of the municipality. Prolonged dry spells or droughts will disrupt the crop cycles and make it difficult for farmers to plan for subsequent cropping seasons. Such changes in crop cycles will distort the existing plans used by farmers to maximize their benefits from both the major and minor seasons. Again, water scarcity resulting from long periods of dryness will affect agricultural production in the municipality. While crops may suffer from water scarcity due to a reduction in soil moisture, the drying up of water resources in the municipality will make it difficult for farmers to consider implementing irrigation practices to save their crops. Wildfires are known to be associated with long periods of dryness and this also poses a challenge for the agricultural sector of the local economy. The dryness can provide the needed burning fuel for any spark of fire thereby leading to a larger incidence of fire outbreak that is likely to destroy large parcels of farm lands. This challenge is particularly common for farmers who engage in the cultivation of perennial crops in the municipality such as cashew, mango, and cocoa.

The agricultural sector of Wenchi stands to lose about 40 percent of its crop production to pests and diseases because of climate change. This is in line with forecasts by the World Economic Forum (2021) which indicates that about 40 percent of global crop production is lost to pests and diseases. On the other hand, excessive

rainfall which is characteristic of recent rainfall patterns in the transition zone of Ghana can also negatively impact the agriculture sector of the municipality. This can manifest in the form of soil erosion which poses a threat to sustainable crop production. Runoff water from heavy rainfall has the potential to wash away the fertile topsoil of most farms hence rendering such farmlands infertile. This will affect the availability of soil nutrients and therefore reduce the productivity of the farm.

The Wenchi municipality is also known for its livestock production. The municipality is home to a significant population of cattle, sheep, goats and all forms of poultry (MoFA, 2023). Livestock production in the municipality is also under threat due to climate change. The most common impact on livestock in the municipality is heat stress and morbidity. Additionally, animals may suffer from heat-related illnesses leading to losses on the part of the farmer. Climate change also lowers the reproduction capabilities of livestock and alters disease dynamics. Indirectly, livestock production in the municipality is affected by lower levels of fodder availability due to rainfall variability. Additionally, livestock faces water scarcity during long periods of droughts which can lead to several deaths and economic losses on the part of the livestock keeper.

6.5 Water resources and security

Water resources in the transition zone of Ghana, and Wenchi to be precise will be impacted negatively by climate change. Climate change, with associated anthropogenic stresses, is projected to increase water scarcity soon due to increased rainfall variability and rising temperatures (Agodzo et al., 2023). This impact on water resources will likely be felt hardly in the urban areas of the municipality as there will be a less reliable water resource base coupled with higher water treatment costs. Reduction in the water resources of the municipality will result from increased evapotranspiration associated with higher temperature levels.

The Black Volta, which is a major water resource in the municipality is also under threat from climate change and this may have a wide-ranging impact on residents in the area. Climate change is expected to impact greatly the river flow and groundwater recharge of the Volta Basin, which will in turn have a wide-ranging impact on the food security and economic development, as well as the livelihoods of residents in the Volta Basin (Mul et al., 2015). Additionally, reduced precipitation, runoff, and groundwater recharge will lead to a reduction in the water resources available to residents of the municipality therefore creating a water crisis. Studies have found that the Black Volta catchment is very sensitive to climate change. It is estimated that for a minimal increment of 8 percent in annual precipitation and 1.7 percent in temperature, annual surface runoff, annual baseflow, and evapotranspiration will increase by 26 percent, 24 percent, and 6 percent respectively (Amisigo, 2000).

Until recently, the existing drinking water system of Wenchi was constructed in 2002 with a production capacity of four hundred cubic meters per day (400m³/day) (EAP Consult, 2024). This created a serious water availability challenge with humans having to share water sources with cattle. It was further reported that several borehole projects that started to help alleviate the plight of the residents had all been abandoned. The lack of portable water renders the residents of these communities susceptible to waterborne diseases. The high level of water insecurity in the Wenchi municipality caught the attention of the government and as such a new water supply project was commissioned which upon completion will serve Wenchi and its environs by providing about 10,700m³/day (Government of Ghana, 2021).

6.6 Flooding

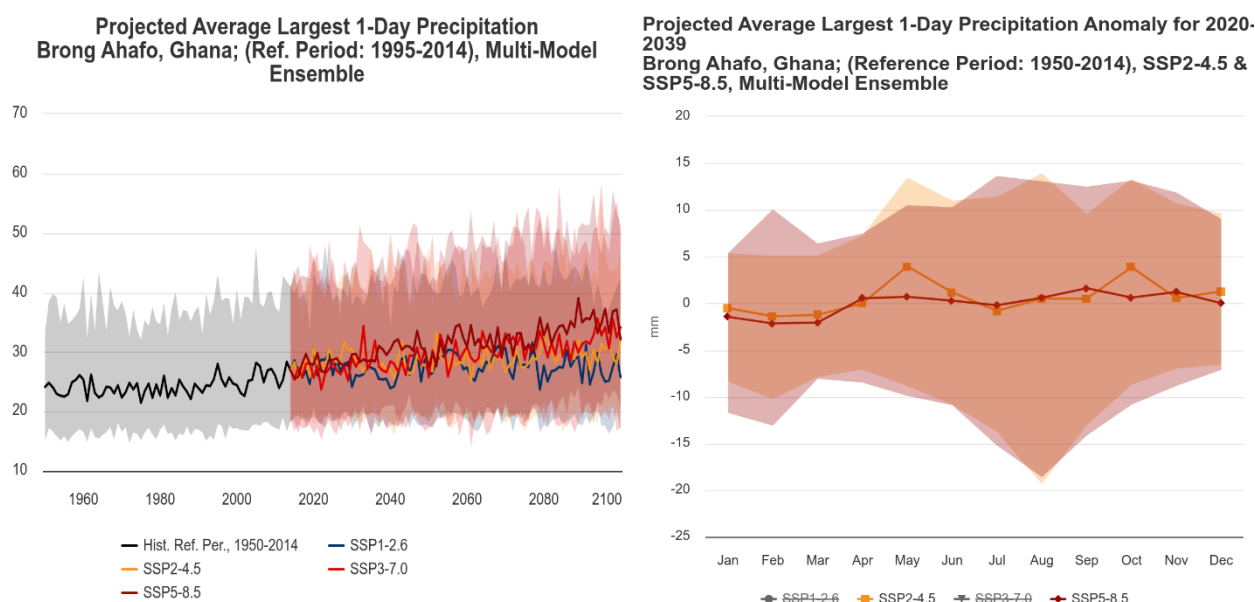
The presence of excessive water and the topography of an area are the two determining factors of flood risk in an area. Flooding could either be classified as flash floods; the rapid rise in water levels from excessive rainfall in low-lying areas or river floods; the overspill of rivers beyond their banks that cannot be contained within their channels. Wenchi is likely to experience inland floods due to its long distance from the coast. It is therefore expected that the variability in rainfall patterns will be a contributing factor to the extent and kinds of flooding

risks experienced in the area. While the unpredictable rainfall patterns coupled with heavy rainfalls may cause flooding due to its intensity, the numerous rivers and streams within the municipality may also overflow their banks and further exacerbate the situation (Tschakert et al., 2008). Additionally, the urban centers in the municipality face the risk of flood due to the absence or lack of adequate drainage systems that can carry off the runoff water from intense rainfalls.

A major factor in determining the degree and extent of damage flooding may cause in the municipality is urban resilience and mapping. Best practices would require that urban centers in the municipality be properly planned and should have resilient infrastructure capable of withstanding floods. However, the development of urban communities in Wenchi like most of Ghana has no appropriate planning and as such lowers their resilience. Such unplanned urbanization and other improper land use exacerbate flooding in the municipality.

Wenchi like most parts of Southern Ghana experiences a bimodal rainfall season, however, unlike most of these locations which record peak rainfall amounts during the major season (especially in June i.e., 170 mm), Wenchi has been noted as recording its peak rainfall amounts during the minor season (mostly in October i.e., 200 mm) (Ansah et al., 2020). This implies that Wenchi faces the risk of flood throughout most of the year. During the major season, runoff water and high river levels from other locations contribute to raising the risk level of Wenchi while this risk is maintained during the minor season by the amount of rainfall experienced in Wenchi itself (Herron et al., 2022). Figure 3 shows that Wenchi records significant rainfall amounts throughout the year hence making the place highly susceptible to flooding.

Figure 20: Expected change in the Maximum Daily Rainfall for the Bono Region of Ghana



Source: Climate Change Knowledge Portal.

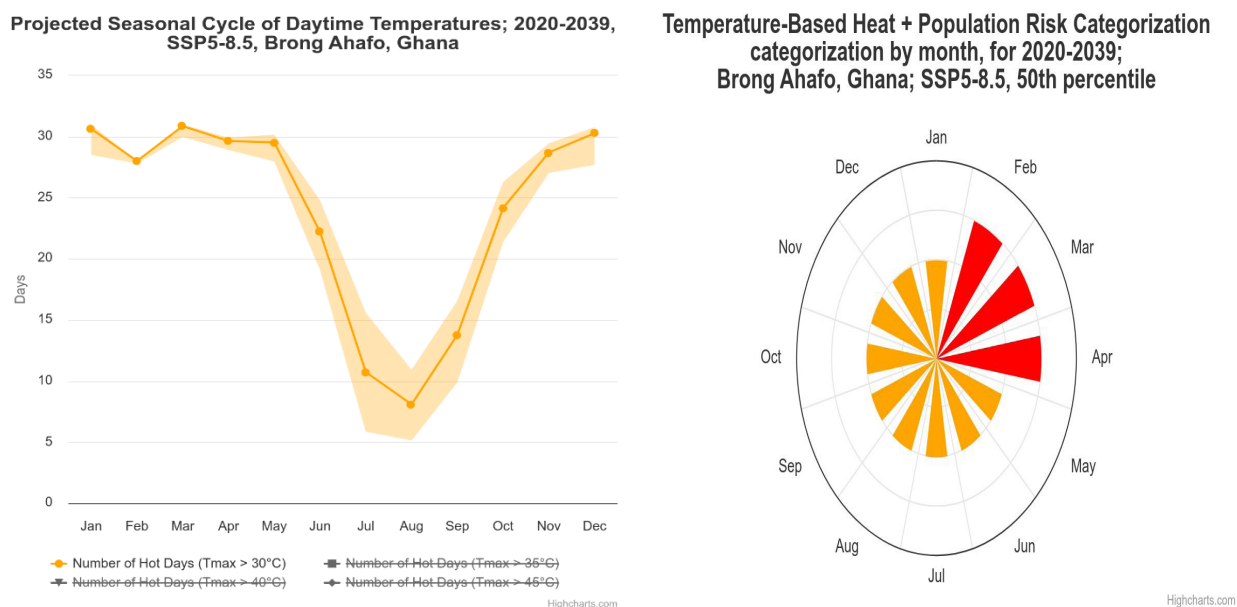
6.7 Drought

The climate of Wenchi and the transitional zone of Ghana is increasingly changing leading to long periods of dryness. Recent estimates have indicated that the transitional zone which is exemplified by Wenchi is experiencing a decreasing trend of rainfall in both the major and minor seasons (Quagraine et al., 2017). This is further compounded by an ever-shortening minor season making the region more prone to droughts in recent times (Quagraine et al., 2017). It is also noted that while the Wenchi area continues to experience its long dry spells, the minor season has increasingly become significantly drier and shorter (Owusu and Waylen,

2012). Drought is an issue of important concern throughout the continent due to the challenge of desertification which results from prolonged droughts (EPA, 2002).

Figure 36 presents the projected seasonal temperature changes that can inform the period of drought being experienced in the Wenchi enclave. It is observed from the estimations that temperatures will continue to rise especially in the dry seasons which may be prolonged into droughts with severe consequences for the area. The months of February, March, and April experience the highest temperatures in the year and are likely to be extended making the period of drought longer in the area.

Figure 21: Projected seasonal daytime temperatures for the Bono Region of Ghana



The trend in the Standardized Precipitation Evapotranspiration Index (SPEI) is the commonly used indicator of drought. The global climate model (i.e., CMIP5) shows a continued decrease in the SPEI for the Wenchi enclave indicating that there is a continued increasing risk of drought for the whole of the Bono Region (Figure 37). This shows that the Bono Region particularly Wenchi and the whole of the transitional zone of Ghana continues to face an increasing risk of drought due to climate change. The prolonged droughts experienced in the municipality present the municipality with several challenges in the areas of agriculture, water supply, and health. Prolonged periods of droughts affect the agriculture sector of the local economy through changes in crop cycles, low yields, and reduced soil fertility. This also leads to a significant reduction in the water resources of the municipality. Accompanying the long periods of drought is the emergence of increased dust in the environment and this together with increased heat levels affects the health of the elderly and other residents in the municipality.

6.8 Wildfires

The Wenchi area and its environs have been identified as a hotspot for wildfires in recent years due to several wildfires recorded in the enclave. Such wildfires are mainly from the activities of humans such as hunting, and they are most likely to occur during hot days. Wildfires in the municipality cause lots of destruction to farms and other properties. This is because wildfires have been documented to destroy acres of cocoa and other perennial crop farmlands (Asante et al., 2017).

Most recent estimates indicate that the major causes of wildfires in Ghana are through land use activities such as farming (19 percent), hunting (15 percent) or charcoal production carried out in forest areas (Agyemang and Muller, 2015). Hunters normally set fires to dried farmland or forest during the dry season to flush out mammals and rodents to be killed for the game. This has resulted in the destruction of most cocoa and cashew farms in the area. These practices have become part and parcel of the strategy available to farmers during dry seasons. Also, farmers tend to use the slash and burn method to clear their lands for cultivation in the upcoming season. These fires sometimes burn beyond their boundaries leading to the destruction of other lands.

The rampant wildfires have contributed to the changing landscape across Africa where woodlands are constantly being turned into grasslands (World Bank, 2023). This has significant implications for the ecosystems of the areas affected. The risk of wildfires is significantly determined by the number of hot and windy days as well as the buildup of fuelwood in the farmland which can easily be triggered by a spark. The changing climate and projection of Wenchí indicates that climate change will continue to drive the occurrence of wildfires in the foreseeable future. This is because Wenchí is projected to experience rising temperatures and more hot days which are favorable for the incidence of wildfires. The influence of climate change on fire outbreaks is categorized as; (i) direct effects on fire i.e., this can be as a result of drought, high temperatures as well as the occurrence of strong winds; (ii) indirect effects i.e., the changes in the nature and availability of biomass/fuel; and (iii) direct and indirect changes in natural and human-caused ignitions and demographic changes resulting from revised climate and land management policies (McKenzie and Littell, 2017; Restaino and Safford, 2018).

6.9 Health

The World Health Organisation (WHO) estimates that between 2030 and 2050, climate change is expected to cause about 250,000 additional deaths per year from undernutrition, malaria, diarrhea and heat stress alone (WHO, 2024). The impact of climate change on health will be more devastating in developing countries like Ghana, and the Wenchí enclave which have weak health infrastructure and would not be able to cope. Changes observed in the climate tend to lead to increased occurrence and intensity of climatic events such as storms, extreme heat, floods, droughts, and wildfires. These subsequently affect the health of humans either directly or indirectly and thereby heighten the risks of climate-related deaths (Ebi et al., 2018; IPCC, 2022). The direct impact of climate change on health may be in the form of deaths and illnesses that occur because of climatic events such as flooding or droughts (IPCC, 2021). Indirectly, climate change can affect health due to alterations in the environment such as high levels of air pollution which tends to cause respiratory and cardiovascular conditions (Mills et al., 2009).

Figure 9 provides an overview of climate-induced health risks, their pathways, and the likely health outcomes. In the framework, climate change creates health risks that impact people and communities differently depending on their level of exposure and ability to adapt. In effect, people and communities that have weaker institutional support are likely to suffer more from the impacts of climate change on their health. These impacts are expected to be severely felt in the Wenchí municipality which has a total of eight healthcare facilities providing health care to its inhabitants consisting of five public and three privately owned facilities (GSS, 2014).

Estimations about Ghana indicate that without proper adaptation planning, heat-related deaths in the elderly are projected to rise to about 70 deaths per 100,000 in 2080 under a high emissions scenario compared to less than 2 deaths per 100,000 annually between 1961 and 1990 (WHO, 2015). Besides heat-related deaths, other climatic events such as flooding can lead to waterborne diseases such as cholera and this will significantly impact the health of the inhabitants of the municipality. Changing climate will also create a

conducive environment for disease-carrying insects such as mosquitoes to multiply thereby increasing the number of malarial cases and deaths in Ghana and the Wenchi enclave.

Additionally, climate change has the potential to impact the food security and nutrition of the inhabitants of the municipality. This can happen in two main ways; first, increasing temperature levels in the municipality will create an inconducive environment for crops due to the unavailability of water and this may lead to minimal crop production levels leading to food insecurity; second, excessive water resulting from floods may also negatively impact crop production and lead to food insecurity as well in the municipality.

