

Adapting Together, Thriving Tomorrow



Climate Change Rapid Risk Assessment for West Mamprusi Municipal Assembly

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



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Acronyms

Abbreviation	Connotation
°C	Degree Celsius
AAP	Annual Action Plan
AEAs	Agricultural Extension Agents
CCV	Climate Change Vulnerability
CO ₂	Carbon dioxide
DRR	Disaster And Risk Reduction
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
GCF	Green Climate Fund
GHG	Green House Gases
GMet	Ghana Meteorological Agency
GSS	Ghana Statistical Service
ICT	Information And Communication Technology
IPCC	Intergovernmental Platform of Climate Change
LI	Legislative Instrument
M&E	Monitoring And Evaluation
MCA	Multi Criteria Analysis
MDAs	Ministries
MEL	Monitoring, Evaluation And Learning
MESTI	Ministry Of Environment, Science, Technology, And Innovation
MMDAs	Metropolitan, Municipal, And District Assemblies
MOFA	Ministry Of Food And Agriculture
MPCU	Municipal Planning Coordination Unit
MTDP	Medium-Term Development Plan
NADMO	National Disaster Management Organization
NAP	National Adaptation Plan
NCCE	National Commission On Civic Education
NDC	Nationally Determined Contributions
NDPC	National Development Planning Commission
NGOs	Non-Governmental Organizations
PLWD	Persons Living With Disabilities
PPPs	Public- Private Partnerships
PWD	Persons With Disabilities
RA	Risk Assessment
RCP	Representative Concentration Pathway
SDG	Sustainable Development Goals
SREX	Special Report for Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation
SSP	Shared Socio-economic Pathways
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNEP	United Nations Environment Programme

Abbreviation	Connotation
UNFCCC	United Nations Framework Convention On Climate Change
VA	Vulnerability Assessment
WMAP	West Mamprusi Adaptation Plan
WMMA	West Mamprusi Municipal Assembly



1

Introduction

1.1 Background

Climate change is recognized as one of the most pressing challenges of the 21st century, with far-reaching implications for environmental sustainability, socioeconomic development, and geopolitical stability. Rising greenhouse gas emissions from human activities have led to unprecedented shifts in weather patterns, including more frequent and intense extreme weather events such as floods, droughts, hurricanes, and heatwaves.

In West Africa, countries are particularly susceptible to these impacts due to their reliance on rain-fed agriculture, high population density along coastlines, and limited capacity to adapt. Additionally, socio-economic factors like poverty, rapid urbanization, and inadequate infrastructure further exacerbate vulnerability and hinder effective adaptation efforts.

In Ghana, climate change poses significant threats to sustainable development and human well-being across various sectors, including agriculture, water resources, health, and infrastructure. The country has witnessed an increase in the frequency and severity of extreme weather events, with devastating consequences for rural livelihoods, urban settlements, and natural ecosystems.

Nonetheless, globally, there is a growing consensus on the importance of adaptation strategies to mitigate the impacts of climate change. Adaptation measures not only enhance the resilience of communities but also contribute to sustainable development goals, safeguarding ecosystems and fostering socio-economic stability.

Within Ghana, the West Mamprusi Municipal Assembly (WMA) is identified as a climate change hotspot. It grapples with high population density, rapid urban growth, and exposure to coastal hazards. The WMA faces dual risks from both inland and coastal climate impacts, such as floods, droughts, sea-level rise, and storm surges. These challenges profoundly affect infrastructure, livelihoods, public health, and exacerbate existing socio-economic disparities.

Recognizing the urgent need for action, Ghana is developing its National Adaptation Plans (NAPs) to strengthen resilience and mitigate climate risks. The WMA is pivotal in this process, selected for detailed climate risk assessments within Ghana's agro-ecological zones. The Climate Change Risk Assessment (CCRA) for the West Mamprusi Municipal Assembly (WMMA), guided by international frameworks like the IPCC's AR5, aim to identify, analyze, and prioritize climate risks specific to the WMMA. They are crucial for enhancing local understanding of vulnerabilities, integrating gender perspectives, and formulating targeted adaptation strategies. By engaging all stakeholders in a coordinated approach, Ghana aims to allocate resources effectively, implement focused interventions, and foster widespread support for climate resilience and sustainable development goals.

1.2 Objectives

The Government of Ghana, through the EPA and MESTI, has secured Green Climate Fund (GCF) support for a three-year initiative to enhance the National Adaptation Plan (NAP) process. Partnering with UNEP,

the project focuses on integrating climate adaptation into national development policies, improving climate risk data systems, and establishing sustainable financing for adaptation. By conducting advanced climate risk assessments, the initiative aims to create a robust climate risk narrative to inform national and regional adaptation plans, support the updated NAP, and secure international climate finance, ultimately strengthening Ghana's resilience to climate change.

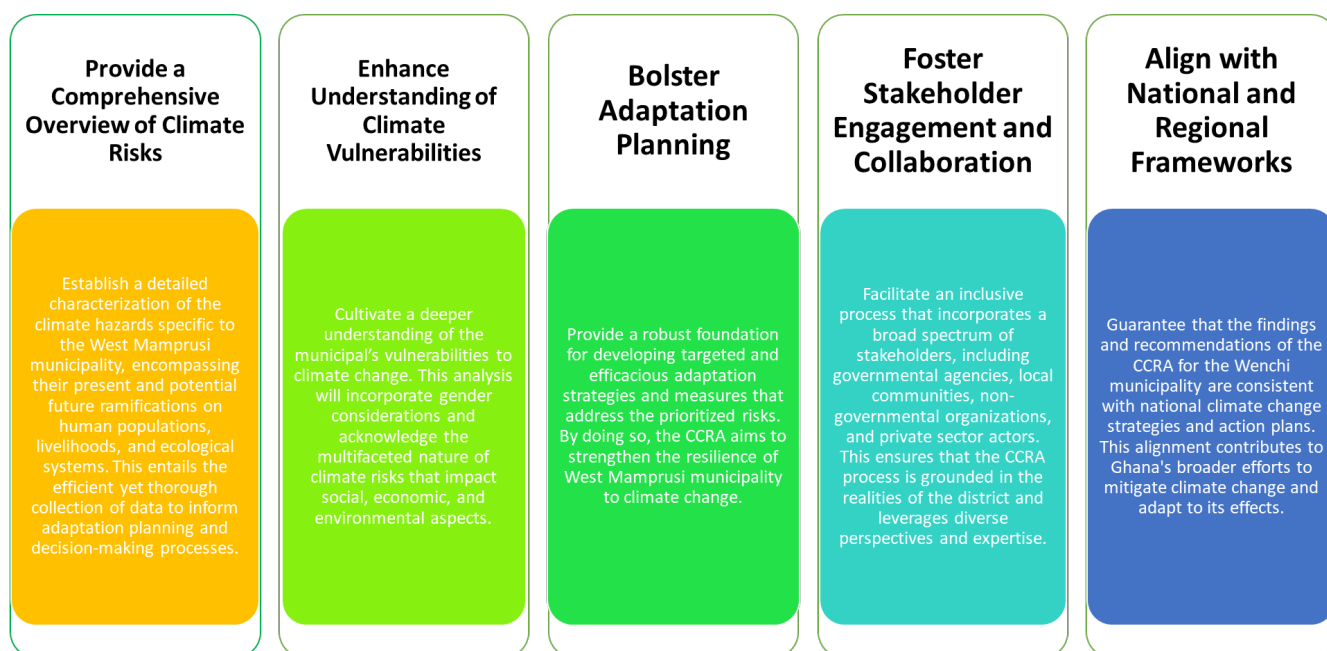
Specifically, this work on “Enhancing Multi-Sector Planning and Capacity for Effective Adaptation in Ghana,” seeks to advance climate resilience by focusing on two critical aspects: creating a robust national adaptation framework and enhancing local-level implementation capacity. The initiative emphasizes the development of a costed National Adaptation Plan (NAP) while simultaneously building the capacity of stakeholders within the West Mamprusi Municipal Assembly (WMMA) to integrate climate adaptation considerations into their Medium-Term Development Plan (MTDP). This approach involves three interconnected components:

- *Conducting Rapid Climate Risk Assessments within the West Mamprusi Municipal Assembly:* This step involves systematically identifying and analyzing the climate-related vulnerabilities and risks faced by WMMA. The assessments focus on understanding the current and projected impacts of climate variability and change across key sectors within the municipality. This information serves as a baseline for planning and prioritizing adaptation actions.
- *Developing Costed Adaptation Plans for the West Mamprusi Municipal Assembly:* Based on the risk assessments, detailed and financially costed adaptation plans will be prepared for the WMMA. These plans will outline specific, actionable strategies tailored to local needs, addressing critical climate risks while ensuring alignment with broader national priorities. The costing will enable better resource allocation and help mobilize both public and private financing for implementation.
- *Formulating Prioritized Sectoral Adaptation Plans:* To ensure targeted and effective interventions, the study will identify and prioritize key sectors that are most vulnerable to climate impacts, such as agriculture, water resources, health, and infrastructure. Sector-specific adaptation strategies will be developed, incorporating inputs from multi-sectoral stakeholders to ensure inclusivity, feasibility, and alignment with sustainable development goals

1.3 Document Purpose

This report presents the Climate Change Risk Assessment (CCRA) for the West Mamprusi Municipal Assembly, focusing on up to four biophysical and three economic sector risk domains, developed through a participatory process with local stakeholders. Its primary aim is to support municipal experts and stakeholders in evaluating the municipality's vulnerability to climate change impacts, using the IPCC's Fifth Assessment Report (AR5) framework to integrate hazard, exposure, and vulnerability components. The CCRA seeks to validate critical findings, identify and prioritize effective adaptation strategies, and outline practical recommendations to strengthen the municipality's resilience to climate-related risks.

Figure 1: A framework of the CCRA goals





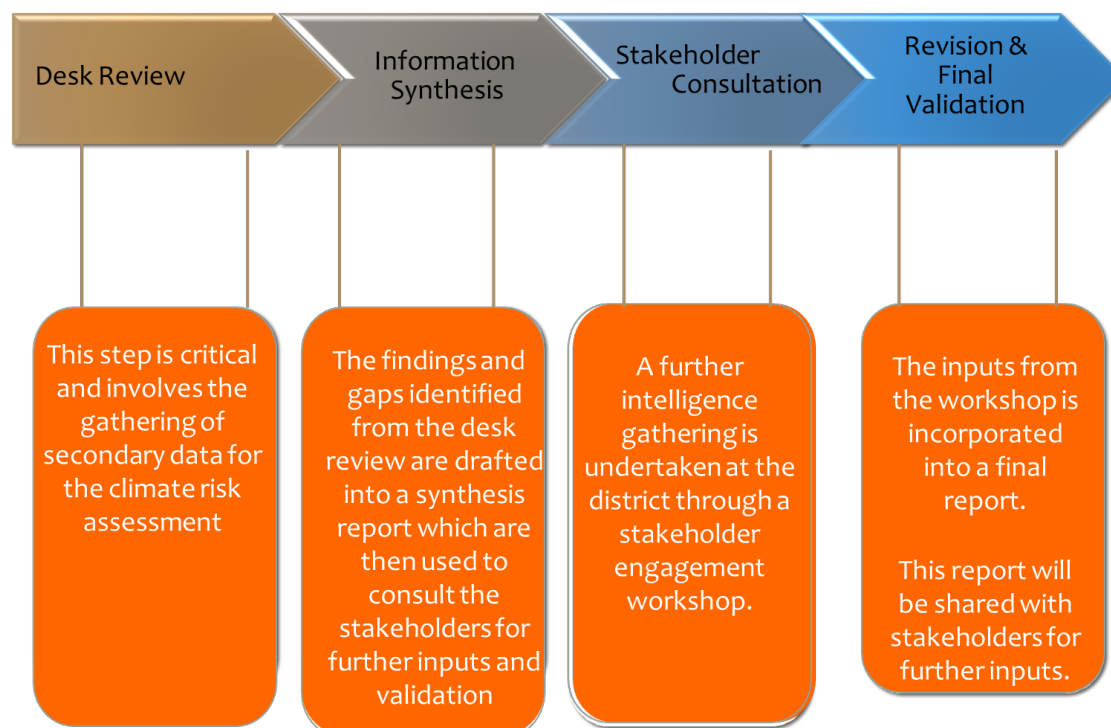
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Approach and Methodology

2.1 Approach

The assessment method for this Climate Change Risk Assessment for the West Mamprusi Municipal Assembly is a structured, sequential procedure that comprises the following steps:

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



Desk Review

The desk review is the first most stage of any risk or vulnerability. For West Mamprusi Municipal VA, the desk review serves as the cornerstone of the climate risk assessment process. In this phase, secondary data is gathered to build a comprehensive understanding of the climate risks the municipality faces. Secondary data includes previously collected and analysed information from sources such as academic research, government reports, climate models, historical weather data, and case studies from other regions or projects.

The primary aim of the desk review is to compile a detailed dataset that forms the basis for evaluating climate risks in WMMA. This step requires extensive research and careful synthesis of various data points to create a well-rounded and accurate view of the municipality's vulnerabilities. Analysts rigorously

assess the reliability of sources, cross-checking information to identify any gaps, discrepancies, or areas that require further exploration.

This process provides essential insights into key climate-related factors such as temperature fluctuations, rainfall patterns, sea level rise, and the increasing frequency of extreme weather events. Understanding these climate variables is critical for identifying the specific vulnerabilities of WMMA's environment, economy, and communities. This foundational step ensures that subsequent phases of the assessment are informed by a solid base of credible and relevant information, guiding effective adaptation planning.

Information Synthesis

After the desk review, the next critical step is the information synthesis phase, where the extensive data collected is distilled into a cohesive and accessible report. This phase is essential for transforming raw data into actionable insights by identifying key trends, findings, and gaps that emerged during the desk review. The synthesis report serves as a valuable tool for several purposes.

It provides a summarized version of the comprehensive research, making the findings easier to understand and more accessible for stakeholders. Additionally, the report facilitates stakeholder engagement by offering a basis for consultation. Involving stakeholders such as local communities, policymakers, scientists, and industry representatives allows for diverse input and validation, ensuring that the climate risk assessment reflects a wide range of perspectives. This participatory process helps to refine the findings, ensuring the assessment's accuracy, relevance, and inclusivity..

Stakeholder Consultation

The stakeholder consultation phase is a critical component in making the climate risk assessment process inclusive and reflective of local realities. This step involves engaging a diverse group of stakeholders in a district-level workshop designed to gather valuable local insights and intelligence. The participants typically include representatives from local government, community organizations, businesses, academic institutions, and other relevant groups. Their involvement is essential, as they bring unique local knowledge, expertise, and experiences that can significantly enhance the assessment.

The consultation workshop provides a platform for open dialogue, where stakeholders can share their perspectives and help identify additional risks and opportunities that may not have been captured during the desk review or information synthesis phases. During the consultation, the preliminary findings from the synthesis report are presented, and stakeholders are encouraged to provide feedback. This participatory approach ensures that the climate risk assessment is not only based on scientific data but also aligned with local needs and realities.

Stakeholders can point out specific vulnerabilities, suggest mitigation strategies, and propose practical adaptation measures that may not have been apparent through secondary data alone. Moreover, involving stakeholders in the process fosters a sense of ownership and trust, increasing the likelihood that they will actively support and contribute to the successful implementation of the assessment's recommendations..

Revision and Final Validation

This stage is about refining the assessment based on the inputs gathered during the stakeholder consultation and ensuring that the final report is accurate, comprehensive, and actionable. The inputs from the stakeholder workshop were meticulously reviewed and incorporated into the final report.

Once the revisions were made, the final report was validated by 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 parties.

The final report serves as a strategic tool for policymakers, planners, and other stakeholders, providing a clear roadmap for addressing climate 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.

2.2 Methodology

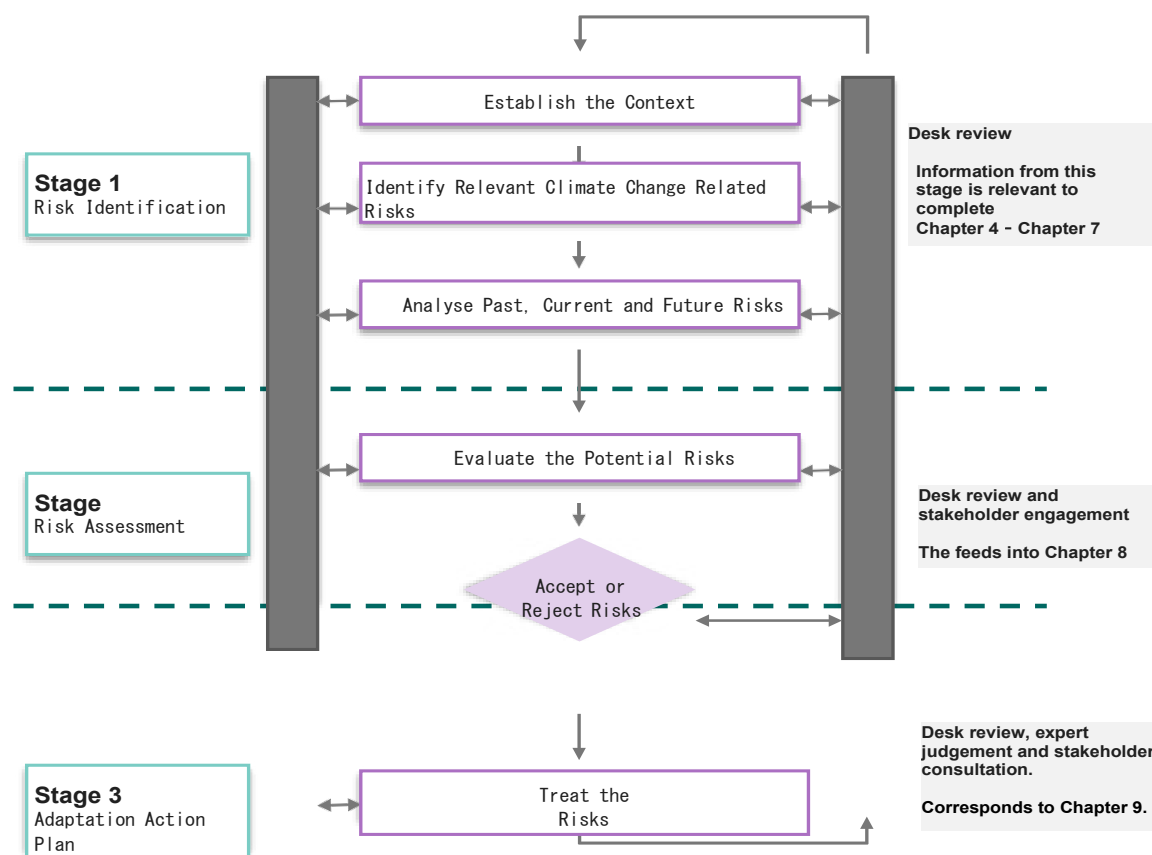
The methodology employed in this Climate Change Risk Assessment for the West Mamprusi Municipal Assembly, adapted from Norman et al. (2014), follows a structured approach divided into three main phases, each with specific focuses and activities (Figure 2):

Stage 1: Risk Identification - Initially, the context was established through an extensive desk review. This dual approach involved gathering secondary data and insights from stakeholder engagements relevant to climate risk assessment within West Mamprusi. The literature review analyzed historical, current, and potential future risks, aiming to understand previous impacts of climate variations on the district and their future projections. Stakeholders, leveraging their expertise and experience, identified risks through maps and participatory discussions. This participatory method ensured a comprehensive evaluation, with identified risks either accepted for further action or rejected based on stakeholder consensus.

Stage 2: Risk Assessment - The subsequent phase involved a detailed evaluation of the identified risks from the previous phase. Insights from the desk review were complemented by stakeholder engagements, providing diverse perspectives on potential risks. This engagement was crucial to ensure the risk assessment incorporated local insights and expertise. Outputs from this phase were systematically documented, including the severity of impacts, financial implications for adaptation, and the district's capacity to effectively manage risks.

Stage 3: Adaptation Action Plan - The final phase focused on developing an Adaptation Action Plan aimed at reducing vulnerabilities and enhancing resilience to climate change impacts in West Mamprusi. This plan synthesized findings from the desk review, expert analyses, and stakeholder consultations, proposing strategic and targeted responses to accepted climate risks. It outlines co-developed, actionable interventions designed to address key risks and support the district's overall objectives for climate change adaptation.

Figure 3: General overview of the risk assessment process.



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



3

West Mamprusi Municipal Assembly

Overview of West Mamprusi Municipality

The West Mamprusi Municipal Assembly is one of the six administrative municipal or district assemblies of the North East Region of Ghana. The municipal assembly has Walewale as its administrative capital. Until 2018, West Mamprusi West was one of the Twenty (20) Administrative Districts in the Northern Region of Ghana. The North East Region was carved out of the Northern Region after a referendum on December 27, 2018 was successful with 81% voter turnout in the proposed region voting 99.8% in favour of the creation of the North East Region. West Mamprusi Municipal Assembly covers a recorded land size of 2610.44 km² and is located on longitudes 0°35'W and 1°45'W and latitude 9°55'N and 10°35'N.

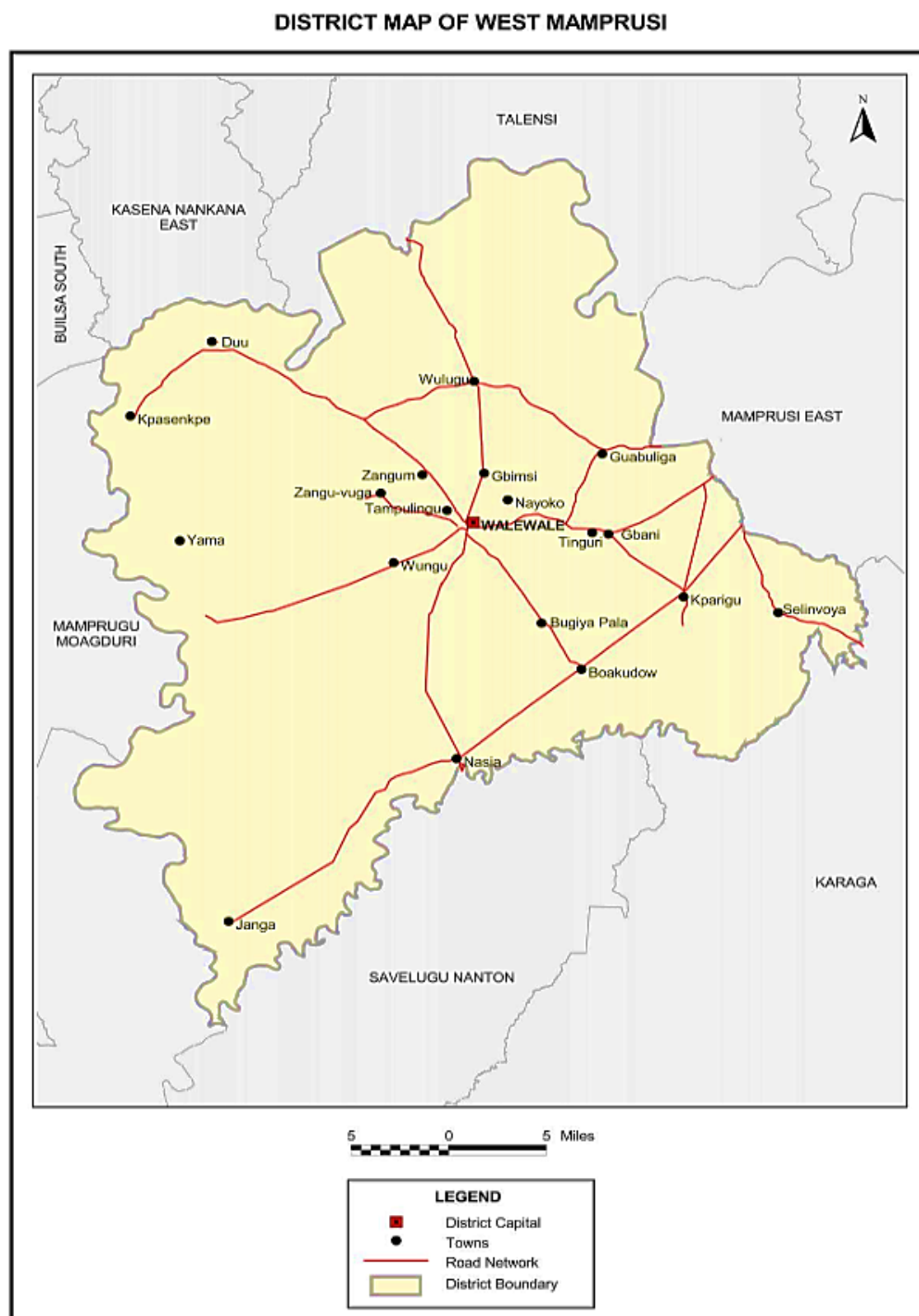
3.1 Physical and environmental features

The West Mamprusi Municipal Assembly shares boundaries with the following assemblies; to the north by Builsa, Kasena-Nankana and Bolgatanga Districts, in the Upper East Region; to the south by North Gonja, Karaga, Kumbungu and Savelugu Districts in the Northern Region; to the west by the Sissala East and Wa East Districts and; to the East by the East Mamprusi Municipal Assembly.

West Mamprusi is characterised by an undulating topography with gentle slopes and few isolated hills. The municipality's geological formation is mainly composed of sandstone, arkose, mudstone, and shale, derived mainly from the Middle Lower Voltarian basin. The geological formation is very important in determining the amount of underground water which contributes to about 67% to Northern Ghana's domestic water needs (Agyekum and Asare 2016)

The district is drained mainly by the White Volta and its tributaries, the Sissili river and the Kulpawn river. The Municipality however has many smaller rivers at Nasia and Pwalugu, at Gbimsi, Diani, Nayorku, Zangu-Vuga, Gbani, Wulugu, Wungu, Zangum and Nabari.

Figure 4: Map of West Mamprusi District



Source: Ghana Statistical Service, 2010 Population & Housing Census

3.2 Climate and Vegetation

Similar to the rest of the Northern regions of Ghana, West Mamprusi experiences a single rainy season and a prolong dry season. This is characterised by a sharp rise to peak and a sharp fall to minimum rains. The rainy season thus begins slowly in April, rising to its highest in July-August and declines sharply to a halt in October. November to April is characterised by a long dry season. Annually, recorded rainfall ranges between 950mm - 1,200mm. The municipality is also characterised as dry and very warm with a yearly average temperature of

34°C. Temperatures however are recorded at maximum at approximately 45°C in the day between March-April and a minimum of approximately 12°C at night between December and January.

West Mamprusi lies within the Guinea Savannah woodland agroecological zone. As such, the vegetation in this agroecological zone and hence municipality has scattered trees with light undergrowth. The municipality is also resourced with economical trees such as shear, dawadawa and baobab. However, due to the high demand for these trees as woodfuels and charcoal, the district is characterised by indiscriminate falling of trees. According to Global Forest Watch, between 2001 and 2022, an average of 615t per year was released into the atmosphere as a result of tree cover loss in West Mamprusi. In total, 13.5 kt of CO₂e was emitted in this period.

3.3 Demographics

The 2020 Population and Housing Census (GSS 2021) records the population of West Mamprusi Municipal as 175,755 people with 51.2 percent females. The report estimates that the population of the municipality will grow at an estimated 2.9 percent annually. As well, more than half, 52%, of the municipality's population lives in rural areas, a decrease from the recorded 62% in the 2010 Population and Housing Census (GSS 2014). This indicates a rising rate of urbanisation. The Municipality has a population density of 46.4 per sq km.

The main ethnic group of the municipality is the Mole-Dagbani ethnic group, forming 87.5% of the population. The Grusi (5.1%), Mande (4.2%), are the remaining main minority ethnic groups. With the Gurma and other ethnic groups constituting 3.2 %. Eight in ten (82.8%) of the municipality's population are affiliated to the Islam Religion, followed by 14.9 % who are Christians. Traditionalist Religions and Others constitute 2.3 % of the population.

About 67.7% of the population are aged 15 years or above and economically active. While 32.3 percent are economically not active. Of the economically active population, 97% percent are employed while 3.0 percent are unemployed. Nearly half (48.3%) of the unemployed population are seeking work for the first time. The proportion of employed males (97.6%) is slightly higher than their female counterparts (96.4%). For those who are economically not active, a larger percentage of them are students (40.5%) while 34.7 percent performed household duties (GSS 2014)

3.4 Administration and governance

The municipality's local governance is administratively divided into seven zonal councils with 31 elected assembly members. The zonal councils include the Janga, Kparigu, Kpesenkpe, Tinguri, Walewale, Wulugu and Wungu zonal councils. These sub-district structures are expected to play a pivotal role in mobilizing communities and local resources to support the development goals of the Municipal Assembly.

The Municipal Chief Executive is the appointed local government head of the municipality. However, the day-to-day administration, management and co-ordination of activities, projects and programmes is coordinated by the Municipal Co-ordinating Director. The Municipality also has thirty-one (31) electoral areas which elects assembly members. Each assembly member forms a unit committee. Each electoral area has a five-member unit committee which coordinates as the basic unit in the local governance system with residents to facilitate community mobilization, public education, local revenue mobilization, environmental cleanliness, registration of births and deaths, implementation and monitoring of self-help projects among others. The municipal assembly has five main departments for the governance of the local assembly. These are Development Planning; Social Services; Works; Justice and Security; and Finance and Administration.



