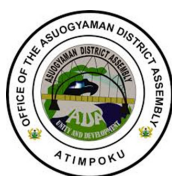


Adapting Together, Thriving Tomorrow



# Climate Change Rapid Risk Assessment for Asuogyaman District Assembly (ADA) in Ghana

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



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# List of Abbreviations

| Acronym | Expanded Form                                                        |
|---------|----------------------------------------------------------------------|
| AfDB    | African Development Bank                                             |
| CBOs    | Community-Based Organizations                                        |
| CCA     | Climate Change Vulnerability                                         |
| CCRA    | Climate Change Risk Assessments                                      |
| COP     | Conference of Parties                                                |
| CSOs    | Civil Society Organizations                                          |
| CWSA    | Community Water and Sanitation Agency                                |
| EPA     | Environmental Protection Agency                                      |
| FAO     | Food and Agriculture Organization                                    |
| FASDEP  | Food and Agriculture Sector Development Policy                       |
| GCF     | Green Climate Fund                                                   |
| GDP     | Gross Domestic Product                                               |
| GES     | Ghana Education Service                                              |
| GHG     | Greenhouse gases                                                     |
| GHS     | Ghana Health Service                                                 |
| GMet    | Ghana Meteorological Agency                                          |
| GSS     | Ghana Statistical Service                                            |
| GWCL    | Ghana Water Company Limited                                          |
| IPCC    | Intergovernmental Panel on Climate Change                            |
| ISD     | Information Services Department                                      |
| IUNCN   | International Union for Conservation of Nature                       |
| MCDM    | Multi Criteria Decision Making                                       |
| MESTI   | Ministry of Environment, Science, Technology and Innovation          |
| MLGDRD  | Ministry of Local Government, Decentralization and Rural Development |
| MMDAs   | Metropolitan, Municipal, and District Assemblies                     |
| MoE     | Ministry of Education                                                |
| MoFA    | Ministry of Food and Agriculture                                     |
| MoH     | Ministry of Health                                                   |
| MSWR    | Ministry of Sanitation and Water Resources                           |
| MTDPs   | Mid-Term Development Plans                                           |
| MWH     | Ministry of Works and Housing                                        |
| NADMO   | National Disaster Management Organization                            |
| NAP     | National Adaptation Plan                                             |
| NCCAS   | National Climate Change Adaptation Strategy                          |
| NCCE    | National Commission for Civic Education                              |
| NCCP    | National Climate Change Policy                                       |
| NCWSP   | National Community Water and Sanitation Programme                    |
| NDCs    | Nationally Determined Contributions                                  |
| NGOs    | Non-governmental Organizations                                       |
| PPPs    | Public-Private Partnerships                                          |
| PFJ     | Planting for Food and Jobs                                           |
| SDGs    | Sustainable Development Goals                                        |

|               |                                                       |
|---------------|-------------------------------------------------------|
| <b>SSPs</b>   | Shared Socio-Economic Pathways                        |
| <b>UNDP</b>   | United Nations Development Programme                  |
| <b>UNEP</b>   | United Nations Environment Programme                  |
| <b>UNFCCC</b> | United Nations Framework Convention on Climate Change |
| <b>WHO</b>    | World Health Organization                             |
| <b>WRC</b>    | World Resources Commission                            |



# 1



## Introduction

---

### 1.1 Background

Climate change currently dominates international discussions as increasingly many countries around the world continue to experience its brutish impacts on development processes. This is particularly critical for sub-Saharan Africa countries whose economies depend heavily on climate sensitive sectors including agriculture (Intergovernmental Panel on Climate Change (IPCC), 2022). Ghana continues to experience is disruptive climate change impacts in key climate-sensitive sectors and sustainable development processes. The country has experienced increases in temperature, erratic rainfall, floods, and more extreme weather events, which all manifest in different ways in diverse places with worsening impacts (Asante and Amankwa-Mensah, 2015). This could compromise the attainment of sustainable development goals in the country. This calls for an urgent need for carefully considered and place-responsive adaptation measures.