6.10 Trade

Climate change has a significant impact on the trade sector in the Wenchi Municipal area. The municipal's agricultural productivity, which forms a substantial part of its trade economy, faces severe threats from changing weather patterns. The effect of agriculture on trade is also felt among women who engage in trading as an off-farm adaptation strategy (Wrigley-Asante, Owusu, Egyir, & Owiyo, 2019). Increased temperatures altered rainfall patterns, and more frequent extreme weather events such as droughts and floods have led to inconsistent crop yields. For instance, the production of staple crops like maize and yam has seen fluctuations, causing economic instability for farmers who rely heavily on these crops for their livelihood.

Moreover, climate change affects the quality and quantity of produce, thereby influencing market prices. Farmers in Wenchi often face reduced incomes due to lower yields and increased costs of production, such as the need for irrigation and pest control. According to the Ghana Statistical Service, agricultural productivity in the Brong-Ahafo region, where Wenchi is located, has been on a decline, partially attributed to climate-related issues. This reduction in productivity impacts the overall trade balance of the region, leading to increased reliance on imports to meet food security needs.

Additionally, the infrastructure supporting trade, such as roads and storage facilities, is vulnerable to climate impacts. Floods and heavy rains can damage roads, disrupting the transportation of goods to markets. This not only increases transportation costs but also leads to post-harvest losses, as perishable goods may spoil before reaching consumers. Investment in climate-resilient infrastructure is essential to mitigate these challenges and ensure the stability and growth of Wenchi's trade sector.

6.11 Energy

Hydropower is a significant component of Ghana's energy mix. For Wenchi Municipal Assembly, changes in precipitation patterns could severely affect hydropower generation. Prolonged droughts can lead to lower water levels in reservoirs, reducing the capacity to generate electricity. Intense rainfall can cause flooding, damaging hydropower infrastructure and reducing efficiency. Biomass, including wood and agricultural residues, is a primary energy source for many households in Wenchi. Changes in weather patterns can affect crop yields and forest growth, limiting the availability of biomass resources primarily impacting women and girls who are responsible for fetching biomass for domestic use. Higher temperatures might increase the need for cooling, leading to higher biomass consumption and potential overexploitation of resources. Further, energy infrastructure, including transmission and distribution networks, is vulnerable to climate change. Storms and floods can damage power lines, substations, and other critical infrastructure. High temperatures can degrade materials and reduce the lifespan of infrastructure components.

6.12 Gender

Climate change has differentiated impacts on men and women in Wenchi Municipal, often exacerbating existing gender inequalities. Women, who constitute a significant portion of the agricultural workforce, are

particularly vulnerable due to their reliance on climate-sensitive resources. They are responsible for most of the subsistence farming and household food security, and climate-induced crop failures directly affect their economic stability and nutritional status. They also have limited access to resources like land and finance which will enable them to adapt. Among farmers who apply climate resilient measures, many male farmers cultivate drought-resistant crop varieties, female farmers on the other hand, engage in the cultivation of traditional crops and mixed cropping (Wrigley-Asante, Owusu, Egyir, & Owiyo, 2019) relying heavily on good weather.

Women in rural Ghana spend a considerable amount of time collecting water and firewood, tasks that are becoming more challenging due to changing climate conditions. The increasing frequency of extreme weather events such as floods and droughts further compound the challenges faced by women. These events can lead to displacement, loss of property, and increased workload as women are often the primary caregivers in their families. Access to resources such as credit, land, and technology is also more limited for women, making it harder for them to adapt to and mitigate the effects of climate change.

6.13 Infrastructure

The infrastructure in Wenchi Municipal is highly susceptible to the impacts of climate change, which poses significant risks to the region's development and sustainability. Increased frequency and intensity of extreme weather events such as heavy rains and floods can damage critical infrastructure, including roads, bridges, and buildings. For example, heavy rainfall can lead to erosion and wash away unpaved roads, isolating communities and disrupting transportation and trade. According to the Ghana Meteorological Agency, the frequency of intense rainfall events has increased over the past decade, heightening the risk of infrastructure damage.

The municipal water and sanitation infrastructure are also vulnerable. Floods can contaminate water supplies and overwhelm drainage systems, leading to waterborne diseases. Ensuring the resilience of water infrastructure is crucial for maintaining public health and safety. Investments in climate-resilient infrastructure, such as flood defenses, improved drainage systems, and durable road surfaces, are necessary to protect these essential services from climate impacts. Moreover, climate change can strain energy infrastructure, particularly in terms of maintaining reliable electricity supply during extreme weather events. Power outages caused by storms or floods can disrupt economic activities and essential services.



7

Climate Change Risk Assessment at the Wenchi Municipality

7.1 Identification of critical climate-related hazards or risks

The earlier analyses painted a clear picture: Wenchi faces a harsh reality of climate extremes. Unpredictable rainfall patterns (leading to both floods and droughts) and temperature fluctuations are already impacting the municipality, with projections indicating further intensification. The stakeholder workshop served a crucial purpose – validating these climate hazards through the lens of local experience.

Table 5: Outcomes of Stakeholder Consultations

Systems Exposed to Hazard	Climate Hazard	Climate Risk and Potential Impacts
Agriculture	Droughts	Certain periods of droughts in the Wenchi Municipality including the drying up of rivers such as the River Subin reduces water availability in the municipal. This leads to decreased soil moisture affecting crop growth and livestock health and results in reduced yields, food shortages, and increased food prices. In recent years, Wenchi has experienced periodic droughts that have significantly affected maize and yam production, sometimes causing economic hardship for farmers.
	Floods	The May 2015 floods caused by seasonal rains exacerbated by poor drainage systems affected several hundred residents, damaging homes and farmlands. Waterlogged areas became breeding grounds for mosquitoes, raising concerns about malaria outbreaks. The affected areas were Ahenfie, Nchiraa and Tromeso. The June 2017 floods affected Buoku, Koase and Wurompo. These communities were cut off due to damaged roads. Floodwaters caused damage to infrastructure and resulted in casualties. Further, the September 2019 and August 2021 floods caused by heavy and continuous rainfall impacted several properties. Homes were submerged, leading to displacement of residents. The floods also damaged roads and other infrastructure, disrupting transportation and daily activities. The floods caused significant economic losses for farmers in the area. The affected places were the communities of Akrobi, Asuano Subinso, Nkonsia, Awisa and Branam.
	Extreme temperatures	Extreme temperature events have led to significant losses in poultry farming, with many birds succumbing to heat stress. Also, in March 2019 some parts of Wenchi experienced unusually high temperatures, with daytime highs frequently exceeding 40°C. The heatwave lasted for several weeks, causing discomfort and health issues among residents. Increased cases of heat-related illnesses such as dehydration were reported. Some cashew and maize farmers faced challenges as the high temperatures affected crop yields and water sources such as the River Atwenem.
	Erratic rainfall	Farmers have reported shifting rainy seasons, making it difficult to time planting and harvesting, resulting in lower yields.

Health	Heatwaves	The municipality has seen a rise in cases of heat-related illnesses during peak temperature periods.
	Vector-borne and Water-borne diseases	There has been an increase in malaria cases in Wenchi, particularly after periods of heavy rainfall. Following flooding events, cholera outbreaks have occurred, putting pressure on the local health systems.
	Air quality deterioration	Higher temperatures can increase air pollution, exacerbating respiratory conditions like asthma and bronchitis. Instances of respiratory issues have been reported to rise during periods of high temperatures and dusty conditions.
Biodiversity	Habitat Loss	Changes in land use and deforestation have reduced natural habitats, impacting local wildlife and plant species. Expansion of agricultural land especially for cashew farming in the Wenchi locality has led to deforestation, reducing habitats for local wildlife.
	Temperature and precipitation changes	Shifts in climate patterns alter the distribution of species, disrupting ecosystems and leading to loss of biodiversity. Changes in local climate have affected the distribution of certain plant and animal species in the municipality.
Water & Sanitation	Drought	Reduced water availability affects drinking water supplies and agricultural needs, leading to water rationing by inhabitants of local Wenchi communities. During drought periods, Wenchi has experienced water shortages, forcing residents to rely on less reliable water sources.
	Flooding	Heavy rains overwhelm sanitation facilities, contaminating water sources and spreading diseases. Infrastructure damage has led to long-term service disruptions. Flooding has led to the contamination of water sources including rivers found in the municipality, resulting in outbreaks of waterborne diseases such as cholera.
	Water Availability	Farmers have faced challenges in irrigation planning due to unpredictable water availability, especially during periods of drought.
Gender	Flooding	Women and girls often bear the brunt of increased household responsibilities during and after heavy flood events, including fetching water and caring for family members. After these flooding events, women in Wenchi have had to travel longer distances to access clean water.
	Economic Disruptions	Droughts have led to reduced agricultural income, disproportionately affecting women and the elderly who rely on farming.
	Resource Scarcity	During water shortages, women and children have reported longer and more dangerous journeys to fetch water. In 2018, prolonged dry spells led to severe water shortages in Nchiraa, a community within the Wenchi municipal. Local water sources dried up, forcing women to travel to distant streams and rivers. Women reported journeys of up to 5 kilometers to fetch water. These extended trips not only increased their physical burden but also exposed them to the risk of assault and harassment, especially when traveling during early mornings or late evenings. Further, a significant reduction in rainfall led to a water crisis in 2017 in Subinso. The community's primary water sources were depleted, compelling residents to seek water from neighboring communities. Women, children, and the elderly faced increased workloads and longer travel times, often walking for hours to fetch water. Reports of verbal harassment and threats of physical violence during these journeys were documented, heightening the community's concern for their safety. Disabled individuals, especially those with mobility issues, found it nearly impossible to travel the increased distances required to fetch water. They became heavily reliant on family members or neighbors, which sometimes led to neglect due to the overwhelming burden on caregivers.

Cities and Infrastructure	Floods	Heavy rainfall in July 2022 led to severe flooding in Wenchi town. The rainfall was unusually intense, resulting in the overflow of local rivers. The floodwaters damaged several homes, roads, and public facilities. Key roads such as the Wenchi-Techiman highway were submerged, disrupting transportation and cutting off access to essential services. Several bridges were also affected, leading to prolonged travel delays and increased difficulty in accessing healthcare and educational facilities. There was a major flood in June 2017 following a period of intense rainfall. The town's drainage systems were overwhelmed, leading to widespread flooding. Homes and businesses were severely affected, with many buildings experiencing water damage. Key public facilities, such as the Wenchi Government Hospital, faced operational disruptions.
	Heatwaves	Increased temperatures lead to heat stress in urban areas and put pressure on energy supplies due to higher demand for cooling. The extreme heat periods led to a surge in the use of cooling appliances such as fans and air conditioners in the municipal. This increased demand for electricity strained the local power grid, resulting in frequent power outages. The outages disrupted daily life, affecting businesses, schools, and households. People faced significant discomfort and health risks, particularly vulnerable populations such as the elderly and those with pre-existing health conditions.
	Infrastructure Degradation	The August 2019 flooding caused substantial damage to roads and drainage systems. Potholes and cracks appeared on many major and minor roads such as the Wenchi-Wa highway and the Wenchi-Offuman highway, making them unsafe for use and increasing the need for frequent repairs. The damage to drainage systems also increased the risk of future flooding, prompting the municipality to invest in improved drainage infrastructure.
Trade	Flooding	Flooding events caused severe disruptions in the supply chain, as trucks and other vehicles carrying goods to and from Wenchi, Techiman and Wa were unable to pass through flooded areas. This led to delays in market supplies, particularly affecting perishable goods. Traders and businesses experienced financial losses due to the increased cost of transportation and spoilage of goods.
	Reduced Agricultural Productivity Due to Droughts	Drought events have led to lower yields for staple crops such as maize and yam. Farmers reported losses of up to 50% in crop yields, reducing the volume of agricultural products available for local and regional markets. This scarcity increased food prices and reduced income for farmers, affecting their livelihoods and economic stability.
Energy	Drought	Reduced water availability caused a significant drop in hydropower output. As a result, there were frequent power outages, and the municipality had to rely more on diesel generators and other alternative sources, which are costlier and less environmentally friendly. This increased the operational costs for businesses and reduced the reliability of power supply for households.
	Higher Temperatures	High heat led to a sharp increase in the use of air conditioners, fans, and other cooling devices. This sudden spike in energy consumption overwhelmed the local power grid, resulting in multiple blackouts. Residential areas, businesses, and critical facilities like hospitals faced power interruptions, highlighting the vulnerability of the energy supply system during extreme temperature events.

Source: Stakeholder engagement, 2024

7.2 Impact Story Lines for Critical Assets and Risk Domain

Individual impact chains were created to help us better understand the climate-related hazards, vulnerabilities, and exposures that affect vital assets in Wenchi Municipal. These chains were built utilizing data and insights offered by stakeholders, with a focus on the top risks identified during the engagement sessions. This approach enabled a thorough examination of how various climate concerns interact with local systems and infrastructure, resulting in more targeted and effective adaptation solutions for the area.

7.2.1 Risk of reduced crop productivity

Critical assets in the Wenchi Municipal include arable land, water resources, seeds, farming equipment, and human capital. These assets are essential for maintaining high crop productivity. However, several

risk domains threaten these assets, including climate change, soil degradation, water scarcity, pest infestations, and inadequate access to modern farming techniques. Climate change manifests in irregular rainfall patterns, prolonged droughts, and extreme weather events. These changes disrupt the agricultural calendar, reduce water availability, and increase the vulnerability of crops to stress. As a result, crop yields are adversely affected, leading to food insecurity and reduced income for farmers. Farmers are at the forefront of the agricultural sector and directly experience the impact of reduced crop productivity. They emphasize the need for timely and accurate weather information, access to quality seeds and fertilizers, and training in sustainable farming practices. Furthermore, the stakeholders note that access to irrigation is limited. Despite the presence of rivers and streams, less than 10% of the arable land in Wenchi is irrigated. This reliance on rain-fed agriculture exacerbates the vulnerability of crops to climatic variations

Soil Degradation:

Continuous cultivation without appropriate soil management practices leads to soil degradation. Loss of soil fertility, erosion, and depletion of organic matter are critical issues that diminish the land's productivity. Stakeholders recognize the need for sustainable land management practices to restore soil health.

Water Scarcity:

Access to adequate water resources is a major challenge. Erratic rainfall and the absence of efficient irrigation systems exacerbate water scarcity. Farmers rely heavily on rain-fed agriculture, making their crops vulnerable during dry spells. The establishment of reliable water management systems is crucial to mitigate this risk.

Access to Modern Farming Techniques:

The adoption of modern farming techniques and technologies is limited due to inadequate extension services, lack of training, and financial constraints. Traditional farming methods often lead to suboptimal productivity. Enhanced training programs and support for technology adoption are vital to improve crop yields.

7.2.2 Risk of wildfires

Over the past decade, Wenchi Municipal has witnessed a notable increase in the frequency and intensity of wildfires. Data from the Ghana National Fire Service (GNFS) indicate that the number of wildfire incidents has risen since 2010. These fires often occur during the dry season, from December to March, when vegetation is highly flammable due to prolonged drought conditions. Stakeholders identify climate change as a critical factor exacerbating the risk of wildfires. Rising temperatures and extended dry periods create ideal conditions for fires to ignite and spread. According to the Ghana Meteorological Agency, Wenchi has experienced an increase in average temperatures over the past 20 years, and annual rainfall has decreased. These climatic changes contribute to the drying of vegetation, making it more susceptible to fire.

Environmental degradation, such as deforestation and land-use changes, also plays a role. The Wenchi Environmental Protection Agency (EPA) reports that deforestation rates in the area have increased in the last decade due to agricultural expansion and logging. The loss of forest cover reduces the natural barriers that can slow the spread of wildfires and exacerbates soil erosion, further degrading the land and increasing fire risk.

The socio-economic impacts of wildfires are profound and multifaceted. Farmers, who constitute a significant portion of the population, are particularly vulnerable. The Wenchi Farmers' Association reports that wildfires have destroyed approximately 15% of farmland annually over the past five years, leading to significant economic losses. These fires not only destroy crops but also damage soil fertility and infrastructure, such as farm buildings and irrigation systems.

Wildfires also pose a direct threat to human life and property. The GNFS records show that wildfires have caused injuries and casualties. Additionally, the destruction of homes and other structures displaces families and disrupts community life. The economic burden of rebuilding and recovery places additional strain on already limited local resources.

One of the primary concerns among stakeholders is the inadequacy of fire management infrastructure and resources. The GNFS in Wenchi Municipal is under-resourced and lacks the necessary equipment and personnel to effectively combat wildfires. There are only two fire stations in the municipality, each serving an area with a population of over 100,000 people. The response time to wildfire incidents is often delayed, resulting in more extensive damage.

Moreover, there is limited public awareness and education on wildfire prevention and management. Many fires are caused by human activities, such as slash-and-burn agriculture, charcoal production, and improper disposal of cigarette butts. The key stakeholders acknowledge the need for increased community education and engagement to reduce these human-induced fire risks.