4

Climate Change Vulnerability of the West Mamprusi Municipal Assembly

In recent years, Ghana has embraced a multifaceted strategy on climate change policy, aimed at reducing greenhouse gas emissions and adapting to climate impacts. The Ghana National Climate Change Policy outlines a comprehensive approach to address challenges such as increasing temperatures, erratic rainfall, and sea-level rise, emphasizing the integration of climate considerations into national development plans. The policy focuses on adaptation, social development, and mitigation across critical sectors including agriculture, food security, disaster preparedness, natural resource management, and infrastructure development. Key components of Ghana's climate change strategy include:

1. **Nationally Determined Contribution (NDC):** Ghana's NDC commits to cutting greenhouse gas emissions and adapting to climate change in priority sectors like mass transit, infrastructure, land use, food production, energy, and forest and water resources management. The country targets reducing emissions by 64 million tons of CO₂ equivalent by 2030, contingent upon international support actions.
2. **National Adaptation Plan (NAP):** Ghana is developing a NAP to bolster resilience against climate impacts, using future climate projections to guide planning up to 2080. The plan will address climate change alongside global challenges such as the COVID-19 pandemic, emphasizing cross-sectoral planning and coordination.
3. **Investment Requirements:** Implementing Ghana's climate change measures, outlined in the NDC, necessitates significant investment estimated at \$9.3 billion to \$15.5 billion from 2020 to 2030. Ghana anticipates substantial international funding, highlighting the importance of innovative financial solutions and partnerships with the private sector.
4. **Challenges in Implementation:** Ghana faces challenges in enforcing climate policies, including the need for stronger political commitment, enhanced technical capacity, and improved corporate compliance. The establishment of a robust climate change regulator is crucial for monitoring and enforcing policies. Technical implementation capacities could be outsourced to private entities under regulatory oversight.
5. **Legislative Instruments (LI):** Ghana's legislative process involves multiple stages, from drafting by the Parliamentary Counsel to approval by various governmental bodies, culminating in the enactment of laws to support climate action.

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 interpretation of climate change risk and vulnerability varies across international organizations, each providing unique perspectives on these fundamental elements of climate science. According to the Intergovernmental Panel on 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. This concept encompasses the likelihood and magnitude of harmful outcomes, considering factors such as the severity of hazards, conditions of vulnerability that can amplify or mitigate risks, and the level of exposure (IPCC, 2014).

The United Nations Framework Convention on Climate Change (UNFCCC) characterizes climate change risk as the probability and severity of adverse effects from climate events on human and natural systems. Vulnerability, according to the UNFCCC, encompasses the character, magnitude, and rate of climate change faced by systems, along with their sensitivity and capacity to adapt (IPCC AR4, 2007).

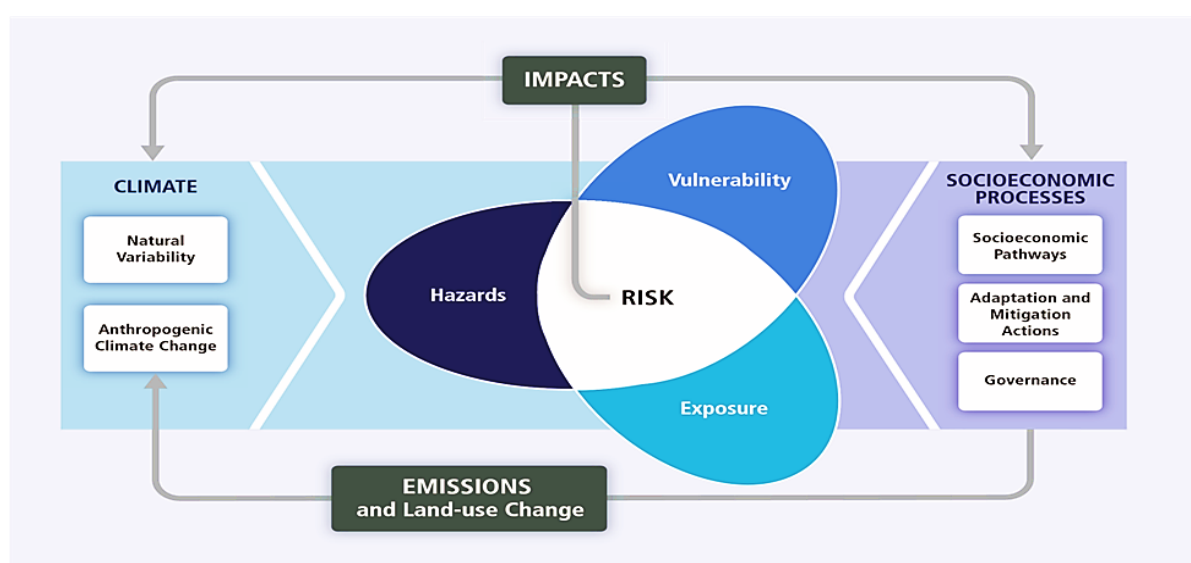
The World Health Organization (WHO) views climate change risk as the likelihood of health consequences arising from climate-related hazards such as heatwaves, floods, or disease proliferation. Vulnerability, from the WHO's perspective, focuses on the predisposition of populations to these health risks, shaped by factors like age, economic conditions, existing health conditions, and access to healthcare (WHO, 2021).

The United Nations Office for Disaster Risk Reduction (UNDRR) defines climate change risk as a combination of the frequency and intensity of climate hazards alongside human exposure and vulnerability. Vulnerability, according to the UNDRR, is influenced by physical, social, economic, and environmental factors that heighten a community's risk in the face of such hazards (UNDRR, 2022).

The World Bank's approach to climate change risk includes both transition risks associated with economic adjustments for a low-carbon transition and physical risks arising directly from climate change impacts. These risks have significant financial and socio-economic implications. The World Bank also discusses vulnerability in terms of economic resilience, highlighting how susceptible an economy is to external shocks induced by climate variability and change (Hallegatte, 2014).

Each perspective emphasizes different aspects of climate risk assessment, whether related to human health, economic systems, disaster risk reduction, or policy formulation. The IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX) and the WGII AR5 provide a comprehensive framework for understanding the potential impacts of climate change on the West Mamprusi Assembly. **(Figure 4).**

Figure 5: Risk assessment framework for evaluating climate change risks



Source: IPCC's AR 5 framework of risk assessment (Adapted from Field et al. 2014)

This framework integrates definitions that emphasize common aspects such as the potential consequences, susceptibility, and the ability to address climate change impacts. Risk and vulnerability collectively underpin assessments by the IPCC and affiliated bodies to measure and understand the potential effects of climate change. These assessments inform the formulation of strategies for adaptation and mitigation, focused on mitigating risks and bolstering the resilience of systems against climate change impacts. Specifically for the West Mamprusi Municipal Assembly, this framework fulfills several key objectives:

1. **Identifying Potential Impacts:** Understanding how climate change could affect local communities, economies, and ecosystems within West Mamprusi.
2. **Assessing Vulnerability:** Evaluating which areas or populations within West Mamprusi are most susceptible to the impacts of climate change.
3. **Evaluating Response Capacity:** Determining the ability of the municipal assembly to respond to and recover from climate-related events.
4. **Guiding Policy and Planning:** Informing the creation of policies and plans that aim to reduce risk and enhance resilience, tailored to the unique needs and capacities of West Mamprusi.
5. In the context of the West Mamprusi Municipal Assembly, the climate components include natural variability and anthropogenic climate change. West Mamprusi, like many regions, experiences natural climate fluctuations that can lead to variability in rainfall, temperature, and seasonal patterns. However, human activities such as deforestation, bush burning, and agricultural expansion significantly contribute to climate change, exacerbating the frequency and intensity of extreme weather events such as floods, droughts, and heatwaves.

The **‘Hazards’** represent these physical manifestations of climate change. For West Mamprusi, key hazards include erratic rainfall patterns leading to flooding, prolonged dry spells causing drought, and extreme temperatures affecting agricultural productivity and water availability. These hazards pose significant risks to the local population, ecosystems, and infrastructure.

‘Exposure’ in West Mamprusi refers to the presence of people, assets, and ecosystems in areas prone to climate hazards. The municipal assembly must consider how rural settlements, critical infrastructure such as health centers and schools, and agricultural lands are exposed to these risks. For example, farming communities near water bodies are particularly vulnerable to flooding, while those reliant on rain-fed agriculture face risks from drought and heat stress.

‘Vulnerability’ in West Mamprusi is shaped by social, economic, and environmental factors. High poverty levels, limited access to healthcare and education, inadequate infrastructure, and a heavy reliance on subsistence farming heighten the community’s susceptibility to climate hazards. Additionally, local capacity for adaptation—such as access to resources, technology, and skills to implement resilient infrastructure or diversify livelihoods—plays a critical role in determining vulnerability.

‘Socioeconomic processes’ further influence climate risk in West Mamprusi. Socioeconomic pathways, including population growth and land-use practices, shape the scale and nature of exposure and vulnerability. Actions taken by the municipal assembly to address these, such as implementing early warning systems, engaging communities in disaster preparedness, and promoting sustainable agricultural practices, are vital for reducing climate risks.

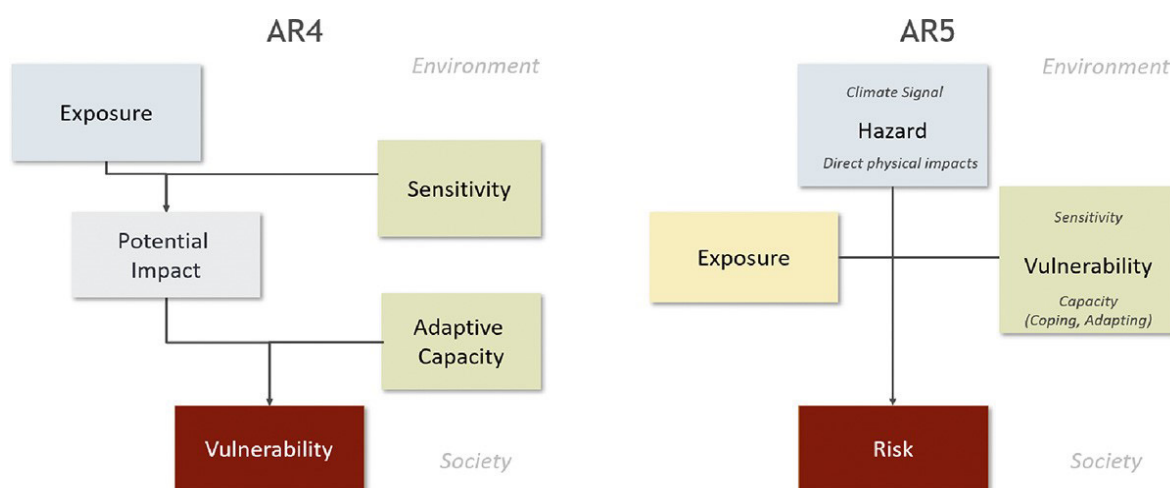
‘Emissions and land-use change’ are also pivotal in this framework. Local activities such as deforestation and charcoal production contribute to greenhouse gas emissions, while practices like reforestation and sustainable farming can mitigate emissions and enhance local climate resilience.

The **‘Risk’** is then a product of these hazards interacting with the exposed and vulnerable systems within the municipality. It represents the likelihood of adverse outcomes, including threats to human life and well-being, damage to infrastructure and property, and the degradation of ecosystems and biodiversity.

The **‘Impacts’** of climate change are evident across natural and human systems in West Mamprusi. These impacts are shaped by the intersection of climate risks with ‘Socio-economic Processes,’ including local development trends, community adaptive practices, and the effectiveness of governance structures in **managing and responding to these risks. Effective policies and coordinated actions at the municipal level are crucial to reducing these impacts and building resilience.**

It is crucial to recognize the shift in how vulnerability and risk are defined between the Fourth Assessment Report (AR4) and the Fifth Assessment Report (AR5), as illustrated in Figure 6. In the context of climate change, vulnerability to potential impacts is determined by sensitivity and adaptive capacity. Current vulnerability, however, is shaped by a combination of socioeconomic factors—such as dependence on high-risk sectors like agriculture—and the institutional capacity to manage and mitigate escalating climate-related risks, including floods and droughts.

Figure 6: Change in conceptual approach to climate change risk assessment



Source: From Zebisch *et al.* (2017)

Source: Zebisch et al., 2021

4.2 Current Vulnerability – Sensitivity and Adaptive Capacity

The current climate change vulnerability for WMMA is a measure of how likely the municipality and its people are to be adversely affected by the impacts of climate change, such as rising temperatures, changing rainfall patterns, extreme weather events, and sea level rise. The vulnerability of West Mamprusi depends on the exposure, sensitivity, and adaptive capacity of the metropolis and its sectors or systems, such as infrastructure, health, agriculture, and environment

4.2.1 Economic Vulnerability

The local economy of the municipality is dominated by Micro, Small and Medium Enterprises. The major economic activities in the municipality are include agriculture, trading in foodstuff such as maize,

beans, rice and other grains, sand winning mostly for construction work, quarrying, fishing along the White Volta, Shea processing and petty trading such as provision stores. Other economic activities include hairdressing, canteen and restaurant services, tailoring and dressmaking, metal-based-blacksmithing, welding, Art-based such as pottery, basketry, weaving, painting & sign writing, Drawing etc. The Municipality has also benefited from the government's 'one district one factory' policy with the construction of watermelon processing factory at Logari and a construction of shea nut processing factory, as the municipality urbanises.

However, poverty remains pervasive in the municipality. According to the Multidimensional Poverty Report of the municipality by the Ghana Statistical Service (GSS 2023), two-fifth (41.5%) of the population of West Mamprusi are multidimensionally poor. This means that a large proportion of the population are deprived of good living conditions, education, health, sanitation and employment. The report notes that, this is particularly much more severe in the municipal's rural areas. As well, the report notes that Multidimensional poverty is more prevalent among workers in the private informal sector, agriculture sector and household heads with no education which makes a large percentage of the population. Also, the 2022 Annual action Plan of the municipality cites the Ghana Household Registry, by reporting that 6,414 households, representing 21% of households in the municipality are leaving with extreme poverty. These households are thus very prone to livelihood stressors as poverty exacerbates vulnerability as it exposes people to the shocks of any disastrous condition.

One way of coping with underdevelopment for an active population is migration. Migration is thus a prevalent phenomenon in the West Mamprusi Municipality. Out-migration, where residents migrate out of the municipality, is very common among the economically active age group. Climatic conditions contribute significantly to this migration as many of the youth migrate to the southern parts of the country, during the dry non-farm seasons. This is because, agriculture in these areas are mainly dependent on rain for irrigation.

4.2.2 Physical Vulnerability

The topographical nature of land and proximity of the municipality to the White Volta and also, the position of the area, downstream of the Bagre dam in Burkina Faso, makes the municipality very prone to flooding. Periodic flooding severely hampers livelihoods during the rainy season. Aside from the White Volta and its tributaries overflowing their bounds, the community is also affected when the Bagre dam is regularly spilled. The flooding of the area is a great threat to food security, income and livelihood security. During floods, roads are cut off, increasing the vulnerability of the municipality as aid to affected areas are difficult to transport. Damage to roads caused by climate hazards threaten access to basic social services including health care access. Economic activities all come to a standstill, farms are flooded and eroded and households destroyed.

As a solution to the perennial floods, the government is in construction to build a multipurpose dam at Pwalugu. The dam is aimed to provide protection from the perennial floods that occur in the White Volta basin during the rainy season and help curtail the flooding from the spillage of the Bagre dam. The Pwalugu dam upon completion is also purposed to provide farmers in the area with an irrigation facility.

However, the construction of a dam poses livelihood risks to residents in the area as the architecture of a dam requires residents to be evacuated and relocated. Households, farms and enterprises in the area there will be relocated which often leads to a loss of livelihood. According to the Volta River Authority, a total of 814 households in 22 communities around the main reservoir area, will be resettled to make way for the construction of the Pwalugu Multipurpose Dam project. Although the authority plans to provide

support systems such as farms and households, experiences from the Akosombo dam, according to (De Wet 2000), reveals that some residents are very likely to not receive compensation in about five years

Further, West Mamprusi according to the Roadmap for Resilient Infrastructure report is at risk of its primary water source due reduced river runoff. The report lists West Mamprusi as part of the top ten districts with the largest number of its population affected. The result shows that over 40,000 people will be affected by a surface runoff reduction of at most 3%. The reliance of the White Volta and other rivers as primary water source, including household use, by the communities reveals the lack access to potable drinking water. The 2022 Annual Action Plan (West Mamprusi Municipal Assembly 2021) of the municipality estimates that about 40% of residents still relies on unwholesome sources of water. This is due to the fact that while some areas have access to small town water systems and boreholes, these resources are either seasonal or poor yielding, highlighting the vulnerability of residents to water access and water-borne diseases.

Shea butter tree and dawadawa trees are noted as economic trees due to the economic value of its products. However, the trees also provide economic benefit deforesters who burn to make charcoal or cut branches for firewood. Makain (2007) notes that charcoal production is considered a significant dry season off-farm economic activity in West Mamprusi. The municipality is recorded to be one of the main charcoal production areas in Ghana. However, the negative impacts of this activity on the municipality's tree cover are causing a devastating effect. According to the Global Forest Watch, West Mamprusi has lost over 42 hectares of relative tree cover, equivalent to 83% decrease since 2000. The lack of tree cover has negative effect on rainfall variability, temperature, air quality and in the case of West Mamprusi, a sustainable economic activity in shea butter processing.

Figure 7: Flood displaces household



Source: Flood victims in Walewale's - North East Region still displaced | Adom Online

4.2.3 Social Vulnerability and Adaptive Capacity

Poverty is prevalent in West Mamprusi. The municipality according to the Ghana Statistical Service (GSS 2023) is multidimensionally poor, as significant proportions of residents are deprived along three dimensions –monetary poverty, education, and basic infrastructure services. The changing climate in the Municipality has also exacerbated the situation of the poor peasant and small holder farmers, who are largely rain dependent and have limited alternative livelihood options.

Socially, the effects of such poverty is inequality in adaption to climate impacts. This is particular to gender and community minorities. Income, education, food, health and other basic infrastructure service insecure households are unlikely to be able to withstand short-term risks to their livelihoods or have the extra ability to weather long-term risks with necessary adaptation measures. One other socioeconomic indicator that is important in considering social vulnerability to climate change is population growth. Population growth increases pressure on natural and communal resources. This exacerbates climate impacts.

Studying gender dimension of vulnerability to climate change and variability in West Mamprusi, (Alhassan, Kuwornu, and Osei-Asare 2019) finds that, although the devastating effects of climate variability is impactful on all farmers, female-headed farming households are more vulnerable to climate change and variability than male-headed farming households. As well, minorities in the municipality include people living with AIDS, persons with disabilities and the aged. Due to cultural beliefs, persons living with diseases such as HIV-AIDS are isolated, decreasing their dependency on support systems and increasing their vulnerability to climate impacts. Other cultural practices such as early marriage render young females very vulnerable, uneducated and economically very reliant on their spouses. Educated farmers and persons are better positioned to understand climate change and take adaptative actions towards resilience.

The youth and economically active men and women in the municipality further also adopt dry-season migration to the South and other cities to often work as kayayei, female porters, who carry goods on their heads for a negotiated fee. However, the state kayayei in Ghana is characterised with the lack of basic amenities such as housing, healthcare, security and food, further presenting them to high risks to direct and indirect climate impacts. As a result, addressing vulnerability issues calls for a multifaceted strategy that takes into account the varied needs of the different resourced persons.



5

Observed Climate Trends at West Mamprusi Municipal Assembly

5.1 Local Level Trends

The lack of data is a significant constrain on analysing local level climate trends. Nonetheless, studies such as (Issahaku, Betey Campion, and Edziyie 2016) project that by 2040, the mean monthly minimum and maximum temperature over the Savannah Zone, in which lies West Mamprusi, is expected to increase by 1.10 °C and a maximum of 2.1 °C. This is corroborated by the (Care International 2013) which reports that the annual minimum and maximum temperatures have been increasing, at a rate of approximately 0.05 °C per year. Moreover, the report shows that the mean annual temperature in Ghana from 1961 to 2000 increased by 1.0 °C. Implying a decadal mean increase of temperature at 1.0 °C. This is further projected to be worsened at 3.0 °C by the 2060s and 5.2 °C by 2090. The trend in temperature has implication on agricultural activities as the municipality's main economic activity, agriculture, is largely rain-dependent. The decadal projected rise in temperatures could lead to increased evapotranspiration, reduced surface and underground water, leading to droughts in the long run.

According to (Abbam et al. 2018), districts in Northern Ghana including West Mamprusi municipality are observed to have experienced significant reduction in annual rainfall and rainfall variability from 1960 to 2014. This is also consistent with (Asare-Nuamah and Botchway 2019). The study observes a general annual decline in rainfall volumes in all the agroecological zones in Ghana. Reduced rainfall in the Guinea Savannah ecological zone, and West Mamprusi by extension could increase risk of vulnerability to food and livelihood insecurity as agricultural output, largely reliant on rain will be reduced or affected.

Figure 8: Average temperature in Walewale, WMMA

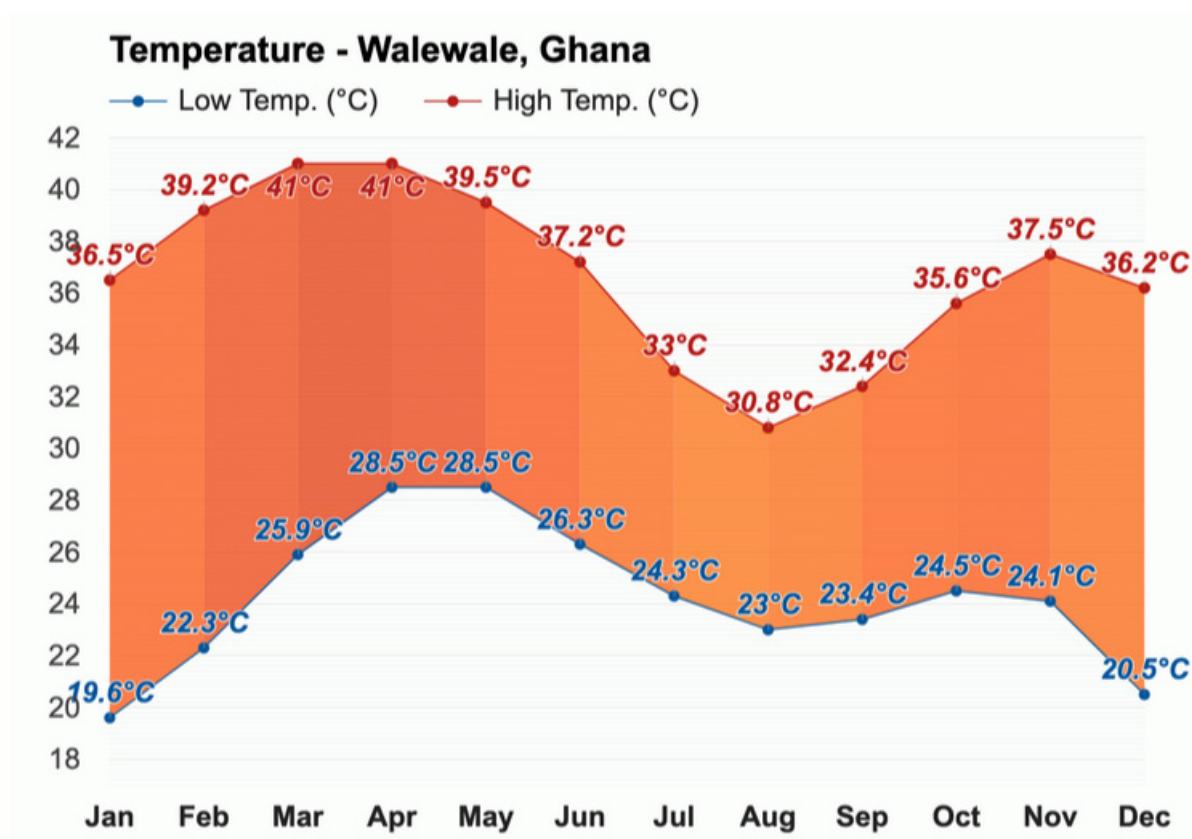
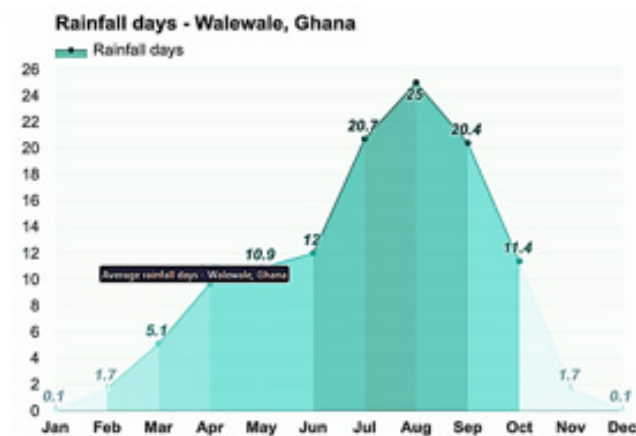
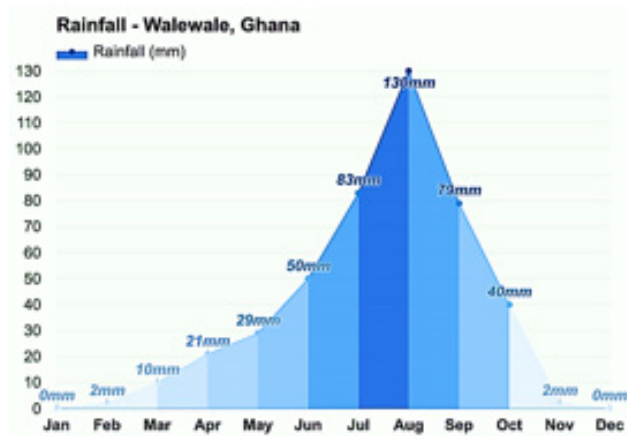


Figure 9: Average Rainfall (Left). Average rainfall days per month (Right)



Source: Weather Atlas

5.2 Observed Natural Hazard and Extreme Events

Table 1: Existing and past climate change events/occurrences at the local area

Date	Hazardous Event	Location	Impact	Reference
February 2023	Fire Outbreak	North East Region	Fire guts petrol station in Janga	https://www.asaaseradio.com/north-east-region-fire-guts-petrol-station-in-janga/ https://www.asaaseradio.com/north-east-region-fire-guts-petrol-station-in-janga/
December 2021	Bushfires	West Mamprusi	Fire destroys estimated 300 acres of maize farm belonging to peasant farmers at Nakpaya	https://www.facebook.com/adomtv/videos/west-mamprusi-farm-fire/1055999748572015/
December 2022	Domestic fires	North East Region	Fire destroys a bedroom at Walewale-Kukuazugu	https://www.ghanaweb.com/GhanaHomePage/NewsArchive/Fire-destroys-a-bedroom-at-Walewale-Kukuazugu-1688081
August 2023	Flood (torrential rainfall)	North East Region	Floods cut off Walewale from Nalerigu	https://www.graphic.com.gh/news/general-news/mamprusi-floods-cut-off-walewale-from-nalerigu.html https://www.a1radioonline.com/64075/north-east-region-flood-waters-destroy-houses-cut-off-major-road-linking-walewale-nalerigu/index.html
August 2023	Flood (torrential rainfall)	North East Region	Residents stranded as Nalerigu-Walewale road caves in after torrential rain Homes flooded and public utilities destroyed	https://www.myjoyonline.com/residents-stranded-as-nalerigu-walewale-road-caves-in-after-torrential-rain/
October, 2019	Scabies outbreak	West Mamprusi (Tinguri and Duu)	over 10 communities were affected.	https://www.myjoyonline.com/scabies-outbreak-reported-in-west-mamprusi-municipality/

August 2022	Flood (torrential rainfall)	North East Region	Many displaced after flood at Gaagbini The heavy downpour flooded almost the entire Gaagbini community destroying properties such as livestock, backyard farms and valuable items of residents	https://www.modernghana.com/news/1180095/west-mamprusi-many-displaced-after-flood-at-gaagb.html
October 2020	Flood (torrential rainfall)	North East Region	Nearly 700 residents in some communities in the West Mamprusi district are bearing the brunt of torrential flooding that has wreaked havoc in the area.	https://www.facebook.com/JoyNewsOnTV/posts/nearly-700-residents-in-some-communities-in-the-west-mamprusi-district-are-beari/4555036034568267/
November 2021	Fire Outbreak	West Mamprusi	Two children have been burnt to death as fire destroys a rice farm in Nasia in the West Mamprusi Municipality of the North East Region	https://www.asaaseradio.com/west-mamprusi-two-children-die-as-fire-destroys-rice-farm-in-nasia/
August 2010	Flood	Communities along the White and Black Voltas in the Upper East and West Mamprusi district of the Northern Region	Flood kills 2	https://www.modernghana.com/news/294729/flood-kills-2.html
March, 2023	Cerebro Spinal Meningitis out break	Northern Region including West Maprusi, East Mamprusi, Sawla Tuna Kalba	2 people died while 23 people received treatment	https://www.modernghana.com/news/159560/ten-die-of-csm-in-northern-region.html

June 2022	Flood	North East Region	Rainstorm destroys Walewale SHS building	https://www.theghanareport.com/rainstorm-destroys-walewale-shs-building/
September 2020	Flood	Northern Region	Flood, Bagre dam spillage Kill 10 in Upper East, North-East Regions	https://www.theghanareport.com/twin-disaster-flood-bagre-dam-spillage-kill-10-in-upper-east-north-east-regions/
December 2022	Bushfire	North East Region	Wildfire destroy over 40 acres of maize farm owned by MCE for West Mamprusi	https://www.ghanaweb.com/GhanaHomePage/NewsArchive/Wildfire-destroy-over-40-acres-of-maize-farm-owned-by-MCE-for-West-Mamprusi-1680491
September 2018	Flood	Northern Region	Floods kill 5, destroy 1,105 acres of arable land in Northern Region	https://otecfmghana.com/2018/09/floods-kill-5-destroy-1105-acres-of-arable-land-in-northern-region/
September 2018	Flood	Mamprusi West	Bagre Spillage Destroys 3,875 Farmlands in Mamprusi	https://dailyguidenetwork.com/bagre-spillage-destroys-3875-farmlands-in-mamprusi/#google_vignette
September 2020	Flood (torrential rains)	North East Region	Six Dead in North-East Flood, Dam Spillage	https://www.theghanareport.com/six-dead-in-north-east-flood-dam-spillage/
February 2021	Flood	North East Region	Farmers return to field after floods left them with unprecedented cost	https://www.myjoyonline.com/farmers-return-to-field-after-floods-left-them-with-unprecedented-cost/
December 2020	Bushfire	Northern Region	About 300 acres of crop farm burnt in Northern Region	https://www.myjoyonline.com/about-300-acres-of-crop-farm-burnt-in-northern-region/
August 2023	Flood	North East Region	Death toll rises to 4	https://www.myjoyonline.com/north-east-flood-death-toll-rises-to-4/
August 2008	Flood (torrential rains)	West Mamprusi	Four perished, 150 others rendered homeless by floods	https://www.myjoyonline.com/four-perished-150-others-rendered-homeless-by-floods/
October 2010	Flood	West Mamprusi	Flood victims in West Mamprusi Upset	https://savannahnewsblogspotcom.blogspot.com/2010/10/flood-victims-in-west-mamprusi-upset.html

September 2010	Flood	communities in the West Gonja District of the Northern Region	Floods submerge 65 West Gonja communities	https://www.myjoyonline.com/floods-submerge-65-west-gonja-communities/
August 2011	Flood	West Mamprusi District of the Northern Region	3 Die in Walewale Floods	https://www.modernghana.com/news/346028/3-die-in-walewale-floods.html
September 2012	Flood	West Mamprusi District of the Northern Region	Floods render markets, 27 communities inaccessible in the North	https://www.modernghana.com/news/417972/floods-render-markets-27-communities-inaccessible-in-the-no.html
September 2013	Flood (torrential rains)	East and West Mamprusi districts, including Bunkprugu and Janga	Six Dead in North-East Flood, Dam Spillage	https://www.theghanareport.com/six-dead-in-north-east-flood-dam-spillage/
August 2020	Flood (torrential rains)	Northern and North East Regions	At least 8 people have lost their lives after flooding in parts of Burkina Faso and northern Ghana, West Africa, from late August	https://floodlist.com/africa/west-africa-burkinafaso-ghana-september-2020
August 2023	Flood	North East Region	5 Confirmed Dead in North East Region Floods	https://www.peacefmonline.com/pages/local/social/202308/491821.php?storyid=100&

5.3 Future Climate Scenarios

The West Mamprusi Municipal MMDA is located in the North Climate Zone of Ghana.