As climate change impacts become even more pervasive in key economic sectors such as agriculture, fisheries, forestry, water resources, mining, health, and many others, the extent and spread of risks and vulnerabilities are also increasing requiring that intentional and purposeful steps are taken to explore such risks and to put in place adaptation measures that respond proactively to both current and projected future impacts. As awareness of impacts continues to grow across Ghana, and as efforts intensify to ensure adaptation to the complexities of climate change phenomenon, it has also become urgently important that conscious efforts are made to understand the nature of impacts and how such impacts translate into risks and vulnerabilities. Effective climate adaptation in Ghana will therefore mean an intentional assessment of risks and vulnerabilities across sectors and places and the deliberate use of such insights and understandings to drive adaptation planning at both national and sub-national levels and in key climate-sensitive sectors.

Effective adaptation also calls for a gender responsive approach to ensure that the needs of different socioeconomic groups including the most vulnerable in society such as women, children and the elderly are taken into consideration. This is especially so because different socioeconomic groups are impacted differently by climate change risks. It is widely acknowledged that women are more vulnerable to the threats of climate change due largely to their limited control over the productive assets that could help them to address the threats posed by climate change (Antwi-Agyei et al., 2015). Cultural norms defined along biological lines have limited the roles played by women in co-management of resources, leadership and in decision making, thus increasing their vulnerabilities (Okyere-Nyako & Nsiah, 2016). Ghana's National Adaptation Plan (NAP) Framework stipulates that, the NAP process should adopt a gender-responsive approach in addressing the threats of climate change.

Effective and proactive climate change adaptation planning is therefore a learning issue and one that requires a conscious process to uncover impacts and to assess associated risks and vulnerabilities (Manteaw, 2020). Central to identifying, assessing, and appreciating the nature and distribution of climate risks is the ability to understand the science and signs behind changing climatic conditions and the varying impacts of such changes on people, communities, and sectors. Such knowledge and understanding, once obtained, become the basis to address uncertainties as well as to make bold and evidence-based predictions about the future.

It also becomes the premise for adaptation planning and actionable adaptation decision-making (Manteaw et al, 2022).

Ultimately, therefore, adaptation planning and resilience building against climate change impacts should be premised on knowledge development and deeper understanding of climate impact manifestations and associated risks and vulnerabilities in diverse places and sectors. Such knowledge should also form the basis of capacity building processes that ensure effective climate adaptation governance are aimed at building the requisite adaptive capacities in diverse sectors, communities and at multi levels. Ghana's National Adaptation Planning (NAP) process has been initiated to respond to these needs and to also ensure that climate adaptation imperatives are mainstreamed in governance processes at different levels.

## **1.2 Project Background**

The National Adaptation Plan (NAP) process emerged from the 16th Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) in Cancun in 2010, where Parties affirmed that “adaptation must be addressed with the same priority as mitigation” (UNFCCC, 2010, p.3). The Cancun Adaptation Framework established a national adaptation planning process to identify medium- and long-term adaptation needs and to develop and implement strategies and programs to address those needs. Guided by this frame, countries around the world are putting in place programs to advance their NAP processes, taking steps to assess development needs and climate vulnerabilities, analyze current climate and future scenarios and review and appraise adaptation options while making conscious effort to communicate or sharing learnings with stakeholders.

The goal is to integrate adaptation into policies and plans for climate-sensitive sectors, such as agriculture, water, health, energy, ecosystems, etc. Most developing countries have also included adaptation within their Nationally Determined Contributions (NDCs) under the Paris Agreement. The Paris Agreement (2015) in its global goal on adaptation (Article 7) brought new elements and dimensions to the climate change adaptation discussions. Namely, enhancing adaptive capacity, strengthening resilience, and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the global temperature limit of less than 2°C. The UNFCCC's Least Developed Expert Group (LEG) on adaptation released Guidelines for National Adaptation Plans (December 2012).