Stakeholders also emphasize the importance of sustainable land management practices and reforestation efforts. The Wenchi EPA has initiated several reforestation projects, aiming to restore 500 hectares of degraded land by 2025. These projects not only help in reducing wildfire risk but also enhance biodiversity and improve soil health.

7.2.3 Risk of flooding

In recent years, Wenchi Municipal has experienced an increasing frequency and severity of flooding events. Data from the Ghana Meteorological Agency indicate that rainfall intensity and volume have risen over the past decade, particularly during the rainy season from April to October. These heavy rains often lead to flash floods that disrupt daily life, damage infrastructure, and affect agricultural productivity. Stakeholders identify this increased intensity in the amount of rainfall as a primary driver of increased flooding risk. Rising global temperatures have altered precipitation patterns, resulting in more intense and erratic rainfall. These changes overwhelm the existing drainage systems, leading to frequent flooding.

Further, the key stakeholders acknowledged environmental degradation, such as deforestation and improper land use, exacerbating the flooding risk. The Wenchi Environmental Protection Agency (EPA) notes that deforestation rates have risen over the past decade due to agricultural expansion and logging activities. The loss of forest cover reduces the land's ability to absorb rainwater, increasing surface runoff and flood risk. Additionally, the conversion of wetlands and floodplains for agriculture and construction further diminishes natural flood buffers.

The socio-economic impacts of flooding are extensive and multifaceted. Farmers, who form the backbone of Wenchi's economy, are particularly vulnerable. Floods damage crops, wash away fertile topsoil, and erode farmlands, leading to significant economic losses. The Wenchi Farmers' Association reports that annual crop losses due to flooding have increased in the last five years. These losses undermine food security and reduce household incomes. Urban areas are also severely affected. Flooding damages

homes, businesses, roads, and public infrastructure, leading to substantial repair and recovery costs. Displaced families and disrupted services strain local resources and hinder economic activities.

One of the primary concerns among stakeholders is the inadequacy of urban drainage infrastructure and poor urban planning. The existing drainage systems in Wenchi are outdated and insufficient to handle the increased volume of stormwater. The key stakeholders acknowledged that some parts of the urban area are not covered by proper drainage systems, leaving many areas prone to flooding.

Urban planners highlight the need for improved land use planning and enforcement of building regulations. Informal settlements and unauthorized construction in flood-prone areas exacerbate the risk. The rapid urbanization of Wenchi, driven by population growth and economic development, has often outpaced the capacity of local authorities to manage it effectively. As a result, many communities lack the necessary infrastructure to cope with heavy rains. Stakeholders also emphasized the importance of sustainable land management practices and reforestation efforts. The Wenchi EPA has launched several reforestation projects, aiming to restore 1,000 hectares of degraded land by 2025 in their 2014-2017 Mid-Term Development Plan. These initiatives help increase the land's capacity to absorb rainwater and reduce surface runoff.

7.2.4 Risk of drought

In recent years, Wenchi Municipal has experienced an increasing frequency and severity of droughts. Stakeholders from the Ghana Meteorological Agency indicated that the region has seen a decline in annual rainfall over the past two decades, with prolonged dry spells becoming more common. These droughts have profound effects on agriculture, water resources, and the overall livelihoods of the residents.

Further, environmental degradation, such as deforestation and unsustainable agricultural practices, also contributes to the increased risk of drought. The loss of forest cover reduces the region's ability to retain moisture, exacerbating the effects of drought. The socio-economic impacts of drought are extensive and multifaceted. Agriculture, which forms the backbone of Wenchi's economy, is particularly vulnerable. Staple crops such as maize, yam, and cassava are heavily affected, leading to food insecurity and reduced household incomes. The reduction in agricultural productivity also impacts the local economy. With over 70% of the population engaged in farming, lower crop yields translate to lower incomes and increased poverty levels. The Ghana Statistical Service (GSS) reports that poverty rates in Wenchi have risen by 10% in the last five years, partially attributed to recurrent droughts.

Water scarcity is another critical issue. Droughts led to the drying up of rivers, streams, and groundwater sources, affecting both domestic and agricultural water supply. The stakeholders report that some of Wenchi's population experiences water shortages during drought periods. This scarcity not only affects daily living but also hampers irrigation efforts, further reducing agricultural productivity.

One of the primary concerns among stakeholders was the inadequacy of infrastructure and resources to manage drought. The Wenchi Municipal Assembly highlights the lack of sufficient irrigation systems. Only a small portion of the arable land in Wenchi is irrigated, leaving the majority of farmers dependent on rain-fed agriculture. This dependence makes them highly vulnerable to drought conditions.

7.2.5 Risk of power outages

In recent years, Wenchi Municipal has experienced frequent power outages, disrupting daily life and economic activities. These outages are attributed to a variety of factors including infrastructural deficiencies, high demand, and environmental challenges. One of the primary concerns among stakeholders is the

inadequacy of the electrical infrastructure. The electrical grid in Wenchi is outdated and cannot meet the growing electricity demand. The Wenchi Municipal Assembly highlights that the electrical grid has not been significantly upgraded in the past two decades, resulting in frequent breakdowns and failures. Moreover, maintenance of the existing infrastructure is insufficient. The ECG reports that only 50% of the scheduled maintenance activities are completed on time due to resource constraints. This lack of regular maintenance leads to the deterioration of electrical components, increasing the likelihood of outages.

The growing population and economic activities in Wenchi have led to an increased demand for electricity. The Ghana Statistical Service (GSS) reports that the population of Wenchi has grown by 20% over the past decade, with a corresponding increase in commercial and residential electricity consumption. However, the supply of electricity has not kept pace with this rising demand, leading to frequent load shedding and outages. Businesses, particularly small and medium enterprises (SMEs), are significantly affected by these power outages. SMEs, which constitute 70% of the local economy, report losses of up to 25% in revenue due to frequent power interruptions.

Environmental factors, such as extreme weather events, also contribute to the risk of power outages. Wenchi experiences heavy rains, especially during the rainy season from April to October. These weather conditions often lead to damage to power lines and transformers, causing outages and further stressing the electrical infrastructure. Additionally, deforestation and poor land management practices exacerbate the impact of weather-related disruptions. The Wenchi Environmental Protection Agency (EPA) highlights that the loss of vegetation cover increases the vulnerability of power lines to wind and storm damage.

7.2.6 Risk of disruptions in the supply chain of business

In recent years, Wenchi Municipal has experienced increasing frequency and severity of supply chain disruptions. These disruptions are attributed to a variety of factors including poor infrastructure, environmental challenges, economic fluctuations, and socio-political issues. One of the primary concerns among stakeholders is the inadequacy of transportation infrastructure. Poor road conditions, particularly in rural areas, hinder the efficient movement of goods. The stakeholders reported that sections of the major roads and highways in the municipality are in poor condition, making it difficult for farmers and traders to transport their products to markets. This is especially problematic during the rainy season when many roads become impassable.

Transport operators highlight that vehicle maintenance costs are high due to the poor state of the roads. This not only increases the cost of transportation but also leads to delays and unpredictability in delivery times.

Further, environmental factors, such as flooding and drought, significantly impact the supply chain. Floods can damage roads and bridges, cutting off access to key trading routes. All these events disrupt agricultural production and the supply of goods. Droughts, in particular, affect the production of key crops such as maize, yam, and cassava, leading to shortages and increased prices.

7.2.7 Risk of loss of biodiversity

Wenchi Municipal has experienced an increasing rate of biodiversity loss. The Ghana Forestry Commission reports a decline in forest cover over the past two decades, leading to habitat destruction and a decline in species diversity. This loss of biodiversity threatens the ecological balance and the sustainability of natural resources that are vital to the community's livelihood.

Stakeholders identified deforestation and land degradation exacerbate the problem. The Wenchi Environmental Protection Agency (EPA) reports that agricultural expansion, logging, and mining activities have led to a reduction in forested areas over the past decade. This habitat destruction is a critical threat to biodiversity, as it reduces the availability of food and shelter for various species, leading to population declines and extinctions.

Unsustainable agricultural practices contribute significantly to biodiversity loss. The expansion of monoculture farming and the overuse of chemical fertilizers and pesticides degrade soil health and reduce habitat diversity. The Wenchi Farmers' Association acknowledges that intensive farming practices have led to soil erosion, loss of soil fertility, and a decline in beneficial insect populations, such as pollinators. The loss of biodiversity has impacted livelihoods that depend on natural resources. Communities that rely on forests for fuelwood, medicinal plants, and non-timber forest products face reduced availability of these resources. This decline affects household incomes and increases poverty levels. The Ghana Statistical Service (GSS) reports that poverty rates in Wenchi have risen by 10% in the last five years, partly due to the loss of biodiversity and its associated resources.

7.3 Risk Assessment Results

7.3.1 Current and Future Climate-Related Risks

The climate risk assessment for the Wenchi municipal has been a collaborative and participatory process, echoing the methodologies highlighted (Figure 2). Local stakeholders, including community leaders, government officials, and representatives of vulnerable groups, were instrumental in shedding light on the climate challenges specific to Wenchi. This engagement has yielded a comprehensive perspective on how climate variability and extreme events are impacting the district, with a keen focus on actionable solutions and increased awareness.

Key Outcomes from the consultations are as follows:

- **Agriculture and Food Security:** The community is actively engaging in climate-smart agricultural practices and diversifying crops. These actions aim to mitigate the impacts of irregular rainfall and land degradation on crop yields and overall food security.
- **Water Resource Adaptation:** In the Wenchi Municipal Assembly, community members are implementing reforestation programs to preserve water catchment areas and conducting educational campaigns to emphasize the importance of water conservation. Law enforcement has been strengthened to regulate mining activities, reducing water pollution. Additionally, there is a push to develop local bylaws to restrict activities that lead to deforestation and irregular rainfall patterns.
- **Health and Community Resilience:** Stakeholders in Wenchi recognize the need for effective health communication systems to disseminate crucial information about climate risks and health advisories. This effort ensures that all community members are aware of the health hazards associated with environmental degradation, such as water pollution and vector-borne diseases.
- **Infrastructure and Human Settlement:** To address frequent flooding and infrastructure damage, Wenchi prioritizes land afforestation, dredging canals, and providing appropriate drainage systems. Building regulations are being enforced more strictly, with a focus on ensuring proper implementation of building schemes to prevent the negative effects of improper construction and land use.

Recommendations from Stakeholder Engagements for Wenchi Municipal Assembly

- **Improving Monitoring and Supervision:** Adequate resources are needed for effective monitoring and supervision of environmental policies and construction activities to ensure compliance with established regulations.
- **Sensitization and Education:** Regular sensitization sessions are recommended for stakeholders, including gender advocates, NGOs, and the broader community, to ensure widespread understanding and support for climate adaptation measures.
- **Alternative Livelihoods:** The government and non-governmental organizations are urged to provide alternative livelihood opportunities to reduce the community's reliance on climate-vulnerable sectors such as agriculture and to counteract the economic draw of illegal mining activities.
- **Enhanced Disaster Response:** There is a call to establish community-based volunteer groups that can respond swiftly to environmental emergencies and disasters, even without immediate financial incentives.

Table 6: Assessment of current climate change risks

Asset/System	Hazard Description	HS	E	HxE	AC	S	V	Comment-Impacts	CCR
Water Resources	Vulnerability to extreme weather variability	H	H	VH	M	H	VH	The water infrastructure faces significant risks from changing precipitation patterns and extreme weather events, which can disrupt supply and water quality. This includes potential damage to reservoirs, increased water treatment costs, and challenges in maintaining consistent water availability.	VH
Agricultural Productivity	Climate variations impacting crop yields	H	H	VH	L	VH	VH	Variations in climate, such as shifts in rainfall patterns and temperature extremes, are likely to lead to crop failures and increased pest outbreaks, jeopardizing food security. This can result in reduced agricultural output and economic losses for farmers.	VH
Municipal Health	Increased risk of climate-related health issues	M	H	H	M	H	H	Climate change exacerbates health risks, including vector-borne diseases like malaria and heat-related illnesses, particularly during extreme weather events. The healthcare system may face increased pressure during such periods.	H

Biodiversity	Climate variations resulting in biodiversity loss	H	H	VH	L	VH	VH	Changes in rainfall patterns and temperature extremes can lead to droughts, desertification, and wildfires. These factors can destroy or degrade natural habitats, forcing plant and animal species to relocate or adapt.	VH
Infrastructure	Exposure to inland flooding	H	H	H	M	H	H	Infrastructure in low-lying areas is vulnerable to recurrent flooding and increased rainfall intensity. Roads, bridges, and buildings, particularly in flood-prone areas, are at risk from flooding, potentially leading to substantial repair and maintenance costs.	H

HS = Hazard Score; E = Exposure; H×E = Hazard × Exposure; AC = Adaptive Capacity; S = Sensitivity/Vulnerability; V = Vulnerability; CCR = Composite Climate Risk

VH= Very High; H= High; M= Moderate.

Table 7: Assessment of Future Residual Risk after implementation of adaptation measures

Asset/System	Adaptation Measures	Residual Adaptive capacity	Sensitivity	Exposure	Vulnerability	Residual Risk
Water Resources	Construction of reservoirs, water conservation practices, and rainwater harvesting.	H	M	H	M	M
Agricultural Viability	Introduction of drought-resistant crops, irrigation systems, soil conservation techniques	M	M	H	M	M
Municipal Health	Improved healthcare infrastructure, vaccination programs, and awareness campaigns	H	M	M	L	M
Biodiversity	Implementing reforestation and afforestation projects to restore degraded forest areas and increase biodiversity. Establishing protected areas to conserve wildlife and promote ecosystem resilience.	M	H	H	M	H

Infrastructure	Reinforcing existing infrastructure to withstand extreme weather events, including enhancing drainage systems to prevent flooding. Building new structures to higher resilience standards and retrofitting older ones to resist climatic stresses. Developing early warning systems and emergency response plans to reduce risks and improve disaster preparedness.	H	M	M	M	M
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Table 8: Climate change risk assessment results matrix and short narrative explaining the risk

Critical Asset/System	Risk Description	Current Risk	Future Risk	Residual Risk
Water Resources	Changing rainfall patterns and extreme weather events elevate the risk of water scarcity and impact the reliability of water infrastructure. These changes necessitate revisions in water management and conservation strategies.	H	VH	M
Agricultural Viability	The sector faces a potential reduction in crop yields and an increase in pest and disease prevalence due to variable weather conditions. Soil fertility could be compromised by flooding, leading to long-term productivity issues.	H	VH	M
Municipal Health	Anticipated changes in temperature and precipitation patterns are expected to exacerbate health risks, including waterborne diseases and heat-related illnesses, stressing local health facilities and services.	M	H	M
Biodiversity	Biodiversity in Wenchi Municipal are at risk from increased temperatures, altered rainfall patterns, and more frequent and intense wildfires, which can lead to significant habitat loss and degradation. These environmental changes threaten species diversity, disrupt ecological balances, and reduce the capacity of forests to provide essential ecosystem services	H	VH	M
Infrastructure	Infrastructure is increasingly vulnerable to extreme weather events, such as storm surges, flooding and constant power outages. The integrity of roads, bridges, and utilities may be compromised, requiring strategic resilience planning.	H	VH	M

7.5. Gender-specific vulnerability assessment

Assessing gender-specific vulnerabilities in the Wenchi District is essential as climate change impacts do not affect all community members equally (Thomas et al., 2019). Women, often central to resource management and caregiving, can face disproportionate challenges during climate crises. Understanding these gendered dimensions is crucial for creating equitable, targeted interventions that ensure effective adaptation and resilience-building.

The assessment of current gender-specific climate change risks in the Wenchi Municipal highlights significant vulnerabilities across different groups (**Table 12**). Women face high exposure and sensitivity to erratic rainfall, sea-level rise, and increased temperatures, which severely impact their roles in water and food provision, stressing their adaptive capacities and elevating their overall vulnerability. Youth experience medium exposure and sensitivity to extreme weather and job market instability, yet they possess a high adaptive capacity due to their innovation potential. Differently, abled individuals are extremely vulnerable, with high exposure and very high sensitivity to accessibility issues during extreme weather, compounded by low adaptive capacity due to physical barriers and inadequate inclusive planning.

Table 9: Assessment of current gender-specific climate change risks

Group	Hazard Description	Exposure	Sensitivity	Adaptive Capacity	Overall Vulnerability	Comments/Impacts
Women, children & elderly	Erratic rainfall, increased temperatures	High	Very High	Low	High	The differential impacts of climate change on women, children, and the elderly present a significant challenge. These groups often experience a heightened vulnerability due to a confluence of factors. Firstly, they face high exposure to climate hazards like extreme weather events and environmental degradation. Secondly, their sensitivity to these hazards is amplified by biological factors (children and elderly) or social inequalities (women). Finally, their capacity to adapt is often constrained by limited resources, information, and decision-making power. Women, typically responsible for water and food provision, face increased burdens due to resource scarcity and extreme weather events.