In general, West Mamprusi Municipality can expect warmer temperatures across all RCP scenarios, with higher emissions leading to more substantial temperature increases. Precipitation patterns are likely to show slight increases in average annual rainfall but with significant variability in extreme events, potentially including both heavier rainfall and periods of decreased precipitation. These projections underscore the importance of adaptive strategies such as water management, agriculture practices, and infrastructure planning to mitigate the impacts of climate change in the region. The latest CMIP6 model results suggest greater climate sensitivity and more significant “wetting”, particularly over the Northern region of Ghana, which includes West Mamprusi.

Temperature Increase: Under the Representative Concentration Pathways (RCP):

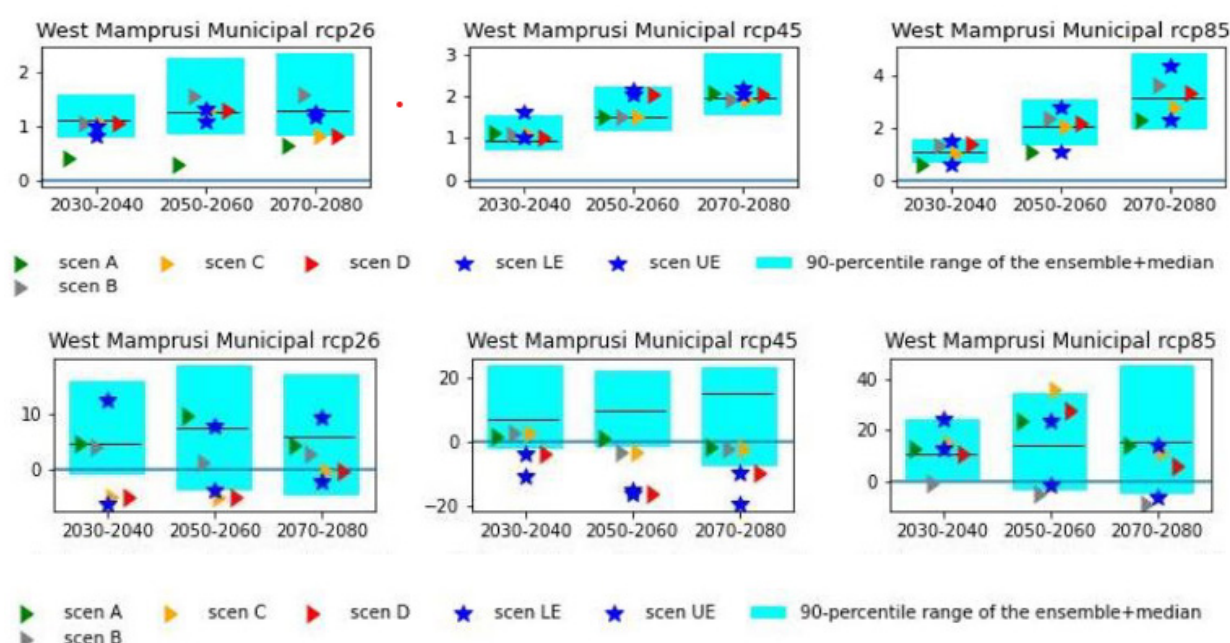
- RCP 2.6: West Mamprusi could experience an increase in temperature of approximately 1.5 °C.
- RCP 4.5: Temperature rise may be around 2.0 °C.
- RCP 8.5 scenario could lead to a temperature increase ranging from 3.5 to 4.5 °C.

- **CMIP6 Model Adjustment:** There's a suggestion of an additional 0.5 °C increase, indicating potential for even higher temperatures than previously projected, especially under higher greenhouse gas concentration scenarios.

Precipitation Changes:

- **Annual Average:** There's a slight likelihood of a 5% increase in annual average precipitation compared to current levels.
- **Extreme Events:** Precipitation extremes could see changes of up to +/- 15/20%, indicating potential for both increased and decreased precipitation events.
- **RCP 4.5 and RCP 8.5:** These scenarios suggest a significant possibility of increased rainfall, potentially up to 20% greater than current levels.

Figure 10: Change in mean annual temperature °C (up) and percentage change in total annual rainfall (down) for West Mamprusi Municipal Assembly



5.4 Downscaled Climate Change Scenarios

Temperature

Early reviewed studies show that in the future, there is a significant high likelihood increases in temperature in the Guinea Savannah zone, as well as generally in Ghana. Using random forest regression, (Dahan, Kasei, and Hussein 2023) predicts an increase in temperature Guinea Savannah zone +0.04 °C for RCP4 and +0.09 °C for RCP8.5 over the simulated period (2022–2100). (Klutse et al. 2021a) also predict that the minimum air temperature is predicted to rise by 0.5 °C under RCP 2.6 and 2.5 °C under RCP 8.5 across northern Ghana. By 2080, the maximum air temperatures are predicted to rise by 1 °C under RCP 2.6 and 2 °C under RCP 8.5. The results revealed that, minimum temperatures are rising more quickly than maximum temperatures..

Extreme Heat

Extreme heat is defined as the hot days with a maximum above 30°C. Nonetheless, (Tachie-Obeng et al. 2014) with number of cool nights becoming less frequent, especially during the Harmattan 1 period. The dry season

is expected to be warmer than the wet season, with high inter-annual variations projected in both maximum (T_T max) studying the number of days with extreme temperatures in Northern Ghana set extreme temperature threshold above 40°C. The study found that March as the hottest month, with an average day of temperature above 40°C per month in the control period of 1961-2000. The study further predicts that the number of days with extreme heat is projected to increase from 1 day per month for the control period to a peak of 12 days for near future and 23 days for far future

Precipitation

Annual precipitation does not vary significantly in Ghana. The probability of change annually is not usually higher or lower than 5%. However, long run projections such as (Dahan et al. 2024), predict long term rain volumes to decrease over the simulated period (2022–2100) in the Guinea Savannah agroecological zone

Extreme Rainfall

Klutse et al. (2021b) define heavy rainfall as days with rainfall above 10mm. The study's downscale climate scenario predicts that RCP 8.5 to have higher inter-annual heavy rainfall trends, under the business-as-usual scenario compared to that of RCP 2.6. According to BoaWest Mamprusia et al. (2020) droughts can be observed to be a regular feature of the climate of northern Ghana, occurring at alternating intervals with wet periods. Explaining a drought event, as defined by continuous negative SPI values that reach a value of -1 or less at least once during the period, and it ends when SPI becomes negative. The study identified eight (8) drought events from 1960 to 2015.

Moreover, the (Adshead et al. 2022) cites that IPCC RCP climate models estimates the number of days with extreme rainfall events are expected to increase in response to growing temperatures



6

Potential Impacts for Priority Risks Domains

6.1 Initial Assessment of Critical Climate-Related Hazards

The potential impact of climate change on the priority risk domains are described here, including: water resources, flooding, drought, wildfires, water security, agriculture and health cannot be overstated. Using the [ThinkHazard!](#) Tool, the study further conducted an assessment of critical climate related hazards in the West Mamprusi Municipal Assembly. The [ThinkHazard!](#) Tool was used to assess the severity of climate related hazards in the Municipality. The results are showed in Table 2 below;

Table 2: Critical Climate related Hazards

Hazard	River Flood	Urban flood	Water Scar- city	Extreme Heat	Wildfire
Level	High	Low	Low	High	High
Interpretation	High	Low	Low	High	High

Source: Think Hazard (Global Facility for Disaster Reduction and Recovery (GFDRR), 2022)

In the West Mamprusi Municipality area, **river flood hazard** is classified as **high** based on modelled flood information currently available to this tool. This means that potentially damaging and life-threatening river floods are expected to occur at least once in the next 10 years. Surface flood hazard in urban and rural areas is not included in this hazard classification, and may also be possible in this location. The tool however notes **medium confidence** of little change in amount or intensity of precipitation. The present hazard level may remain similar in the long-term when considering climate change only. However, changes to environment and land-use also influence how localized river flood hazard evolves into the future and alter future hazard level.

Moreover, **urban flood hazard** is classified as **low** based on modeled flood information currently available to this tool. This means that there is a chance of more than 1% that potentially damaging and life-threatening river floods occur in the coming 10 years (return period of c. 1 in 1000 years). As well, the tool also asserts medium confidence of little change in amount or intensity of precipitation. The present hazard level may remain similar in the long-term when considering climate change only. However, changes to environment and land-use also influence how localized river flood hazard evolves into the future and alter future hazard level.

Water scarcity in West Mamprusi according to the ThinkTool is classified as **low** according to the information that is currently available to this tool. This means that there is a 1% chance drought will occur in the coming 10 years. However, the tool notes that model projections are inconsistent in their estimates of change in drought hazard, which influences water scarcity. The present hazard level may increase in the future due to the effects

of climate change. It would be prudent to design projects in this area to be robust to increased drought hazard and water scarcity in the long-term.

Additionally, extreme heat hazard is classified as **high** based on modeled heat information currently available to this tool. This means that prolonged exposure to extreme heat, resulting in heat stress, is expected to occur at least once in the next five years. According to the most recent assessment report of the Intergovernmental panel on Climate Change (IPCC, 2013), continued emissions of greenhouse gases will cause further warming, and it is virtually certain that there will be more frequent hot temperature extremes over most land areas during the next fifty years. Warming will not be regionally uniform. In the area you have selected, the temperature increase in the next fifty years will be slightly lower than the worldwide average, but still significant. It would be prudent to design projects in this area to be robust to global warming in the long-term.

Moreover, the wildfire hazard is classified as **high** according to the information that is currently available to this tool. This means that there is greater than a 50% chance of encountering weather that could support a significant wildfire that is likely to result in both life and property loss in any given year. Modeled projections of future climate identify a likely increase in the frequency of fire weather occurrence in this region, including an increase in temperature and greater variance in rainfall. Further, the fire season is likely to increase in duration, and include a greater number of days with weather that could support fire spread because of longer periods without rain during fire seasons. Climate projections indicate that there could also be an increase in the severity of fire.

6.2 Priority Risk Domains

6.2.1 Water Resources

The Guinea Savannah Zone, including West Mamprusi, faces substantial challenges with water availability attributed to climate change, such as flooding and drought (Ampadu, Frimpong Boateng, and Abassa, 2018). The shifting precipitation patterns and increasing temperatures directly threaten the quantity and quality of water resources in the municipality, potentially worsening water scarcity and impacting agricultural productivity and community water supply.

Moreover, the community's reliance on the White Volta and other rivers for essential water needs, including household consumption, highlights the inadequate access to safe drinking water and increases the municipality's vulnerability to water stress exacerbated by climatic factors. During the rainy season, river flooding and overflow occur, while water quality and volume diminish during the dry season.

Additionally, projections indicate a potential 3% decrease in river runoff, further jeopardizing water availability for residents (Adshead et al., 2022). The municipality's 2022 Annual Action Plan (West Mamprusi Municipal Assembly, 2021) estimates that approximately 40% of residents still depend on unreliable water sources. Despite some regions having access to small-town water systems and boreholes, their supply remains sporadic due to prevailing climatic conditions.

Figure 11: Children fetching water at a well (left). Un-engineered dam (right)



Source: Author's Site Visit

6.2.2 Flooding

The natural topography of West Mamprusi, characterized by generally undulating terrain with occasional highlands, combined with intense rainfall events and regular overflow from the Bagre dam, makes the area highly susceptible to annual flooding. Although Abbam et al. (2018) observed significant decreases in annual rainfall and variability from 1960 to 2014 in districts across Northern Ghana, including West Mamprusi municipality, the impact of heavy rainfall days remains substantial for residents. Persistent flooding directly threatens local infrastructure and the livelihoods of the population. Roads, bridges, and buildings are vulnerable to damage, disrupting transportation networks and hindering economic activities. This situation also disrupts sectors such as trade and commerce, affecting income streams and overall economic stability.

Furthermore, floods can compromise water quality, posing significant public health risks. Inundation of sewage systems and contamination of water sources increase the likelihood of waterborne diseases. Communities in West Mamprusi that depend on local rivers for drinking water face heightened health hazards during and after flood events.

The annual recurrence of floods also erodes community resilience and adaptive capacity. The cumulative impact of frequent flooding strains local resources and heightens vulnerability to future events. Strengthening community resilience through sustainable land-use planning, early warning systems, and community involvement is crucial for mitigating the long-term effects of flooding in the region.

Figure 12: Flood cuts off highway from Walewale to Nalerigu



Source: Asaase Radio | Floods destroy Walewale-Nalerigu main road

6.2.3 Drought

Drought significantly impacts agriculture, which serves as the cornerstone of West Mamprusi's economy. Inadequate rainfall and prolonged dry periods lead to depleted soil moisture, crop failures, and reduced agricultural output. These adverse effects directly affect staple crops such as millet, sorghum, and maize, amplifying food insecurity in a municipality already grappling with multidimensional poverty (GSS, 2023). Drought, akin to floods which have recurred eight times between 1960 and 2015 according to BoaWest Mamprusia et al. (2020), challenges the resilience and adaptive capacity of communities. The strain of water scarcity and economic instability may undermine the resilience farmers have built concerning income and food security.

Moreover, the economic repercussions of drought extend beyond agriculture, affecting local livelihoods and overall community well-being. Declines in crop yields and livestock productivity not only threaten food security but also diminish household incomes and exacerbate poverty levels. Vulnerable populations, including smallholder farmers and rural households, are particularly susceptible to these impacts, further widening socio-economic disparities within the municipality. Additionally, prolonged drought conditions can strain water resources for domestic use, compounding challenges for communities already facing water scarcity issues during dry periods. Strengthening drought preparedness through sustainable agricultural practices, diversified livelihood strategies, and community-based adaptation initiatives is essential for enhancing resilience and mitigating the socio-economic impacts of drought in West Mamprusi.

6.2.4 Wildfires

West Mamprusi's economy, which relies heavily on agriculture, faces significant vulnerability from wildfires, posing a threat to the livelihoods of local communities. According to Dahan, Kasei, and Hussein (2023), fire outbreaks are most prevalent in farms and agricultural areas. Wildfires can directly destroy crops, degrade soil quality, and alter agricultural landscapes. These events not only impact agricultural productivity but also have repercussions for air quality and public health in the region. The ecological consequences of wildfires are profound as well, affecting biodiversity and ecosystems across West Mamprusi. Habitat destruction, displacement of wildlife, and loss of biodiversity disrupt the ecological

balance critical for the region's environmental health. Recognizing these ecological impacts is essential for guiding conservation efforts and promoting sustainable land management practices.

Moreover, wildfires in West Mamprusi highlight broader challenges related to climate change and land use practices. As temperatures rise and weather patterns become more unpredictable, the frequency and intensity of wildfires may increase, exacerbating risks to agricultural production and ecosystem stability. Effective wildfire management strategies, including early detection systems, community engagement in fire prevention, and restoring fire-affected landscapes, are crucial for mitigating these risks. Collaborative efforts between government agencies, local communities, and environmental organizations are necessary to develop resilient ecosystems and safeguard the livelihoods of West Mamprusi's residents. By prioritizing sustainable land practices and enhancing fire preparedness, stakeholders can work towards a more resilient future amidst evolving environmental challenges.

In addition to natural causes, wildfires in West Mamprusi Municipality are exacerbated by human activities such as bushfires for charcoal production. The practice of burning vegetation for charcoal not only contributes to the incidence of wildfires but also intensifies their impact on the environment and local communities. Charcoal production often involves clearing large areas of land through fire, which can quickly escalate into uncontrolled wildfires under dry and windy conditions. This not only poses immediate risks to agricultural lands, biodiversity, and air quality but also undermines long-term efforts in sustainable land management and conservation. Addressing the root causes of these human-induced wildfires through education, enforcement of regulations, and promoting alternative livelihoods is crucial for reducing fire incidents and fostering resilient landscapes in West Mamprusi. Efforts to promote sustainable charcoal production practices and community-based fire prevention strategies are essential for mitigating the dual challenges of wildfire risk and environmental degradation in the region.

Figure 13: Fire ravages orphanage at Yamah, Walewale



Source: Fire ravages orphanage at Yamah - Ghanaian Times

6.2.5 Agriculture

Agriculture, which forms the cornerstone of West Mamprusi's local economy, stands particularly vulnerable to the impacts of climate change. These impacts pose significant direct and indirect threats to the economic sector. The cumulative effect of climate change on agriculture in West Mamprusi directly

jeopardizes food security and the livelihoods of its residents. Decreased crop yields, disruptions in livestock farming, and heightened susceptibility to pests create a complex array of challenges.

For example, heavy rainfall leading to flooding can result in soil erosion, nutrient depletion, and crop damage, severely impacting agricultural productivity. Farmland inundation during flood events destroys crops, causing yield losses, disrupting food supply chains, and exacerbating food insecurity. Agriculture in the municipality heavily relies on rainfall, making variations in climate information and significant rainfall fluctuations reported in various studies critical factors affecting water availability for agriculture. These variations stress the sector's vulnerability, compelling farmers to adapt by adjusting planting and harvesting schedules to align with changing climatic conditions.

Rising annual temperatures, as previously noted in the Guinea Savannah zone and West Mamprusi, impose heat stress on crops, hindering their growth and development. Increased occurrences of extreme heat events can lead to diminished crop yields, particularly for heat-sensitive crops such as maize and millet. Warmer temperatures also create favorable conditions for the proliferation of pest populations, posing threats to both crops and livestock.

6.2.6 Health

The impacts of climate change are evident in both direct and indirect effects on health and health infrastructure in West Mamprusi. Temperature changes in the region contribute significantly to an increased risk of heat-related illnesses. Rising temperatures have been linked to the spread of vector-borne diseases such as cerebrospinal meningitis, which tends to proliferate during the dry season. Prolonged periods of extreme heat further exacerbate these risks, leading to conditions like heat exhaustion and heatstroke, particularly affecting vulnerable groups such as the elderly. The projected increase in both minimum and maximum daily temperatures underlines the conducive environment created for the expansion of diseases like malaria and dengue fever.

Limited access to clean water, exacerbated by extreme weather events, also heightens the risk of waterborne diseases in the region. Variations in rainfall patterns due to climate change directly impact agricultural productivity in West Mamprusi, potentially contributing to food insecurity and malnutrition. Droughts and floods can disrupt crop yields and livestock farming, affecting the availability of nutritious food. Moreover, flood events can sever road infrastructure connecting communities to Walewale, where the district hospital is located, thereby limiting access to essential health services.

Additionally, the complex interaction of climate change impacts, including extreme weather events and disruptions to livelihoods, can contribute to mental health challenges in West Mamprusi. Increased stress, anxiety, and trauma associated with climate-induced events necessitate a comprehensive approach to addressing the mental health needs of the community. While specific studies on mental health in the context of climate change in West Mamprusi may be limited, broader research underscores the critical importance of considering mental health as a fundamental aspect of climate change impacts.



7



Climate Change Risk Assessment for WMMA

7.1 Stakeholder Engagement

Stakeholder engagement in climate change vulnerability or risk assessment should be a participatory process to ensure the inclusion of diverse perspectives and knowledge, fostering more comprehensive and effective solutions. A participatory approach acknowledges the unique challenges, needs, and priorities of groups such as women, youth, and vulnerable populations in the context of climate change. Key benefits of this approach include:

- **Inclusivity:** Ensures that all voices, particularly those of marginalized and vulnerable groups, are recognized and integrated into the assessment process.
- **Equity:** Addresses power disparities by providing equal opportunities for all stakeholders to participate in discussions and decision-making.
- **Local Knowledge:** Leverages the valuable insights and traditional knowledge of local communities, enhancing the accuracy and relevance of climate risk and vulnerability assessments.
- **Ownership:** Encourages stakeholders to take responsibility for the outcomes, increasing support for and commitment to implementing adaptation strategies.
- **Resilience:** Focuses on the specific needs and capacities of diverse groups, enabling the development of more robust and sustainable responses to climate change.

As such, relevant stakeholders in the West Mamprusi Municipal Assembly were engaged in a consultative workshop dedicated to co-developing a district-specific risk and vulnerability assessment and formulating priority adaptation plans. The workshop aimed to evaluate the unique risks and vulnerabilities faced by the district, devise tailored adaptation strategies, and foster collaborative efforts towards building resilience in West Mamprusi's communities by bringing together a diverse group of stakeholders. This included 29 key participants from various sectors within the municipality, such as municipal officials, representatives from government agencies involved in climate change mitigation, traditional leaders, community groups, disability advocates, non-governmental organizations, corporate entities, and media representatives.

The participatory workshop began with an introductory session that contextualized Ghana's National Adaptation Plan process and underscored the importance of conducting a vulnerability risk assessment specific to the West Mamprusi Municipal Assembly. The session emphasized identifying key climatic hazards and vulnerable areas within the district. Subsequently, participants divided into smaller groups to pinpoint specific climatic risks, map areas and resources at risk, and exchange insights on existing community adaptation strategies.

Following these breakout sessions, participants reconvened in plenary to collectively prioritize hazards based on their severity and potential impact. Seasonal calendars detailing hazard occurrences and their implications for local livelihoods were collaboratively developed, highlighting periods of heightened vulnerability. The workshop also involved identifying and prioritizing adaptation actions tailored to sectors affected by climate

impacts, focusing on practical and locally applicable measures. Discussions encompassed the challenges associated with implementing these adaptation actions, prompting brainstorming sessions aimed at proposing viable solutions.

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Figure 14: Group picture from Stakeholder Workshop



Identification of Critical Climate Change Vulnerabilities

7.1.1 Hazard Identification and resource mapping

The participatory group discussions effectively aided in experts and members of the municipality co-identifying based on the expertise and experience with climate hazards in the municipality. The groups conducted an assessment of climate hazards in West Mamprusi Municipality, identifying and mapping extreme weather events such as floods and coastal erosion, air pollution, wildfires, windstorms, and wetlands encroachment.

Main Climate Hazards and Impacts:

Both groups identified the main climate hazards affecting West Mamprusi Municipality. The co-identified climate hazards prominent in the municipality in order of their severity and provided justifications for their assessments.

- Extreme heat – 1st
- Drought – 2nd
- Floods – 3rd
- Bushfires – 4th
- Rainstorm – 5th

- Water scarcity – 6th

These rankings provide insights into the relative severity and characteristics of each climate hazard in the area, guiding prioritization of adaptation strategies and resilience-building efforts. Extreme heat is ranked 1st due to its higher intensity, widespread impact on livelihoods, and frequent occurrence. Drought follows closely at 2nd place, noted for its widespread occurrence and high impact on agriculture and water scarcity. Floods are ranked 3rd, primarily due to their seasonal occurrence, higher impact on health, and localized nature, affecting specific locations within the municipality. Bushfires are ranked 4th, primarily due to their seasonal occurrence, impact on biodiversity, and livelihood disruptions. Rainstorms are ranked 5th due to their seasonal occurrence and higher impact on infrastructure and livelihoods. Water scarcity ranks 6th, attributed to low underground water levels and seasonal shortages.

Impacts of climate hazards

Climate hazards pose complex and interconnected impacts on both human societies and natural environments. According to stakeholder deliberations, the impacts of climate hazards in the Municipality include immediate threats such as loss of lives and properties due to floods, extreme heatwaves, and wildfires, which also lead to significant destruction of infrastructure and disruption of essential services. Waterborne diseases proliferate in flood-prone areas, while droughts and heatwaves devastate agricultural livelihoods, resulting in crop failures and economic losses. Health risks escalate with heat-related illnesses and diseases like Cerebrospinal Meningitis (CSM), exacerbated by prolonged periods of extreme heat. Habitat destruction from wildfires and altered climate conditions threaten biodiversity, potentially leading to the extinction of vulnerable species and disruptions to ecosystem functions. Soil fertility declines due to erosion from heavy rains, while increased greenhouse gas emissions from wildfires contribute to atmospheric carbon dioxide levels, further intensifying global warming.

Current Adaptation Strategies

Participants discussed various adaptation strategies currently employed in response to climate hazards. The identified diverse strategies collectively aim to build adaptive capacity and reduce vulnerability in the face of changing climate conditions

These include agricultural measures such as using early maturing crops and practicing limited irrigation farming to cope with drought conditions. Building flood-resilient infrastructure, implementing conservation aquaculture practices, and protecting water bodies address issues related to floods and water scarcity. To combat extreme heat, strategies involve constructing ventilated buildings, using electronic devices like fans and air conditioners, and changing building designs to enhance heat resilience. Additionally, efforts such as anti-bushfire campaigns, public sensitization, and enforcing bushfire laws aim to reduce the frequency and impact of wildfires. Planting windbreaks and adopting rainwater harvesting techniques further contribute to enhancing community resilience to climate hazards.

While some adaptation strategies were deemed effective, such as early maturing crops and flood barrier creation, challenges were identified. These include low adoption rates of effective measures, ineffective strategies for extreme heat like ventilated buildings, limited compliance with anti-bushfire programs, and inadequate effectiveness of strategies for water scarcity and rainstorms. Barriers to effective adaptation include financial constraints, technical knowledge gaps, climate variability affecting resource availability, and insufficient support systems for sustainable practices.