The Government of Ghana, through the Environmental Protection Agency (EPA), under the auspices of the Ministry of Environment, Science, Technology, and Innovation (MESTI), is currently implementing a 3-year Green Climate Fund's (GCF) Readiness Project on National Adaptation Plans (NAPs) to build capacity to advance adaptation planning in Ghana. The UN Environment is the Delivery Partner for the project, with the role of supporting and overseeing the project implementation. As part of this process, the government of Ghana, working with development partners, have initiated various efforts to identify, quantify and understand the mediating effects of both current and future climate change impacts and to respond with the appropriate adaptation measures. Ghana's NAP, which is the vehicle for adaptation planning and mainstreaming at both national and sub-national levels, has adopted a district-focused adaptation planning process which uses district level risk and vulnerability assessments to ground adaptation planning for districts and key climate sensitive sectors.

A central objective, as specified in Ghana's NAP Framework (Antwi-Agyei, 2018), is to reduce vulnerability to adverse impacts of climate change by building adaptive capacity and resilience in local communities. And to achieve this, the Ghana NAP process and indeed this project are both premised on the fact that adaptation impacts are not homogeneous; they are place and context-specific and that there is the need for planning processes to be place-based and context-responsive.

The intention therefore is to develop standalone costed district or municipal adaptation plans for all 261 Assemblies constituting Ghana's local governance system. Eight districts have already completed climate risks and vulnerability assessments (six financed by the IISD and two by UNEP) and are currently in the process of completing adaptation plans.

This project financed by the UNEP is an advancement of the NAP process and a part of a broader vertical integration process that uses place, or district-based climate risk and vulnerability assessment as starting point to co-create knowledge to address uncertainties, build capacity, as well as mainstream climate change considerations in policy and development decision-making processes at the sub-national level. Complementing the district-specific risk and vulnerability assessments, and as part of this project is a prioritized sector-specific risks and vulnerabilities assessment to inform the development of adaptation plans for four critical and prioritized sectors in Ghana's sustainable development processes. While the intention is to develop standalone costed adaptation plans for both districts and the four prioritized sectors key climate-sensitive sectors, the different adaptation plans will be consolidated into a composite costed national adaptation plan.

### 1.3 Study Aims and Objectives

The Government of Ghana, through the Environmental Protection Agency (EPA), under the auspices of the Ministry of Environment, Science, Technology, and Innovation (MESTI), has successfully obtained a grant from the Green Climate Fund (GCF) for a three-year project to build capacity to advance National Adaptation Plan (NAP) process in Ghana. The United Nations Environment Programme (UNEP) is **1.2** Delivery Partner, supporting and overseeing the project implementation.

The project entitled “**Enhancing multi-sector planning and capacity for effective adaptation in Ghana**” is being implemented by a small project team headed by a National Coordinator.

The NAP project seeks to support multi-sectoral, medium- to long-term adaptation planning and budgeting in Ghana and promote the integration of climate change adaptation issues into development planning processes and policies. Systems for developing and sharing climate risk and vulnerability information will be reinforced, and sustainable financing mechanisms for climate change adaptation initiatives are set to be developed.

To support the objectives of the NAP program, this Project has been initiated to support Producing Climate Change Scenarios and Risk Assessments for Ghana based on best available techniques and data that can be used as the basis for national and sub-national climate change adaptation planning.

Central to the preparation of effective climate change risk assessments (CCRAs) is the ability to understand the science behind the projections, manage the inherent uncertainty associated with them, analyse them using a variety of techniques and then communicate the impact risks clearly and concisely in an actionable format for decision makers and wider non-technical stakeholders and users.

This work is intended to support several national initiatives in Ghana, including the updated NAP. However, it must also be able to underpin the climate rationales necessary to secure international climate finance. This requires an understanding of the past and current climate impacts, the potential impact of future climate, with and without climate change and the disaggregation of other changes that are occurring in the area covered by the risk assessment, so that the impact of climate change can be isolated, analyzed and presented in the form of a robust and clear climate risk narrative for Ghana.