Youth	Extreme weather events, job market instability	High	Medium	Low	Medium	The impacts of climate change on the youth are profound and multifaceted, posing significant risks to their health, education, economic stability, and overall well-being. Young people face high exposure to climate-related hazards such as extreme weather events, food and water insecurity. Their sensitivity to these impacts is heightened due to their developmental stages, health conditions, and dependence on adults and existing systems. The limited adaptive capacity of youth further exacerbates their vulnerability, as they often lack the financial resources, decision-making power, and access to necessary information and support systems needed to effectively respond to and recover from climate impacts.
PLwD	Accessibility issues during extreme weather	High	Very High	Low	Very High	Physical barriers and lack of inclusive planning result in heightened vulnerability and lower adaptive capacity.



8

Potential Adaptation Options and Recommendations

8.1 Future Climate Change Scenarios for Wenchi Municipal Assembly

As climate change continues to intensify, Wenchi Municipal Assembly is projected to experience significant environmental and socio-economic impacts. By the mid-21st century, average temperatures in the region are expected to rise by 1.5 to 2.5 degrees Celsius, with more extreme heat events becoming increasingly common under the CMIP6 models. These higher temperatures will exacerbate existing heat stress on both humans and livestock, reduce agricultural productivity, and heighten the risk of heat-related illnesses. The frequency and intensity of heatwaves are likely to increase, posing substantial challenges to public health and local economies reliant on agriculture and livestock farming.

In addition to rising temperatures, Wenchi is anticipated to experience changes in precipitation patterns under the SSP5-8.5 scenario. Projections indicate a trend towards more erratic rainfall, with an increase in the frequency of both droughts and intense rainfall events. This variability poses a dual threat: prolonged dry spells can severely impact water availability for drinking, irrigation, and sanitation, while heavier rainfall events can lead to flooding, soil erosion, and infrastructure damage. Such hydrological extremes are likely to disrupt agricultural cycles, leading to decreased crop yields and food security issues, thus affecting the livelihoods of the predominantly agrarian communities. The compounded effects of higher temperatures and altered precipitation patterns will have far-reaching implications for the Wenchi Municipal Assembly.

8.2 Potential Adaptation Options and Recommendations

The Ghanaian Government has been proactive in integrating climate change objectives into sector-specific development plans to mainstream climate change strategies. Key areas of focus include agriculture, transportation, and energy, with coordinated strategic climate adaptation activities in line with the country's socio-economic development objectives. The 2012 Ghana National Climate Change Adaptation Strategy (NCCAS) included sector-specific adaptation strategies for agriculture, water resources, energy, and transportation. Ghana's National Climate Change Policy (NCCP) 2013 had three main objectives: effective adaptation, social development, and mitigation. It outlines strategies for addressing adaptation issues in key sectors such as agriculture, water resources, and infrastructure. Further, the 2021 Ghana Roadmap for Resilient Infrastructure in a Changing Climate report, developed through a partnership between the government and international organizations, provided an assessment of climate risks to national infrastructure systems, and a roadmap for targeted adaptation options in the built and natural environments was proposed.

Therefore, to address the identified priority risks and vulnerabilities due to climate change in the Wenchi Municipal Assembly, a multi-faceted approach that includes both immediate and long-term adaptation strategies is necessary. These adaptation options aim to reduce the residual risks by enhancing resilience across various sectors.

The appendix prioritizes the climate risk description proposed by the key stakeholders as posing the most significant climate-related risks to Wenchi's communities and their proposed adaptation measures.

ADAPTATION ACTION PLAN FOR THE WENCHI MUNICIPAL ASSEMBLY



9

Adaptation Action Plan for the Wenchi Municipal Assembly

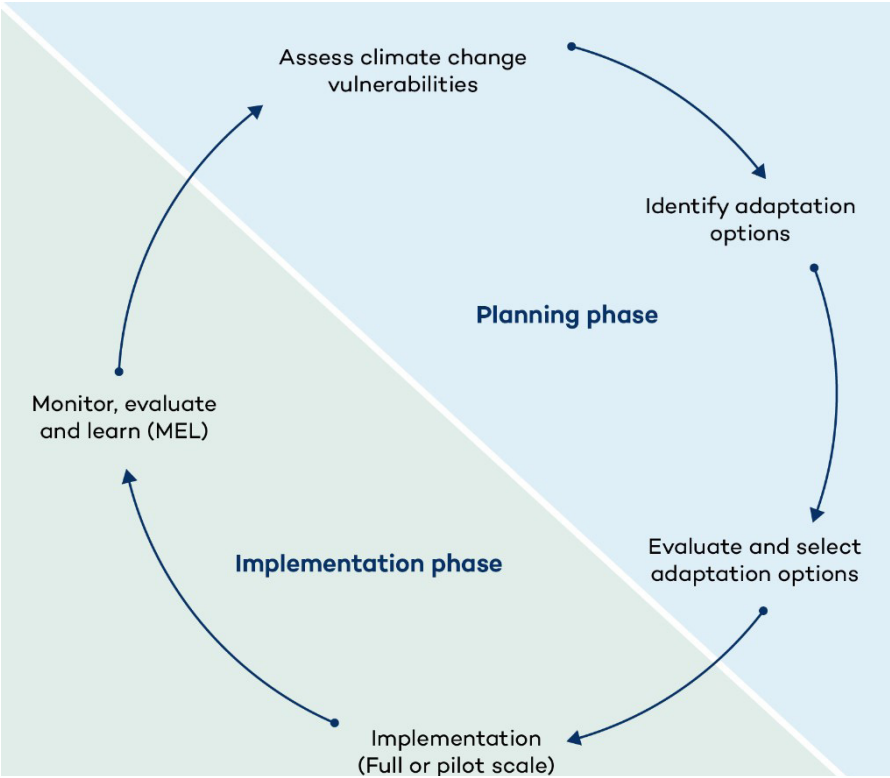
9.1 Introduction

The WMA is committed to enhancing the resilience and sustainability of the city in the face of climate change. Adaptation Action Planning is a strategic approach designed to address the specific vulnerabilities and risks

posed by climate change to the Wenchi Municipality. This plan aims to integrate climate adaptation into the city's development agenda, ensuring that infrastructure, services, and communities are better prepared for the impacts of climate variability and change. The Adaptation Action Plan for Wenchi focuses on several key areas:

- **Risk Assessment and Vulnerability Analysis:** Identifying the most significant climate risks and vulnerable sectors within the metropolis.
- **Stakeholder Engagement:** Involving local communities, government agencies, and other stakeholders in the planning process to ensure inclusive and effective adaptation strategies.
- **Implementation of Adaptation Measures:** Developing and executing specific actions to mitigate identified risks, such as improving drainage systems, enhancing green spaces, and promoting sustainable land use practices.
- **Monitoring and Evaluation:** Establishing mechanisms to track the progress and effectiveness of adaptation measures, allowing for adjustments and improvements over time.

Figure 22: Approach to WMA adaptation planning



9.2 Identification and Compilation of Sector-Specific Adaptation Actions

The comprehensive climate change adaptation plan for WMA outlined and gathered specific adaptation strategies tailored to the municipality. This process enabled the examination of various potential adaptation strategies and the identification of appropriate actions. The planning team used the techniques described in Table 12 to determine these adaptation options.

Methodology to identify adaptation options

Vulnerability assessment report recommendations	The climate change vulnerability assessment for the WMA made recommendations regarding adaptation measures that could be explored to build resilience, increase adaptive capacity, and reduce vulnerability. These recommendations were well considered in the planning process.
Literature review	An extensive review of best solutions and practices was undertaken, using desk review of government documents, scientific publications, grey literature, Metropolitan reports, etc. to identify adaptation actions that ameliorate similar impacts and vulnerabilities.

Stakeholder consultation	Identified stakeholders were engaged and consulted through participatory workshops that allowed for open and equal discussions of adaptation options based on climate scenarios and identified prevailing and future impacts and vulnerabilities. In Wenchi, sector-specific stakeholders were consulted. The stakeholders were organized into six groups that addressed six sectors: 1. Agriculture 2. Gender (cross-cutting sector) 3. Cities and Infrastructure 4. Water and sanitation 5. Health 6. Biodiversity
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Source: Author diagram based on the WMA Adaptation Plan.

In total, 45 adaptation options were identified across the six sectors. Table 13 shows the distribution of these actions, with water and sanitation having the highest number of actions (10), followed by Gender (8).

Table 10: Distribution of adaptation actions by sector

Sector	Number of Adaptation actions	Rank
Water and Sanitation	10	1
Gender	8	2
Agriculture	7	3
Biodiversity	7	3
Health	7	3
Cities and infrastructure	6	6

9.3 Methodological Approach for Ranking Adaptation Actions

After compiling a list of potential adaptation options in the climate change rapid risk assessment for Wenchi Municipal Assembly, the next step was to evaluate and prioritize them using clear information and criteria. This involved assessing how suitable the options were for the Wenchi Municipal context, their ability to enhance resilience and reduce vulnerabilities identified in the Wenchi vulnerability assessment report, and their overall impact on sustainable development. This prioritization process aimed to make informed decisions that lead to effective adaptation and avoid maladaptation. To achieve this, relevant actors and stakeholders were involved in the assessment process to ensure the chosen adaptation options were appropriate and free from potential negative outcomes. Each of the six key stakeholder groups (Agriculture, biodiversity, water and sanitation, health, cities and infrastructure, and gender) evaluated the proposed adaptation options using a Multicriteria Decision Making (MCDM) Analysis (see Appendix A). This approach was necessary because each adaptation measure might perform differently across various criteria and could involve trade-offs. Therefore, they needed to be carefully and critically evaluated, and the results of the analysis integrated into decision-making about priority options.

Multicriteria Decision Making (MCDM) Analysis is a systematic approach used to evaluate and prioritize multiple options based on various criteria. It involves identifying relevant criteria, assigning weights to each criterion based on their importance, and then scoring each option against these criteria. This method helps in making informed and balanced decisions, especially when dealing with complex issues involving multiple stakeholders and conflicting objectives (Dixit & McGray, 2013). The criteria for the evaluation of the climate change adaptation strategies are defined in Table 14.

Plate 4: Consultation with the sector stakeholders for the ranking and prioritization exercise



Table 11: Criteria for the assessment of the climate change adaptation options

S/N	Dimension	Indicators	Description
1	Technological	Effectiveness	Effectiveness or importance describes how well effective an adaptation option can mitigate climate damage. In essence, an effective option yields considerable benefits in terms of avoided consequences, albeit potentially at a high cost.
2	Economic	Affordability (cost efficiency)	This refers to the cost of implementing the adaptation option
3	Institutional	Institutional feasibility	Institutional feasibility refers to institutional and legal capacity. The preferred adaptation option aligns with laws, regulations, and institutional structures.
		Alignment with district and/or national priorities	The extent to which does this measure supports other development priorities of the district or the country?
4	Technological	Technical feasibility	Technical feasibility focuses on evaluating the technological expertise and the availability of necessary human, financial, and administrative resources for a specific option.

5	Social	Traditional acceptance of adaptation	Traditional acceptance refers to the degree of acceptability of an adaptation strategy aligning with the context of traditional values.
6	Social	Social co-benefits	This entails evaluating whether the proposed adaptation aligns with existing social practices and customs and whether it is likely to be embraced by the affected community or population.
7	Environmental	Flexibility	Flexibility refers to the ability to change behavior in response to changing conditions.
8	Environmental	Environmental considerations	This evaluates the potential of the intervention to improve GHG emissions, biodiversity, human health, soil quality, water quality, air quality, climate, and landscape.
9	Social	Gender responsiveness	This evaluates the extent to which the adaptation options address gender-related issues.
10	Social	Equity	The extent to which the adaptation option will benefit vulnerable groups and communities.
11	Technological	Replicability or scalability	This defines the ability or possibility of the intervention to be replicated elsewhere in the country or scaled up.
12	Technological/ Economic/ Institutional/ Environmental or social	Barriers to implementation	This identifies potential institutional, economic, technological, and social barriers to the implementation of the adaptation option.

Source: Dixit & McGray (2013)

After ranking the different indicators, it was essential to assign appropriate weights to them. An unequal weighting system, reflecting the relative importance of each indicator, was used (Zobeidi et al., 2024; Antwi-Agyei et al., 2013; UNFCCC, 2011). Therefore, a five-point Likert scale (Table 15) was utilized, where climate change experts, as well as agricultural and food experts, ranked the indicators based on their perceived importance, similar to the method used by Antwi-Agyei et al. (2013). The frequency with which each indicator was cited was used to develop the weighting system (Zobeidi et al., 2024; Antwi-Agyei et al., 2013; UNFCCC, 2011).

Table 12: Ranking of adaptation options based

1	Low
2	Neutral
3	Medium
4	High
(....)	Enclose a number in a bracket to show high uncertainty .

9.4 Adaptation options

The prioritized climate change adaptation options are described in this section, highlighting the adaptation objective, justification, and critical considerations for each adaptation option.

9.4.1 Agriculture

Out of the 7 adaptation options that were identified and evaluated through the MCDM Analysis, 5 were selected and prioritized (Table 16). Crop diversification, mulching, agroforestry, access to weather forecasts and early warnings, use of climate-smart agricultural practices, and strengthening the capacity of agricultural extension officers were identified as the key adaptation strategies for the agricultural sector in Wenchi. Crop diversification involves planting a variety of crops to reduce the risks posed by

climate-induced crop failures and pests, ensuring food security even when some crops do not perform well. Mulching is a practice used to retain soil moisture, improve soil quality, and reduce erosion, which is particularly important during periods of drought. Agroforestry integrates trees with crops and livestock to enhance biodiversity, reduce soil erosion, and improve water retention. Access to weather forecasts and early warnings helps farmers make informed decisions about planting and harvesting, thus minimizing losses due to unexpected weather events. Climate-smart agricultural practices focus on increasing productivity while reducing the environmental impact, such as using drought-resistant crops or efficient irrigation methods. Access to weather forecasts and early warning systems is seen as crucial for improving farmers' preparedness and decision-making, particularly about planting schedules and disaster risk reduction.

Table 13: Ranking of adaptation options for the agriculture sector

Adaptation option	Final score from stakeholders	Rank
Crop diversification	48	1
Mulching	48	1
Agroforestry	47	3
Access to weather forecasts and early warnings	47	3
Use of climate-smart agricultural practices	47	3

Table 14: Summary of the adaptation actions for the agricultural sector

Adaptation Actions	Objectives	Indicators of Success	Time Frame (Short, medium and long term)	Resources (Finance, Human, Technology)	Lead	Implementing Partners	Estimated Costs
Crop diversification	Enhance the resilience of agricultural systems to climate change and other environmental stresses.	Percentage of smallholder farmers adopting diversified cropping systems compared to previous farming practices.	Short-term	Human Financial Technology	MoFA	CSIR FAO NDPC MESTI NGOs	
		Measurement of crop yields and income levels from diversified crops					
		Decrease in crop losses due to droughts, floods, or pests, demonstrating improved resilience					
Mulching	Encourage the use of crop varieties that are resistant to pests and diseases to increase agricultural resilience, thereby enhancing food security and reducing reliance on chemical inputs.	Percentage of farmers who consistently apply mulching techniques on their farms	Short-term	Human Technical / Technology Finance	MoFA	EPA CSIR MESTI FAO NGOs	
		Measurable increase in soil moisture levels in mulched areas, particularly during dry spell					
		Decrease in soil erosion rates on farms using mulching					

Agroforestry	Encourage long-term investments in climate-resilient technologies and practices by providing affordable financial options that reduce the risks associated with unpredictable weather patterns and market fluctuations.	Percentage of farmers in the municipality who implement agroforestry techniques	Medium-term	Human Technology Finance	MoFA	EPA MLNR FC MESTI NGOs	
		Positive changes in soil quality, including increased organic matter and improved moisture retention					
		Increase in income from tree-based products such as fruits, timber, and medicinal plants, alongside traditional crops, demonstrating the economic benefits of agroforestry					
		Greater species diversity (both flora and fauna) in agroforestry system					
		Reduction in crop losses due to agroforestry's protective effects					
Access to weather forecasts and early warnings	Providing access to weather forecasts and early warnings in the Wenchi Municipality is to enhance the community's ability to anticipate and respond to climate-related hazards.	The number of farmers who report using weather forecasts and climate data to make critical decisions regarding crop management.	Short-term	Human Technology Finance Multi-media	MoFA	GMet NADMO NDPC FAO MLGDRD	
		Percentage of crop yields and overall productivity					
		Number of farmers understanding and aware of weather and climate patterns					
		Number of farmers accessing weather information through mobile phones or other digital platforms					