Table 3: Main Climate Hazards and Impact

CLIMATE HAZARD	ADAPTATION STRATEGY	WORKING WELL	IMPACTS	Time line changes in years		Rank	Justification
				10 – 20	10 years ago		
FLOODS	- Use of early maturing crops - Building of flood resilient infrastructure	- Working well but low adaption rate	- Loss of lives and properties - Destruction of infrastructure - Water borne diseases. - Destruction of livelihood eg farms	Low	High	3rd	- Seasonal - Higher impact on health - Limited to specific location
EXTREME HEAT	-Construction of ventilated buildings -Use of electronic gadgets eg fans, Airconditions etc	-Not effective	-Heat related diseases like CSM -Risk of fire outbreak -Extinction of some species -Stress	Low	High	1 st	- Higher intensity of heat - Widespread - High impact of livelihood
DROUGHT	-Limited irrigation farming -Protection of major water bodies -Conservation Aquaculture practices (Climate smart)	-Working but limited coverage	-Flood shortage -Loss of livelihood -Water scarcity	High	High	2 nd	- Mostly occurrence - Widespread - High impact
BUSHFIRES	-Anti-Bushfire campaign -Public sensitization -Bye laws on bushfire	-Working but low compliance	-Impact on bio-diversity -Loss of soil fertility -Destruction of livelihoods -Health related hazards -Emission of CO2	High	High	4th	- Seasonal - Widespread - Impact on biodiversity and livelihood
WATER SCARCITY	-Protection of water bodies -Limited rain water harvesting	-Not effective	-Outbreak of disease -Loss of lives and livelihoods	Low	High	6th	- Low underground water - Seasonal water shortage

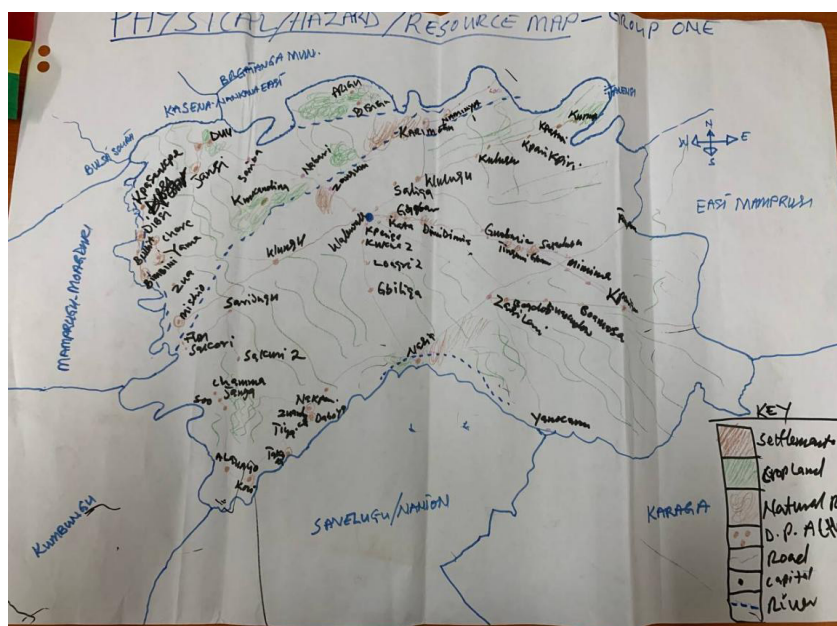
RAINSTORM	-Change of building designs -Planting wind breaks	-Working but not very effective	-Destruction of infrastructure -Loss of lives and livelihoods -Increased vulnerability	Low	High	5th	- Seasonal - Higher impact on infrastructure and livelihood
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7.1.2 Mapping of Climate Hazards in West Mamprusi Municipal Assembly

The group's mapping exercise in West Mamprusi Municipal Assembly provided valuable insights into the spatial distribution of resources, hazards, and critical infrastructure. Using a hand-sketched map, they identified key features such as crop fields, settlements, and major road networks crucial for the connectivity of the municipality with neighboring districts. Notably, the map highlighted flood-prone areas concentrated in the North-Western part, including communities like Yama, Chore, Bimbini, and Kpasenkpe, as well as several areas in the Central and Eastern parts. Lush vegetation was observed in Arigu in the Northern region, alongside significant roadways linking the municipality to its surroundings. Major communities like Walewale, Wungi, and Nabari were marked on the map, showcasing their strategic locations within the municipal boundaries.

Moreover, the mapping exercise delineated the river and water body network traversing the municipality, emphasizing their role in local geography and potential flood pathways. Specific flood-prone zones were identified, such as Mishio, Zuu, Yama, Bimbini in the Northern areas, and Kata Banawa and Gaagbeni in the southern part. This spatial analysis not only provided a visual representation of vulnerabilities but also underscored the importance of proactive planning and targeted adaptation strategies to mitigate risks posed by climate hazards like floods. By mapping out these critical elements, the group facilitated a comprehensive understanding of the municipality's geographical context, aiding in the formulation of tailored resilience measures to safeguard communities and infrastructure against future environmental challenges.

Figure 15: Resource and Hazard Mapping of West Mamprusi



7.1.3 Seasonality of Climate Risks

The results from stakeholder discussions revealed a comprehensive assessment of climate hazards within the West Mamprusi Municipal Assembly (West Mamprusi). The group discussions assigned scores to gauge the intensity and seasonality of co-identified climate hazards, in Table 4. The results showed that each of these climate hazards follows distinct seasonal patterns in the Municipality, influencing their impact on public health, safety, and infrastructure throughout the year.

1. **Extreme Heat:** This hazard shows an inverted “U” shape in terms of impact throughout the year. It starts moderately impactful in January, increases to its peak from March to April, and then gradually decreases every two months until the end of August. This period poses significant risks to public health and safety due to soaring temperatures.
2. **Flooding:** The threat of flooding intensifies from July to October, with the highest intensity in September. This period marks the peak of heavy rainfall and flood risks in the Municipality, emphasizing the need for robust flood preparedness and response strategies during these months.
3. **Dust Pollution:** Dust pollution has a high impact in the first three months of the year (January to March) but gradually declines as the year progresses. This hazard is likely influenced by seasonal weather patterns and human activities affecting air quality.
4. **Bushfires:** Similar to extreme heat, bushfires exhibit heightened activity in specific months: from March to June and again from October to December. These periods experience increased fire risks due to dry conditions and agricultural practices, necessitating proactive measures to mitigate fire hazards and protect vulnerable communities.
5. **Drought:** Droughts are prevalent from May to June and again from September to October. During these periods, the scarcity of rainfall significantly affects crop yields and livestock, posing challenges to food security and the economic stability of agricultural communities. Vulnerable groups within the community, such as smallholder farmers and pastoralists, face increased hardships as they struggle to cope with reduced water availability and diminished agricultural productivity.
6. **Water Scarcity:** This hazard is a persistent challenge throughout the year but intensifies during seasonal periods of low rainfall, exacerbating the availability of water resources. The impacts include outbreaks of waterborne diseases, loss of lives and livelihoods, particularly affecting communities dependent on limited groundwater sources and rainwater harvesting. Mitigating strategies like protecting water bodies and enhancing rainwater harvesting become crucial during these times to ensure sustainable water management practices.
7. **Rainstorms:** Rainstorms primarily occur from July to September, with their peak intensity in September. These storms pose significant risks to agricultural production and transportation infrastructure. They lead to floods that disrupt market accessibility, hinder goods distribution, and cause property damage and loss of life. Moreover, rainstorms contribute to increased vulnerability among communities, particularly those residing in flood-prone areas, necessitating effective flood preparedness and response strategies to minimize impacts on livelihoods and infrastructure.

Table 4: Seasonality calendars of Hazards

Climate Hazard	Months of the Year											
	J	F	M	A	M	J	J	A	S	O	N	D
Extreme heat	1	2	3	3	2	2	1	1			1	1
Flooding							1	2	3	2		
Dust	3	3	3	2	2	1					1	1
Bushfires	3	3	3	1						1	1	2
Drought					1	1	2	2	2	1		

Water Scarcity	1	1	3	3	2						1	1	
Rainstorm				1	1	2	2	3	3	2			

Scores: 3 = Highly impacted and vulnerable; 2 = Medium impacted; 1 = Moderately impacted and 0 = No impact

Further,

7.1.4 Vulnerability Matrix and Analysis of Hazards on Livelihoods

Further, the results from stakeholder discussions highlighted key vulnerabilities and risks across various sectors in the West Mamprusi Municipal Assembly (West Mamprusi), particularly in the Agriculture, Biodiversity, Fisheries, Gender and Trade sectors

Agriculture Sector: The group outlined significant risks and vulnerabilities affecting agriculture, including rainstorms, floods, droughts, soil erosion, and extreme temperatures. These hazards are exacerbated by causes such as water body siltation, deforestation, heavy rainfall, and poor soil preparation techniques. Vulnerable groups identified include children, women, persons with disabilities, and the elderly. Strategies proposed to mitigate these risks include cultivating on higher lands to minimize flood impacts, using early maturing crop varieties to combat droughts, and planting trees as windbreaks against rainstorms. Additional measures such as climate change radio sensitization, community afforestation campaigns, and training on effective land preparation techniques have been prioritized.

Biodiversity: Biodiversity faces significant stress from bushfires and deforestation, impacting ecosystem stability and resilience. The sector is vulnerable to floods, rainstorms, extreme heat, bushfires, droughts, water scarcity, and deforestation, leading to habitat destruction and biodiversity loss. Urgent interventions are required to enhance resilience and adaptive capacities, including sustainable land management practices, biodiversity conservation initiatives, and policies to mitigate climate impacts.

Trade: The trade sector encounters multiple climate risks such as floods, rainstorms, extreme heat, and droughts, which disrupt infrastructure and economic activities. These hazards contribute to decreased market accessibility, disrupted supply chains, and increased operational costs. Measures to build resilience include infrastructure development, disaster preparedness plans, and diversification strategies to mitigate climate-related risks.

Gender: Gender considerations revealed heightened vulnerability across all climate factors, scoring the highest total of 18 in the vulnerability matrix. Women, children, and other vulnerable groups are disproportionately affected by floods, rainstorms, extreme heat, bushfires, droughts, and water scarcity. These hazards exacerbate existing gender inequalities, impacting livelihoods, health, and economic opportunities. Addressing these vulnerabilities requires gender-sensitive policies, capacity-building programs, and inclusive climate adaptation strategies to empower vulnerable groups and reduce their exposure to climate risks.

Both groups highlighted multifaceted factors exacerbating these vulnerabilities, including deforestation, wetland encroachment, overfishing, and extreme weather events. Vulnerable groups identified include residents along the the aged, persons with disabilities, women, children, and migrants.

Table 5: Vulnerability Matrix of Sectors

SECTORS	CLIMATE FACTORS						
	Flood	Rainstorm	Extreme heat	Bush fires	Droughts	Water scarcity	Deforestation
Agriculture	3	3	2	3	3	2	2
Biodiversity	2	2	2	3	2	1	3
Trade	3	3	3	3	2	2	
Gender	3	3	3	3	3	3	

Scores: 3 = Highly impacted and vulnerable; 2 = Medium impacted; 1 = Moderately impacted and 0 = No impact

The impact of climate hazards on livelihood strategies in West Mamprusi Municipality spans across various sectors, influencing activities crucial for community health, economic stability, and environmental sustainability. Stakeholders also explored how climate risks affect livelihood activities such as health education, outreach services, desilting of gutters, sanitary interventions, waste evacuation, petty trading, livestock/poultry farming, and crop production.

Health Education: The health education sector, crucial for community well-being, faces significant disruptions due to climate hazards prevalent in West Mamprusi. During the rainy season, which peaks from July to September, floods pose a high risk, impacting health services and hindering community engagement efforts. Extreme heat throughout most months of the year exacerbates health risks, compromising outreach services and educational campaigns aimed at promoting community health.

Outreach Services: Community outreach services, essential for disseminating information and resources, are particularly vulnerable to seasonal climate hazards. Floods and rainstorms, prevalent from June to August, disrupt outreach efforts and hinder community participation in educational activities and developmental programs. These challenges underscore the need for adaptive strategies to ensure continuity and effectiveness of outreach services despite climatic disruptions.

Desilting of Gutters: The desilting of gutters is crucial for flood mitigation, especially at the onset of the rainy season. Increased rainfall from July to September heightens the need for effective gutter maintenance to prevent flooding and minimize infrastructure damage. Challenges in desilting operations during this period impact flood resilience efforts and necessitate proactive measures to manage water drainage effectively.

Sanitary Interventions: Sanitary interventions, aimed at improving waste management and sanitation practices, face heightened challenges during the rainy season, particularly from July to September. Increased rainfall exacerbates waste pollution and sanitation issues, posing health risks and complicating efforts to maintain clean and hygienic environments. Addressing these challenges requires robust strategies to ensure sanitation infrastructure resilience and community health protection.

Evacuating of Waste: The evacuation of waste, essential for maintaining clean and healthy environments, encounters seasonal challenges influenced by climate hazards. During the months of July to September, floods and rainstorms disrupt waste management efforts, leading to increased waste pollution and health complications. Effective waste evacuation strategies are essential to mitigate environmental degradation and safeguard community health amid climatic variability.

Petty Trading: Petty trading activities, crucial for local economic livelihoods, are impacted by climate hazards such as floods, extreme heat, and droughts. Disruptions in market access and operational challenges during the rainy season affect trade dynamics and income generation opportunities. Sustainable economic strategies and resilience-building initiatives are essential to mitigate climate impacts and support livelihood sustainability in the face of environmental challenges.

Livestock/Poultry: Livestock and poultry farming, integral to rural livelihoods, face significant risks from climate hazards including floods, extreme heat, and droughts. Seasonal variability in rainfall patterns affects fodder availability, water resources, and animal health, posing challenges to livestock management and productivity. Adaptive farming practices and climate-resilient strategies are crucial to enhance the resilience of livestock and poultry farming systems amidst changing climatic conditions.

Farming/Crop Production: Farming and crop production, central to agricultural livelihoods, are vulnerable to climate risks such as floods, droughts, and extreme temperatures. The agricultural cycle, which peaks from April to November, aligns closely with seasonal climate patterns, influencing planting, harvesting, and yield outcomes. Climate-smart agricultural practices, early warning systems, and diversified cropping strategies are essential to mitigate risks and ensure food security in the region.

Table 6: Vulnerability Matrix of of Livelihoods Strategies

Impact on Livelihood												
Sector	Months of the Year											
	J	F	M	A	M	J	J	A	S	O	N	D
Health Education	1	1	1	1	1	1	3	3	3	2	1	1
Outreach Services	1	1	1	1	1	1	3	3	3	2	1	1
Desilting of Gutters	1	1	1	2	2	3	3	3	3	2	1	1
Community durbar	1	1	1	1	1	1	3	3	3	2	1	1
Sanitary Interventions	1	1	1	1	2	2	3	3	3	3	1	1
Evacuating of Waste	1	1	1	1	1	2	3	3	2	2	1	1
Petty trading	3	1	2	1		1	1	3	3	2	1	
Livestock/ Poultry	1	3	3	2	1	1	1	1	1			
Farming/Crop Production			2	2	1	2	1	2	2	2		1

7.1.5 Gender-specific vulnerability assessment

Climate change does not affect all communities equally, its impacts are often felt more acutely by vulnerable groups as well as marginalized communities with limited access to resources and adaptive capacity (IPCC, 2021). In West Mamprusi, this unequal vulnerability is evident in the varying levels of exposure, sensitivity, and adaptive capacity among different demographic groups.

Women, children, the elderly, and people with disabilities are particularly vulnerable due to their high sensitivity to climate hazards, such as erratic rainfall and increased temperatures, combined with limited adaptive capacity. These groups often rely heavily on agriculture and live in areas with poor infrastructure

and minimal access to healthcare, which exacerbates their vulnerability. The lack of accessible infrastructure, such as roads, shelters, and transport, makes it difficult for them to respond effectively to climate events, leaving them at higher risk of suffering from floods, droughts, and other extreme weather conditions.

In contrast, youth and men in West Mamprusi show lower levels of vulnerability. Youth, benefiting from social mobility opportunities and lack of dependents have a moderate level of vulnerability. They can potentially diversify their livelihoods or migrate away from high-risk areas, which provides them with more adaptive capacity. Men, with greater access to resources and infrastructure, particularly in agricultural sectors, experience lower overall vulnerability. However, they are not immune to the effects of climate change, as they still face challenges such as poor infrastructure, which can disrupt access to markets and livelihoods. Overall, the Gender-specific vulnerability assessment underscores the need for tailored climate adaptation strategies that address the specific vulnerabilities and capacities of these diverse groups in West Mamprusi, focusing on improving access to resources and alternative livelihoods, infrastructure access, access to services and resilience-building initiatives for those most at risk.

Table 7: 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 Residents deprived along three dimensions –monetary poverty, education, and basic infrastructure services	High	High	Low	High	Women, children, and the elderly in West Mamprusi face high exposure and sensitivity to climate impacts. These groups are often less resourced with essential resources such as monetary income, access to own land, education, and basic infrastructure services, which reduces their adaptive capacity. Their overall vulnerability remains high, as they are more likely to cope with the impact of climate-related risks with limited access to coping resources
Youth	Erratic rainfall, increased temperatures Residents deprived along three dimensions –monetary poverty, education, and basic infrastructure services	High	Medium	Medium	Medium	The youth have high exposure to climate hazards but moderate sensitivity, as they often benefit from social mobility opportunities like migration and free senior high boarding schools. Also, the youth have relatively less to no number of dependents. However, challenges like disruptions such as youth unemployment can still amplify their vulnerability.
People with disability	Erratic rainfall, increased temperatures Residents deprived along three dimensions –monetary poverty, education, and basic infrastructure services	High	Very high	Very Low	Very high	PwDs are extremely vulnerable to climate change in West Mamprusi, with very high sensitivity and very low adaptive capacity. This stems from their high dependence on others for daily support and access to resources. The lack of specialized services and support systems leaves PwDs disproportionately affected by climate-related risks, often trapping them in cycles of poverty and exclusion. For instance, in times of climate-induced disasters, the lack of accessible shelters and evacuation routes compounds their vulnerability, as they are unable to move swiftly or safely.

Group	Hazard Description	Exposure	Sensitivity	Adaptive Capacity	Overall Vulnerability	Comments/Impacts
Men	Erratic rainfall, increased temperatures Residents deprived along three dimensions –monetary poverty, education, and basic infrastructure services	High	Medium	High	Low	Men in West Mamprusi face high exposure to climate hazards but have relatively lower vulnerability due to moderate sensitivity and higher adaptive capacity. Men are more likely to engage in income-generating activities such as farming but typically have better access to resources, networks, and infrastructure to adapt to climate risks. Additionally, they tend to have fewer dependents and greater decision-making autonomy, allowing them to respond more effectively to challenges posed by erratic rainfall and rising temperatures.

7.1.5 Roles of Stakeholders and Challenges in implementing adaptation actions for the West Mamprusi Municipal Assembly

Stakeholders play a crucial role in addressing challenges in implementing adaptation actions for the West Mamprusi Municipal Assembly. To ensure sustainable development and resilience in the face of climate change impacts.

Roles of Stakeholders: Stakeholders identified through an individual quick survey, institutions involved in climate adaptation efforts within the West Mamprusi Municipal Assembly. The analysis revealed that the identified roles of stakeholders encompass environmental protection, promoting youth and women in agricultural development, disease prevention, local government interventions, and disaster prevention. Stakeholders from institutions such as the Department of Agriculture, Forestry Department, Fisheries, NADMO, NGOs focused on agriculture and climate activities, the Environmental Protection Agency, traditional authorities, assembly members, and the media contribute through supervision, coordination, and direct operational involvement. They collectively aim to educate communities about climate risks, promote food security, advance sustainable agriculture, engage in disaster prevention, sensitize the public, and collaborate extensively with other stakeholders to build resilience and mitigate climate impacts.

Challenges in Implementing Climate Adaptation Actions: However, implementing adaptation actions faces severe challenges. Challenges constraining implementing adaptation actions include;

- **Bush fires and animal destruction of tree seedlings:** Frequent bush fires and animals grazing on young tree seedlings pose significant threats to reforestation efforts and tree cover preservation, hindering initiatives aimed at mitigating climate risks.
- **Water availability for seedlings during dry seasons:** Inadequate water supply for seedlings during dry seasons limits successful planting and survival rates, impacting agriculture and afforestation programs that depend on consistent water access.
- **Inadequacies in tractor services and combine harvesters:** Limited availability and access to agricultural machinery like tractors and combine harvesters delay planting and harvesting schedules, affecting agricultural productivity and food security efforts.
- **Resource constraints and logistical limitations:** Insufficient financial resources, coupled with logistical challenges in transporting equipment and supplies to remote areas, hamper the effective implementation of adaptation measures and community resilience-building efforts.
- **Capacity gaps in climate change knowledge and adaptation planning:** Limited knowledge and skills among stakeholders regarding climate change dynamics, adaptation strategies, and effective planning impede the development and implementation of robust climate resilience programs.
- **Occasional lack of cooperation from communities:** Resistance or reluctance from local communities to participate in adaptation initiatives due to varying perceptions, cultural factors, or communication gaps undermines collaborative efforts and community engagement strategies.
- **Erratic rainfall patterns and floods disrupting activities:** Unpredictable rainfall patterns and increased frequency of floods disrupt agricultural activities, infrastructure development, and other adaptation projects, leading to setbacks and increased vulnerability.

- **Need for comprehensive strategies to overcome barriers:** The complex nature of climate change impacts requires holistic strategies that address interconnected challenges such as environmental degradation, socio-economic vulnerabilities, and institutional capacities.
- **Mode of community entry and communication skills affecting engagement:** Challenges in effectively communicating adaptation strategies and building trust with communities due to inadequate communication skills or inappropriate community entry methods hinder the adoption and success of adaptation initiatives.
- **Logistics, physical tools, and transportation challenges for on-the-ground implementation:** Difficulties in procuring and maintaining necessary physical tools, equipment, and transportation infrastructure for implementing adaptation measures in remote and rural areas constrain operational effectiveness and timely project delivery.



8



Conclusions & Recommendations

8.1 Future Climate Scenarios for West Mamprusi Municipal Assembly

Future climate projections for West Mamprusi Municipality in Ghana's North Climate Zone indicate significant temperature increases under Representative Concentration Pathways (RCP) scenarios. Temperatures are expected to rise by approximately 1.5 °C under RCP 2.6, 2.0 °C under RCP 4.5, and between 3.5 to 4.5 °C under RCP 8.5, with potential additional increases suggested by CMIP6 models. Precipitation patterns are likely to show a slight average annual increase of about 5%, alongside increased variability in extreme events, potentially leading to both heavier rainfall and periods of decreased precipitation. Extreme heat events, defined as days exceeding 40°C, are projected to increase significantly. These projections underscore the critical need for adaptive strategies such as improved water management, resilient agriculture practices, and robust infrastructure planning to mitigate the impacts of climate change in the region effectively.

In summary, future climate projections for the West Mamprusi Municipality, located in the North Climate Zone of Ghana, indicate significant changes in temperature and precipitation patterns under various scenarios:

1. Temperature Increase:

- **RCP 2.6:** Temperatures could increase by approximately 1.5 °C.
- **RCP 4.5:** Expect a rise of about 2.0 °C.
- **RCP 8.5:** Higher emissions scenario could lead to a temperature increase ranging from 3.5 to 4.5 °C.
- **CMIP6 Model Adjustment:** Suggests an additional 0.5 °C increase, potentially resulting in even higher temperatures, especially under high greenhouse gas concentration scenarios.

2. Precipitation Changes:

- **Annual Average:** A slight increase of around 5% in average annual precipitation compared to current levels is projected.
- **Extreme Events:** Significant variability in extreme precipitation events, with potential changes up to +/- 15-20%. This variability could mean both heavier rainfall events and periods of decreased precipitation.
- **RCP 4.5 and RCP 8.5:** These scenarios suggest a substantial possibility of increased rainfall, potentially up to 20% greater than current levels.

3. Extreme Heat:

- Studies suggest an increase in extreme heat events (days with maximum temperatures above 40°C), with projections indicating a rise from 1 day per month historically to possibly 12 to 23 days per month in the future, depending on the emission scenario.

4. Implications for Adaptation:

- Given the projected changes, adaptive strategies such as improved water management, resilient agricultural practices, and robust infrastructure planning are crucial to mitigate the impacts of climate change in the region.
- The projected increases in temperature and variability in precipitation underscore the need for flexible and adaptive approaches to climate resilience.

These projections highlight the urgency for proactive measures in West Mamprusi Municipality and similar regions to prepare for and mitigate the anticipated effects of climate change, particularly focusing on sectors vulnerable to temperature extremes and variable precipitation patterns.

8.2 Current and Future Climate Related Risks

The climate risk assessment for the West Mamprusi Municipal Assembly was co-generated through a collaborative and participatory process, echoing the methodologies highlighted (Figure 2). Local stakeholders, including community leaders, environmental experts, and representatives of vulnerable groups through consensus, highlighted the contextual climate risks specific to West Mamprusi. West Mamprusi's climate risk assessment has identified several first and second-order priority risk domains based on the locale's specific vulnerabilities:

- Extreme heat – 1st
- Drought – 2nd
- Floods – 3rd
- Bushfires – 4th
- Rainstorm – 5th
- Water scarcity – 6th

Key findings from the assessment across various sectors highlight significant vulnerabilities and the urgent need for targeted adaptation strategies:

Agriculture Sector

The agriculture sector faces challenges from unpredictable rainfall patterns, including erratic onset, distribution, and duration. These variations can adversely affect traditional crop varieties that rely on longer growing seasons. Additionally, extreme weather events such as floods and prolonged dry spells pose significant threats to crop yields, food security, and livestock health.

The agriculture sector also contends with challenges related to extreme heat, which can accelerate crop maturation and reduce yields. High temperatures during critical growth stages can lead to crop stress, affecting productivity and food supply. Additionally, prolonged dry spells exacerbate water scarcity, impacting both crop growth and livestock health. Promoting climate-resilient farming practices and diversifying crop varieties can help mitigate these risks, ensuring sustainable agricultural production despite unpredictable climate patterns.

Settlements Sector

Settlements are increasingly vulnerable to climate change, particularly due to the heightened frequency and intensity of flooding events. These floods often lead to the destruction of housing and infrastructure, exacerbating risks for communities living in low-lying areas. Moreover, rising temperatures can impact building materials and infrastructure stability, posing additional challenges for urban planning and development.

West Mamprusi faces unique settlement challenges to climate change impacts. Flooding is a significant concern, exacerbated by heavy rainfall during rainy seasons and inadequate drainage systems. This further intensifies vulnerabilities, with informal settlements and poor infrastructure heightening risks for residents.

Disaster Risk Reduction Sector

The disaster risk reduction sector highlights vulnerabilities exacerbated by climate change, including inadequate public education and leadership during extreme weather events. These factors contribute to increased risks for communities in disaster-prone areas, emphasizing the need for comprehensive disaster preparedness and effective response strategies.

Effective disaster risk reduction in the face of climate change requires not only proactive measures but also inclusive community engagement and capacity building. Vulnerable communities often lack access to timely information and resources during emergencies, increasing their exposure to risks. Implementing inclusive disaster preparedness programs, strengthening early warning systems, and fostering community-based resilience initiatives are essential steps toward reducing vulnerability and enhancing adaptive capacity.

Transport Sector

Transportation systems are significantly affected by climate-related challenges such as floods, which disrupt road access and market connectivity. These disruptions can hinder the flow of goods and services, impacting economic activities and community resilience. Extreme weather events like heavy rains further exacerbate risks, necessitating resilient infrastructure and improved emergency response measures.

Health Sector

In the health sector, climate change manifests through disruptions in service delivery during intense rainy seasons and extreme heatwaves. Floods can compromise healthcare facilities and access to medical services, while heat-related illnesses pose health risks to vulnerable populations. Addressing these challenges requires resilient infrastructure and expanded healthcare resources to ensure continuous service delivery and community health resilience.

Biodiversity Sector

The biodiversity sector faces threats from activities like deforestation and bushfires, which diminish ecosystem stability and biodiversity. These factors contribute to environmental degradation and habitat loss, impacting wildlife populations and ecosystem resilience. Implementing measures such as anti-bushfire laws and reforestation efforts are crucial for preserving biodiversity and enhancing ecosystem resilience against climate impacts.

Gender Sector

Climate change exacerbates vulnerabilities within the gender sector, particularly affecting youth and elderly populations. Climate-induced migration increases risks for vulnerable groups, while limited access to resources and education further compounds challenges. Implementing gender-responsive strategies such as alternative

livelihood opportunities and education initiatives can mitigate these risks and enhance resilience among vulnerable communities.

Gender dynamics intersect with climate change impacts, amplifying vulnerabilities among marginalized groups. Women, particularly in rural areas, face compounded challenges due to limited access to resources and decision-making processes. Climate-induced migration further strains livelihoods, impacting women's economic stability and health outcomes. Empowering women through education, livelihood support, and gender-responsive policies not only builds resilience but also fosters sustainable development, ensuring equitable adaptation and mitigation strategies that benefit entire communities.

Water Resources Sector

The water resources sector faces challenges such as contamination of water bodies during floods and depletion of water sources during droughts. These events compromise water quality and availability, impacting community health and livelihoods. Effective water management practices and policies, including rainwater harvesting and watershed protection, are essential for ensuring water security and resilience against climate variability.

Managing water resources amidst climate variability involves addressing multiple challenges, including pollution from urban runoff and agricultural activities. Inefficient water use and infrastructure limitations exacerbate water scarcity during droughts, affecting both rural and urban populations. Integrated water management approaches that promote sustainable practices, such as watershed management and water conservation, are crucial for enhancing water security and resilience to climate impacts. Strengthening governance frameworks and community participation in water resource management can foster adaptive capacity and ensure equitable access to clean water.

8.3 Co-developed, Potential Adaptation Options

The study additionally co-developed with stakeholders, recommended adaptation measures tailored to address specific vulnerabilities and capacities within West Mamprusi Municipal Assembly (**Appendix B**). While ensuring scalability and integration with broader climate resilience efforts. The approach not only aims to mitigate immediate climate impacts but also aims to enhance long-term adaptive capacity and resilience. The strategies are organized into strategic categories aligned with key sectors:

- Agriculture
- Settlements
- Disaster Risk Reduction
- Transport
- Health
- Biodiversity
- Gender
- Water resources and water systems

These sectors are pivotal to the socio-economic and environmental framework of the West Mamprusi Municipal Assembly. Each adaptation strategy is dynamic, addressing the interconnect challenges and specific

requirements of these sectors. This approach aims to foster resilience and sustainability in response to the changing climate conditions.

Agriculture

- Cultivate early maturing crop varieties that require shorter growing seasons to mitigate risks associated with unpredictable rainfall patterns and ensure harvests before prolonged dry spells.
- Promote the use of indigenous rain harvesting technologies on farms to enhance water availability during dry periods and reduce dependency on erratic rainfall.
- Educate farmers on climate-smart agriculture practices, including soil conservation techniques and efficient water management strategies, to improve resilience against extreme weather events.
- Provide subsidies and incentives for the adoption of drought-resistant crop varieties and improved seeds that can withstand water scarcity and temperature fluctuations.
- Establish farmer training programs to build capacity in adaptive farming techniques, such as crop diversification and integrated pest management, to enhance agricultural productivity and sustainability.