### 1.4 Document Purpose

The specific activities to be undertaken under this Study are as follows:

- Task 1: Develop a methodology for producing national climate change scenarios

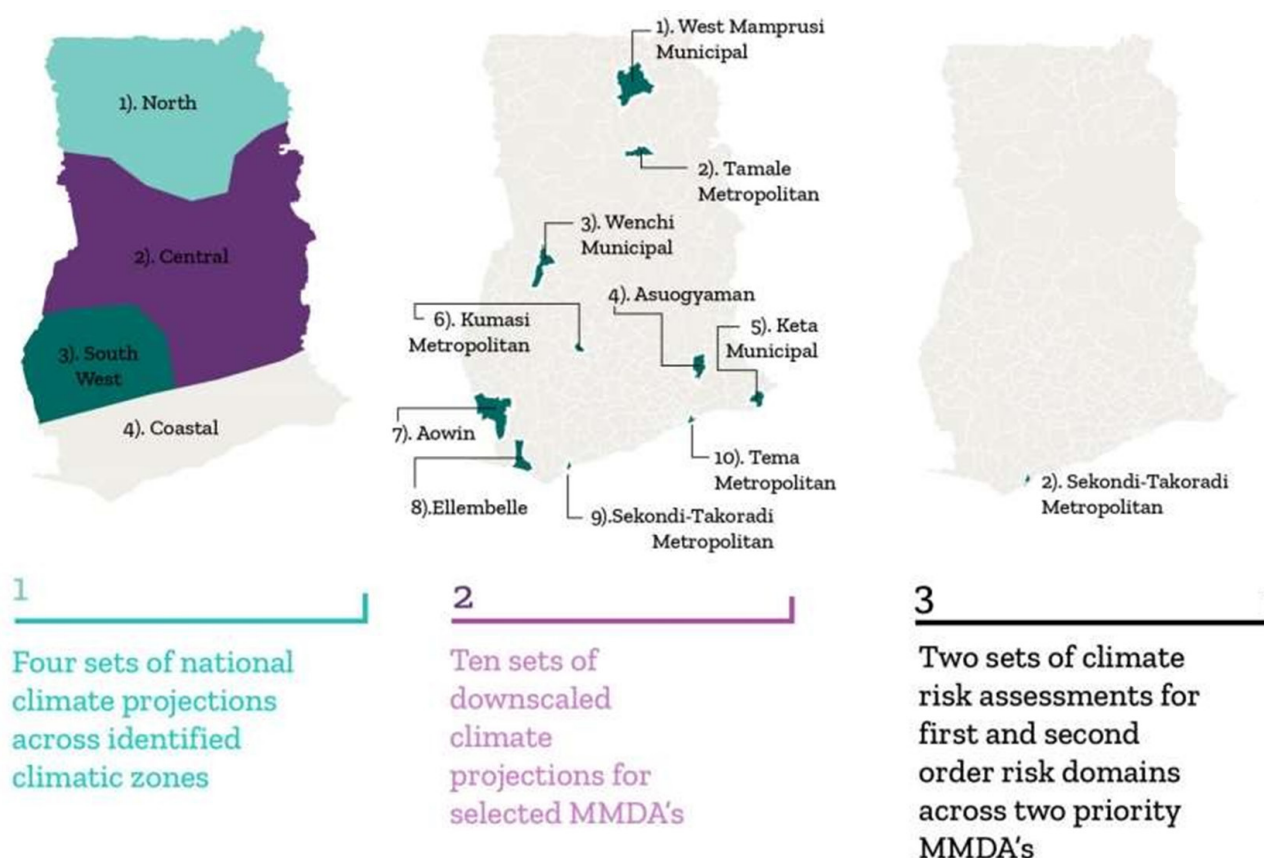
- Task 2: Develop downscaled/area-based climate change projections for Ghana
- Task 3 & 4: Develop national and sub-national level climate risk assessments for two MMDAs
- Task 5: Summary for Policy Makers, Training and Capacity Building.