Use of climate-smart agricultural practices	Enhance the resilience of smallholder farmers to climate change. This involves several key goals including sustainably increasing agricultural productivity and incomes, building resilience to climate change, and reducing greenhouse gas emissions.	Percentage of farmers adopting at least one climate-smart agricultural practice	Medium-term	Human Technology Finance	MoFA	NGOs MESTI MLGDRD FAO EPA GIDA	
		Measurable increase in crop yields and productivity for farmers using climate-smart practices					
		Improvement in soil fertility					
Strengthening the capacity of agricultural extension officers	Strengthening the capacity of agricultural extension officers in the Wenchi municipality to enhance their ability to support farmers in adopting climate-smart agricultural practices	Percentage of agricultural extension officers who complete training programs on climate-smart agricultural practices	Medium-term	Human Technology Finance	MoFA	GIDA EPA CSIR MESTI GAES MLGDRD NGOs	
		Number of farmers in Wenchi Municipality who report receiving updated and relevant climate-smart agricultural advice from extension officers					
		Percentage of farmers who adopt climate-smart agricultural practice					
		Number of new collaborations between extension officers, local government, NGOs, and farmers' groups					

Promote the availability of machinery	Enhance the productivity and resilience of smallholder farmers in by promoting the availability and accessibility of modern agricultural machinery, enabling farmers to adopt efficient and climate-resilient farming practices, reduce labor costs, and improve overall agricultural productivity	Percentage of farmers in who have access to modern agricultural machinery		Human Technology Finance	MoFA	MESTI GMC GADB EPA CSIR MESTI FAO	
		Reduction in the time and labour required for various farming activities					
		Percentage of farmers using machinery for practices					
		Measurable increase in crop yields and overall farm productivity resulting from the use of machinery	Medium-term				
Use of improved seeds	Enhance agricultural productivity and resilience to climate change by promoting the use of improved seeds among smallholder farmers, thereby improving crop yields, strengthening food security, and ensuring the sustainability of farming systems under changing climatic conditions	Percentage of farmers in adopting improved seed varieties	Short-term	Human Technology Finance	MoFA	NGOs MESTI NASTAG GADB FAO GIDA	
		Measurable increase in crop yields for farmers using improved seeds					
		Increase in farm productivity and income					
		Reduction in crop losses for farmers using improved seeds					
		Number of farmers investing in improved seeds					
Establishment of agricultural mechanization service provision	Enhance the efficiency and productivity of smallholder farmers by establishing accessible agricultural mechanization service provision, enabling farmers to adopt modern farming technologies that improve crop yields, reduce labor costs, and increase resilience to climate change.	Percentage of farmers who have access to affordable mechanization	Long-term	Human Technology Finance	MoFA	NGOs GAMS NDPC EPA MoF FAO	
		Measurable reduction in time and labor due to the use of mechanization services					
		Percentage of farmers using mechanized services for climate-smart practices					

Adoption of drip irrigation	Improve water-use efficiency and agricultural productivity by promoting the adoption of drip irrigation systems, enabling farmers to conserve water, enhance crop yields, and adapt to climate variability and water scarcity	Percentage of farmers who have adopted drip irrigation systems Measurable reduction in water usage for irrigation			MoFA	GIDA EPA MESTI GWCL WRC MoF NGOs	
		Significant improvement in crop yields, particularly for water-intensive crops	Medium-term				
Rainwater harvesting	Enhance water availability and support sustainable agricultural practices by promoting the adoption of rainwater harvesting systems, ensuring that farmers can efficiently collect and utilize rainwater for irrigation during dry periods, thereby improving crop yields and resilience to climate variability.	Percentage of farmers adopting rainwater harvesting systems	Medium-term	Human Technology Finance	MoFA	EPA CSIR MESTI GIDA WRC FAO	
		Increased volume of rainwater collected and stored by farmers,					
		Reduction in the dependency on external water sources during dry periods					
		Increase in the quality and yield of crops					

9.4.2 Biodiversity

The adaptation options for the biodiversity sector in Wenchi Municipal Assembly aim to strengthen ecosystem resilience, enhance sustainable land and resource management, and support the protection of local biodiversity (Baffour-Asare, 2018). Climate-smart practices focus on integrating climate change considerations into farming and land management, ensuring long-term sustainability. Diversifying crops helps increase agricultural resilience to climate stressors, providing farmers with multiple income streams and food security. Tree planting initiatives contribute to carbon sequestration, soil fertility, and habitat restoration, further enhancing the region's ecological stability. Together, these objectives promote a holistic, community-driven approach to biodiversity conservation and climate change adaptation (Di Sacco et al., 2021).

Wenchi Municipal Assembly prioritized these adaptation options due to the region's vulnerability to climate change, environmental degradation, and the decline of biodiversity, which threaten both ecological and community resilience. By supporting community-based natural resource programs, the assembly aims to foster local ownership and ensure the long-term sustainability of conservation efforts (Obi and Maya, 2021). Ecosystem restoration and the establishment of ecological corridors were prioritized to reverse the effects of land degradation, improve habitat connectivity, and safeguard local wildlife. Tree planting was selected as a critical action to combat deforestation, enhance carbon capture, and restore degraded landscapes, contributing to the region's long-term ecological health and resilience (Di Sacco et al., 2021).

Table 15: Ranking of adaptation options for the biodiversity sector

Adaptation option	Final score from stakeholders	Rank
Climate-smart practices	51	1
Diversifying crops	50	2
Developing and supporting community-based natural resource programs	50	2
Restoration of degraded ecosystems	49	4
Establishment of ecological corridors and buffer zones	49	4
Tree planting	49	4

Table 16: Summary of the Adaptation Actions for the Biodiversity Sector

Adaptation Actions	Objectives	Indicators of Success	Time Frame (Short, medium, and long term)	Resources (Finance, Human, Technology)	Lead	Implementing partners	Estimated costs
Climate-smart practices	Enhance the resilience of ecosystems and biodiversity to climate variability through sustainable farming and conservation techniques.	Increase in the adoption rate of climate-smart techniques by farmers.	Short-term	Human Technology Finance	Ministry of Food and Agriculture (MoFA).	UNEP, IUCN, MESTI, World Bank, Local Agricultural Extension Services.	
		Improved soil fertility and reduced land degradation.					
		Enhanced biodiversity in farming landscapes.					
Diversifying crops	Reduce vulnerability of agricultural systems to climate risks and enhance food security while preserving biodiversity.	Increased compliance with conservation policies and regulations.	Short-term	Human, Technology, Finance.	MoFA	FAO, Global Environment Facility (GEF), Traditional Authorities, Ghanaian NGOs, USAID.	
		Reduction in poaching and illegal wildlife trade activities.					
		Improved habitat quality and stability of endangered species populations.					
Developing and supporting community-based programs	Empower local communities to manage biodiversity sustainably while adapting to climate change.	Increased community participation in biodiversity management programs.	Medium-term	Human, Finance, Education/Training.	Ministry of Environment, Science, Technology, and Innovation (MESTI).	IUCN, Traditional Authorities, Local Community Groups, UNDP, Ghana Wildlife Society.	
		Successful establishment of community-managed conservation areas.					
		Enhanced local capacity for sustainable resource use.					

Restoration of degraded ecosystem	Rehabilitate degraded habitats to support biodiversity conservation and ecosystem resilience	Increase in vegetation cover in previously degraded areas.	Long-term	Human, Technology, Finance.	Environmental Protection Agency (EPA).	UNEP, Forestry Commission, Ghanaian NGOs, World Bank, Global Environment Facility (GEF).	
		Return of native flora and fauna species.					
		Reduced soil erosion and improved water retention.					
Establishment of corridors and buffer ecological zones	Connect fragmented habitats to support species migration and gene flow.	Creation of functional ecological corridors.	Long-term	Finance, Human, Technology	Forestry Commission.	UNEP, MESTI, Local Landowners, Ghana Wildlife Society, IUCN.	
		Increase in wildlife movement between habitats.					
		Improved genetic diversity among target species.					
Tree planting	Enhance carbon sequestration and create habitats for biodiversity conservation.	Number of trees planted and surviving after five years.	Medium-term	Human, Technology, Finance	Forestry Commission.	UNEP, Global Environment Facility (GEF), Traditional Authorities, Ghanaian NGOs, Local Schools.	
		Increase in carbon sequestration levels in target areas.					
		Improvement in habitat conditions for native species.					
Implementation of camera trap monitoring programs	Monitor wildlife populations and detect changes in biodiversity to inform conservation strategies.	Increased detection of target species through camera trap data.	Medium-term	Human, Technology, Finance	Ghana Wildlife Society.	IUCN, UNEP, Local Conservation Groups, Universities, Forestry Commission.	
		Improved understanding of species distribution and behaviour.					
		Use of data in decision-making for conservation policies.					

9.4.3 Health

Table 20 presents the adaptation options for the health sector in Wenchi Municipal Assembly aiming to improve community health outcomes, strengthen healthcare infrastructure, and promote public awareness and education to address the impacts of climate change on public health. National health control initiatives focus on implementing policies and programs to address climate-related health risks, such as the spread of diseases due to changing weather patterns. Developing and implementing public awareness campaigns is a key strategy to inform the population about emerging health issues and climate change adaptation strategies. Upgrading health facilities aims to enhance the capacity of healthcare systems to cope with the increased demand and the health impacts of climate change. Creating urban green spaces promotes physical and mental well-being, improves air quality, and provides climate resilience by reducing heat stress in urban areas.

Wenchi Municipal Assembly prioritized these adaptation options to address the growing health risks associated with climate change, including the increased frequency of extreme weather events, heat waves, and the spread of vector-borne diseases. The health of local communities is directly impacted by environmental changes, and these strategies were chosen to mitigate these risks through proactive health measures and community education. National health control initiatives were prioritized to provide a framework for addressing climate-related health challenges at the national and local levels (Ma et al., 2022). Continued education and public awareness campaigns are crucial for empowering residents with the knowledge needed to protect themselves from climate-induced health threats, such as the spread of malaria or waterborne diseases.

Table 17: Ranking of adaptation options for the health sector

Adaptation option	Final score from stakeholders	Rank
National health control initiatives	47	1
Continued education of local communities	47	1
Development and implementation of public awareness campaigns	47	1
Upgrading health facilities	43	4
Creating urban green spaces	43	4

Table 18: Summary of the Adaptation Actions for the Health Sector

Adaptation Actions	Objectives	Indicators of Success	Time Frame (Short, medium, and long term)	Resources (Finance, Human, Technology)	Lead	Implementing partners	Estimated costs
National health control initiatives	Strengthen public health systems to mitigate biodiversity-related health risks, such as zoonotic diseases.	Reduction in biodiversity-related disease outbreaks (e.g., malaria, dengue).	Long-term	Human Technology Finance	Ministry of Health (MoH).	WHO, UNEP, Ghana Health Service, Local NGOs, World Bank.	
		Increased vaccination and preventive healthcare coverage.					
		Establishment of disease surveillance systems in biodiversity hotspots.					
Continued education of local communities	Continued education of local communities Enhance biodiversity conservation through community awareness and capacity-building initiatives.	Increased community participation in biodiversity conservation projects.	Short-term	Human, Technology Finance	Ministry of Environment, Science, Technology, and Innovation (MESTI).	UNEP, IUCN, Local Community Groups, Ghanaian NGOs, Traditional Authorities.	
		Improvement in local knowledge about biodiversity's importance.					
		Reduction in unsustainable resource use (e.g., illegal hunting, deforestation).					
Development and implementation of public awareness campaigns	Raise public awareness about the importance of biodiversity and the need for sustainable practices.	Increased public engagement with biodiversity campaigns.	Short-term	Human, Technology/ Media Finance	Ghana Wildlife Society.	UNEP, FAO, Local Media Outlets, Traditional Authorities, Local NGOs.	
		Improved public attitudes toward biodiversity conservation.					
		Growth in adoption of sustainable practices (e.g., waste segregation, tree planting).					

Creating urban green space	Promote biodiversity conservation in urban areas while enhancing ecosystem services.	Increase in the number and size of urban green spaces.	Medium-term	Technology, Finance, Human	Ministry of Local Government, Decentralization, and Rural Development (MLGDRD).	UNEP, World Bank, Ghanaian NGOs, IUCN, Traditional Authorities.	
		Growth in urban biodiversity (e.g., native plants, pollinators).					
		Improved air and water quality in urban areas.					
Upgrading health facilities	Enhance health infrastructure to address climate and biodiversity-related health challenges.	Increased capacity of health facilities to handle climate-related health issues.	Medium-term	Finance, Human, Technology	Ministry of Health (MoH).	WHO, Ghana Health Service, UNEP, Global Environment Facility (GEF), Local NGOs.	
		Improved access to healthcare services in rural and biodiversity-sensitive areas.					
		Reduced disease burden in vulnerable populations.					
Investing in telemedicine infrastructures	Provide accessible healthcare to remote communities near biodiversity hotspots.	Increase in telemedicine consultations and healthcare access.	Medium-term	Human, Technology, Finance	Ministry of Health (MoH).	WHO, ITU (International Telecommunication Union), UNEP, Ghana Health Service, Local NGOs.	
		Reduced travel time for remote communities to access healthcare.					
		Improved health outcomes in biodiversity-sensitive areas.					
Upgrading sewage systems and promoting proper waste management	Reduce pollution and protect aquatic and terrestrial biodiversity by improving waste management infrastructure.	Reduced discharge of untreated sewage into natural ecosystems.	Long-term	Human, Technology, Finance	Environmental Protection Agency (EPA).	UNEP, Ghana Water Company Limited, Local Municipal Authorities, World Bank, IUCN.	
		Increase in the percentage of properly managed waste.					
		Improved water quality in rivers and wetlands.					

9.4.4 Cities and Infrastructure

Out of the 6 adaptation options that were identified and evaluated through the MCDM Analysis, three were selected and prioritized (Table 22). The adaptation options for the cities and infrastructure sector in Wenchi Municipal Assembly focus on creating resilient, sustainable urban environments that can withstand the challenges posed by climate change. Revising building codes to incorporate climate change considerations ensures that new and existing buildings are better equipped to handle extreme weather events, such as heavy rainfall, heat waves, and storms (Croese et al., 2020). Integrating green infrastructure elements into urban planning promotes the use of natural solutions, such as green roofs, permeable pavements, and urban forests, to manage stormwater, improve air quality, and reduce the urban heat island effect.

Wenchi Municipal Assembly prioritized these adaptation options due to the increasing vulnerability of urban areas to climate change impacts, such as flooding, heat stress, and infrastructure degradation. The municipality recognized that adapting urban planning and building standards to climate change is essential for protecting residents and ensuring the long-term viability of infrastructure. Integrating green infrastructure was seen as a key strategy to enhance sustainability, mitigate flooding, and improve the quality of life by providing green spaces that benefit both the environment and the community.

Table 19: Ranking of adaptation options for the cities and infrastructure sector

Adaptation option	Final score from stakeholders	Rank
Revising building codes to incorporate climate change	49	1
Integrating green infrastructure elements into urban planning	48	2
Conducting climate risk assessment	47	3

Table 20: Summary of the Adaptation Actions for the Cities and Infrastructure Sector

Adaptation Actions	Objectives	Indicators of Success	Time Frame (Short, medium, and long term)	Resources (Finance, Human, Technology)	Lead	Implementing partners	Estimated costs
Revising building codes to incorporate climate change	Ensure climate-resilient infrastructure by updating building standards to withstand climate impacts such as extreme weather events.	Adoption and enforcement of updated building codes nationwide.	Medium-term	Human Technology Finance	Ministry of Works and Housing (MoWH).	UNEP, MESTI, Local Municipal Authorities, Ghanaian NGOs, Global Environment Facility (GEF).	
		Increased construction of buildings meeting climate-resilient standards.					
		Reduction in damage to infrastructure during extreme weather events.					
Integration of infrastructure elements into urban planning	Incorporate green and sustainable infrastructure into urban development plans to enhance climate resilience.	Increased incorporation of green infrastructure in urban master plans.	Medium-term	Human Technology Finance	Ministry of Local Government, Decentralization, and Rural Development (MLGDRD).	UNEP, Traditional Authorities, Local Urban Planners, Ghanaian NGOs, IUCN.	
		Development of multifunctional infrastructure (e.g., parks that double as flood zones).					
		Enhanced urban biodiversity through sustainable design.					
Conducting climate risk assessment	Identify vulnerabilities in urban systems and prioritize actions to mitigate risks to cities and infrastructure.	Completion of climate risk assessments for major urban areas.	Short-term	Human Technology Finance	Environmental Protection Agency (EPA).	World Bank, UNEP, Ghana Meteorological Agency, Local Research Institutions, MESTI.	
		Development of targeted risk mitigation strategies.					
		Increased allocation of resources for high-risk areas.					
Incorporating climate considerations into urban planning	Embed climate adaptation and mitigation measures into all urban development projects to ensure sustainable growth.	Increase in climate-sensitive policies in urban planning.	Medium-term	Technology, Finance, Human	Ministry of Lands and Natural Resources (MLNR).	UNEP, FAO, Traditional Authorities, Local Planning Authorities, Global Environment Facility (GEF).	
		Development of low-carbon and climate-adaptive urban projects.					
		Reduced greenhouse gas emissions in urban areas.					