The proposed adaptation actions in the agriculture sector, such as cultivating early maturing crop varieties and promoting indigenous rain harvesting technologies, are expected to significantly enhance resilience against climate risks. By diversifying crop varieties and adopting climate-smart agricultural practices, farmers can mitigate the impacts of unpredictable rainfall patterns and prolonged dry spells. This approach not only reduces vulnerability to weather extremes but also improves crop yields and food security. Additionally, training programs on adaptive farming techniques empower farmers to effectively manage climate-related risks, thereby fostering sustainable agricultural development and resilience in the face of changing climatic conditions.

Settlements

- Construct flood-resilient infrastructure such as elevated buildings, flood barriers, and drainage systems to minimize damage from increased flooding events.
- Implement green infrastructure initiatives, including the planting of trees and creation of urban green spaces, to improve water retention, reduce heat island effects, and enhance overall resilience.
- Enforce stringent building codes and regulations that restrict construction in high-risk flood zones and ensure new developments adhere to climate resilience standards.
- Promote community-based disaster preparedness and resilience-building activities, including training programs on flood preparedness and response.
- Integrate climate considerations into urban planning processes to prioritize sustainable land use, resilient infrastructure, and equitable development.

Implementing flood-resistant infrastructure and green infrastructure initiatives in urban settlements is anticipated to yield substantial benefits in enhancing resilience to climate impacts. By constructing elevated buildings, flood barriers, and improving drainage systems, communities can mitigate the adverse effects of increased flooding events. Planting trees and creating urban green spaces not only improves water retention and reduces urban heat islands but also enhances overall community well-being. Strengthening building regulations and promoting disaster preparedness activities further reinforces resilience, ensuring that urban areas in savannah zones like West Mamprusi are better equipped to withstand climate-related hazards and promote sustainable urban development.

Disaster Risk Reduction

- Conduct comprehensive public education campaigns to raise awareness about climate-related risks and hazards, emphasizing proactive measures for disaster preparedness and response.
- Establish and train community-based disaster volunteer groups to strengthen local capacity for emergency response and disaster management.
- Enhance early warning systems through the installation of weather monitoring stations and the development of robust communication networks to disseminate timely alerts.
- Facilitate community engagement and participation in disaster-risk reduction initiatives, promoting inclusive decision-making and resilience-building activities.
- Integrate climate resilience into national and local development plans, policies, and strategies to mainstream disaster risk reduction and climate adaptation efforts.

The proposed actions in disaster risk reduction, such as public education campaigns, establishment of disaster volunteer groups, and enhancement of early warning systems, are critical in reducing vulnerability to climate-related disasters. By raising awareness and improving preparedness among communities, these initiatives empower individuals to respond effectively to emergencies and minimize risks. Strengthening early warning systems ensures timely dissemination of crucial information, enabling proactive measures and swift responses during extreme weather events. Integrating climate resilience into national and local policies further supports adaptive capacity, fostering resilience and reducing disaster impacts across vulnerable regions.

Transport sector

- Develop and maintain resilient transportation infrastructure, including roads, bridges, and railways, using climate-resilient design principles and materials.
- Implement alternative transportation routes and emergency evacuation plans to ensure continuity of essential services during extreme weather events.
- Improve early warning systems and information dissemination mechanisms to alert travelers and stakeholders about weather-related risks and road conditions.
- Enhance the capacity of transportation agencies and emergency response teams to coordinate and manage responses to climate-related disruptions.

Investing in resilient transportation infrastructure and improving emergency response measures is essential for mitigating climate-related disruptions in the transport sector. By constructing and maintaining flood-resilient roads, bridges, and railways, communities can ensure continuous access to essential services and economic opportunities during extreme weather events. Developing alternative transportation routes and enhancing early warning systems enhances safety and mobility, reducing the socio-economic impacts of climate hazards. Promoting sustainable transport solutions not only reduces carbon emissions but also enhances resilience, ensuring reliable transport networks that support economic development and community resilience.

Health Sector

- Expand healthcare facilities and services in climate-vulnerable areas to ensure continuous access to medical care during extreme weather events and health emergencies.

- Improve healthcare infrastructure to enhance resilience against climate impacts, including floods, heatwaves, and disease outbreaks.
- Strengthen public health surveillance and early warning systems to detect and respond to climate-related health risks and emergencies.
- Educate healthcare workers and communities on climate-sensitive health issues, preventive measures, and adaptive strategies.
- Integrate climate resilience into health policies and programs, including disaster preparedness and response plans, to safeguard public health and improve community resilience.

Enhancing healthcare infrastructure resilience and promoting climate-sensitive health interventions are crucial for mitigating the impacts of climate change on public health. By expanding healthcare facilities in vulnerable areas and retrofitting buildings to withstand climate extremes, communities can maintain continuity of medical services during emergencies. Educating healthcare workers and communities on climate-related health risks and preventive measures improves health outcomes and resilience. Integrating climate resilience into health policies and programs ensures adaptive capacity, safeguarding public health and enhancing community resilience to climate impacts.

Biodiversity

- Enforce and strengthen regulations to prevent illegal activities such as deforestation, poaching, and habitat destruction, which threaten biodiversity and ecosystem resilience.
- Implement habitat restoration and conservation initiatives, including reforestation, protected area establishment, and sustainable land management practices.
- Foster community disaster volunteer groups and engagement in biodiversity conservation through education, training, and participatory decision-making processes.
- Promote sustainable agriculture and forestry practices that conserve biodiversity, enhance ecosystem services, and support climate resilience.
- Monitor and assess biodiversity indicators to track ecosystem health, identify threats, and inform adaptive management strategies.

Implementing conservation and restoration initiatives in the biodiversity sector plays a pivotal role in mitigating climate impacts and preserving ecosystem resilience. By enforcing anti-bushfire laws, restoring habitats, and promoting sustainable land management practices, communities can safeguard biodiversity and ecosystem services. These actions not only protect endangered species and habitats but also enhance ecosystem resilience to climate change. Engaging communities in biodiversity conservation fosters stewardship and resilience, promoting sustainable livelihoods and maintaining ecological balance amidst climate variability.

Water Resources Sector

- **Implement rainwater harvesting systems and decentralized water storage solutions to enhance water availability and resilience** during droughts and water scarcity.
- Protect and restore natural water systems, including rivers, wetlands, and watersheds, to maintain water quality, biodiversity, and ecosystem services.

- Improve water infrastructure and management practices, such as efficient irrigation techniques and sustainable water use strategies, to optimize resource allocation and reduce climate impacts.
- Strengthen governance frameworks and regulatory mechanisms for integrated water resource management, including watershed management and pollution control.
- Foster community participation and stakeholder engagement in water governance and decision-making processes to enhance resilience and **equity in water management**.

Implementing the proposed adaptation actions in the water resources sector is expected to significantly enhance resilience to climate change impacts on water availability and quality. By implementing rainwater harvesting systems and decentralized water storage solutions, communities can improve water security during droughts and reduce dependency on external water sources. Protecting and restoring natural water systems, such as rivers and wetlands, preserves biodiversity and enhances ecosystem services crucial for water quality and quantity regulation. Improving water infrastructure and management practices, including efficient irrigation techniques and sustainable water use strategies, optimizes resource allocation and reduces climate vulnerability. Strengthening governance frameworks and stakeholder engagement in water management promotes equitable access to clean water and enhances community resilience to climate impacts.

Gender

- **Promote Economic Opportunities:** Create and promote economic opportunities tailored to women and vulnerable groups in sectors susceptible to climate impacts, such as agriculture and small-scale enterprises. This includes providing access to credit, training in climate-resilient livelihoods, and supporting women-led cooperatives and businesses.
- **Enhance Access to Resources:** Ensure equitable access to climate information, resources, and decision-making processes for women. This involves integrating gender perspectives into climate policies and programs, facilitating women's participation in community resilience planning, and providing training on climate-smart practices.
- **Support Health and Well-being:** Address gender-specific health impacts exacerbated by climate change, including reproductive health, maternal and child health, and mental health. Enhance healthcare services in climate-vulnerable areas and promote gender-responsive health interventions.
- **Build Knowledge and Skills:** Provide education and training programs that equip women and girls with skills in climate-smart agriculture, disaster preparedness, and sustainable natural resource management. Empower women through leadership development and capacity-building initiatives focused on climate resilience.
- **Strengthen Social Protection:** Implement social protection measures that recognize and address the differential impacts of climate change on women, men, and diverse social groups. This includes ensuring access to safety nets, insurance schemes, and support systems that mitigate economic shocks and enhance resilience.
- **Foster Gender-Responsive Policies:** Advocate for and implement gender-responsive policies and legal frameworks that mainstream gender considerations into climate adaptation strategies. This involves promoting gender equality in access to land, water, and productive resources, as well as addressing barriers to women's participation in decision-making and leadership roles.

These adaptation options are poised to have significant positive impacts on gendered climate risks and vulnerabilities. By empowering women and vulnerable groups, integrating gender perspectives into climate policies, and fostering inclusive participation, societies can better withstand climate impacts and build a more resilient future for all. Further, integrating gender considerations into Annual Action Plans ensures that adaptation strategies are inclusive and responsive to the specific needs and challenges faced by women, thereby enhancing their resilience. Strengthening social protection measures and fostering gender-responsive policies promotes gender equality and inclusivity, ensuring that women have equal access to resources and decision-making processes in climate adaptation. Overall, these actions not only mitigate immediate socio-economic risks but also contribute to building long-term resilience and sustainable development within vulnerable communities affected by climatic hazards.

8.4 Recommendations for WMMA

The government of Ghana has acknowledged the profound impact of climate change and has taken proactive steps to address its effects across various sectors. National frameworks like the National Climate Change Policy (NCCP) and the National Climate Change Adaptation Strategy (NCCAS) prioritize adaptation strategies to mitigate the risks associated with climate change. The NCCP specifically emphasizes the need for gender-responsive measures to ensure that vulnerable groups, particularly women, are supported in adapting to changing climatic conditions. Furthermore, the National Disaster Management Organization (NADMO) plays a crucial role in disaster preparedness and response, coordinating efforts across the country to minimize the effects of climate-related hazards.

For West Mamprusi, it is essential to adopt similar national frameworks at the local level, considering the unique challenges and vulnerabilities of the district. To enhance resilience and effectively tackle the impacts of climate change, the study recommends to West Mamprusi Municipal Assembly the following key actions:

1. Localized Action Plans

Develop city-specific climate change adaptation plans that reflect the district's unique vulnerabilities and needs. These plans should align with national frameworks but focus on the particular context of West Mamprusi.

2. Gender-Specific Programs

Design programs that empower women in agriculture by providing access to drought-resistant crops, training, and financial resources. Partner with women's groups for community outreach and education to ensure these initiatives reach the intended beneficiaries.

3. Strengthen Early Warning Systems

Establish robust weather forecasting and early warning systems to alert communities about potential floods and droughts, helping them prepare in advance and mitigate impacts on agriculture and livelihoods.

4. Capacity Building

Invest in strengthening local institutions and communities to implement climate adaptation measures effectively. Building capacity will ensure that the district can respond to the challenges posed by climate change.

5. Research and Data Collection

Invest in localized climate research and monitoring to gather data specific to West Mamprusi. This will help in identifying climate trends, risks, and vulnerabilities in the district, allowing for targeted interventions.

6. Ecosystem-Based Approaches

Promote the adoption of green infrastructure, sustainable land use practices, and ecosystem-based adaptation to enhance the district's natural resilience and reduce the impact of climate risks.

7. Funding for Adaptation Efforts

Explore innovative financing mechanisms, such as public-private partnerships and climate finance initiatives, to support climate adaptation efforts in West Mamprusi.

By implementing these recommendations, West Mamprusi can build a resilient, climate-adaptive community, ensuring a sustainable future for its citizens while addressing both current and future climate-related challenges.

8.5 Supporting Policies to Streamline Adaptation Options

The study also proposes policies, plans and guides through which the recommended adaption options and impacts could be streamlined to mitigate the vulnerabilities of the identified risks. This included;

- The National Climate Change Policy sets out overarching strategies to mitigate and adapt to climate change impacts nationwide.
- The Ghana National Spatial Development Framework (NSDF) guides spatial planning efforts, ensuring sustainable urban and regional development that considers climate resilience.
- The Medium Term Development Plan outlines specific developmental goals and strategies, including infrastructure resilience and disaster risk reduction measures.
- The West Mamprusi Municipal Assembly Annual Action Plan operationalizes local initiatives, such as enhancing flood-resilient urban planning and improving community preparedness.
- Additionally, the Local Government Act, 2016 (Act 936), empowers local governments to implement climate adaptation measures effectively. These policies collectively support the integration of climate adaptation options across sectors, promoting sustainable development and resilience in West Mamprusi.

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ADAPTATION ACTION PLAN FOR THE WEST MAMPRUSI MUNICIPAL ASSEMBLY



9



Adaptation Action Plan for the West Mamprusi Municipal Assembly

9.1 Introduction

The growing evidence of climate change and its widespread effects across multiple sectors in Ghana has made adaptation an urgent priority. Ghana's National Adaptation Planning (NAP) process recognizes this urgency and has put in place systems to strengthen national and subnational capacities to effectively plan and implement adaptation measures. The NAP process provides the organizational framework for local governance bodies like the West Mamprusi Municipal Assembly to take decisive actions aimed at enhancing human and institutional capacity, thereby improving community resilience.

A foremost part of a successful adaptation planning is understanding the present and future climate risks and vulnerabilities, which can inform the development of appropriate adaptation strategies. This insight provides deeper understanding of the distribution of vulnerabilities across various sectors. The municipality-specific vulnerability assessment approach, as applied to the West Mamprusi Municipal Assembly, follows the guidelines in Ghana's NAP Framework (EPA, 2018), enabling the creation of tailored adaptation measures based on reliable and current information.

Phase I of the vulnerability assessment focused on evaluating the socio-economic conditions and identifying the existing climate change impacts within West Mamprusi. Phase II involved a qualitative examination of vulnerabilities in specific areas and key climate-sensitive sectors. Phase III provided a quantitative assessment of data and outlined municipality-specific climate projections, offering a comprehensive understanding of both current and future climate scenarios (**Box 1**). The Climate Change Vulnerability Assessment (VA) for West Mamprusi Municipal Assembly provides crucial insights into the scale of climate-induced vulnerabilities within the municipality.

Box 1. Climate Change Vulnerability Assessment for the West Mamprusi Municipal Assembly

Ghana's EPA, with support from the West Mamprusi Municipal Assembly (WMMA), conducted a climate change vulnerability assessment for the municipality in 2023–2024. This comprehensive assessment included an analysis of historical and projected climate patterns, participatory risk mapping to pinpoint vulnerable locations, and an evaluation of community resilience using a matrix-of-functions approach. Additionally, vulnerability scores were derived for six key sectors: agriculture; biodiversity and ecosystems (forests); water resources; health and sanitation; disaster risk reduction and transportation; and mainstreaming gender. The participatory approach to this scoring ensured that all relevant stakeholders were in concord of the most vulnerable sectors of West Mamprusi's economy. The vulnerability assessment reviewed both current climate change impacts and anticipated future scenarios, identifying pathways to inform adaptation strategies. Priority areas for action were established as a foundational step for WMMA's adaptive approach: "Building climate resilience to support sustained economic and social development, despite climate changes anticipated by 2050."

Source: EPA, 2024

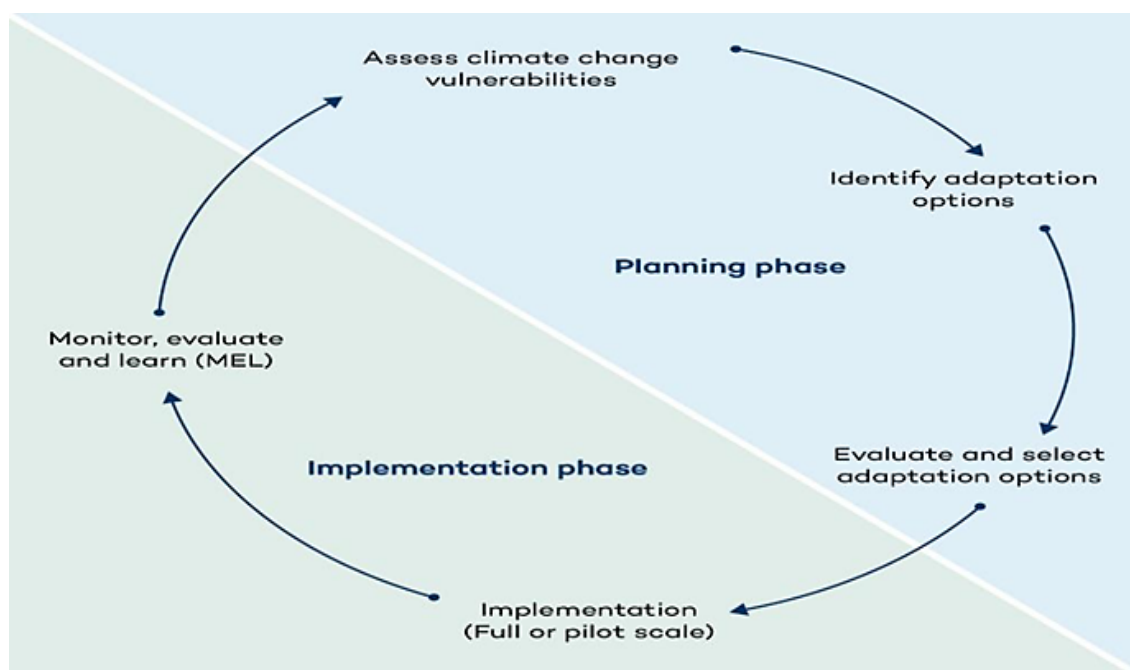
As part of Ghana's NAP process, the development of this adaptation plan marks the next step in West Mamprusi Municipal Assembly's adaptation planning efforts. The preparation of this plan was a pilot initiative designed to implement the findings from the municipality's Vulnerability Assessment (VA), with the aim of positioning the municipality on a path toward building climate resilience while also promoting economic and social development. The West Mamprusi process is unique at the subnational level in Ghana and offers valuable lessons and guidance for adaptation planning in other local governments.

The creation of the West Mamprusi Adaptation Plan (WMAAP) involved the collaboration of diverse stakeholders who worked to transform the vulnerability assessment results into a practical plan designed to enhance resilience and adaptive capacity in key sectors across the municipality. The adaptation plan is targeted at the West Mamprusi Municipal Assembly and the Environmental Protection Agency (EPA), who will oversee its implementation. Additionally, the plan will provide guidance to various stakeholders in the municipality who will play a role in its execution. Furthermore, the plan serves as a model for developing adaptation strategies in other metropolitan, municipal, and district assemblies (MMDAs).

In consideration of the limited resources and multiple development needs, the WMMA must carefully strategize its selection and prioritization of climate adaptation actions. These adaptation actions address climate-related challenges by minimizing negative impacts and, where possible, leveraging any benefits that changing climate conditions might present. Adaptation strategies can include a broad range of efforts, such as strengthening community knowledge, building supportive institutions, and implementing management systems like land-use plans or insurance mechanisms.

The choice of adaptation actions is guided by insights into current and future vulnerabilities, as highlighted by a vulnerability assessment that considers historical climate data, future projections, and socio-economic factors. This section outlines the process for identifying, evaluating, and prioritizing adaptation options, along with the needs for implementation and potential for resource mobilization. The adaptation planning framework used by the WMMA follows a structured approach, as depicted in Figure 16

Figure 16: Approach to WWMA Adaptation Planning



The comprehensive climate change adaptation plan for KMA outlined and gathered specific adaptation strategies tailored to the metropolis. 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 4 to determine these adaptation options

The Adaptation Action Plan for West Mamprusi Municipality 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.

9.2 Identification and Compilation of Sector-Specific Adaptation Actions

Expected Outcomes

The adaptation plan, along with its supporting evidence as outlined in the West Mamprusi Municipal Assembly Vulnerability Assessment (VA), will enable the Assembly to:

- Address critical climate-related risks promptly and effectively by identifying adaptation measures that are balanced, efficient, cost-effective, measurable, and timely.

- Develop both short- and long-term business and operational plans based on insights from the vulnerability assessment.
- Strengthen the capacity of the West Mamprusi Municipal Assembly and its team to manage the complex risks and opportunities of climate change.
- Prepare an adaptation plan that presents well-assessed adaptation options with clear steps for implementation.
- Ensure the adaptation plan aligns seamlessly with the priority actions outlined in the Assembly's Medium-Term Development Plans (MTDPs) for both present and future needs.

Time Frame

The time frame for the implementation of the West Mamprusi Municipal Assembly Adaptation Plan is 2024–2030, aligning with Ghana's revised Nationally Determined Contribution (NDC) period (2020–2030). This period also coincides with the next iteration of the Municipality's MTDP, 2025–2030. This timing presents opportunities to intentionally integrate the adaptation strategy into the municipality's programs, policies, and activities.

Guiding Principles

- **Builds on Ghana's NAP Process:** Ghana's National Adaptation Plan (NAP) Framework serves as the overarching roadmap for climate change adaptation planning and implementation. The NAP process has identified key stakeholder institutions and agencies, such as the Ministry of Food and Agriculture (MoFA).
- **Gender Responsive:** Gender is a socially constructed concept, and in Ghana, while normative gender implications are recognized, the term is broadly defined to include women, children, youth, and persons with disabilities. These groups are particularly vulnerable to the impacts of climate change, and their unique needs were carefully considered in the development of this plan.
- **Incorporates Nature-Based Adaptation Solutions:** Nature-based solutions have been increasingly acknowledged for their positive environmental impacts and their role in building resilience to climate change. This plan emphasizes the use of such solutions to strengthen local adaptation efforts.
- **Driven by Science:** It is essential that adaptation efforts are guided by a thorough understanding of both current and projected climate impacts, supported by scientific evaluations of climate vulnerabilities and a comprehensive vulnerability assessment process.
- **Applies Traditional and Indigenous Knowledge:** The plan development placed a special focus on the knowledge and experiences of local people and made conscious efforts to tap into such knowledge systems to enhance the plan, especially from the perspective of selecting adaptation options.
- **Adopts Participatory, Inclusive, and Local Ownership:** Guided by the Ghana NAP framework, processes for both the vulnerability assessment and the development of the plan have as much as possible been participatory and inclusive to ensure that the plan is led and owned by local people.

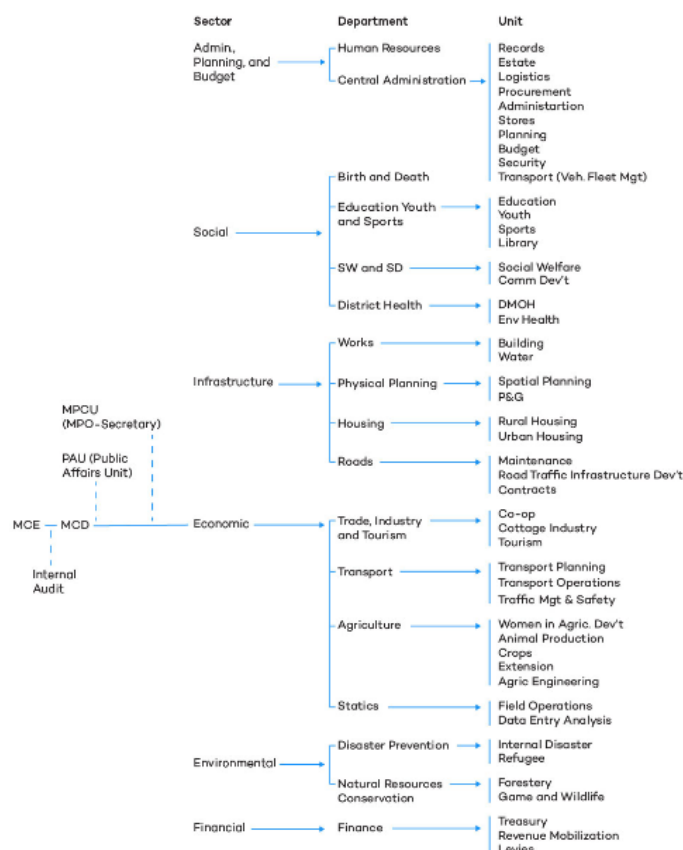
Aligns with SDGs and National Development Goals: Adaptation projects may provide benefits to or trade-offs with the United Nations Sustainable Development Goals (SDGs) and other national development priorities. As much as possible, the adaptation planning process must aim to reduce the trade-offs, as well as complement efforts to achieve the SDGs and national development goals.

9.3 Institutional Arrangements and Municipal Level Adaptation Governance

Proposed Arrangements for Adaptation Governance

The West Mamprusi Municipal Assembly's Medium-Term Development Plans (MTDPs) are strategic guides, outlining all development programs and projects within the municipality over a three-year span. These plans consolidate the intended activities of various departments, units, and stakeholders within the Assembly. Figure 3 provides an overview of the current governance structure of the West Mamprusi Municipal Assembly.

Figure 17: Municipal department's organogram



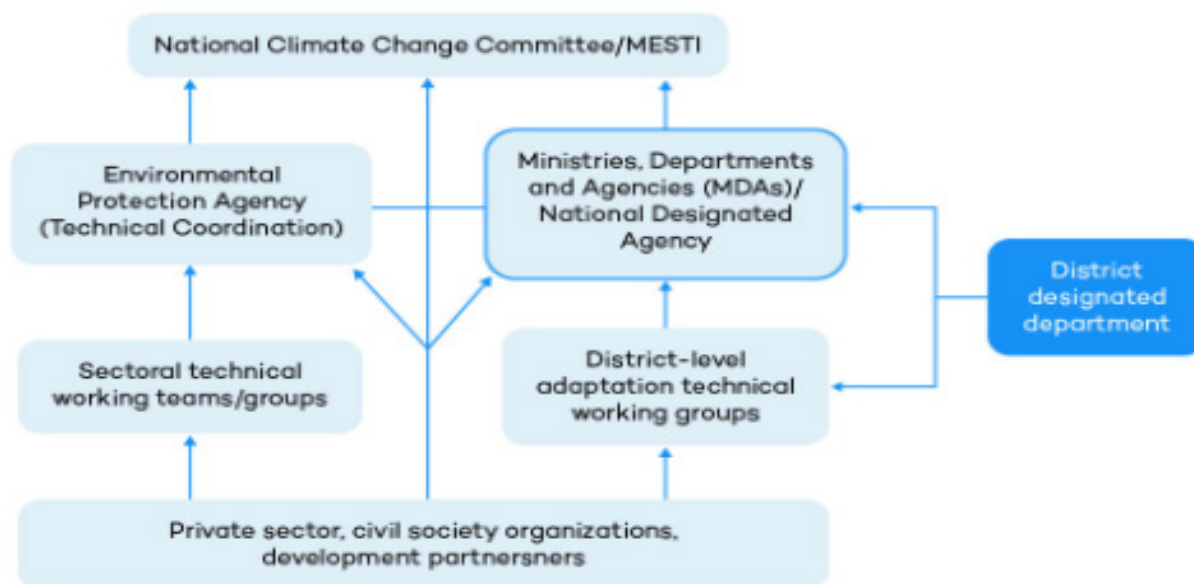
Source: WMMA MTDP

To ensure the effective mainstreaming of climate change in the municipality, the governance structure of the West Mamprusi Municipal Assembly must align with the broader institutional arrangement proposed under the NAP framework (EPA, 2018). The NAP framework ensures that the Municipal Assembly is connected and engaged with the national process through relevant Ministries, Departments, and Agencies (MDAs) (as shown in the organogram in Figure 4). Addressing climate change impacts is a relatively new challenge for many municipal governments, and it remains unclear which department within the current structure of the Municipal Assembly will serve as the focal point for leading climate action. This uncertainty can impede leadership and the sustainable implementation of adaptation strategies.

According to the NAP framework, the EPA is responsible for coordinating the creation of a comprehensive NAP, which will include adaptation priorities in critical sectors such as agriculture, forestry, water, energy, gender, and health. Meanwhile, the NDPC will oversee adaptation planning at the municipal level and integrate these plans into broader development strategies. Designating a specific department within the municipality will

enable efficient coordination and integration of climate action at the local level. In the West Mamprusi Municipal Assembly, the Municipal Planning Coordination Unit (MPCU) has been tasked with leading the implementation of this adaptation plan by establishing a climate change desk within the assembly, marking the first initiative of its kind at the subnational level in the country.

Figure 18: Proposed institutional arrangement for Ghana's NAP, including the role of the Municipal designated lead department



Source: Adapted from Figure 1 in Ghana's NAP Framework (EPA, 2018, p. 18)

9.4 Methodological Approach for Ranking Adaptation Options

9.4.1 Adaptation Plan Development Process

Figure 19 outlines the process used to develop the adaptation plan for the WMMA. This process ensures that the climate adaptation plan remains relevant and adaptable. It covers various stages of the decision-making process, from defining the problem or scope to implementation, monitoring, evaluation, and learning from the adaptation actions taken. The adaptation plan was developed through a three-stage approach, including a desk review, stakeholder consultations, and municipal validation, as shown in Figure 1 and elaborated upon below.

Figure 19: Development Process of Adaptation Plan



Source: Author diagram.

Phase I involved a comprehensive review of adaptation priorities and measures outlined in national and sectoral climate change documents (such as those from the Ministry of Environment, Science, Technology, and Innovation [MESTI], 2013, 2015), the West Mamprusi Municipal Assembly Medium-Term Development Plan (MTDP) and the West Mamprusi 2023 Annual Action Plan, existing academic literature, and recommendations from the municipality-specific West Mamprusi Vulnerability Assessment (VA). This review aimed to ensure that the plan was based on scientific evidence and aligned with both national and municipal priorities, as outlined in the MTDP, making it context-specific. The findings from the desk review were used to create a catalog of sectoral adaptation actions.