The identification of priority MMDAs followed a selection process developed in consultation with representatives of the Government of Ghana and with technical support from the UNEP (Figure 1).

This report is the deliverable from Task 3 and 4 and provides the rapid CCRA for Asuogyaman District Assembly, for up to four first order (biophysical) risk domains, and up to three second order (economic sector) risk domains, developed through an initial desk review and validation with stakeholders.

The overall methodology used to assess the climate change risk for Asuogyaman District Assembly (ADA) follows the approach developed under Task 3.

**Figure 1 Spatial scale of key deliverables**





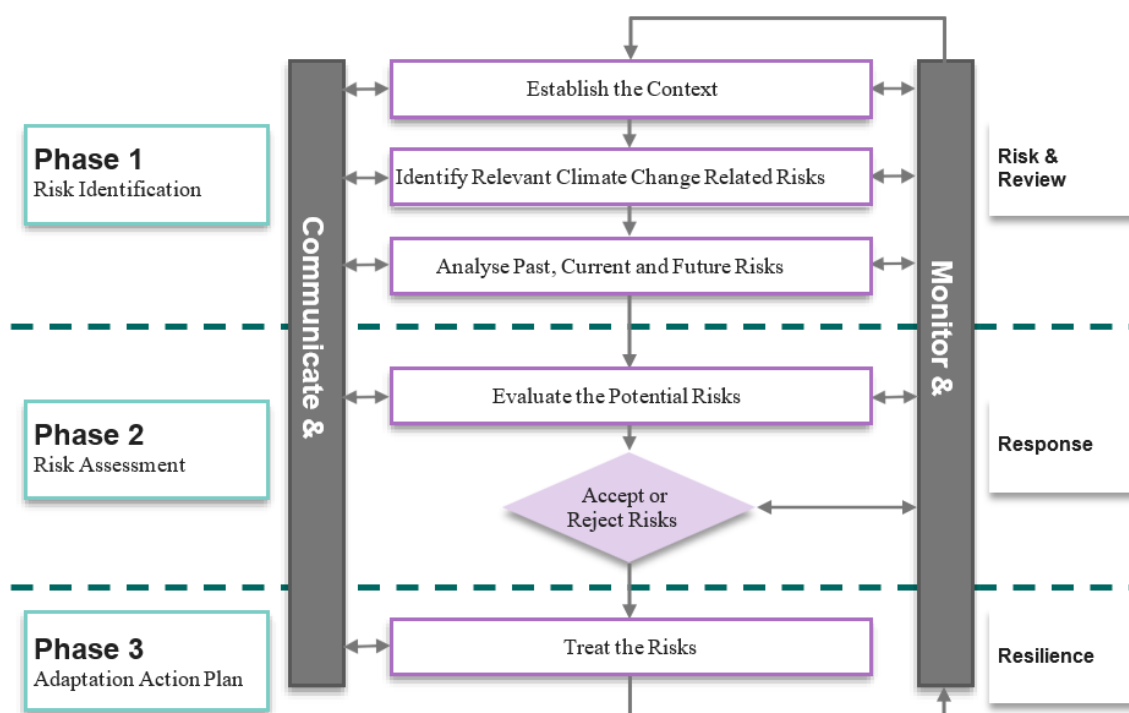
# 2

## Approach and Methodology

### 2.1 Approach

The approach undertaken to determine the Climate Change Risk Assessment for Asuogyaman District Assembly follows the general risk assessment process designed and used for the Tamale and Sekondi Takoradi CCRA as shown in Figure 2.