Upgrading and maintaining the drainage system	Improve urban drainage to prevent flooding and reduce water damage to infrastructure and ecosystems.	Reduction in the frequency and severity of urban flooding.	Long-term	Finance, Human, Technology	Ministry of Works and Housing (MoWH)	UNEP, Local Municipal Authorities, Ghana Water Company Limited, World Bank, Ghanaian NGOs.	
		Increased maintenance schedules and improved drainage capacity.					
		Enhanced water quality in urban runoff systems.					
Collaborating with landscape architects and environmental NGOs	Design and implement climate-adaptive landscapes that enhance urban biodiversity and ecosystem services.	Increase in urban green spaces designed by landscape architects.	Short-term	Human, Technology, Finance	Ministry of Local Government, Decentralization, and Rural Development (MLGDRD).	UNEP, IUCN, Ghana Wildlife Society, Local Landscape Architects, Traditional Authorities.	
		Successful implementation of biodiversity-focused urban landscaping projects.					
		Improved public access to climate-resilient green spaces.					

9.4.5 Gender

Integrating gender considerations into all climate change adaptations, developing disaster management plans that are gender-responsive, and integrating climate change education in school curriculums are important adaptation strategies in the gender sector (Table 24). Others include disseminating weather forecasts and information and providing training programs and resources focused on women. Integrating gender considerations ensures that climate adaptation actions address the specific needs and vulnerabilities of both men and women, promoting equitable participation in climate solutions. Gender-responsive disaster management plans are designed to address the unique challenges women face during and after climate disasters, such as access to healthcare and economic recovery. Integrating climate change education in schools equips the younger generation with the knowledge and skills needed to address climate challenges. Disseminating weather forecasts and information empowers both men and women with the knowledge to make informed decisions, especially in agriculture and disaster preparedness.

These strategies were prioritized by stakeholders in the Wenchi Municipal Assembly to ensure that climate change adaptation efforts are inclusive and tailored to the needs of both men and women. Integrating gender considerations into all climate actions was seen as essential to addressing the unequal impacts of climate change on women, particularly in rural areas where they are often the primary caregivers and farmers. Gender-responsive disaster management plans were emphasized because women often face unique vulnerabilities in disaster scenarios, such as caregiving responsibilities and limited access to resources. By prioritizing education and training programs for women, stakeholders aimed to build their capacity to adapt to climate impacts and increase their participation in decision-making processes. Disseminating weather forecasts and integrating climate education were viewed as essential tools to empower communities, ensuring that both genders have equal access to vital climate information.

Table 21: Ranking of adaptation options for the gender sector

Adaptation option	Final score from stakeholders	Rank
Integrating gender considerations into all climate change adaptations	48	1
Developing disaster management plans that are gender-responsive	48	1
Integrating climate change education in school curriculums	47	3
Disseminating weather forecasts and information	47	3
Training programs and resources focused on women	47	3

Table 22: Summary of the Adaptation Actions for the Gender Sector

Adaptation Actions	Objectives	Indication of success	Time Frame (Short, medium and long term)	Resources (Finance, Human, Technology)	Lead	Implementing Partners	Estimated Costs
Integrating gender considerations into all climate change adaptations	Integrating gender considerations in all climate change adaptations in the Wenchi Municipality, Ghana ensures that both men and women are equally involved and benefit from climate adaptation efforts.	Percentage of women with secure land tenure or access to water for agriculture.	Medium-term	Human Technology Finance	MOGCSP	MoFA MLGDRD NDPC FAO EPA Academia NGOs Media outlets	
		Percentage of women participating in climate-related decision-making bodies.					
		Number of women trained in climate-resilient practices.					
Developing disaster management plans that are gender-responsive	Ensure that disaster risk reduction and climate change adaptation efforts are inclusive and equitable	Proportion of women in disaster management and planning bodies.	Medium-term	Human Technology Finance	MOGCSP	MoF MLGDRD Academia NGOs MoFA NADMO NDPC	
		The proportion of men and women receiving early warnings through accessible and inclusive communication channels					
		Proportion of men and women receiving equitable support during disaster recovery.					
		Percentage of disaster management personnel trained in gender-responsive approaches.					

Integrating climate change education in school curriculums	Integrating climate change education into school curriculums in the gender sector of the Wenchi Municipality is to foster a comprehensive understanding of climate change among students while promoting gender equality and empowering all genders to participate in climate action	Number of girls pursuing STEM-related subjects linked to climate science after exposure to climate education.	Long-term	Human Technology Finance	MoE	MOGCSP MLGDRD NCCE GES NDPC Academia NGOs	
		The number of climate change education materials highlighting the unique impacts on and roles of women and men.					
		Balanced enrollment and participation rates of boys and girls in climate change-related courses or extracurricular activities.					
Disseminating weather forecasts and information	Disseminating weather forecasts and information in the gender sector of the Wenchi Municipality is to enhance the municipality's resilience and ensure that all genders have equitable access to critical information for making informed decisions.	Percentage of women and men receiving timely and accurate weather forecasts through accessible channels	Short-term	Human Technology Finance Multimedia	MoCD	MOGCSP GMet MoFA EPA Academia NGOs	
		The proportion of women actively involved in community-based weather information dissemination groups or networks.					
		Increase in the number of women and men using weather forecasts to inform agricultural practices, fishing activities, or disaster preparedness					

Training programs and resources focused on women	Implementing training programs and resources focused on women in the gender sector of the Wenchi Municipality is to empower women and enhance their capacity to adapt to climate change	Percentage of women attending and completing training programs relative to the target population	Medium-term	Human Technology Finance	MOGCSP	MoFA MLGDRD EPA NGOs NCCE MESTI	
		Training materials tailored to address women's unique roles, needs, and challenges in climate adaptation and mitigation					
		Increase in the number of women taking up leadership or decision-making roles in climate initiatives after participating in training programs					
Integrating gender considerations into urban planning	Create inclusive urban environments that address the unique needs, priorities, and vulnerabilities of all genders, promoting equitable access to resources, infrastructure, and opportunities in the face of climate challenges	The proportion of women involved in urban planning committees, advisory boards, or community consultation	Long-term	Human Technology Finance	MOGCSP	MLGDRD MWH UDM MESTI MoRH Academia NGOs	
		Percentage of women and men with equitable access to essential services like water, sanitation, public transportation, and healthcare facilities.					
		Increase in the availability of affordable housing and land tenure programs accessible to women, especially female-headed households.					
		Urban planning policies explicitly addressing gendered needs, such as safety, mobility, and access to services					

Supporting women entrepreneurs	Empower women entrepreneurs by providing equitable access to resources, skills, and opportunities, fostering gender parity in economic participation and resilience to climate impacts	Number of women entrepreneurs benefiting from loans, grants, or microfinance programs tailored to their needs, including climate-resilient ventures	Medium-term	Human Technology Finance		MLGDRD MoTI NBSSI MASLOC MoF NEIP Academia NGOs	
		Percentage of women entrepreneurs attending and completing capacity-building workshops					
		Proportion of women-led enterprises adopting sustainable, climate-resilient technologies or practices.					
Women's land rights and reforms	Women's land rights and reforms Ensure equitable access, ownership, and control of land for women through legal reforms, community awareness, and practical interventions, fostering gender equality and enhancing resilience to climate change	Proportion of national or local land laws explicitly recognizing and protecting women's rights to own, inherit, and use land	Long-term	Human Technology Finance	MESTI	MOGCSP MLGDRD EPA NDPC Academia NGOs Local government	
		Increase in the percentage of land titles or deeds registered in women's names, including joint ownership with spouses					
		Increase in the availability and utilization of affordable legal aid or advisory services for women to claim or defend their land rights.					

9.4.6 Water and sanitation

Out of the 10 adaptation options that were identified and evaluated through the MCDM Analysis, three were selected and prioritized (Table 26). Investing in repairing and upgrading existing water infrastructure, implementing public awareness campaigns, and proper management of waste are key adaptation strategies for the water sector in Wenchi. Repairing and upgrading water infrastructure involves modernizing old and inefficient systems, such as pipelines and water treatment plants, to improve water distribution and quality. Implementing public awareness campaigns focuses on educating the community about water conservation practices and the importance of responsible water use. Proper waste management aims to improve waste collection, treatment, and disposal to prevent water contamination, ensuring safe and clean water sources for the population.

These strategies were prioritized by stakeholders in the Wenchi Municipal Assembly due to the increasing challenges posed by climate change. Climate variability, such as changing rainfall patterns and more frequent droughts and floods, has strained existing water systems. By upgrading infrastructure, the community can better withstand these shocks and ensure a stable water supply. Public awareness was emphasized as a critical tool to encourage responsible water use and conserve resources, especially as water scarcity becomes more pressing. Additionally, waste management was prioritized to prevent contamination of water sources, which is particularly important in a region where extreme weather events can exacerbate pollution.

Table 23: Ranking of adaptation options for the water and sanitation sector

Adaptation option	Final score from stakeholders	Rank
Investing in repairing and upgrading existing water infrastructure	47	1
Implementing public awareness	47	1
Proper management of waste	45	3

Table 24: Summary of the Adaptation Actions for the Water and Sanitation Sector

Adaptation Actions	Objectives	Indication of success	Time Frame (Short, medium, and long term)	Resources (Finance, Human, Technology)	Lead	Implementing Partners	Estimated Costs
Investing in repairing and upgrading in existing water infrastructure	Enhance water accessibility, quality, and reliability by repairing and upgrading existing water infrastructure, promoting equitable access and resilience to climate variability	Reduction in water supply interruptions and increased consistency in water availability for communities, especially during peak demand periods.	Long-term	Human Technology Finance	MSWR	MESTI WRC EPA CWSA MoF NGOs	
		Decrease in water leakage and wastage within the distribution network					
		Increased community satisfaction with water services					

Strengthening public awareness of water and sanitation	Enhance community knowledge and practices regarding water and sanitation, fostering healthier lifestyles, environmental sustainability, and equitable access to clean water and hygienic conditions	Percentage of the population demonstrating improved understanding of water conservation, sanitation practices, and hygiene	Short-term	Human Technology Finance Multimedia	MSWR	MESTI WRC EPA NGOs Academia NCCE MoE MoH	
		Increase in the number of individuals and communities participating in water and sanitation programs					
		Increased frequency and coverage of public awareness campaigns on water and sanitation issues					
Proper management of water and waste	Ensure the sustainable management of water and waste, improving public health, environmental quality, and resource efficiency	Percentage of households with reliable access to safe and clean water for domestic and agricultural use.	Short-term	Human Technology Finance	MSWR	EPA GWCL MLGDRD MESTI MoH MMDAs NGOs Academia	
		Decrease in illegal dumping and waste accumulation in public spaces and water bodies.					
		Percentage of community members participating in water conservation and waste management initiatives.					

Improved vegetation	Enhance vegetation cover, reducing soil erosion, and promoting ecosystem services to strengthen resilience	Percentage of local communities actively involved in afforestation, reforestation, or sustainable land management initiatives.			MSWR	MLGDRD MESTI EPA MoF WRC GWCL NGOs NDPC FC	
		Measurable expansion of forested and green areas based on satellite imagery or ground surveys.	Long-term				
		Decrease in erosion rates and soil loss in areas with vegetation improvement projects					

Desilting of gutters	Implement desilting of gutters enhancing drainage systems, reducing flooding, and minimizing waterborne diseases	Reduction in water stagnation and flooding incidents in areas where gutters have been desilted.	Short-term	Human Technology Finance	MSWR	MESTI GWCL WRC EPA NDPC Academia NGOs	
		Decrease in cases of diseases such as malaria and cholera due to improved drainage and hygiene.					
		Percentage of households and community groups participating in periodic gutter-cleaning and maintenance initiatives.					
		Reduction in the amount of solid waste found in drainage systems					
Rainwater harvesting systems	Promote the adoption of rainwater harvesting systems, improving water availability, reducing dependence on unreliable sources, and enhancing resilience to climate variability	Number of households, schools, and community centers installing rainwater harvesting systems.	Short-term	Human Technology Finance	MSWR	MESTI EPA WRC GWCL Academia NGOs	
		Decrease in reliance on external water sources,					
		Percentage of the population actively participating in rainwater harvesting initiatives					

Establishment of riparian buffer zones	Establish riparian buffer zones to protect water quality, prevent soil erosion, enhance biodiversity, and improve climate resilience	Reduction in sedimentation and contaminants in water sources due to the filtering and buffering effects of riparian vegetation	Long-term	Human Technology Finance	MSWR	MESTI MoF WRC EPA FC Academia NGOs	
		Decrease in soil erosion rates in riparian areas as a result of vegetation and land stabilization within the buffer zones.					
		Expansion of protected riparian buffer zones along water bodies, assessed through satellite imagery or ground surveys.					
Recycling of plastic wastes	Promote the recycling of plastic waste, reducing plastic pollution, conserving resources, and enhancing environmental sustainability while improving waste management practices	Percentage increase in the amount of plastic waste recycled compared to the total waste generated in the municipality	Medium-term	Human Technology Finance	MSWR	MESTI MoF WRC EPA GSA Academia NGOs	
		Decrease in plastic waste in public spaces, landfills, and waterways due to increased recycling efforts.					
		Percentage of the population actively participating in plastic waste recycling programs or segregating waste at the household level					

Installation of green roofs and walls on buildings	Promote the installation of green roofs and walls on buildings enhancing urban sustainability, improving air quality, reducing the urban heat island effect	Increase in the number of buildings (residential, commercial, public) with installed green roofs or walls in the municipality.	Medium-term	Human Technology Finance	WRC	MESTI MoF MLGDRD EPA Energy commission Academia NGOs	
		Observable improvement in air quality, with reduced levels of particulate matter and other pollutants					
		Decrease in urban temperature variations, particularly during the hottest months					
Upgrading and maintaining water harvest techniques	Upgrade and maintain water harvesting enhancing water availability, improving water use efficiency, and building resilience against climate variability in both urban and rural communities	Percentage of households, schools, and community centers in the municipality using upgraded rainwater harvesting systems or other water collection methods	Long-term	Human Technology Finance	WRC	MLGDRD NDPC EPA MoFA Academia NGOs	
		Increase in the volume of water stored for domestic and agricultural use					
		Number of local residents, especially women and farmers, trained in the maintenance and operation of water harvesting systems					



10



Framework for Adaptation Monitoring, Evaluation, and Learning

Monitoring, evaluation, and learning (MEL) are very important for effective adaptation actions in the Wenchi Municipality for several reasons:

- **Tracking Progress:** MEL provides a systematic way to track the implementation of adaptation plans, ensuring that activities align with the set objectives.
- **Assessing Effectiveness:** It helps determine whether the adaptation actions are achieving their desired outcomes and contributing to resilience building.
- **Identifying Challenges:** MEL uncovers barriers and bottlenecks in implementation, enabling timely corrective measures to address unforeseen challenges.
- **Enhancing Accountability:** Through transparent monitoring and reporting, MEL ensures that stakeholders, including funders and communities, can hold implementers accountable for their commitments.
- **Facilitating Informed Decision-Making:** Data collected through MEL provides evidence-based insights that inform future planning and resource allocation for adaptation efforts.
- **Encouraging Stakeholder Engagement:** The MEL process often involves diverse stakeholders, fostering collaboration and ensuring that all voices, including vulnerable groups, are considered.
- **Learning and Capacity Building:** Lessons learned from MEL processes enhance institutional and community capacity, equipping stakeholders with better tools and strategies for future adaptation.
- **Promoting Flexibility and Adaptive Management:** MEL allows for adjustments to be made in response to changing circumstances, ensuring that adaptation measures remain relevant and effective over time.
- **Demonstrating Impact:** It provides tangible evidence of how adaptation actions are reducing climate risks and improving resilience in the Wenchi Municipality.
- **Attracting Funding and Support:** Well-documented MEL results showcase the success and potential of adaptation actions, making it easier to secure funding and continued support from donors and partners.

10.1 Building on Existing Structures to Facilitate Mainstreaming

Building on existing structures is pivotal to mainstreaming Monitoring, Evaluation, and Learning (MEL) in the Wenchi Municipal Assembly. Leveraging established institutional frameworks, such as local government administrative systems, sectoral committees, and community-based organizations, provides a foundation for

integrating MEL processes seamlessly into existing workflows. For instance, using the Municipal Planning and Coordination Unit (MPCU) as a central hub for MEL activities ensures alignment with broader development objectives and facilitates cross-sectoral collaboration. Additionally, enhancing the capacity of these structures through targeted training, digital tools, and resource allocation ensures that MEL becomes an intrinsic part of planning and decision-making processes. This approach minimizes duplication of efforts, fosters stakeholder buy-in, and strengthens ownership at the local level. Therefore, by aligning MEL with ongoing projects and existing reporting mechanisms, the Assembly can ensure sustainable implementation while maintaining consistency with national frameworks, such as Ghana's National Adaptation Plan (NAP). Ultimately, building on these structures ensures that MEL is not seen as an external or standalone activity but as an integral element of development and climate adaptation planning in Wenchi.