Phase II evaluated the initial adaptation option proposals from consultants through participatory stakeholder multi-criteria analysis conducted in specially organized workshops within the municipality. The consultation process took place in the West Mamprusi Municipal Assembly, involving five key stakeholder consultation groups that analyzed adaptation options in the following priority sectors:

- Agriculture
- Biodiversity and forestry (ecosystems)
- Water resources
- Sanitation, and health
- Disaster Risk Reduction (DRR) and Transportation
- Gender and marginalized groups

Each group consisted of key participants from WMMA departments, non-governmental organizations (NGOs), the private sector, gender groups (youth, women, PWD), traditional leaders, farmer organisations and media. Information from the vulnerability assessment was used to generate possible adaptation options, which were presented at the stakeholder consultation workshop.



Consultation with the sector stakeholders for the ranking and prioritization exercise

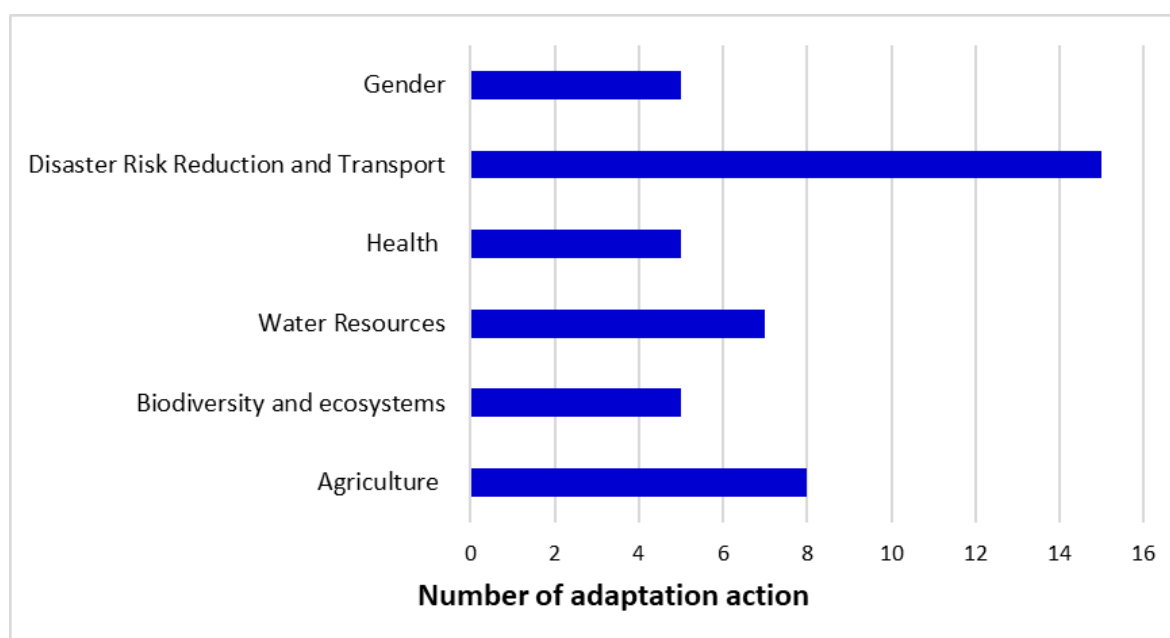
Table 8: Methodology to identify adaptation options.

Input Source	Description
 Vulnerability Assessment Report Recommendations	The climate change vulnerability assessment for the West Mamprusi Municipal Assembly provided specific recommendations on adaptation measures. These suggestions aim to strengthen resilience, boost adaptive capacity, and lower vulnerabilities. They were thoroughly integrated into the planning process.
 Literature Review	A comprehensive review of effective solutions and practices was conducted. This included a desk review of government reports, scientific studies, grey literature, and municipal documents to pinpoint adaptation strategies that address similar climate impacts and vulnerabilities.
 Stakeholder Consultation	Identified stakeholders were actively engaged through participatory workshops, allowing open, inclusive discussions on adaptation options based on climate scenarios and current and projected impacts.

Source: Author diagram based on the WMMA Adaptation Plan.

The measures discussed were utilized to create a catalogue of relevant adaptation options presented in the tables in Appendix B. Overall, 44 adaptation options were identified across eight sectors: agriculture, biodiversity, water resources, health, DRR and transport and gender. The distribution of the identified actions is illustrated in Figure 7.

Figure 20: Distribution of adaptation actions by sector



Source: Author diagram based on the WMMA Adaptation Plan

9.4. 2 Adaptation Assessment Criteria

After identifying and compiling a list of 44 potential adaptation options, the next step for the West Mamprusi Municipal Assembly was to evaluate and prioritize them based on clearly defined information and criteria.

This process involved assessing the suitability of the options within the context of the West Mamprusi Municipal Assembly, their potential to enhance resilience and reduce the vulnerabilities identified in the vulnerability assessment report, and their overall impact on sustainable development. The objective of the prioritization process was to make informed decisions that facilitate effective adaptation and avoid maladaptation. To achieve this, relevant actors and stakeholders were engaged in the assessment process to ensure that the selected adaptation options are appropriate and do not result in potentially negative outcomes.

The stakeholders were divided into five groups (Agriculture and Biodiversity Group; Water resources group, Health and Sanitation Group; and Gender Group) screened the proposed adaptation options using a multicriteria analysis (MCA) (see Appendix A). This approach is crucial because each adaptation measure may perform differently across multiple criteria and may involve trade-offs. Therefore, these options must be closely and critically evaluated, with the results of the analysis integrated into decision-making regarding priority options.

MCA, also known as multi-objective decision-making, is a tool designed for scenarios where single-criterion methods, such as cost-benefit analysis, fail to address all relevant factors. This is especially true when environmental and social impacts are significant but cannot be quantified monetarily. MCA offers a framework for evaluating a comprehensive range of criteria, encompassing social, environmental, technical, economic, and financial aspects (Ngara, 2011). In this method, desired outcomes are clearly defined, and relevant attributes or indicators are established. The evaluation of these indicators is not solely monetary; it often incorporates a quantitative approach involving scoring, ranking, and weighting a variety of qualitative impacts and criteria. The criteria for assessing adaptation options are outlined in Table 9.

Table 9: Criteria for assessment of adaptation actions

Criteria	Description
Adaptation Type	Assesses the risk reduction or risk transfer potential of an adaptation option. For instance, an irrigation system reduces drought risk, while crop insurance transfers it.
Implementation Level	Identifies the implementation scale of an adaptation, which could be community, municipal/government, or autonomous.
Risk Gradient	Determines if the adaptation option is “risk-specific” (only effective if a particular risk occurs) or has broader applicability. Risk-specific options, like crop insurance, are beneficial only when certain impacts materialize, while others, such as post-harvest loss technology, are useful continuously.
SDGs and Development Co-benefit	Evaluates alignment of Municipal development programs with Sustainable Development Goals (SDGs) for additional benefits.
Risk Mitigation Potential	Assesses the option’s effectiveness in reducing specific climate risks.
Upscaling and Replicability Potential	Examines the potential to expand or replicate an adaptation intervention.
Cost-effectiveness	Evaluates cost-effectiveness for planning and implementing the adaptation measure.
Social and Cultural Acceptance	Ensures local buy-in by assessing the social and cultural acceptance of the project.

Criteria	Description
Cross-sectoral Maladaptation	Evaluates if an adaptation option might unintentionally harm other sectors.
Deliverability and Feasibility	Assesses the overall practicality and feasibility of the adaptation option.
Technical Feasibility	Determines if the necessary technical knowledge and capacity for implementing the adaptation measure are available.
Governance Implications	Evaluates if the adaptation aligns with current governance structures or if it requires modifications or new governance frameworks.
Social Considerations	Considers the impact of the adaptation measure on social inclusion and community cohesion.
Environmental Considerations	Assesses potential benefits for GHG reduction, biodiversity, human health, soil and water quality, air quality, climate, and landscapes.
Stakeholder Interest	Gauges the level of stakeholder support for the adaptation measure.
Potential Negative Outcomes	Identifies possible adverse effects from implementing the adaptation option.
Barriers to Implementation	Highlights potential institutional, economic, or social obstacles to implementing the adaptation option.

Source: Author diagram based on WMMA Adaptation Plan.

Indicators were derived for each criterion and applied through scoring, ranking, and weighting. The stakeholder groups ranked the criteria for each of the 44 adaptation options identified during the sector group consultations. The results of the comprehensive assessment are presented in Appendix A. The outcomes of the multicriteria analysis (MCA) were utilized as inputs to identify adaptation options for further development into concrete actions, based on their aggregated scores from the sum of the variables for each indicator. Additionally, expert judgment, findings from the literature review, and consultations with authorities from the West Mamprusi Municipal Assembly and the Environmental Protection Agency (EPA) informed the selection of priority adaptation options.

In each sector, approximately half of the proposed actions were prioritized and selected for further development and implementation considerations. The identification of priority adaptation actions was based on the vulnerability and relative importance of each sector within the West Mamprusi Municipal Assembly, as well as the alignment of the actions with the assembly's developmental priorities outlined in the MTDP 2022–2025.

9.5 Adaptation options

This section describes the prioritized climate change adaptation options, highlighting each option's adaptation objective, justification, and critical considerations.

9.5.1 Agriculture

According to the West Mamprusi Municipal Assembly Vulnerability Assessment, agriculture is identified as the most vulnerable sector and requires significant attention. Seven (7) adaptation actions were identified and assessed through the multicriteria analysis (MCA), are discussed below. These actions target small-scale farmers who currently depend on rain-fed agriculture and are designed to enhance or

maintain agricultural productivity in the face of climate change. The West Mamprusi Municipal Assembly Vulnerability Assessment identifies agriculture as the most vulnerable sector and highlights the need for adaptation actions. The seven actions, target small-scale farmers relying on rain-fed agriculture to enhance agricultural productivity amidst climate change. These actions promote climate-smart agriculture, using climate-resilient crop varieties, improved production technologies, and water-efficient practices to boost yields and sustainability under unpredictable weather patterns. Given the reliance on rain-fed agriculture, these practices can mitigate the impacts of droughts and irregular rainfall. Conservation agriculture, early warning systems, livelihood diversification, and efficient irrigation are key strategies to strengthen resilience. These approaches ensure long-term sustainability, improve soil health, and reduce climate risks, while promoting inclusivity for vulnerable groups such as women and smallholder farmers. Gender-responsive interventions, like equitable access to irrigation, will further support adaptation efforts, improving food security and economic resilience in the region.

Table 10: Ranking of adaptation options for the agriculture sector

Agriculture and food security	Final score	Rank
Climate resilient agriculture	45	1
Conservation agriculture	42	2
Early warning and response mechanisms	37	3
Diversification of livelihoods	37	3
Climate resilient crop varieties	36	5
Improve production Tech.	36	5
Irrigation systems	35	7
Improved cultivation approach	32	8

Table 11: Summary of the Adaptation Actions for the Agricultural Sector

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME Short, Medium, or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Conservation agriculture practices including CSA	To promote conservation agriculture as a sustainable adaptation strategy in the West Mamprusi Municipal Assembly (WMMA) that enhances soil health, improves agricultural productivity, and builds resilience against climate change, while aligning with local priorities and fostering environmental sustainability..	▫ Education and training programs (e.g., workshops, field demonstrations). ▫ Access to resources (e.g., seeds, reduced tillage tools, organic fertilizers). ▫ Formation of cooperatives or community groups for resource sharing. ▫ Enhancement of soil fertility and reduction of erosion. ▫ Biodiversity promotion and restoration of degraded lands. ▫ Market integration for sustainably produced crops. ▫ Consumer education on conservation agriculture benefits. ▫ Government incentives for sustainable farming inputs. ▫ Policies enabling land access for conservation practices.	Short-term	Human Finance Technology	WMMA	MOFA MESTI Agric Extension Agents (AEAs) Farmer Cooperatives and Community Groups Research Institutions and Universities Non-Governmental Organizations (NGOs) Private Sector Companies – including Local Markets and Retailers Development Partners and Donors	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME Short, Medium, or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Early warning and response mechanisms	To implement early warning and response mechanisms in the West Mamprusi Municipal Assembly to enhance climate resilience by providing timely and accurate information on weather extremes and other hazards, enabling proactive action to mitigate the impacts of climate-related risks on agricultural productivity and livelihoods	- Integration of locally relevant climate data. - Establishment of localized weather stations and community-based data collection systems including building local governance capacity for coordination and response.. - Investment in reliable technological infrastructure (e.g., satellite data, mobile networks). - Partnerships with technology providers for accessible, state-of-the-art tools. - Use of diverse communication channels (e.g., local radio, community centers) to ensure widespread message dissemination. - Focused outreach to remote and vulnerable communities with real-time, easy-to-understand alerts. - Collaborative financing models involving government, development partners, and the private sector. - Training farmers, local officials, and extension officers on early warning information interpretation and response.	Medium-term	Human Technical / Technology Finance	MESTI	MoFA GMET NGOs Research Institutions Private Sector Technology Providers, Mobile Network Operators and ICT Providers Community-Based Organizations (CBOs) Farmer Associations and Cooperatives Media Outlets (Local Radio and TV) Educational Institutions NADMO Women's Cooperatives and Youth Groups Traditional and Local Leaders	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME Short, Medium, or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
		▫ Regular simulations or drills for practicing responses to threats. ▫ Inclusive communication methods targeting women, youth, and marginalized groups. ▫ Continuous monitoring and feedback systems to evaluate system effectiveness. ▫ The percentage of farmers regularly using weather and climate information for planning agricultural activities, such as planting, irrigation, and harvesting. ▫ Higher crop yields and livestock productivity as a result of better-informed farming practices ▫ Strengthened response networks (e.g., disaster management committees, farmer associations, health services).					

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME Short, Medium, or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Diversification of livelihoods	To promote the diversification of livelihoods as a climate adaptation strategy that reduces vulnerability to climate shocks, enhances economic resilience, and provides inclusive opportunities for sustainable growth beyond traditional agricultural practices. By focusing on key contextual considerations, livelihood diversification can significantly contribute to building climate resilience in West Mamprusi, fostering economic empowerment, and reducing the risks associated with climate-dependent farming	▫ Expansion of income-generating activities (e.g., agro-processing, small-scale businesses, eco-friendly ventures). ▫ Promotion of social equity by targeting opportunities for women, youth, and marginalized groups. ▫ Access to affordable credit through savings schemes, microfinance, or grants. ▫ Focus on value addition in agriculture (e.g., processing and packaging). ▫ Integration of indigenous knowledge and natural resources into diversification initiatives. ▫ Development of training programs in entrepreneurship, vocational skills, digital literacy, financial literacy training for effective management of new ventures. ▫ Engagement with community leaders to ensure social acceptance of new livelihoods.	Short term	Human Technology Finance	WMMA	Local Government Institutions. Non-Governmental Organizations (NGOs) Financial Institutions (Microfinance and Savings Schemes) Development Partners, Donors, International Organizations (e.g., UNDP, FAO)	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME Short, Medium, or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
		□ Adoption of environmentally sustainable and climate-resilient practices (e.g., organic farming, biochar, renewable energy). □ Strong institutional support from local governments and NGOs. □ Policies that incentivize diversification (e.g., tax breaks, subsidies for eco-friendly technologies). □ Institutional partnerships for technical support and seed funding. □ Establishment of monitoring and evaluation systems for continuous improvement.				Private Sector Farmer Cooperatives and Women's Groups Educational and Vocational Training Institutions Traditional and Local Leaders Research Institutions Business Development Organizations Community-Based Organizations (CBOs)	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME Short, Medium, or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Irrigation systems	To enhance the adoption and effectiveness of irrigation systems in the West Mamprusi Municipal Assembly as a climate adaptation strategy that improves agricultural productivity, ensures water resource efficiency, and builds resilience against droughts and erratic rainfall patterns.	□ Adoption of water-efficient irrigation technologies (e.g., drip or sprinkler systems) to optimize water usage. □ Promotion of sustainable water management techniques to reduce runoff, evaporation, and waste. □ Implementation of innovative financing models (e.g., subsidies, pay-as-you-go, low-interest loans) for affordability. □ Incorporation of solar-powered irrigation pumps to reduce reliance on electricity or fuel. □ Development of water capture and storage technologies for drought resilience. □ Training programs to build farmers' technical skills for operating, repairing, and maintaining irrigation systems.	Medium term	Human Technology Finance	MoFA	WMMA NGOs Agricultural Extension Agencies Microfinance Institutions and Cooperatives Private Sector Companies – For supplying irrigation technologies (e.g., solar pumps, drip systems) and maintenance services. International Development Agencies (e.g., FAO, UNDP, World Bank)	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME Short, Medium, or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
		- Establishment of community-based water management committees for equitable water distribution and conflict resolution. - Representation of women and marginalized farmers in water management decision-making processes. - Gender-sensitive approaches to ensure women's equitable access to irrigation resources, training, and leadership roles. - Alignment of irrigation projects with broader climate adaptation and water management strategies. - Continuous monitoring and feedback systems to ensure sustainability, equity, and responsiveness to farmer needs.				Research Institutions (e.g., CSIR-Ghana, universities) Traditional and Community Leaders Community-Based Organizations (CBOs) Women's Groups and Cooperatives	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME Short, Medium, or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Improved agricultural production technologies	To promote the adoption of improved agricultural production technologies in West Mamprusi Municipal Assembly as a climate adaptation strategy that enhances crop yields, increases efficiency, and builds resilience against climate-induced agricultural challenges while ensuring sustainable and inclusive farming practices.	□ Adoption of mechanized farming and precision agriculture methods to optimize resource use and productivity. □ Use of drought-tolerant seeds to enhance resilience to climate stress. □ Financial incentives like subsidies, low-interest loans, and leasing programs to improve affordability of technologies. □ Formation of cooperative groups to pool resources for shared investments in technologies. □ Comprehensive and continuous farmer training programs on new agricultural technologies. □ Development of robust infrastructure, including roads and market access points, to facilitate technology distribution. □ Establishment of local hubs for access to mechanized tools, digital platforms, and technical assistance. □ Policy support, including tax incentives for technology importation and collaboration with agricultural institutions.	Medium term	Human Technology Finance	MoFA	WMMA IUCN UNDP Agricultural Extension Agents Microfinance Institutions and Cooperatives Private Sector Companies Research Institutions (e.g., CSIR-Ghana, universities). NGOs (e.g., CARE, ActionAid). Development Banks (e.g., African Development Bank, World Bank). Agricultural Technology Providers. Women's Groups and Cooperatives	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME Short, Medium, or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
		- Gender-inclusive approaches ensuring women and marginalized groups access resources and training for technology adoption. - Context-specific adaptation of technologies to suit local soil, crop, and climatic conditions. - Improved storage and processing facilities to support increased yields and reduce post-harvest losses.					
Planting of drought-resistant varieties of crops	Enhance agricultural resilience and ensure food security.	- Consistent or increased crop yields despite varying rainfall patterns and drought conditions. - High rates of adoption of drought-resistant crop varieties among local farmers. - More stable and potentially increased incomes for farmers due to reliable crop yields. - Reduced costs associated with irrigation and other water management practices. - Improved access to markets for drought-resistant crops, potentially leading to better prices and higher income for farmers.	Short term	Human Technology Finance	MoFA	WMMA EPA FAO UNDP Research Institutions (e.g., KNUST) Private Sector	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME Short, Medium, or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Climate resilient agriculture on adaptive farming techniques and climate-smart agriculture	To enhance climate resilience in the agricultural sector by promoting the adoption of sustainable farming practices, particularly through the use of climate-resilient crop varieties and farming practices, while ensuring that these solutions are socially accepted, environmentally efficient, and flexible, offering scalable solutions that can be replicated across diverse farming communities.	- Farmer knowledge and skills development through training. - Strengthened agricultural extension services for continuous support, monitoring, and guidance. - Partnership with research institutions like SARI and FRI to introduce locally suitable climate-resilient technologies. - Government commitment and policy frameworks that incentivize sustainable practices, including subsidies and tax breaks. - Financial inclusion through microloans, subsidies, and affordable access to inputs such as seeds and irrigation systems. - Inclusive resource distribution to ensure that resources reach all farmers, including vulnerable and marginalized groups. - Strengthened market linkages for fair pricing of climate-resilient products.	Short term	Human Technology Finance	WMMA	NGOs Private Sector Partners (e.g., technology providers, financial institutions) Agricultural Extension Agents Research and Development Institutions Financial Institutions (e.g., microfinance banks, cooperatives) Local farmer cooperatives and associations	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME Short, Medium, or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
		- Improved infrastructure, including roads, storage facilities, and digital platforms for market access and reduced post-harvest losses. - Effective monitoring and feedback systems to track and adjust interventions based on farmer input. - Collaboration among farmers, local institutions, and policymakers to refine and scale interventions. - Gender-responsive and inclusive interventions addressing challenges faced by women and marginalized groups, and promoting equity in land ownership.					

9.5.2 Biodiversity and ecosystem

West Mamprusi's biodiversity is highly vulnerable to climate change, primarily due to deforestation, bush burning, and changing weather patterns that threaten local ecosystems. These activities disrupt biodiversity and ecosystems, reduce carbon sequestration, and accelerate soil erosion, making the region more susceptible to climate-related impacts. The key adaptation options identified focuses on restoring biodiversity, community participation and alternative livelihood for persons who depend on the ecosystems for income and sustenance. In West Mamprusi, deforestation, bush burning, and charcoal production are major threats to biodiversity, causing habitat loss and species decline. Community-based management provides a sustainable solution by involving locals in the protection of natural resources. This approach uses local knowledge to ensure conservation strategies are culturally relevant and accepted, boosting long-term success. It also promotes social cohesion, gender inclusion, and equitable sharing of conservation benefits. Afforestation is vital for restoring ecosystems in West Mamprusi, as it addresses deforestation and provides additional benefits like improved air and water quality, forest products, and local employment. Disaster volunteer groups are key to biodiversity protection, acting as first responders to environmental emergencies like bushfires and deforestation. These groups help raise awareness, prevent disasters, and integrate local knowledge into conservation efforts. Creating protected areas is essential for safeguarding biodiversity. These areas act as refuges for endangered species and help prevent habitat loss from human activities. They also provide ecological, social, and economic benefits, such as improved water regulation and carbon sequestration. Livelihood diversification is critical for reducing pressures on natural resources in West Mamprusi. Sustainable alternatives like agroforestry, beekeeping, and eco-tourism help communities thrive economically while protecting biodiversity, thereby enhancing resilience to climate change.

Table 12: Ranking of adaptation options for the biodiversity and ecosystem sector

Biodiversity	Final score	Rank
Formation of disaster volunteer groups	45	1
Create Protected areas	44	2
Community based management	43	3
Afforestation	42	4
Diversification of livelihoods	39	5

Table 13: Summary of the Adaptation Actions for the Biodiversity and ecosystem Sector

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Community-based management through anti-Bushfire law enforcement, and public sensitization	To promote community-based management in West Mamprusi as a key adaptation strategy for biodiversity protection, enhancing local participation in conservation efforts, restoring ecosystems, and ensuring the sustainable use of natural resources to combat deforestation, bush burning, and charcoal production	- Trust and collaboration between municipal authorities, traditional leaders, and community members. - Involvement of local stakeholders in decision-making processes. - Education and capacity-building programs focused on sustainable land-use practices and biodiversity. - Technical skill development for managing and protecting local ecosystems. - Incentive systems that reward conservation efforts, with equitable benefits for vulnerable groups. - Strong institutional backing from local government, NGOs, and international organizations. - Integration of community-led initiatives with broader conservation goals. - Balancing biodiversity conservation with local livelihoods through sustainable alternatives.	Short term	Human Technology Finance	WMMA	Private sector Academic and Research Institutions Philanthropic organizations WWF Ghana Nature Conservation Research Centre (NCRC) IUCN Friends of the Earth Ghana MESTI Traditional Authorities Local Farmer Groups and Cooperatives Private Sector Partners CSOs/NGOs	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
		□ Inclusive participation of both men and women, and marginalized groups. □ Gender-responsive strategies to enhance social acceptance and equity. □ Ongoing monitoring and adaptive management of biodiversity efforts. □ Use of traditional ecological knowledge alongside modern conservation practices. □ Clear conflict resolution mechanisms for land-use and resource access issues. □ Long-term, sustainable funding sources, including external support and income-generating activities					

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Afforestation	To promote afforestation in West Mamprusi as a critical adaptation strategy for biodiversity protection, aimed at restoring degraded ecosystems, enhancing carbon sequestration, and increasing the resilience of local environments to climate change impacts.	□ Prioritization of indigenous tree species □ Community involvement in afforestation projects □ Economic opportunities linked to afforestation (e.g., eco-tourism, agroforestry) □ Gender inclusiveness in afforestation efforts □ Institutional support and enabling policies □ Continuous monitoring and maintenance of newly planted forests □ Integration of afforestation with local land use planning □ Raising awareness about afforestation benefits	Short-term	Human Technology Finance	WMMA	Private sector companies Financial institutions Development partners (e.g., UNDP, World Bank, etc) NGOs Local communities MESTI Forestry commission Local farmers and community leaders Educational institutions (e.g., schools, universities) Private sector (e.g., eco-tourism operators, agroforestry businesses)	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Formation of disaster volunteer groups	To establish disaster volunteer groups in West Mamprusi as a community-driven approach to respond to and prevent environmental crises, including those that threaten biodiversity, such as wildfires, deforestation, and unsustainable land use practices.	▫ Strong community ownership and local leadership involvement ▫ Regular training for volunteers on disaster management, forest fire prevention, and biodiversity conservation ▫ Integration into local and national disaster management frameworks ▫ Coordination with municipal authorities, NADMO, and environmental agencies ▫ Access to necessary physical infrastructure (communication tools, transport, protective gear) ▫ Gender inclusiveness and representation in volunteer groups ▫ Consistent funding and resource mobilization, including local fundraising mechanisms ▫	Short-term	Human Technology Finance	WMMA	EPA NADMO Private sector companies Financial institutions Development partners (e.g., UNDP, AfDB, etc) NGOs Academic and Research Institutions Philanthropic organizations Local community-based organizations Local government agencies Traditional leaders and local community groups Educational institutions (for public awareness campaigns) International development organizations	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
		- Public awareness campaigns on disaster prevention and biodiversity protection - Active engagement in environmental education to reduce unsustainable practices - Robust monitoring and evaluation framework with feedback loops for continuous improvement					

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Create Protected areas	To promote the creation of protected areas in West Mamprusi as a key strategy for safeguarding biodiversity, preventing deforestation, and ensuring the long-term conservation of critical ecosystems against climate-related and anthropogenic threats.	- Strong legal frameworks with clear boundaries and enforceable regulations. - Active involvement and support of local communities in management. - Participatory management frameworks with community engagement. - Promotion of sustainable livelihood alternatives to reduce pressure on protected areas. - Strategic zoning to protect high biodiversity value areas and connect ecological corridors. - Coordination between local, municipal, and national environmental agencies. - Establishment of a sustainable financial model, including conservation trust funds and public-private partnerships. - Regular ecological monitoring and research to track biodiversity changes and assess conservation effectiveness.	Short-term	Human Technology Finance	WMMA Forestry commission	Private sector companies Financial institutions Development partners Academic and Research Institutions NADMO EPA Forestry Commission Local community groups and traditional leaders NGOs such as World Wildlife Fund (WWF) International organizations (e.g., UN Environment Programme, Global Environment Facility) Conservation Trust Funds and financial institutions	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Diversification of Livelihoods	To promote the diversification of livelihoods in West Mamprusi as a strategy for reducing pressure on biodiversity, mitigating deforestation, bush burning, and charcoal production, and fostering sustainable economic development through environmentally friendly income-generating activities.	□ Capacity-building through skills training programs □ Access to financial support (microcredit, grants, loans) □ Strengthening market linkages for local products □ Inclusivity in programs, particularly for women and marginalized groups □ Alignment with local cultural practices and social norms □ Engagement of local leaders and community members □ Partnerships between local communities, NGOs, authorities, and the private sector □ Promotion of climate-resilient livelihoods □ Regular monitoring and evaluation of outcomes	Short-term	Human Technology Finance	WMMA	MoFA MESTI Private sector companies Development partners NGOs Academic and Research Institutions Financial Institutions (for microcredit and loans)	

9.5.3 Disaster Risk Reduction and Transport

The West Mamprusi Municipal Assembly faces a combination of high-impact climate vulnerabilities, particularly in the context of disaster risk reduction and transport infrastructure. Flooding, exacerbated by inadequate drainage systems, deforestation, and extreme weather events, presents significant risks to both human life and property. Out of the 13 adaptation actions that were identified and assessed through the MCA, six were selected and discussed below due to their cross cutting nature of the adaption option and its discussion in previous sectors. Water bodies in West Mamprusi are vital for local biodiversity and agriculture, both of which are vulnerable to climate-induced disasters like floods and droughts. Protecting these water resources is crucial for reducing disaster risks and maintaining environmental health. This aligns with municipal priorities for disaster resilience and long-term sustainability, enhancing climate resilience by addressing water scarcity and flood risks, and supporting community well-being. Disaster information groups are essential for improving early warning systems and ensuring communities are informed about potential risks. These groups promote community participation in disaster management, strengthening social cohesion and resilience to climate hazards like floods and bushfires. Community engagement is key to disaster risk reduction (DRR). By actively involving individuals in preparedness efforts, communities can share knowledge and resources, improving response capabilities and reducing vulnerability to climate-induced disasters.