**Figure 2 General overview of the risk assessment process**



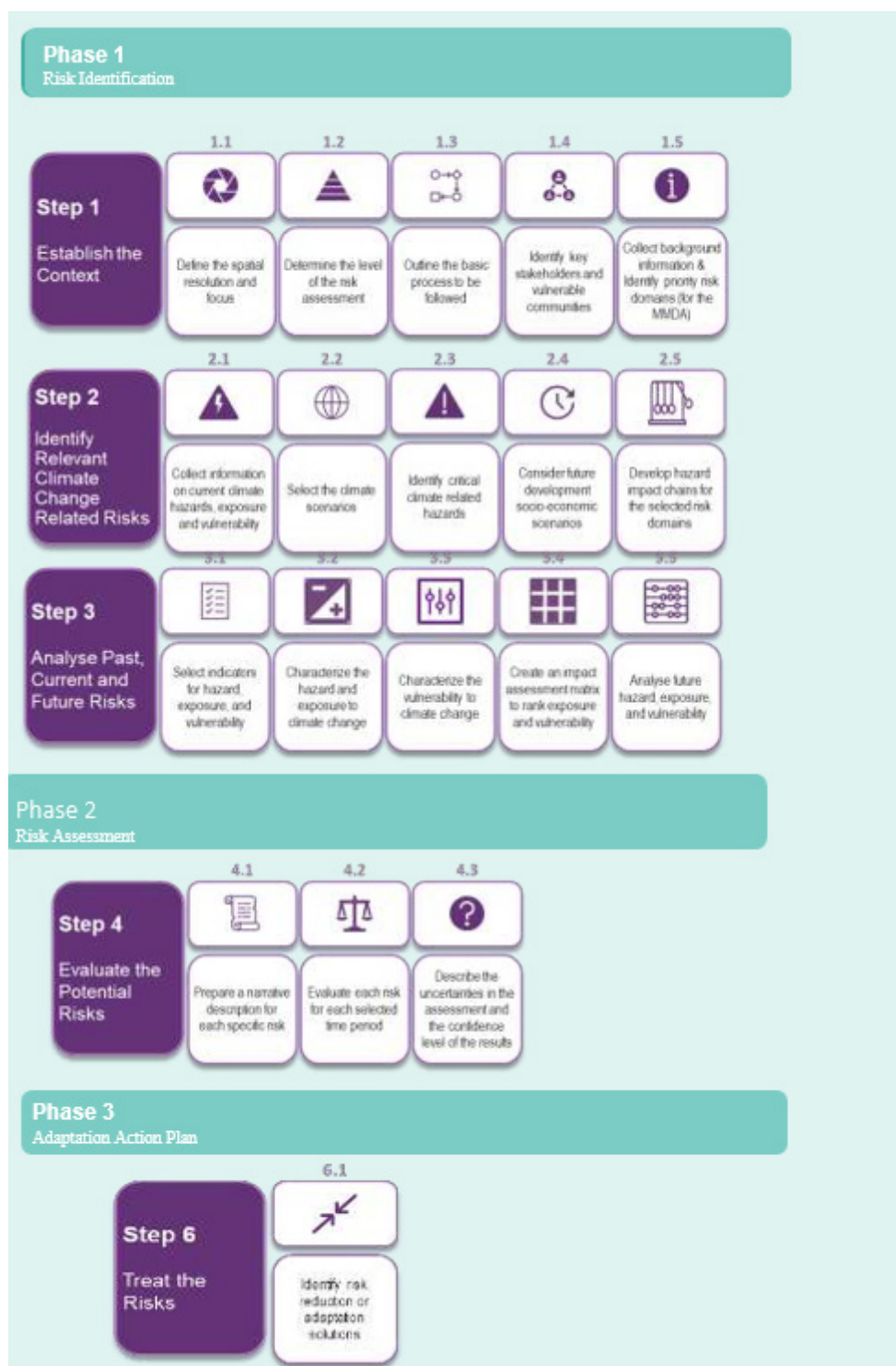
Source: Adapted from (Norman, et al., 2014)

In contrast to the comprehensive assessment conducted for the Tamale and Sekondi Takoradi Municipal assemblies, this evaluation primarily relied on a desk review of pertinent academic literature, national and international reports, media articles, and similar sources. To ensure that the identified risks are accurately rooted in the local context and address the specific needs and concerns of the communities within the two MMDAs, a validation workshop was held at the district level. This workshop validated the information and collected additional data and anecdotal evidence to better understand the current and potential future climate change-related risks, their impacts, and the adaptive capacity of local communities and institutions.