10.2 MEL Design

MEL in the WMA is designed to achieve several key climate change adaptation objectives:

1. **Enhancing Climate Resilience:** MEL aims to monitor the effectiveness of adaptation strategies in reducing vulnerabilities across sectors such as agriculture, water, and infrastructure. By tracking progress, the Assembly ensures targeted actions improve resilience to climate shocks.
2. **Informed Decision-Making:** MEL provides data-driven insights that support evidence-based decisions, ensuring that adaptation plans address real and emerging climate risks effectively.
3. **Resource Optimization:** By identifying successful adaptation measures, MEL helps allocate financial and human resources to strategies that yield the most significant benefits, avoiding wasteful investments.
4. **Stakeholder Engagement:** MEL encourages collaboration between local communities, governmental agencies, and other stakeholders. Assessing engagement levels ensures inclusive and participatory adaptation processes.
5. **Promoting Sustainability:** Regular monitoring ensures that adaptation initiatives are implemented sustainably, maintaining their relevance and benefits over time while preventing maladaptation.
6. **Building Adaptive Capacity:** Through evaluation and learning, MEL identifies capacity gaps and provides feedback for training and resource provision, equipping stakeholders to manage future climate challenges.
7. **Reporting and Accountability:** MEL ensures transparent reporting on adaptation outcomes to stakeholders, including the government and donors, strengthening accountability and trust in the adaptation process.

So, achieving these objectives, MEL becomes a cornerstone for successful climate change adaptation in the Wenchi Municipal Assembly.

Table 25: Outline of approach to MEL of Wenchí's adaptation actions

Steps	Indicative activities—to be led by the WMA Planning Coordination Unit
1. Monitoring the adaptation actions	• Identify adaptation activities that will be monitored through qualitative and quantitative performance measures to determine progress made toward the adaptation objective(s). • Define metrics and indicators for documenting progress for the adaptation activities identified for monitoring. • Collect information on the metrics and indicators throughout the adaptation process.
2. Reviewing the adaptation process to assess progress, effectiveness, and gaps – Evaluation	• Determine the means for measuring and communicating levels of effectiveness and assessing gaps. • Gather and combine insights from recent studies and new scientific developments, along with feedback and results from current adaptation efforts. This process is essential for evaluating and modernizing the approach or strategy in question. • Revise the adaptation activities using evaluation information and metrics.
3. Iteratively updating the NAP – Learning	• Update the adaptation activities based on the information collected. • Document key lessons of what worked and what did not. • Establish a basis of success and/or failure. • Implement remedial measures. • Align learning and correctional measures with broader targets within the WMA MTDP.
Steps	Indicative activities—to be led by the WMA Municipal Planning Coordination Unit
4. Communication Report progress, process effectiveness, outreach, and knowledge and information dissemination	• Disseminate adaptation documents and learning products. • Provide information in the WMA annual progress report on the progress and effectiveness of the adaptation process.

Source: Adapted (and modified) from the Government of Liberia's four-step approach to the MEL of its NAP. See Environmental Protection Agency, Republic of Liberia, 2022.



11



Conclusion and Recommendations

11.1 Future Climate Change Scenarios for Wenchi Municipal

The climate projections for the Wenchi Municipal Assembly in Ghana suggest significant environmental challenges due to climate change. Temperature increases are expected to range between 1.5 to 4°C by the end of the century, depending on the emission scenarios considered. This aligns with general projections for Ghana, where temperature rises of 1.6 to 5.4°C are anticipated by 2100 under different scenarios. Precipitation patterns in Wenchi are expected to become more variable, with potential changes of around 10% relative to historical averages. Some scenarios predict increased frequency and intensity of rainfall events, which can heighten the risks of flooding, affecting both urban and rural areas within the municipality. These changes will pose significant challenges to the municipal's infrastructure, agriculture, and overall livelihoods, necessitating proactive measures to mitigate and adapt to these impacts.

11.2 Priority Climate-Related Hazards and Risks

The climate risk assessment for Wenchi Municipal has identified several critical risk domains that are particularly sensitive to the impacts of climate change:

- **Water Resources:** Threats to water availability due to erratic rainfall and increased evaporation.
- **Agricultural Systems:** Vulnerability of crop production to changing temperature and precipitation patterns.
- **Forest and Biodiversity:** Risks to forest cover from increased temperatures and changing rainfall regimes.
- **Health:** Challenges related to waterborne and vector-borne diseases exacerbated by climate change.
- **Cities and Infrastructure:** Increased susceptibility to damage from flooding and land degradation.

Key climate hazards for Wenchi include extreme heat, altered rainfall patterns, and flooding. These conditions threaten the municipal's agricultural base, water resources, forest biodiversity, and the overall health of the community.

Engagement with stakeholders in Wenchi has been crucial for understanding the impacts of climate hazards. This interaction has helped in identifying the levels of current and future risks based on the district's hazard exposure and adaptive capacity. Some of the most pressing risks identified include:

- Agricultural production is under threat from unpredictable weather patterns and temperature variations, potentially reducing crop yields and affecting food security.
- Water resources are at risk from reduced rainfall and increased evaporation, leading to water scarcity and affecting both drinking water supplies and agricultural irrigation.

- Municipal health could deteriorate due to an increase in waterborne diseases from flooding and inadequate water quality, and from vector-borne diseases due to warmer climates.

11.3 Adaptation Strategies and Residual Risks

Proposed adaptation strategies for Wenchi Municipal are focused on reducing the identified risks and enhancing resilience across key sectors. These strategies include:

- Improving water management systems to enhance storage and conservation of water resources, ensuring availability during dry spells.
- Promoting sustainable agricultural practices such as introducing drought-resistant crops and improving soil health to mitigate the effects of climate variability.
- Strengthening healthcare systems to better manage and prevent outbreaks of climate-related diseases.
- Enhancing infrastructure resilience to withstand severe weather events, particularly focusing on road and bridge construction to manage flood risks effectively.
- Involve women and other vulnerable groups in the design and implementation of adaptation strategies to increase their resilience.

Despite the planned adaptation measures, residual risks remain, particularly in areas with limited current adaptation capacity. The strategy emphasizes the need for integrated planning and implementation of adaptation measures within local development agendas to ensure sustainable management and conservation of resources in Wenchi Municipal.

11.4 Adaptation Action Plan for the WMA

The Adaptation Action Plan for the Wenchi Municipal Assembly outlines a strategic and inclusive approach to addressing climate change impacts across various sectors. By engaging stakeholders from agriculture, gender, biodiversity, water and sanitation, health, and cities and infrastructure, the plan ensures that adaptation actions are well-rounded and effective. Emphasizing crop diversification, mulching, agroforestry, and climate-smart agricultural practices will enhance resilience and productivity. Access to weather forecasts and early warnings will help farmers make informed decisions. Integrating gender considerations into all climate change adaptations, developing gender-responsive disaster management plans, and incorporating climate change education in school curriculums will promote gender equity and empower women. Revising building codes to incorporate climate change, integrating green infrastructure into urban planning, and conducting climate risk assessments will ensure sustainable urban development. Investing in the repair and upgrade of existing water infrastructure, implementing public awareness campaigns, and promoting proper waste management will protect water resources and improve sanitation. National health control initiatives continued education of local communities, public awareness campaigns, upgrading health facilities, and creating urban green spaces will enhance public health resilience. Implementing climate-smart practices, diversifying crops, supporting community-based natural resources programs, restoring degraded ecosystems, establishing ecological corridors and buffer zones, and tree planting will protect and enhance biodiversity. The framework for adaptation monitoring, evaluation, and learning will ensure that the plan remains adaptive and responsive to new challenges, fostering a resilient and sustainable future for Wenchi. This holistic approach addresses immediate climate impacts while building long-term resilience across all sectors.

Based on the findings and the conclusion, the following recommendations are suggested:

- Policies should focus on increasing community involvement in planning and implementation processes. This ensures that local knowledge and needs are integrated into adaptation strategies.
- There should be a push for developing resilient infrastructure to withstand climate impacts. This includes improving roads, water supply systems, and health facilities.
- Policies should emphasize support for sustainable agricultural practices. This includes promoting crop diversification and efficient water management techniques to ensure food security.
- Policies should aim to build the capacity of local institutions and stakeholders through training and education programs. This ensures the effective implementation and sustainability of adaptation measures.
- These recommendations are designed to create a more resilient and sustainable community in the face of climate change for the Wenchi Municipality.

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Appendix

Appendix A: Wenchi Municipal Assembly: Risk Description and Proposed Adaptation Measures

Sectors	Risks	Adaptation measures	Assessment of the impact of proposed actions	Supporting policies/laws or measure
Agriculture	Wenchi's agriculture is heavily reliant on rain. There are observed changes in rainfall patterns, with increased instances of both droughts and floods ¹ . Droughts have severely stressed crops, reducing yields and leading to crop failure. Floods have also washed away crops and damaged fields, impacting food security and livelihoods. Warmer temperatures also favor the spread of pests and diseases, further threatening crops. This has led to increased reliance on pesticides, which can have negative environmental consequences.	Nature-Based Solutions (NBS) Crop diversification can spread risk, with farmers planting a mix of crops with varying water needs and heat tolerance. Agroforestry can increase crop yields, reduce soil erosion, and improve water management.	Agriculture is the mainstay of the Wenchi Municipal Assembly (WMA). The main aim of the proposed adaptation measures for Wenchi's agricultural sector is to increase resilience, enhance food security, and promote sustainable agriculture. By conserving water and using it more efficiently, farmers can ensure their crops have enough water even during droughts. This reduces crop failure and maintains yields. Planting heat-resistant crops and varieties adapted to shorter rainy seasons helps crops survive and produce under changing climatic conditions. Crop diversification spreads risk, ensuring some crops will perform well even if conditions become less favorable for others. Timely information allows farmers to take proactive measures like adjusting irrigation schedules or applying pest control before problems become severe. This minimizes damage and protects yields. The dissemination of such information should particularly target vulnerable groups to help them reduce their vulnerabilities. Diversifying livelihoods into other economic activities which are not prone to climate change risks can spread the economic risk. The youth are particularly able to embrace new livelihood opportunities.	-National Climate Change Policy (2015) -Planting for Food and Jobs (PFJ) -Ghana Irrigation Development Authority (GIDA) -Farmer Cooperatives -Food and Agriculture Sector Development Policy (FASDEP) -Seed Act, 2000 (Act 576) -Ghana Climate Change Gender Action Plan
		Crop diversification can also spread risk, with farmers planting a mix of crops with varying water needs and heat tolerance. Drought resistant, early maturing seeds and other improved seeds combined with reliable weather information can reduce risk. Diversified livelihoods and support for women in supplemental or alternative livelihoods as part of their adaptation strategies. Eg. support women farmers with trade options. Farmers can reduce farm size and venture into other non-farm complementary livelihoods.		

¹ Quagraine, K., Klutse, N., Nkrumah, F., Adukpo, D. and Owusu, K. (2017) Changes in Rainfall Characteristics in Wenchi and Saltpond Farming Areas of Ghana. International Journal of Geosciences, 8, 305-317. doi: 10.4236/ijg.2017.83015.

Sectors	Risks	Adaptation measures	Assessment of the impact of proposed actions	Supporting policies/laws or measure
		Technological/Engineering Measures -Farmers can adopt practices like drip irrigation, which delivers water directly to the roots of plants, minimizing waste. - Drip irrigation also minimizes water wastage and ensures that crops receive consistent moisture. -Intensify the establishment of agricultural mechanization service provision centres with backup spare parts for all machinery and equipment. -Promote the availability of machinery under hire purchase and lease schemes. -Access to weather forecasts and early warnings of extreme weather events can allow farmers to take steps to protect their crops. This could involve delaying planting during periods of high drought risk or preparing for floods by building raised planting beds. - The dissemination of weather information and early warning systems should extend to platforms for women, youth, and other vulnerable farmers.		
		Policy/Institutional/Social Measures -Crop insurance and access to credit can help farmers manage the financial risks associated with climate change. Insurance can provide financial compensation for crop losses due to drought or floods. Access to credit allows farmers to invest in adaptation measures like water-saving irrigation systems or drought-resistant seeds. -Develop and deliver training programs for farmers on climate-smart agriculture practices. These programs should be gender responsive and tailored to the specific challenges faced by Wenchi's farmers, such as use of improved seeds, adapting to drought, heat stress, and erratic rainfall. The training could be provided through partnerships with agricultural extension services, NGOs, and universities in the Bono region.		

Sectors	Risks	Adaptation measures	Assessment of the impact of proposed actions	Supporting policies/laws or measure
Health	Warmer temperatures and changes in rainfall patterns will create ideal breeding grounds for mosquitos and other insects that transmit diseases like malaria and dengue fever. Increased flooding has also spread these diseases by dispersing stagnant water where mosquitos breed. This will lead to outbreaks and eventually put a strain on Wenchi's healthcare system. Droughts will lead to water scarcity, increasing the risk of contamination from improper sanitation practices. Floods will overwhelm sewage systems and contaminate water sources with pathogens causing outbreaks of waterborne illnesses like diarrhea, cholera, and typhoid.	Nature-Based Solutions (NBS) -Create urban green spaces like parks and community gardens throughout Wenchi. These spaces can help to regulate temperatures, reduce air pollution, and provide opportunities for physical activity. This can improve overall health and well-being, especially for vulnerable populations like children, the disabled, and the elderly. Policy/Institutional/Social Measures -Existing national health programs like malaria control initiatives can be adapted to incorporate climate change and gender considerations. -Continued education of local Wenchi communities about the risks, symptoms, and preventive measures for climate-sensitive diseases empowers them to protect themselves. -Develop and implement gender responsive public awareness campaigns to educate residents about the health risks associated with climate change, such as heatstroke, vector-borne diseases, and respiratory problems. Technological/Engineering Measures -Upgrading health facilities to withstand extreme weather events like floods is crucial. This could involve elevating structures, improving drainage systems, and ensuring backup power supplies. -Upgrading sewage systems and promoting proper waste management practices minimize contamination of water sources. -Invest in telemedicine infrastructure to allow for remote consultations with healthcare providers. This can be especially beneficial in rural areas of Wenchi where access to healthcare facilities might be limited.	These adaptation measures for Wenchi's health sector are to reduce vulnerability to climate change and its associated health risks, minimize the spread of climate-sensitive diseases, and strengthen healthcare system preparedness. Upgrading facilities ensure they remain functional even during extreme weather events. This allows healthcare services to continue uninterrupted, crucial for responding to emergencies and treating illnesses. Early detection and rapid response minimize outbreaks and their impact. This reduces the number of people who get sick, protects public health, and lessens the strain on healthcare services in the WMA.	- Ghana National Climate Change Policy (NCCLP) - National Health Policy (NHP) - Public Health Act (2000, Act 521) - National Disaster Management Act (2005, Act 659)

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Biodiversity	Climate change poses a significant threat to the rich biodiversity of WMA. The area has experienced poor rainfall distribution and frequent droughts, which can lead to water scarcity. This scarcity affects not only the human population but also the flora and fauna that depend on regular water supply for survival. Drought conditions can lead to habitat degradation, reduced plant growth, and lower crop yields, which in turn can affect food availability for both humans and wildlife. Rising temperatures due to climate change can result in heat stress on plants and animals. This stress can alter species distribution and lead to a mismatch in the timing of biological events, such as flowering and migration. Such changes can disrupt the delicate balance of ecosystems and may lead to a decline in species diversity. Additionally, higher temperatures can exacerbate the spread of invasive species and diseases, further threatening local biodiversity.	Nature-Based Solutions (NBS) -Initiatives to restore degraded ecosystems through tree planting and soil conservation techniques. This helps to restore lost habitats and provide sanctuaries for displaced species. -Establish ecological corridors and buffer zones around protected areas. These corridors can connect fragmented habitats, allowing for animal movement and promoting biodiversity. Buffer zones can help to protect these areas from human encroachment and activities that harm wildlife.	This involves determining whether the adaptation actions are capable of achieving their intended goals, such as enhancing ecosystem resilience, conserving key species, or reducing vulnerability to climate-related stressors. This includes assessing potential positive or negative effects on species populations, habitats, and ecological processes. For instance, adaptation measures like habitat restoration may benefit certain species by providing suitable habitats, while others may experience displacement or altered interactions. Assessments should involve engaging stakeholders and local communities to ensure that adaptation measures are gender responsive, socially acceptable, culturally appropriate, and aligned with the local needs and priorities of the Wenchi municipal.	- National Biodiversity Strategy and Action Plan (NBSAP) -Forestry Commission Act (Act 571) -National Climate Change Adaptation Strategy (2015) -Ghana National Climate Change Policy (2011) -National REDD+ Strategy (Reducing Emissions from Deforestation and Forest Degradation) -Environmental Protection Agency Act (Act 490) -Forest and Wildlife Policy (1994)
		Technological/Engineering Measures -Implement camera trap monitoring programs in key biodiversity areas to track wildlife populations and identify species most vulnerable to climate change impacts. This data can be used to inform conservation efforts and prioritize adaptation strategies.		
		Policy/Institutional/Social Measures -Farmers in the Wenchi area are adapting by diversifying their crops, including the planting of early maturing and drought-tolerant crop varieties. This helps to ensure that critical crop growth stages do not coincide with harsh climatic conditions during the growing season. -Climate-smart practices such as agroforestry, conservation agriculture, and water-efficient irrigation methods that conserve biodiversity while enhancing agricultural productivity must be encouraged. -Develop and support gender inclusive community-based natural resource management programs that involve local communities in protecting biodiversity. These programs could involve activities like sustainable harvesting of natural resources, reforestation projects, and education campaigns on the importance of biodiversity conservation.		