Supporting NADMO officials is critical for effective DRR. Well-resourced and motivated officials are better able to lead disaster management efforts and ensure that initiatives align with local needs. Improving infrastructure, such as drainage systems, is vital for managing water runoff and preventing flooding. Enhanced drainage supports better water management, reduces infrastructure damage, and improves road access, helping to protect lives, property, and essential services. Resettling flood-prone communities is an important strategy for disaster risk reduction. Relocating people from high-risk areas reduces the impact of flooding, while ensuring sustainable livelihoods and cultural preservation. Protecting roads and infrastructure is crucial for DRR. These structures are lifelines during emergencies, and safeguarding them ensures continued access to services, supports disaster response, and promotes long-term economic stability.

Table 14: Ranking of adaptation options for the DRR and transport sectors

DRR	Final score	Rank
Protection of water bodies	48	1
Early warning and response mechanisms	48	1
Community engagement and awareness	48	1
Expansion of Drainage system	48	1
Water conservation practices	48	1
Formation of Disaster Volunteer groups	48	1
Diversification of livelihoods	47	7
Formation of disaster information groups	46	8
Provide incentives and support for NADMO officials	46	8
Construct and improve infrastructure	46	8
Construction of improved drainage system	46	8
Resettlement of flood prone communities	42	12

Transport	Final score	Rank
Early warning and response Mechanisms	48	1
Protection of roads / infrastructure	47	2
Construct and improve infrastructure	46	3

Table 15: Summary of the Adaptation Actions for the DRR and Transport Sectors

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium and Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Protection of water bodies	To ensure the protection of water bodies in West Mamprusi as a primary disaster risk reduction (DRR) strategy aimed at safeguarding water resources, enhancing ecosystem resilience, and preventing floods and drought-related disasters.	□ Strong local and national regulatory frameworks for water protection □ Regular monitoring and enforcement by municipal authorities □ Community-based monitoring initiatives and educational campaigns □ Adequate financial resources allocated for water protection initiatives □ Collaboration between municipal authorities, environmental agencies, and local communities □ Integration of water protection into disaster risk reduction frameworks □ Equitable access to clean water and inclusive management participation □ Replication of successful water protection efforts in other regions □ Knowledge sharing through municipal networks and community exchanges	Short-term	Human Technology Finance	WMMA	NADMO EPA Urban Planning and Development Partners CBOs NGOs Academic and Research Institutions Community leaders and traditional authorities Private sector partners (e.g., companies in water infrastructure and eco-tourism)	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium and Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Formation of disaster information groups	To enhance disaster preparedness and community resilience in West Mamprusi through the establishment of disaster information groups that facilitate timely communication, effective response coordination, and community engagement in disaster risk reduction (DRR) efforts.	▫ A significant increase in the number of community members trained in disaster response and emergency management. ▫ Reduced time taken for community emergency response teams to mobilize and respond to disasters. ▫ Regularly conducted and well-attended community preparedness drills and simulations. ▫ Training and capacity-building opportunities for group members ▫ Alignment with local governance structures ▫ Strong monitoring and evaluation (M&E) systems ▫ Integration of traditional knowledge and practices ▫ Contextually appropriate information dissemination ▫ Inclusive participation, with leadership roles for women ▫ Effective resource mobilization and funding strategies ▫ Creation of replicable models for broader community impact	Short term	Human Technology Finance	WMMA	NADMO Municipal Disaster Management Committee EPA CBOs NGOs Local Health Departments Academic and Research Institutions Traditional Leaders and Community Elders Media Organizations International Development Partners	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium and Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Community engagement on sensitization and awareness campaigns on disasters and information from early warning systems	To enhance disaster resilience in West Mamprusi by promoting community engagement and awareness initiatives that foster local participation, knowledge sharing, and preparedness in disaster risk reduction (DRR) efforts.	▫ Incorporation of local knowledge and traditional practices in DRR planning. ▫ Inclusive engagement of marginalized groups (women, youth, persons with disabilities). ▫ Sustained awareness campaigns tailored to local realities and cultural contexts. ▫ Establishment of feedback mechanisms for community input.	Short-term	Human Technology Finance	WMMA	NADMO EPA CBOs NGOs Academic and Research Institutions Private Sector Professional Training Organizations International Development Partners Local media outlets (e.g., radio, social media) Traditional leadership structures	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium and Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Provide incentives and support for NADMO officials	To enhance the effectiveness and operational capacity of the National Disaster Management Organization (NADMO) officials in West Mamprusi by providing incentives and support that motivate their performance in disaster risk reduction (DRR) initiatives.	▫ Competitive compensation packages, including bonuses and allowances. ▫ Ongoing training and development opportunities for NADMO officials. ▫ Access to necessary resources (equipment, transportation, technology). ▫ Adequate funding for operational needs. ▫ Implementation of recognition and reward systems for outstanding contributions. ▫ Public acknowledgment of officials' efforts. ▫ Collaboration with local stakeholders and community leaders.	Medium-term	Human Technology Finance	WMMA NADMO	EPA Forestry Commission NADMO CBOs NGOs CSOs Academic and Research Institutions International Disaster Response Agencies Local Educational Institutions and Training Providers Private Sector Partners (e.g., technology and equipment suppliers) United Nations Agencies (e.g., UNDP, UNICEF) Local community groups and leaders	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium and Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Construct and improve infrastructure and drainage system	To enhance disaster resilience in West Mamprusi by constructing and improving infrastructure and drainage systems that effectively mitigate flood risks and support sustainable development.	- Comprehensive infrastructure plan addressing geographical and climatic conditions. - Community engagement in design and implementation of infrastructure projects. - Use of sustainable materials and environmentally friendly construction techniques. - Effective and efficient drainage systems designed for extreme weather events. - Regular maintenance schedule for drainage systems and infrastructure. - Integration of infrastructure development into broader urban planning efforts. - Alignment with municipal priorities for cohesive growth and disaster resilience. - A measurable decrease in the frequency and severity of flooding events in areas where desilting has been carried out.	Long-term	Human Technology Finance	NADMO	MESTI Forestry Commission EPA NADMO Local communities CBOs NGOs Academic and Research Institutions Private Sector International Development Partners	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium and Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
		- Enhanced flow capacity of rivers, streams, and drainage systems, leading to better management of stormwater and reduced risk of overflow. - Higher efficiency of drainage systems in quickly and effectively channeling water away from urban areas during heavy rainfall.					
Resettlement of flood prone communities	To enhance community safety and resilience by resettling flood-prone communities in West Mamprusi to safer areas, thereby reducing their vulnerability to flooding and related disasters.	- Comprehensive risk assessments to identify vulnerable communities and hazards. - Community involvement in resettlement planning, including location choice and settlement design. - Development of necessary infrastructure and services (clean water, sanitation, education, healthcare, livelihood opportunities). - Preservation of cultural identities and community ties during relocation. - Ongoing support and monitoring post-resettlement for livelihood development, social integration, and disaster preparedness.	Medium-term	Human Technology Finance	WMMA NADMO	MLGRD MESTI EPA NADMO CBOs NGOs Academic and Research Institutions Private Sector International Development Partners	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium and Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Protection of roads / infrastructure by planting trees by the roadside to improve surface water retention	To enhance the resilience of critical road and infrastructure networks in West Mamprusi against natural disasters, particularly flooding, ensuring continued accessibility, economic activity, and disaster response capabilities.	- Identification and prioritization of critical infrastructure (roads, bridges, culverts, drainage systems). - Incorporation of climate-resilient engineering techniques for infrastructure protection. - Engagement of local communities in infrastructure design, maintenance, and protection. - Development of affordable, phased maintenance strategies for infrastructure. - Gender-responsive infrastructure protection measures addressing mobility needs of women, elderly, and persons with disabilities. - Regular infrastructure inspections and preventive repairs to minimize costly damage. - Municipal budgets optimized for cost-effective infrastructure maintenance.	Short-term	Human Technology Finance	WMMA	Ministry of roads and highways NADMO GMet EPA CBOs NGOs Academic and Research Institutions Media Organizations International Development partners	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium and Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Establishing community emergency response teams to counter basic disasters in the metropolis	To enhance local resilience and preparedness by empowering communities to effectively respond to and manage disasters	▫ Community involvement in formation and management of community emergency response teams. ▫ Regular and comprehensive training programs for disaster response. ▫ Integration of local knowledge and practices in disaster strategies. ▫ Provision of essential emergency equipment, communication tools, and transport resources. ▫ Strong coordination with local government and national disaster management agencies. ▫ Equal participation of men, women, and marginalized groups in community emergency response teams activities. ▫ Consistent funding sources for maintaining teams and resources. ▫	Short term	Human Technology Finance	KMA	NADMO Local Health Departments CBOs NGOs Academic and Research Institutions Local Emergency Services (E.g., fire Departments) Private Sector International Development Partners	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium and Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
		- Regular assessments of CERT performance and effectiveness. - Community education and awareness campaigns on disaster risks. - Alignment of community emergency response teams with existing emergency management frameworks and local governance structures.					

9.5.4 Water Resources

According to the West Mamprusi Municipal Assembly Vulnerability Assessment, agriculture is identified as the most vulnerable sector and requires significant attention. Six (6) adaptation actions that were identified and assessed through the multicriteria analysis (MCA) due to their cross cutting nature of the adaption option and its discussion in previous sectors. These actions target water scarcity for household and agricultural use. West Mamprusi, located in an arid region, faces challenges in accessing reliable potable water, particularly during dry seasons. Climate change and population growth worsen water scarcity, creating health risks and economic burdens. Expanding access to clean water is crucial for health, local agriculture, and resilience to climate change, while also supporting vulnerable populations and promoting social equity.

In northern Ghana, water bodies are vital for drinking, agriculture, and ecosystem health. Climate change, land use changes, and human activities threaten these resources, risking contamination and depletion. Protecting these water bodies will secure local water supplies, enhance biodiversity, and support climate resilience, aligning with West Mamprusi's environmental goals. Community education on water conservation is key to ensuring long-term water security. Teaching sustainable water management and investing in water-saving technologies can reduce the impact of droughts and support climate adaptation. Empowering local communities through education fosters ownership and encourages best practices for water conservation. Investment in water-saving infrastructure also improves resilience and provides economic benefits by reducing water wastage and boosting agricultural productivity.

Afforestation is a crucial strategy to improve watershed health, reduce soil erosion, and enhance groundwater recharge, which contributes to water availability. In West Mamprusi's dry climate, establishing vegetation cover helps combat land degradation, conserve moisture, and support local ecosystems and communities dependent on limited water resources. Dams for irrigation can store and regulate water, providing a consistent water source for agriculture during dry spells. By improving water access, dams support sustainable farming, reduce reliance on erratic rainfall, and enhance adaptive capacity to climate change. Enforcing building regulations related to water management ensures sustainable water use and mitigates the impacts of flooding and droughts. Proper enforcement supports community resilience, economic development, and social stability, aligning with municipal goals.

Table 16: Ranking of adaptation options for the water sector

Water	Final score	Rank
Increase access to potable water	46	1
Protection of Water bodies	43	2
Community Education and investment	43	2
Practice Afforestation	42	4
Construct and Improve Infrastructure	42	4
Dams (Irrigation)	42	4
Enforce building regulations	41	7

Table 17: Summary of the Adaptation Actions for the water sector

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Increase access to potable water	To increase access to potable water in West Mamprusi by implementing sustainable and resilient water infrastructure that addresses the water scarcity challenges in arid northern Ghana eg. Investing in rainwater harvesting.	□ Cost-effective water treatment and distribution systems with low maintenance costs. □ Collaboration with local governance structures and water authorities for implementation and management. □ Alignment of potable water initiatives with municipal and private sector development priorities. □ Identification of durable, low-maintenance, and efficient water supply technologies suitable for the arid climate. □ Flexibility and scalability in water infrastructure design to adapt to changing water demands. □ Use of culturally appropriate water sources and systems to improve community acceptance and sustainability. □ Community engagement to raise awareness about water conservation and health benefits.	Medium-term	Human Technology Finance	WMMA	MSWR EPA NGOs Local communities Educational Institutions Private sector International development agencies and donors Women's advocacy groups and gender-focused organizations. Health and education institutions for awareness campaigns. Research institutions for technology and scalability solutions. Traditional leaders and local influencers	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
		□ Consideration of women and girls' roles in water collection, focusing on reducing workload and ensuring safety. □ Equitable access to water across socio-economic groups and remote communities. □ Monitoring the volume of rainwater collected and used can indicate the effectiveness of rainwater harvesting systems in supplementing the water supply. □ Tracking the frequency and severity of flooding events can help assess the impact of rainwater harvesting on reducing runoff and mitigating flood risks.					

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Enforce building regulations	To promote the enforcement of building regulations that enhance water management and climate resilience in West Mamprusi. This will involve establishing effective frameworks that ensure compliance with regulations, integrate water adaptation options, and foster community engagement.	□ Tailored regulations addressing local environmental and socio-economic conditions. □ Active involvement of stakeholders and community members in the development and implementation of regulations. □ Community education on the importance of building regulations for water management and climate resilience. □ Training and resources for builders, contractors, and local officials to ensure compliance. □ Incentives for compliance, such as tax breaks, subsidies, or recognition programs. □ Partnerships with traditional authorities, local assemblies, private sector, and media for enforcement. □ Strengthened legal framework with clear penalties for non-compliance. □ Regular monitoring and evaluation of compliance with building regulations.	Medium term	Human Technology Finance	WMMA EPA	MLGRD MESTI EPA Water Resources Commission Ghana Police Service NGOs CBOs Private Sector Unit committees Traditional authorities Media International development and donor organization Academic and research organizations	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
		- Measuring the compliance rates of industries, businesses, and households with the by-laws can show how well the regulations are being followed. - High levels of compliance with updated building codes and regulations among new and existing buildings. - A measurable decrease in the extent and frequency of damage to buildings during extreme weather events indicates that structures are more resilient. - Lower incidence of injuries and fatalities related to building failures during climate-related disasters. - Increased frequency and thoroughness of building inspections, along with effective enforcement of building codes					

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Protection of Water bodies by creating buffer zones along rivers to protect water quality and reduce erosion and to reduce disaster risks during flooding	To protect and preserve water bodies in West Mamprusi by implementing sustainable management and conservation strategies, reducing pollution, and ensuring water availability for both current and future needs in the face of climate change.	□ Engaging local communities to promote sustainable practices and social acceptance. □ Involving traditional leaders and local stakeholders to enhance adherence to protective measures. □ Aligning water protection strategies with national and local policies for institutional support. □ Establishing vegetative buffers along water bodies to filter pollutants and reduce soil erosion. □ Educating the public on the importance of water body protection to foster a conservation mindset. □ Ensuring equitable access to clean water without disproportionately impacting vulnerable communities. □ Implementing effective monitoring and enforcement mechanisms to prevent illegal dumping and unsustainable extraction.	Short term	Human Technology Finance	WMMA	Ghana Water Company Limited (GWCL) Community Water and Sanitation Agency (CWSA) EPA Ministry of Sanitation and Water Resources NGOs Local communities Private sector Traditional leaders CBOs	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Community Education	To enhance sustainable water management practices and improve community resilience by promoting education on water conservation, investment in water-saving technologies, and community-led water resource initiatives in West Mamprusi.	□ Building on traditional knowledge of water conservation. □ Ensuring educational materials are accessible in local languages and formats. □ Highlighting the economic benefits of water conservation to promote investment. □ Collaborating with local schools, NGOs, and government agencies. □ Incorporating gender-responsive strategies for equitable access and community buy-in. □ Developing scalable pilot projects for sustainable water management practices. □ Establishing periodic assessment mechanisms for education initiatives and adoption of water-saving practices	Short term	Human Technology Finance	WMMA	Ministry of Sanitation and Water Resources (MSWR) EPA Zoomlion Ghana Limited NGOs Local communities Private sector Local schools CBOs Women's groups and associations Municipal water authorities	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Construct dams and Improve Infrastructure	To construct and enhance dam infrastructure in West Mamprusi to support irrigation, improve water availability, and enhance agricultural productivity in response to arid climate conditions. This will help stabilize water supplies for farming, contributing to food security, improved livelihoods, and climate resilience.	□ Design dam structures with climate-resilient materials to handle extreme weather like droughts and flash floods. □ Integrate efficient irrigation systems, such as drip irrigation, to minimize water wastage and optimize water distribution. □ Implement soil conservation practices to protect soil health and ecosystems affected by dam construction. □ Encourage active community involvement and ownership in dam maintenance, management, and sustainable use. □ Respect local customs and traditional values related to water use to foster acceptance and support. □ Establish financial models for regular dam maintenance, repairs, and upgrades to ensure functionality. □ Provide training for farmers on efficient irrigation practices and dam management for agricultural benefits. □ Develop and raise awareness about early warning systems for flooding or drought, and response strategies.	Long term	Human Technology Finance	MSWR	WMMA MSWR EPA GWCL Ghana Irrigation Development Authority MoFA WRC NGOs Local communities Private Sector CBOs Traditional leaders Farmer cooperatives	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
		□ Conduct comprehensive environmental impact assessments (EIAs) to mitigate adverse effects on biodiversity, water quality, and habitats. □ Ensure equitable access to irrigation water for marginalized farmers and communities to prevent conflicts. □ Design scalable or replicable dam infrastructure for similar arid regions in northern Ghana □ Regular testing of water quality parameters, such as turbidity and pollutant levels, to assess improvements following desilting. □ Measuring the capacity of reservoirs and dams before and after desilting to ensure they can store more water, especially during dry periods.					

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium or Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Afforestation	To promote afforestation practices that enhance water retention and soil stability in West Mamprusi, contributing to sustainable water management and increased resilience to water scarcity.	□ Selecting tree species compatible with local soil types for optimal water absorption and root stability. □ Establishing community-led initiatives for tree care to enhance survival rates and water benefits. □ Providing incentives, such as access to timber or non-timber forest products, to encourage community participation in afforestation. □ Raising local awareness about the ecological and hydrological benefits of afforestation to gain community support. □	Short-term	Human Technology Finance	WMMA	MSWR EPA WRC Forestry commission NGOs Local communities Private Sector Farmer groups	

9.5.5 Health

Climate change adaptation options identified on human health in the WMMA municipality emanate from direct impacts of extreme events such as heatwaves and storms, and indirect impacts from its linkage to other sectors such as waste, sanitation, and agriculture (food insecurity). Three out of the five identified adaptation actions have been selected and expanded on due on the interlinkages and discussions in other related sectors. Public health education is vital in areas like West Mamprusi, where limited resources, climate challenges, and communicable diseases increase health risks. Localized education campaigns can raise awareness, promote preventive health behaviours, and help communities cope with health issues related to arid conditions, such as waterborne diseases and malnutrition. These campaigns empower communities with practical information and resources, building resilience and reducing health vulnerabilities.

Public health regulations are essential in West Mamprusi to address the heightened health risks caused by environmental and resource challenges. Enforcing regulations on sanitation, water quality, and food safety can protect vulnerable populations, reduce disease spread, and improve overall health outcomes. These regulations strengthen health infrastructure, ease the burden on healthcare systems, and promote sustainable practices that align with local adaptation needs. Strong infrastructure is the foundation of an effective health system, providing safe, accessible spaces for healthcare delivery, emergency responses, and community health initiatives. Building and improving infrastructure enhances the health system's ability to address current and future health challenges, supporting both preventive and curative care. When tailored to local needs, these infrastructure improvements promote social equity, environmental sustainability, and long-term community resilience.

Table 18: Ranking of adaptation options for the health sector

Health	Final score	Rank
Public Health Education Campaigns	46	1
Public Health Regulations	44	2
Construct and Improve Infrastructure	42	3
Afforestation/ Agroforestry	40	4
Use Heat Resilient gadgets eg. fans, Air conditions, etc	34	5

Table 19: 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)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Enhance and enforce Public Health Regulations	To establish and enforce public health regulations in West Mamprusi, northern Ghana, to reduce health risks, improve sanitation, and enhance the resilience of the community against climate-induced health impacts, particularly in the face of arid conditions.	□ Ensuring compliance with health regulations is affordable for all income categories. □ Establishing clear roles and providing training and resources for local institutions to enforce regulations effectively. □ Regular assessments and feedback loops to ensure compliance and identify areas for improvement. □ Ensuring regulations align with broader health and environmental objectives for cohesive development. □ Mainstreaming gender-sensitive regulations addressing specific health risks faced by gender groups. □ Considering local customs and traditional health practices for acceptance and integration. □ Implementing a flexible regulatory framework that can adapt to new health challenges or environmental changes. □ Prioritizing education on public health regulations and involving local leaders and residents in regulation development.	Medium-term	Human Technology Finance	WMMA	Ghana Health Service (GHS) Ministry of Health (MoH) Local Health institutions and clinics EPA WHO NGOs Academic and Research Institutions International Development Partners (e.g., UNDP) Traditional authorities Gender Advocacy groups Media	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium, and Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Construct and Improve Infrastructure	To construct and improve health-related infrastructure that is accessible, resilient, and adaptable to community needs, enhancing the capacity to deliver essential health services and promoting overall public health resilience.	□ Alignment with community health needs (clean water access, sanitation, emergency health services) □ Financial feasibility for long-term sustainability (affordable construction and maintenance costs) □ Technical compatibility with local capabilities (materials, technology, labor availability) □ Incorporation of climate-resilient and sustainable design principles (environmentally friendly materials, energy-efficient systems) □ Community engagement in planning (traditional knowledge, cultural acceptance, ownership) □ Ongoing maintenance planning (local staff training, durable materials) □ Scalability and replicability of infrastructure models (adaptable to similar health and environmental challenges) □ Monitoring systems for infrastructure performance and health impact (real-time assessment and continuous improvement)	Long-term	Human Technology Finance	MoH	MLGDRD MoH GHS EPA Solar Energy Companies NGOs CBOs International Development Partners Academic and Research Institutions Local communities Health institutions and local clinics	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium, and Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Public Health Education Campaigns	To implement targeted public health education campaigns in West Mamprusi, to improve community awareness and practices around health, hygiene, and disease prevention, promoting resilience and adaptive capacity in an arid region vulnerable to health challenges.	- Higher levels of awareness among health Tailored health messages addressing local issues, including waterborne diseases and climate-induced health risks. - Use of simple, low-cost technologies for health campaigns in areas with limited internet and electricity. - Low-cost or subsidized campaigns using accessible materials and local resources like community radio and volunteer networks. - Partnership with respected leaders to disseminate health messages, ensuring credibility. - Campaigns designed to address the specific health needs of women, such as maternal and child health, hygiene, and nutrition. - Incorporation of local beliefs and practices in health messaging to promote behavior change. - Alignment with municipal health institutions, NGOs, and CSOs to avoid duplication and enhance impact. - Education on climate-resilient health practices, such as safe water storage and drought-resistant crops. - Active participation of communities in climate change and health-related activities and discussions.	Short term	Human Technology Finance	WMMA	GHS MoH Municipal Health Department Ministry of Education (MoE) EPA Health focused - NGOs International Development Partners Academic and Research Institutions Local communities and Traditional leaders Local radio station and media outlets Women Groups	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium, and Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
		▫ Establishment of a feedback system to assess community understanding and improve campaign content. ▫ professionals and the public about the health impacts of climate change. ▫ The number of training sessions conducted for health workers on climate change and health. ▫ Inclusion of climate change topics in health education curricula at various levels of education. ▫ Observable changes in public behavior that reduce health risks associated with climate change, such as increased use of mosquito nets and hydration practices during heatwaves. ▫ Active participation of communities in climate change and health-related activities and discussions.					

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium, and Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Afforestation	To protect public health and health infrastructure from the adverse effects of flooding. This involves growing trees to reduce the risk and impact of flooding on health facilities and communities, ensuring continuous access to healthcare services.	□ Selection of tree species compatible with local soil and climate conditions □ Community-led initiatives for tree care and maintenance □ Incentives for community participation in afforestation activities □ Increased local awareness of ecological and hydrological benefits □ Integration of traditional knowledge in afforestation practices □ Long-term sustainability and maintenance planning for planted trees □ Monitoring and evaluation of tree survival rates and ecosystem impact □ Collaboration with local authorities and stakeholders for support and resources □ Decrease in the frequency and severity of flooding events affecting health facilities and communities. □ The number of health facilities with improved flood defenses, such as trees	Short term	Human Technology Finance	WMMA	GHS MoH EPA NGOs CBOs Traditional leaders and local authorities International Development Partners Academic and Research Institutions	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium, and Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Use heat resilient gadgets eg. fans, Air conditions, etc	To integrate sustainable and resilient practices into the health sector. This involves encouraging the efficient use of heat resilient gadgets eg. fans, Air conditions, etc to reduce environmental impact of heat on health and enhance resilience.	□ Selection of energy-efficient heat-resilient gadgets (e.g., fans, air conditioners) □ Integration of climate-resilient cooling technologies (suitable for local conditions) □ Cost-effectiveness and affordability of gadgets for local populations □ Access to affordable installation and maintenance services □ Promotion of energy conservation and sustainability in the use of gadgets □ Awareness campaigns on the benefits and usage of heat-resilient gadgets □ Collaboration with local vendors and distributors for accessible availability □ Evaluation of effectiveness in reducing heat-related health risks and improving comfort	Short term	Human Technology Finance	WMMA	GHS MoH EPA Waste management companies NGOs CBOs International Development Partners Academic and Research Institutions Local communities	

9.5.6 Gender

The prioritized gender actions focus on delivering economic empowerment to women and other marginalized groups (youth and PWDs). Sustainable livelihood programs are crucial for meeting the diverse needs of communities, especially in arid regions like West Mamprusi, where livelihoods are vulnerable to climate variability and economic changes. Including gender considerations in these programs ensures that women, who are vital to household and community well-being, have the skills, resources, and opportunities to build sustainable livelihoods. This approach boosts economic resilience, promotes social equity, and empowers women. In West Mamprusi, relying on a single income source can make households more vulnerable to shocks like climate changes, market fluctuations, and health crises. Diversifying livelihoods reduces these risks and strengthens food security, economic stability, and community resilience. Gender-sensitive approaches ensure that women, who often manage household sustenance, have equal access to various livelihood opportunities, fostering inclusive economic growth.

Inadequate infrastructure in West Mamprusi limits access to healthcare, education, and economic opportunities, disproportionately impacting women who juggle household responsibilities and work. Improved infrastructure is key to promoting gender equity, improving mobility, and delivering services more efficiently. By integrating gender considerations into infrastructure development, we can create an environment that empowers women and supports their role in the economy and society. Climate change presents significant challenges in arid regions like West Mamprusi, where women often face the worst impacts due to existing inequalities. Gender-responsive climate education programs can raise awareness, promote sustainable practices, and help communities adapt to climate impacts. Empowering women through education enhances decision-making and strengthens resilience against climate change, benefiting the entire community.

Table 20: Ranking of adaptation options for gender

Gender	Final score	Rank
Gender mainstreaming in disaster risk reduction	45	1
Sustainable livelihood programmes	43	2
Diversification of livelihood	38	3
Improved Infrastructure	37	4
Climate Education programmes	36	5

Table 21: Summary of the Adaptation Actions for gender

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium and Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Climate Education programmes	To promote gender empowerment and equity in West Mamprusi that specifically enhance awareness of climate change impacts and empower women and marginalized groups to actively participate in climate adaptation and mitigation efforts	□ Gender-sensitive climate education curricula addressing impacts on women and marginalized groups □ Accessible educational materials using local languages and culturally relevant content □ Community-based training programs involving women and local leaders □ Training for local leaders and influencers on climate issues and gender mainstreaming □ Engagement of local women's groups and organizations in the development and delivery of programs □ Use of technology and social media platforms to increase awareness and encourage participation □ Monitoring and evaluation framework to assess effectiveness and promote gender-responsive actions □ Advocacy for funding and resources from local authorities and NGOs to support program sustainability	Short-term	Human Technology Finance	WMMA	Ministry of Gender, Children and Social Protection NGOs Community-based organizations (CBOs) Academic and Research Institutions Women groups and organizations Local educational institutions and schools Traditional leaders International and donor organizations	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium and Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Sustainable livelihood programmes	To promote sustainable livelihood programs in West Mamprusi that effectively empower women and marginalized groups, enhancing their economic resilience, social equity, and adaptive capacity in the face of environmental and economic challenges.	□ Comprehensive assessments of livelihood needs, preferences, and constraints for women and marginalized groups □ Targeted training programs for women in skills development, entrepreneurship, and sustainable agriculture □ Support for traditional livelihood practices with cultural significance for women □ Access to microfinance and credit facilities tailored for women and marginalized groups □ Promotion of gender equality in program design, addressing power dynamics and barriers □ Partnerships with local women's organizations and NGOs for effective outreach and implementation □ Facilitation of women's access to markets and development of value chains for their products □ Number and percentage of vulnerable groups (women, children, elderly, marginalized communities) actively involved in project activities. □ Increase in income levels for vulnerable groups through project-related activities.	Short term	Human Technology Finance	WMMA	Ministry of Gender, Children and Social Protection CBOs NGOs International Development Agencies (e.g., UNDP) Academic and Research Institutions Local women's organization Micro finance institutions Educational institutions offering entrepreneurship and skills training programs	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium and Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
		- Enhanced resilience of vulnerable communities to climate impacts, measured through reduced vulnerability to extreme weather events. - Overall improvement in the quality of life for vulnerable groups, including better housing and access to clean water. - Strengthened social networks and community support systems.					
Diversification of livelihood	To promote alternative income opportunities in West Mamprusi, with a specific focus on empowering women and marginalized groups to engage in varied economic activities that enhance resilience and adaptability to environmental and economic changes.	- Local market assessments to identify viable livelihood opportunities - Implementation of training programs in agriculture, handicrafts, and services - Support for women-led small-scale enterprises (resources, mentorship, networking) - Access to microfinance and savings programs tailored for womenIncrease in the number of women-led businesses and their revenue growth. - Number of women entrepreneurs accessing financial services and products, such as loans and grants. - Number of jobs created by women-led businesses. - Increase in the number of women in leadership roles within their businesses and communities.	Short term	Human Technology Finance	WMMA	Ministry of Gender, Children and Social Protection CBOs NGOs International Development Agencies (e.g., UNDP) Academic and Research Institutions Training centers and Vocational schools Microfinance institutions	

ADAPTATION ACTIONS	OBJECTIVES	INDICATORS OF SUCCESS	TIME FRAME (Short, Medium and Long Term)	RESOURCES (Finance, Human, Technology)	IMPLEMENTING PARTNERS		Estimated costs
					Lead	Collaborating	
Improved Infrastructure such as installation of solar-powered water pumping and borehole systems in communities to reduce drudgery for women	To promote improved infrastructure in West Mamprusi that addresses gender-specific needs and enhances access to essential services and economic opportunities for women and marginalized groups.	□ The number of new women-led solar energy businesses established. □ The number of jobs created through solar energy initiatives, particularly for women and marginalized groups. □ Gender-sensitive infrastructure design (transportation, sanitation, healthcare services) □ Active participation of women and marginalized groups in planning and decision-making □ Environmentally sustainable construction practices (durable, climate-resilient infrastructure) □ Training programs for women in construction and infrastructure maintenance □ Creation of job opportunities for women in the local economy □ Gender-sensitive monitoring and evaluation framework (impact on women's access to services and economic opportunities)	Medium-term	Human Technology Finance	WMMA	Ministry of Gender, Children and Social Protection NGOs CBOs International Development Agencies (e.g., UNDP) Local women organizations Training centers and Vocational schools	



10

Framework for Adaptation Monitoring, Evaluation, and Learning

Monitoring, Evaluation, and Learning (MEL) is essential in adaptation planning as it allows for tracking progress, assessing impact, and ensuring resources are used effectively. In West Mamprusi, MEL would provide accountability to stakeholders and foster a responsive management approach, enabling project adjustments based on real-time data. By documenting both successes and challenges, MEL builds a culture of continuous learning, which supports knowledge sharing and informs future projects. Additionally, MEL insights can guide local policymakers in refining policies and identifying best practices for scaling, ultimately enhancing the effectiveness and sustainability of adaptation efforts in the region.

10.1 Building on Existing Structures to Facilitate Mainstreaming

MEL (Monitoring, Evaluation, and Learning) for climate adaptation plays a crucial role in tracking progress on adaptation actions and assessing advances toward climate resilience. This system is designed to enhance and build upon both national and municipal monitoring and evaluation efforts, creating a comprehensive framework for gauging outcomes and effectiveness. By aligning with existing structures, MEL not only measures adaptation progress but also fosters learning around climate change, ensuring a cohesive and streamlined approach to development goals and contribute to a sustainable agenda.

In Ghana, various laws, policies, and plans provide a framework for developing monitoring and evaluation systems for development initiatives. The National Development Planning Commission (NDPC) holds the primary responsibility for M&E, establishing a system that analyses the interconnections between inputs, activities, outputs, outcomes, and impacts in delivering public services. Key legislative documents, such as Articles 86 and 87 of the 1992 Constitution, the National Development Planning System Act of 1994 (Act 480), and the National Development Planning (System) Regulations of 2016 (LI. 2232), mandate government agencies to implement M&E for their policies and programs.

For the West Mamprusi Municipal Assembly (WMMA), there is an expectation to develop its own M&E plan that includes sub-district levels, guided by the NDPC's frameworks (NDPC, 2020). While there isn't a specific M&E plan dedicated to climate change adaptation, the NDPC guidelines encompass various indicators related to climate change, the Sustainable Development Goals (SDGs), Agenda 2063, and green economy initiatives. The integration of climate change issues into the WMMA's Medium Term Development Plan (MTDP) underscores the importance of monitoring and evaluating relevant indicators and targets. However, the NDPC's M&E framework does not explicitly emphasize the learning aspect, which is vital for continuous improvement. Globally, the learning component of MEL is an emerging concept that necessitates intentional efforts to enrich its application in the context of climate adaptation.

10.2 MEL Design

The framework for the West Mamprusi Municipal Assembly (WMMA) adaptation Monitoring, Evaluation, and Learning (MEL) system is designed to achieve the following objectives:

- monitor the implementation of agreed-upon adaptation measures within the municipality to ensure effective execution.
- assess the effectiveness of adaptation actions in reducing community vulnerability.
- generate insights and knowledge that guide policy development and decision-making while raising awareness among stakeholders.
- produce information for local government and national reporting to ensure transparency and accountability.
- create a system for acquiring and storing climate data to measure and track adaptation progress at the local level.
- establish clear communication channels to disseminate information about the adaptation strategy and efforts within the municipality.

Operationalizing the adaptation MEL system requires integrating climate adaptation considerations and MEL planning into the municipal development plans and policies, such as the Annual Action Plans (AAP) and the district's Medium Term Development Plan (MTDP)

Table 22: Outline of approach to MEL of WMMA adaptation actions

Steps	Indicative Activities—To Be Led by the WMMA Planning Coordination Unit
1. Monitoring the Adaptation Actions	• Identify adaptation activities for monitoring using both qualitative and quantitative performance measures to assess progress toward the adaptation objectives. • Define metrics and indicators to document progress for the selected adaptation activities. • Collect data on the defined metrics and indicators throughout the adaptation implementation process.
2. Reviewing the Adaptation Process to Assess Progress, Effectiveness, and Gaps – Evaluation	• Establish methods for measuring and communicating effectiveness levels and identifying gaps in the adaptation process. • Integrate insights from recent studies, new scientific developments, and feedback from ongoing adaptation efforts to evaluate and improve strategies. • Revise adaptation activities based on evaluation results and metrics.

3. Iteratively Updating the Adaptation Plan – Learning	• Update adaptation activities in response to the information gathered during monitoring and evaluation. • Document key lessons learned, highlighting successful strategies and areas for improvement. • Establish criteria for success and/or failure of adaptation initiatives. • Implement necessary remedial measures based on evaluations. • Align learning outcomes and corrective actions with broader targets outlined in the WMMA Medium Term Development Plan (MTDP).
4. Communication – Reporting Progress, Process Effectiveness, Outreach, and Knowledge Dissemination	• Disseminate adaptation-related documents and learning outcomes to stakeholders. • Include information in the WMMA annual progress report regarding the advancement and effectiveness of adaptation actions.

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 Conclusion

The Adaptation Action Plan for the West Mamprusi Municipal Assembly represents a pioneering effort in climate change adaptation at the subnational level in Ghana. As one of the first of its kind in the country, the Plan positions the West Mamprusi Municipal Assembly as a frontrunner in localized climate adaptation planning in Ghana. By building on the framework of Ghana's National Adaptation Plan (NAP), applying science-based approaches, participatory governance, and innovative financing, the plan not only addresses immediate climate vulnerabilities but also lays the groundwork for long-term resilience and sustainable development. The plan also aligns with Ghana's Sustainable Development Goals (SDGs), and the country's Medium-Term Development Plan (MTDP). Its success will serve as a model for other districts in Ghana, demonstrating the transformative potential of inclusive and adaptive planning. The assessment highlighted the specific vulnerabilities of marginalized groups, such as women, youth, and persons with disabilities, ensuring that their needs are central to adaptation strategies.

The development process involved extensive stakeholder consultations, including local government representatives, community leaders, civil society organizations, private sector actors, and international development partners. A multi-criteria analysis (MCA) was used to rank and prioritize adaptation actions, ensuring that decisions were evidence-based, transparent, and inclusive.

This process outlined 44 prioritized adaptation actions across all relevant socioeconomic sectors of WMMA. This include agriculture, biodiversity, water resources, disaster risk reduction (DRR) and transportation, health and sanitation sector as well as gender. The plan's sector-specific adaptation actions provide innovative solutions tailored to the municipality's unique challenges.

In **agriculture**, actions such as climate-smart agriculture, conservation practices, and irrigation systems seek to strengthen the productivity and resilience of smallholder farmers. Similarly, **biodiversity** initiatives emphasize community-based management, afforestation, and protected area creation to restore ecosystems and mitigate the impacts of deforestation and bushfires. These strategies are complemented by **water resource** interventions, such as protecting water bodies, expanding potable water access, and implementing afforestation for watershed health.

Addressing **disaster risk reduction (DRR)** is another critical aspect of the plan. Prioritized actions, including early warning systems, community engagement, and enhanced drainage infrastructure, aim to reduce the municipality's vulnerability to floods and other climate-induced disasters. These initiatives align with national DRR frameworks, ensuring coherence and scalability.

The plan also highlights **public health and gender equity** as cross-cutting themes. Public health strategies focus on improving infrastructure, enforcing health regulations, and conducting awareness campaigns to mitigate climate-induced health risks. Gender-responsive programs promote sustainable livelihoods, climate

education, and enhanced access to economic opportunities for women and marginalized groups. These efforts seek to bridge systemic inequalities and strengthen community resilience.

Successful implementation of this plan requires a concerted focus on **resource mobilization, institutional capacity-building, and robust monitoring frameworks**. The involvement of key stakeholders, such as government agencies, private sector partners, and local communities, is critical to ensuring sustainability and scaling adaptation efforts across the region. Partnerships with academic and research institutions will further provide evidence-based insights to refine strategies and measure impact.

11.1.1 Future Outlook

The West Mamprusi Municipal Assembly is poised to become a model for subnational climate adaptation in Ghana. By leveraging the insights and methodologies developed through this plan, the assembly can not only enhance local resilience but also contribute to national climate adaptation goals.

The plan's emphasis on participatory governance, gender responsiveness, and nature-based solutions positions it as a forward-looking strategy that integrates climate adaptation with sustainable development. Key actions, such as climate-smart agriculture, water conservation, and disaster preparedness, will have far-reaching benefits, including:

- Improved livelihoods for smallholder farmers and vulnerable groups.
- Enhanced biodiversity and ecosystem services.
- Strengthened disaster resilience and reduced economic losses.

11.2 Recommendations

To ensure the success and sustainability of the Adaptation Action Plan, the following actions are recommended:

- **Strengthen Resource Mobilization**
 - Actively pursue diversified funding sources, including government allocations, international donors, and public-private partnerships.
 - Explore innovative financing mechanisms such as private-public partnerships (PPPs), climate bonds and green funds to address resource gaps.
- **Enhance Institutional Capacity**
 - Establish a dedicated Climate Change Desk within the Municipal Planning Coordination Unit (MPCU) to oversee adaptation efforts.
 - Provide capacity-building programs for municipal staff and community leaders to strengthen technical and operational capabilities.
- **Promote Inclusive Stakeholder Engagement, Public Awareness and Education**
 - Strengthen participation of vulnerable groups, including women, youth, and persons with disabilities, in decision-making processes.
 - Develop targeted programs to empower women economically and socially, ensuring equal access to resources, training, and leadership roles.
 - Institutionalize gender-sensitive approaches across all adaptation actions.

- Foster collaborations with traditional authorities, farmer cooperatives, and local community groups to ensure grassroots ownership of initiatives.
- Launch targeted public education campaigns on climate adaptation strategies, focusing on local languages and culturally relevant approaches.
- Include climate-resilient practices in school curricula to instill early awareness and engagement.
- **Prioritize Monitoring, Evaluation, and Learning (MEL)**
 - Develop and implement a robust MEL framework to track progress, assess impact, and refine interventions.
 - Incorporate community-based monitoring mechanisms to ensure accountability and feedback integration.
- **Leverage Technology and Innovation**
 - Invest in advanced technologies, such as localized weather stations, early warning systems, and digital platforms, for real-time climate risk management.
 - Promote adoption of climate-smart agricultural technologies, water-saving infrastructure, and renewable energy solutions.
- **Ensure Sustainability of Biodiversity and Ecosystems**
 - Intensify community-based management practices to protect and restore biodiversity, especially through afforestation and the establishment of protected areas.
 - Incentivize sustainable livelihoods, such as agroforestry and eco-tourism, to reduce dependency on natural resource extraction.
- **Enhance Coordination Across Sectors**
 - Foster collaboration among municipal departments, national agencies, and NGOs to ensure alignment of efforts and avoid duplication.
 - Establish periodic inter-sectoral reviews to identify synergies and gaps in implementation.
- **Develop Scalable and Replicable Models**
 - Design pilot projects for key adaptation actions (e.g., irrigation systems, disaster response networks) that can be scaled across similar municipalities in Ghana.
 - Document and share lessons learned to inform national adaptation planning efforts.

11.2.1 Call to Action

For successful implementation, all stakeholders must play their roles:

- The government must allocate sufficient resources and create enabling policies.
- Communities must embrace ownership of adaptation actions and actively participate in their execution.

- Development partners and the private sector must support through funding, technology transfer, and capacity building.

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Appendix

A. Implementation Roles and Responsibilities.

Climate change is no longer solely an environmental issue; it is a multifaceted challenge that requires cross-sectoral coordination and shared responsibilities. Isolated and uncoordinated efforts within and across sectors can lead to overlapping initiatives and, in some cases, maladaptation. To improve efficiency through cross-sectoral synergies, a diverse range of institutional stakeholder arrangements is essential for the West Mamprusi Municipal Assembly.

Table 23: Relevant stakeholders, their key roles, responsibilities, and expected outcomes from their engagement in the implementation of the NAP

Institution	Role/Responsibility	Expected Outcome from Engagement
Public Sector		
Municipal Planning Coordinating Unit, WMMA	- Facilitates the development of climate action plans in WMMA.	- Effective integration of climate adaptation in local planning.
	- Leads monitoring and evaluation of climate initiatives.	- Enhanced capacity for monitoring climate actions.
	- Coordinates climate adaptation projects in WMMA.	- Increased financing and partnerships for adaptation.
Assembly Members, Town/Area Councils and Unit Committees	- Advocate and facilitate public participation in adaptation initiatives.	- Enhanced local awareness and support for climate adaptation.
	- Be a liaison between the Municipal Assembly and local population in developing and implementing localized climate adaptation plans.	- Improved climate implementation of community adaptation initiatives.
WMMA Departments (Agriculture, Disaster Prevention, Health, Natural Resources)	- Implements adaptation priorities within their sectors.	- Reduced climate vulnerability within sectors and communities.
		- Strengthened local resilience through sectoral adaptation initiatives.
National Disaster Management Organisation (NADMO)	- Promotes disaster risk reduction and climate risk management.	- Lowered community vulnerability to climate and disaster impacts.
	- Mobilizes community involvement for disaster prevention.	- Disaster resilience included in adaptation plans.
	- Provides relief in times of disaster.	
Gender Department	- Ensures climate strategies consider women, youth, and vulnerable groups.	- Increased focus on addressing gender-based climate vulnerabilities.
Ghana Health Service	- Integrates climate change considerations into health risk management at the municipal level.	- Strengthened adaptation for climate-sensitive health risks.
Forestry Commission	- Regulates forest and wildlife resources; provides technical assistance for adaptation measures.	- Technical expertise to support forest and wildlife-related adaptation activities.
National Development Planning Commission (NDPC)	- Develops national policy frameworks, coordinating implementation across districts and municipalities.	- Comprehensive climate change integration in WMMA development plans.
	- Integrates climate adaptation in economic, social, and environmental planning.	- Aligned and coordinated adaptation planning across municipalities.

Institution	Role/Responsibility	Expected Outcome from Engagement
Ghana Meteorological Agency (GMet)	- Supplies climate and weather data for decision-making at the municipal level.	- Access to accurate, municipality-specific climate data.
Environmental Protection Agency (EPA)	- Leads on the NAP process, overseeing pollution control, sanitation, and environmental protection.	- Clear adaptation priorities for WMMA sectors.
	- Develops sector-specific vulnerability reports.	- Support for vulnerability assessments.
Ministry of Food and Agriculture (MoFA)	- Oversees agricultural policies in WMMA.	- Improved climate resilience in agriculture.
	- Trains extension staff to integrate climate considerations into agricultural practices.	- Effective climate messaging by extension staff.
	- Facilitates technology transfer.	- Improve adaptation of climate smart agriculture
National Commission on Civic Education (NCCE)	- Educates the public on climate change and adaptation measures.	- Increased community understanding and engagement in climate resilience efforts.
Regional Coordinating Council	- Oversees WMMA's Climate Change Adaptation Strategy through monitoring and evaluation.	- Enhanced support for smooth implementation of adaptation initiatives.
	- Coordinates regional planning.	
Ministry of Finance	- Manages financing for climate vulnerability assessments and adaptation strategies.	- Financial support for vulnerability assessments and adaptation implementation.
Research and Academia		
CSIR (SARI, FRI, STEPRI, CRI, etc.) KNUST, UNER, UDS	- Provides technical support, climate education, and capacity building.	- Enhanced climate education and informed adaptation strategies.
	- Conducts climate resilience research relevant to WMMA.	
Private Sector		
Farm Input Dealers	- Promote climate-resilient farm inputs and technologies.	- Improved access to climate-adaptive farming technologies.
Financial Institutions	- Provide credit facilities for climate-related initiatives.	- Increased financial support for climate adaptation among farmers and businesses.
Farmer-Based Organizations	- Advocate for farmers, enhance bargaining power, and influence policy on adaptation.	- Improved resilience and adaptive capacity among farmers.
Development Partners		
Green Climate Fund, Bilateral Organizations (e.g., GIZ, USAID)	- Mobilize resources, offer capacity development, and facilitate technology transfer for adaptation.	- Financial and technical support for WMMA's adaptation projects.
UN Agencies (UNDP, UNICEF, NAP Global Network)	- Provide support for planning, advocacy, research, and monitoring of climate adaptation.	- Improved capacity building, effective planning, and implementation of adaptation actions.

Institution	Role/Responsibility	Expected Outcome from Engagement
NGOs/Civil Society Organizations		
Braveurora, Walewale Youth Parliament, etc	- Engage in planning, advocacy, education, research, and monitoring of adaptation programs.	- Enhanced community awareness and resilience through supported adaptation projects.
	- Initiate and fund local adaptation efforts.	
Traditional Councils	- Mobilize communities, support engagement for adaptation activities.	- Strong community involvement in climate adaptation practices.
Faith-Based Organizations	- Mobilize communities and raise awareness on climate issues.	- Strong community commitment to climate adaptation practices.
Opinion Leaders	- Champion climate awareness and engage communities.	- Increased local engagement in climate resilience efforts.
Local Media (Walewale FM, community information centres, other local radio and television stations, etc)	- Educate and inform the public on WMMA's climate adaptation plan and strategies.	- Greater community awareness and support for climate adaptation.
Vulnerable Groups		
Women, Youth, and PWDs	- Participate in the design and execution of adaptation initiatives.	- Greater visibility of climate impacts on vulnerable groups.
	- Engage in public awareness on climate impacts and adaptation.	- Increased advocacy and support for these groups in adaptation measures.

Source: Adapted from West Mamprusi Vulnerability Assessment Report.

C: List of Stakeholders

1. **Traditional Authority (Chief).**
2. **National Disaster Management Organisation (NADMO)**
3. **Fisheries Commission**
4. **Walewale Tech Institute – Senior High School.**
5. **Walewale FM – Media.**
6. **Department of Agriculture (WMMA)**
7. **AG Church – Religious leader**
8. **WIPVAC – Women’s Group.**
9. **Person With Disability Group**
10. **Ghana Health Service**
11. **Forestry Commission**
12. **Farmers Group**
13. **Ghana National Fire Service (GNFS)**
14. **Braveaurora Non-Governmental Institutions.**
15. **Information Service Department**
16. **Municipal Planning Department (WMMA)**
17. **Municipal Chief Executive**
18. **Municipal Coordinating Director**
19. **Department of Works (Municipal Engineer)**
20. **Gender Desk Office**
21. **Environmental Protection Agency (EPA)**
22. **Chief Imam (Religious Group)**
23. **Municipal Physical Planning Department**
24. **National Commission of Civic Education (NCCE)**
25. **Municipal Sanitation and Health Unit**
26. **Youth Parliament President (Youth group)**
27. **Zoomlion**
28. **DSW & CD**

B. Long List of Adaptation Measures For The West Mamprusi Municipal Assembly

SECTORS	IDENTIFIED CLIMATE RISKS	PROPOSED ADAPTATION ACTIONS	ASSESSMENT OF IMPACTS OF PROPOSED ACTIONS	SUPPORTING POLICIES
Agriculture	The unpredictable nature of rainfall patterns, characterized by erratic onset, distribution, and duration of rainfall, poses a significant challenge to traditional crop varieties, which often require longer growing seasons.	Use of early maturing crops Encourage indigenous technologies for rain harvesting on farms	By cultivating early maturing crops, farmers mitigate the uncertainty associated with rainfall timing and availability, as these varieties have shorter growth cycles and can be harvested before the onset of prolonged dry spells or erratic weather events.	National Climate Change Policy Planting for Food and Jobs (PFJ) Program Ghana Agriculture Sector Investment Plan (GASIP) Ghana's Revised Nationally Determined Contributions
	Floods often inundate farmlands, destroying farms and drastically impacting crop yield	Advising farmers to cultivate on higher lands to lessen impacts from floods Venturing into alternative income-generating activities		
	floods inundate agricultural lands	Conservation Aquaculture practices (Climate Smart) Build raised platforms and embankments around farmlands to protect crops from floodwaters.		

	Unreliable rainfall patterns affect	Regular and reliable weather updates Improved weather forecasting through the radio and social media (WhatsApp)		
	Extreme heat, peaking in March and April, adversely affects perishable goods both on the farm and during transportation, leading to reduced cash flow and loss of goods. Long periods without rains result in water scarcity, crop failures, and livestock losses. Prolonged dry spells reduce soil moisture levels, impairing crop growth and leading to decreased yields.	Encouraging farmers to diversify their crop varieties to include drought-resistant crops and the use of early maturing crops Develop training programs to educate farmers on adaptive farming techniques and climate-smart agriculture. Provide subsidies for drought-resistant and fast-growing seed varieties to encourage farmers to adopt resilient crop options.		
	Droughts cause food insecurity leading to extreme hunger in communities			

Settlements	Increased frequency and intensity of flooding events due to climate change leading to the destruction of housing and infrastructure	It was suggested that building infrastructure resistant to flooding and using early-maturing crops Plant trees and mangrove along rivers to enhance water retention and reduce flood impacts. Enforce building regulations that prevent construction in high-risk flood areas Conduct training programs for residents on flood preparedness, response, and recovery	Implementation of flood-resistant infrastructure can minimize risks associated with floods	Ghana National Spatial Development Framework (NSDF) Medium-Term Development Plan Local Government Act, 2016 (Act 936) West Mamprusi Municipal Assembly Annual Action Plan
	Higher temperatures and increased heat waves due to climate change.	Construction of ventilated buildings Use of electronic gadgets eg fans, Air conditions, etc Promote the planting of trees in households		
	Higher temperatures can cause infrastructure materials to expand and contract, leading to cracks in roads, bridges, and buildings	Change of building designs to include durable and flood or extreme heat resistant materials Investing in reinforcing housing against flooding	By allocating resources towards reinforcing housing infrastructure, communities can reduce the risks associated with natural disasters, however, this investment is constrained by limited income. Which further strains individual livelihood strategies	

Disaster Risk Reduction	Lack of education among the general public, and instances of ineffective leadership and government, increase vulnerabilities and risks of the population extreme climate events	Providing sensitization and awareness campaigns on disasters and information from early warning systems Incorporating Disaster Volunteer groups	Implementing public education campaigns and organizing drills can empower residents to respond effectively and minimize potential disasters	National Climate Change Policy Ghana National Spatial Development Framework (NSDF) Medium-Term Development Plan
	Heavy rainfalls often lead to the flooding of communities in proximity to river bodies	Planting trees as windbreaks Construction of better drainage facilities	Incorporating flood-resilient urban planning measures can help minimize the impact of flooding on houses and infrastructure	West Mamprusi Municipal Assembly Annual Action Plan
	Climate vulnerabilities manifest in risks such as the loss of properties and, more critically, the loss of lives	The desilting of gutters is nonetheless crucial for flood mitigation, during the onset of the rainy season Implementing prompt early warning systems through the use of communication technologies Change of building designs to include durable and flood or extreme heat resistant materials Enhance the capacity of NADMO and disaster response agencies		

Transport	Notably, floods occur predominantly from July to September, and pose significant challenges to transportation systems, by cutting off access to major road networks, impacting market accessibility and goods distribution	Building of flood-resilient infrastructure (roads) Plant trees by the roadside to improve surface water retention Improve early warning systems to forewarn users of major roads	Constructing flood-resilient roads and utilizing durable materials, ensures continuity of essential services such as healthcare, education, or employment locations even during extreme climate events	Ghana National Spatial Development Framework (NSDF) Medium-Term Development Plan Local Government Act, 2016 (Act 936)
	Extreme weather events such as heavy rains affect the passability of roads cutting off communities from education and healthcare facilities	Investment in good road materials Develop alternative routes into and out of the municipality Establish volunteer emergency response teams within communities to assist during extreme weather events and ensure rapid response to infrastructure damage.		West Mamprusi Municipal Assembly Annual Action Plan

Health	The health education sector, vital for community well-being, faces significant disruption during the rainy season, most intense from July to September, marked by high vulnerability to floods	House-to-house or community health visits and provision of healthcare Extension or expansion of health facilities or personnel to distant communities	The extension or expansion of health facilities and personnel to distant communities presents an opportunity to enhance access to healthcare services, particularly in flood-prone areas.	Ghana Health Policy Environmental Sanitation Policy National Gender Policy
	Extreme heat as well was noted to trigger health complications linked to soaring temperatures	Education and sensitization on preventative health measures Planting of trees improve shade and heat conditions. Construct flood-resilient infrastructure such as elevated schools and healthcare facilities, improved drainage systems, and flood barriers. Construction of ventilated buildings Use of electronic gadgets eg fans, Air conditions, etc	Activities such as education and sensitization campaigns, become a proactive approach toward addressing seasonal vulnerabilities and promoting resilience within the health education sector	

Biodiversity	Bush burning for charcoal Deforestation, driven by various factors including bushfires, aggravates environmental degradation and reduces biodiversity, impacting ecosystem stability and resilience	Anti-Bushfire law enforcement, and public sensitization Provide alternative income opportunities to prevent charcoal making during the dry season Encourage climate smart agriculture Implementation of anti-bush fire bye-laws Reafforestation and tree planting campaign Create protected forest areas.	The provision of alternative livelihoods discourages people from cutting down and burning trees for charcoal production The implementation of bush fire bye-laws ensures that the risks associated with the incidence of bushfires during the dry season are reduced to the minimum	West Mamprusi Municipal Assembly Bye Laws National Climate Change Policy Environmental Sanitation Policy Ghana Forest and Wildlife Policy
	Bush fires pose threats to biodiversity, destroying natural habitats and disrupting ecosystems, which can have long-term repercussions on wildlife populations and ecosystem	Formation of disaster volunteer groups Additionally, measures such as planting more trees, protecting existing tree cover, creating fire belts around farms, and community engagement in bushfire prevention were stated to reduce the risks of bushfires Develop early warning systems to promptly disseminate	The formation of disaster volunteer groups empowers community members to take ownership of local government resilience efforts, fostering a sense of collective responsibility and solidarity in preparation against climate hazards Through active participation and collaboration, communities can co-create solutions that not only mitigate climate risks but also strengthen social cohesion and build adaptive capacity	

Gender	The youth are forced to migrate to the south in the dry season increasing their vulnerabilities as migrants in the destinations and the vulnerabilities of the aged population	Provision of alternative income opportunities during the dry season Train youth on climate smart agriculture practices Dry season gardening for women and other marginal groups without access to own land Encouraging the youth to stay in school and attain higher education Install solar-powered water pumping and borehole systems in communities to reduce drudgery for women and increase time for productive activities	Instituting alternative livelihood opportunities presents the youth with enhanced livelihood options which decrease climate-induced migration during the dry season. Similarly, encouraging the youth to increase their years in education further increases their career or livelihood options. Thereby decreasing the vulnerability of themselves and their dependents	Medium-Term Development Plan West Mamprusi Municipal Assembly Annual Action Plan National Gender Policy
	Among the population, women, children, PLWD, and the aged are identified as more at risk due to factors such as limited mobility, dependency, and socioeconomic status.	Integrate gender considerations into climate change policies and programs, ensuring that they address the specific needs and priorities of women, and promote women's participation in decision-making processes. Establish and support women's empowerment groups and cooperatives (such as VSLA) that provide platforms for collective income-generating activities, skills training, etc.	Mainstreaming gender dimensions in local governance will help to decrease gender inequality and reduce the climate vulnerability of one gender	

Water resources and water systems	Flooding often leads to the transfer of waste materials into the water bodies leading to the contamination of water bodies	Improve rainwater harvesting or harvesting of floodwater Protection of water bodies Implementing communal waste management practice Encourage agroforestry to improve soil moisture retention and reduce evaporation. Enforce buffer zones along rivers to protect water quality and reduce erosion. , As well as to, reduce disaster risks during flooding and river overflows	Trapping flood water in reservoirs or rainwater collection techniques further bolster water security and community empowerment during the dry season Improving communal waste management systems prevents the pollution of water bodies during floods	Environmental Sanitation Policy West Mamprusi Municipal Assembly Annual Action Plan Ghana National Water Policy National Climate Change Policy
	Long periods with no rains (droughts) coupled with excess heat lead to the drying up of water bodies that communities rely on for survival	Implementing rainwater collection techniques Increase afforestation programmes and encourage agro-forestry Investing in communal water storage infrastructure. Install large community water storage tanks to collect and store water from various sources during periods of rainfall. Conduct training programs on water conservation techniques and sustainable water management practices. Improve implementation of 1-Village 1-dam policy. Which serve as detention basins and retention ponds.	Trapping flood water in reservoirs or rainwater collection techniques further bolster water security and community empowerment during the dry season.	