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Water & Sanitation	Wenchi's water resources heavily rely on predictable rainfall patterns. Climate change disrupts these patterns, leading to both droughts and floods. The drainage basins in the Wenchi Municipal include the Tain, Subin, Kyiridi, Trome, and Yoyo rivers. These rivers serve the communities in the Municipality, with some streams drying up in the dry season while the major rivers flow throughout the year. Droughts can therefore cause severe water scarcity, reducing river and groundwater levels. This can make it difficult to access water for essential needs like drinking, sanitation, and agriculture. Floods, on the other hand, can contaminate water sources with debris and pathogens, increasing the risk of waterborne diseases. Increased temperatures can exacerbate water scarcity in several ways. Higher evaporation rates lead to more water loss from reservoirs. Additionally, hotter temperatures can increase water demand for irrigation in agriculture, putting further strain on limited water resources in the municipal. These disruptions to Wenchi's water sector can have cascading effects on public health, food security, and the overall well-being of the community.	Nature-Based Solutions (NBS) -Implement rainwater harvesting systems to collect and store rainwater for non-potable uses such as irrigation, flushing toilets, and cleaning. This can reduce the demand on the municipal water supply. -Establish riparian buffer zones along water bodies to prevent erosion, filter pollutants, and provide habitat for wildlife. These zones consist of native vegetation that stabilizes the soil and absorbs contaminants. -Encourage the installation of green roofs and walls on buildings to absorb rainwater, provide insulation, and reduce runoff. This can help manage stormwater and lower urban temperatures. -Restore floodplains to their natural state to enhance their ability to absorb and store floodwater, which can reduce the impact of flooding on the community. -Involve women and other vulnerable groups in the design and implementation of these strategies to increase their resilience.	Rainwater harvesting and water conservation programs directly reduce reliance on dwindling freshwater resources. Sustainable groundwater management ensures the long-term availability of this crucial resource. This combined approach helps maintain water security even during droughts. Upgrading existing infrastructure and building climate-resilient water systems ensure continued access to clean water even during extreme weather events. This minimizes disruptions and safeguards public health. These are further echoed in The Wenchi Municipal Assembly's 2020 Annual Progress Report² which states the importance of hygiene, water, and sanitation in the context of climate change and disaster risk reduction programs, emphasizing the need to safeguard these essential services in the face of changing environmental conditions³.	- National Water Policy (2007) - Ghana National Climate Change Policy (NCCLP) - National Irrigation Policy (2015) - National Community Water and Sanitation Programme (NCWSP) - Water Resources Commission Act (1996, Act 522) - Environmental Protection Agency Act (1994, Act 490)

2 Adjei-Nsiah, S.; Issaka, R.N.; Fening, J.O.; Mapfumo, P.; Anchirina, V.; Giller, K.E. Farmers 8217; Perceptions of Climate Change and Variability and Existing Opportunities for Adaptation in Wenchi Area of Ghana. *International Journal of Climate Change: Impacts and Responses* (2010) 2 (2) 49-60.

3 https://ndpc.gov.gh/media/BR_Wenchi_APR_2020_YOQ8vcw.pdf

Sectors	Risks	Adaptation measures	Assessment of the impact of proposed actions	Supporting policies/laws or measure
		Technological/Engineering Measures -Investing in repairing and upgrading existing water infrastructure like wells, pumps, and treatment plants is essential. This ensures they are functional and resilient enough to withstand extreme weather events in the municipal. -Upgrading and maintaining existing drainage infrastructure can reduce the impact of flooding on water and sanitation systems. -Promoting rainwater harvesting techniques at the household and community level can capture and store water during the rainy season for use during dry periods. This can involve installing rainwater collection tanks on individual homes or constructing larger communal cisterns. -Engage women in the design and execution of engineering solutions to enhance the socio-economic benefits.		
		Policy/Institutional/Social Measures Develop and implement public awareness campaigns to educate residents on the importance of water conservation, especially during dry periods. The campaigns could promote practices like fixing leaky faucets, taking shorter showers, and watering lawns and gardens efficiently.		

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Gender	Traditionally, women and girls are responsible for water collection in many Ghanaian communities. With water scarcity, they may have to travel further distances or spend more time collecting water, taking away from other essential activities like education, income generation, or childcare. Further, women often play a central role in food production and household food security. Droughts and floods can threaten their ability to grow food or earn income to buy food in the district, impacting their families' nutrition and well-being. People with disabilities, especially those with mobility impairments, may face challenges evacuating during extreme weather events like floods or fires. Climate-induced malnutrition and waterborne diseases can disproportionately impact children's health in the Wenchi Municipal.	Nature Based Solutions -Support women entrepreneurs in starting eco-friendly businesses that capitalize on the sustainable use of natural resources. This could include ventures such as eco-friendly handicrafts made from locally sourced materials, ecotourism enterprises that showcase the area's natural beauty, or sustainable agriculture-based businesses. Providing access to training, financing, and market linkages can help women entrepreneurs succeed in these ventures while contributing to local economic development.	By equipping women with knowledge, extension support, resources, and leadership opportunities, these measures empower them to adapt their agricultural practices, improve livelihoods, and participate in decision-making. This fosters a more equitable distribution of resources and strengthens the municipal's overall resilience. Early warning systems, accessible infrastructure, and targeted education programs ensure everyone in the community, including children and disabled people, can prepare for and respond to climate hazards. This minimizes risks and safeguards the well-being of vulnerable populations. By addressing the specific needs of women, children, and disabled people, and by building stronger infrastructure and economic opportunities, the measures aim to make Wenchi less susceptible to the negative consequences of climate change.	- Ghana National Climate Change Policy - Ghana's Nationally Determined Contributions (NDCs) -National Gender Policy - Children's Act (1998, Act 560) -Disability Act (2006, Act 715)

Sectors	Risks	Adaptation measures	Assessment of the impact of proposed actions	Supporting policies/ laws or measure
		Policy/Institutional/Social Measures -Integrating climate change education into school curriculums, equipping children with knowledge on how to stay safe and healthy in a changing environment. -Integrate gender considerations into all climate change adaptation planning processes. This means ensuring women's voices are heard and their specific needs are addressed in policies and programs. -The Wenchi Municipal Assembly could establish a gender working group within its climate change unit and actively seek input from women's organizations on adaptation strategies. -Disseminating weather forecasts and information on potential hazards through accessible channels (including sign language or Braille) to ensure everyone can prepare for extreme weather events. -Training programs and resources focused on women farmers, equipping them with knowledge and tools for drought-resistant crops, efficient water management techniques, and diversified income opportunities. - Agriculture extension officers who understand the gender limitations and can provide technical assistance to women and other vulnerable farmers. The Wenchi Municipal Assembly's Department of Agriculture could partner with NGOs that focus on women in agriculture to design and deliver these programs.		

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		Technological/Engineering Measures -Integrate gender considerations into urban planning processes. This includes designing public spaces, parks, and recreational facilities that are inclusive and safe for women and girls. Ensure access to essential services such as healthcare facilities, schools, and markets are conveniently located and accessible. -Develop disaster management plans that are gender-responsive, taking into account the unique vulnerabilities and needs of women and girls during emergencies. This includes providing access to safe shelters, healthcare services, and psychosocial support.		
Cities and infrastructure	Urban areas in Wenchi may face challenges in managing runoff, which can overwhelm drainage systems and cause flooding, leading to property damage and disruptions in transportation along major highways such as the Wenchi-Wa highway, Wench-Nsawkaw, and the Wenchi-Techiman highway. Higher temperatures can exacerbate urban heat island effects, particularly in densely built areas, leading to increased heat-related illnesses and energy demands for cooling. The heat stress on infrastructure, such as roads, buildings, and utilities, can reduce their lifespan and increase maintenance costs. Further, these changes can impact agricultural productivity and food security in the municipal, indirectly affecting urban populations in Wenchi. Changes in rainfall patterns and temperatures can disrupt agricultural activities, leading to reduced food availability and increased food prices in urban markets. This can strain local economies and exacerbate poverty and inequality, affecting the overall resilience of the municipal.	Nature-Based Solutions (NBS) -Integrate green infrastructure elements into urban planning and development projects, such as planting trees, creating green roofs, and establishing rain gardens. -Develop and maintain climate resilient and disability friendly footpaths and bridges to link essential services like hospitals, schools and markets. Constructing and restoring natural water retention areas and expanding culverts to upgrade and maintain drainage systems.	The primary goal is to determine whether the proposed adaptation actions are effective in reducing vulnerability to climate change impacts and enhancing resilience. This involves assessing the technical feasibility of implementation, considering available resources, expertise, and infrastructure in the Wenchi district of Ghana. Analyzing the impact of adaptation measures on the performance, functionality, and lifespan of urban infrastructure. This involves assessing whether climate-resilient infrastructure designs and retrofitting efforts effectively withstand climate stresses and contribute to long-term sustainability. Assessing the level of stakeholder engagement, collaboration, and capacity building achieved through adaptation actions. This involves evaluating the extent to which local governments, gender groups, communities, businesses, and civil society organizations are involved in adaptation planning, implementation, and monitoring in the municipal.	- National Urban Policy (NUP) - National Building Regulations (LI 1630) - National Climate Change Policy (2011) - National Housing Policy

Sectors	Risks	Adaptation measures	Assessment of the impact of proposed actions	Supporting policies/ laws or measure
		Technological/Engineering Measures -Upgrade and maintain drainage systems to cope with increased rainfall and reduce the risk of flooding, including expanding culverts and implementing floodplain management strategies. -Revise building codes to incorporate climate change considerations, such as requirements for stronger roofs, permeable surfaces, and water-efficient fixtures.		
		Policy/Institutional/Social Measures -Incorporate climate considerations into urban planning processes, including zoning regulations, land-use planning, and building codes that prioritize climate resilience. -Conduct climate risk assessments for all new and existing infrastructure projects to identify vulnerabilities to extreme weather events and ensure infrastructure can withstand these events. - The Wenchi Municipal Assembly's Department of Urban Development could collaborate with landscape architects and environmental NGOs to design and implement these projects. -Revise building codes to incorporate climate change considerations. This could include requirements for stronger roofs to withstand high winds, permeable surfaces to reduce flooding, and water-efficient fixtures to conserve water.		

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Trade	Agriculture is a key component of trade in the municipal, with many people relying on farming for their livelihoods via daily market sessions at Boadan market, Saboa mini market, and Thursday market day at Anantase. However, climate change brings increased uncertainty in weather patterns, leading to more frequent and intense droughts, erratic rainfall, and rising temperatures. These changes can directly impact crop yields, affecting the availability and quality of agricultural products for trade. Reduced crop yields could disrupt local markets and trade networks, leading to economic losses for farmers and traders alike. Another risk associated with climate change in the Wenchi municipal is the vulnerability of infrastructure and transportation networks. Extreme weather events such as flooding and heavy rainfall can damage roads, bridges, and other critical transportation infrastructure essential for trade activities. This damage can impede the movement of goods to and from markets, leading to delays, increased transportation costs, and disruptions in supply chains. Small traders and businesses, already operating with limited resources, may struggle to cope with these challenges, affecting their ability to participate effectively in local and regional trade	Nature-Based Solutions (NBS) -Integrate green infrastructure elements into urban planning and development projects. This could involve planting trees along streets, creating green roofs on buildings, and establishing rain gardens. These features can help to reduce flooding, improve air quality, and regulate temperatures in Wenchi, making the municipal more resilient to climate change impacts. The Wenchi Municipal Assembly's Department of Urban Development could collaborate with landscape architects and environmental NGOs to design and implement these projects.	To enhance the reliability and continuity of trade networks, promoting economic stability and market integration despite climate-related challenges. Strengthening infrastructure resilience reduces disruptions in trade activities caused by extreme weather events. Improved roads, bridges, and market facilities facilitate efficient movement of goods, reducing transportation costs and market access challenges. Timely market information empowers traders to make informed decisions, optimizing trade flows and reducing losses due to market fluctuations exacerbated by climate variability.	- National Climate Change Policy (2014) - National Climate Change Adaptation Strategy (2016) - Ghana National Agriculture Investment Plan (2016-2020) - National Trade Policy (2004):

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		Technological/Engineering Measures -Upgrade and maintain drainage systems to cope with increased rainfall and reduce the risk of flooding. This may involve constructing and restoring natural water retention areas, expanding culverts, and implementing floodplain management strategies. -Conduct climate risk assessments for all new and existing infrastructure projects. This will help to identify vulnerabilities to extreme weather events like floods and droughts. Based on these assessments, the infrastructure can be built or upgraded to withstand these events. The Wenchi Municipal Assembly's Department of Works could partner with engineering consultants with expertise in climate-resilient infrastructure design.		
		Policy/Institutional/Social Measures Incorporate climate considerations into urban planning processes to ensure infrastructure is designed to withstand climate impacts such as flooding, extreme heat, and storm events. This includes zoning regulations, land-use planning, and building codes that prioritize climate resilience. Revise building codes to incorporate climate change considerations. This could include requirements for stronger roofs to withstand high winds, permeable surfaces to reduce flooding, and water-efficient fixtures to conserve water. The Wenchi Municipal Assembly could collaborate with the Ghana Standards Authority to develop these revised codes and ensure their enforcement.		

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Energy	In the context of the Wenchi district specifically, where agriculture is a significant economic activity, climate change risks can also indirectly affect the energy sector. Changes in temperature and rainfall patterns can impact agricultural productivity, potentially leading to shifts in energy demand patterns. For instance, increased reliance on irrigation systems during dry spells could place additional pressure on the energy grid. The social and economic implications of climate change can further exacerbate risks to the energy sector in Wenchi. Climate-related impacts such as water scarcity, food insecurity, or displacement of communities can create social tensions and increase demand for energy-intensive solutions like air conditioning or water pumping, further stressing the energy infrastructure.	Nature Based Solutions By diversifying the energy mix with micro-hydropower, Wenchi Municipal Assembly can enhance energy security and resilience to external shocks such as fuel price fluctuations or supply disruptions.	Households in Wenchi have varying levels of access to electricity. The Wenchi Municipal Assembly Medium Term Development Plan (2014-2017)⁴ reported that 42% of households in Wenchi had access to electricity. The urban-rural divide is not explicitly addressed, but urban households in Wenchi likely have higher access to electricity compared to rural households. The primary goal of adaptation measures is to build resilience within the energy sector. This involves reducing vulnerabilities to climate-related risks such as water scarcity, extreme weather events, and changing rainfall patterns. Expanding solar energy capacity can help increase the resilience of Wenchi's energy system to climate change impacts like droughts affecting hydropower. Strengthening power plants and transmission/distribution infrastructure against climate hazards like floods and storms can safeguard the reliability of energy supply. This can help maintain consistent energy services even during extreme weather events	- National Climate Change Policy (2013) - Renewable Energy Act (2011) - National Energy Policy (2010) - National Climate Change Adaptation Strategy (2016)
		Technological/Engineering Measures Upgrade and strengthen energy infrastructure to withstand climate-related hazards such as floods, storms, and extreme temperatures. This may involve reinforcing power lines, securing substations, and using climate-resilient construction materials for new infrastructure projects.		

Sectors	Risks	Adaptation measures	Assessment of the impact of proposed actions	Supporting policies/ laws or measure
		Policy/Institutional/Social Measures -Invest in decentralized renewable energy systems like solar panels and mini-hydropower plants in rural areas of Wenchi. These systems can provide clean and reliable energy to communities that are not connected to the national grid. The Wenchi Municipal Assembly could partner with private companies or NGOs with experience in implementing these types of projects. -Capacity development and regulatory frameworks to support local renewable energy generation, including solar energy and biogas, to enhance resilience of remote, vulnerable communities. Capacity building should equally target women and other vulnerable groups		
		-Encourage the use of sustainable biomass energy sources, such as planting fast-growing trees for firewood or using agricultural residues for pellet production. This can provide a renewable energy source and reduce reliance on fossil fuels, which are vulnerable to price fluctuations and contribute to climate change. The Wenchi Municipal Assembly could work with the Forestry Commission and the Ghana Renewable Energy Agency to develop regulations and incentives for sustainable biomass use.		