The approach to identifying climate risks involved selecting key risk domains and determining relevant climate hazards, levels of exposure and sensitivity, and the potential for adaptive capacity within each specific risk domain or sub-sector.

Summarizes the specific steps, and timeline, followed for undertaking the CC

**Figure 3 | Process followed during the CCRA**





# 3



## Background and Context

### 3.1 Defining Climate Change Risk and Vulnerability

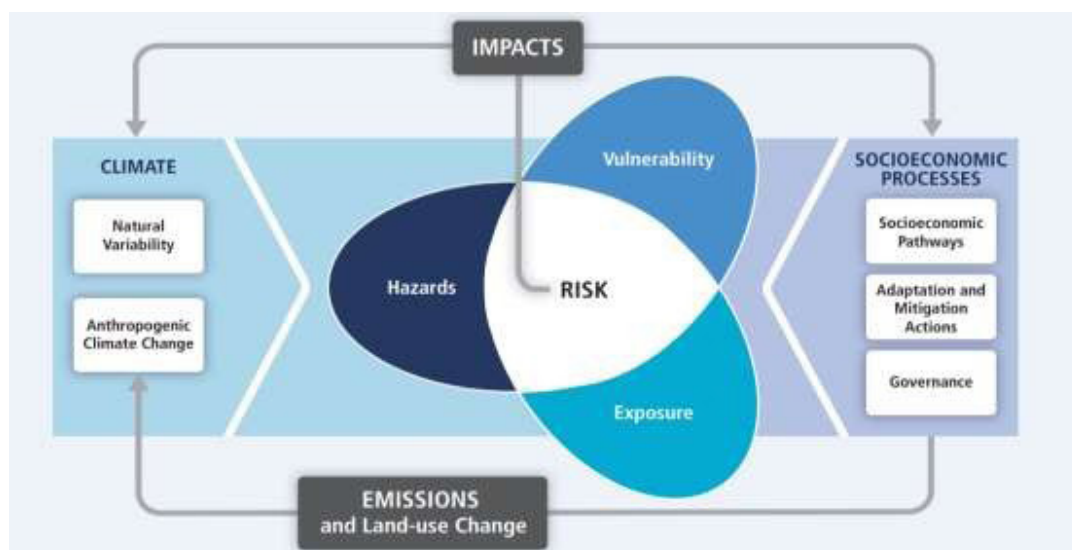
The Intergovernmental Panel on Climate Change (IPCC) defines climate risk as the result of the interaction between hazard, exposure, and vulnerability. The updated definition of risk, which appears in the IPCC online glossary and is used in the Special Report on Climate Change and Land and the Special Report on the Ocean and Cryosphere in a Changing Climate (SRCCL, 09/2019), is graphically represented in Figure 4 (from IPCC, 2014).

**Climate Change Risk** is defined as the potential for adverse consequences for human or ecological systems, recognizing the diversity of values and objectives associated with such systems. In the context of climate change, risks can arise from potential impacts of climate change as well as human responses to climate change. Relevant adverse consequences include those on lives, livelihoods, health and wellbeing, economic, social and cultural assets and investments, infrastructure, services (including ecosystem services), ecosystems and species.

- In the context of climate change impacts, **risks** result from dynamic interactions between climate-related hazards with the exposure and vulnerability of the affected human or ecological system to the hazards. **Hazards, exposure, and vulnerability** may each be subject to uncertainty in terms of **magnitude and likelihood of occurrence**, and each may change over time and space due to **socio-economic changes and human decision-making**.
- In the context of climate change responses, risks result from the potential for such responses not achieving the intended objective(s), or from potential trade-offs with, or negative side-effects on, other societal objectives, such as the Sustainable Development Goals. Risks can arise for example from uncertainty in implementation, effectiveness or outcomes of climate policy, climate-related investments, technology development or adoption, and system transitions.

Source: IPCC online glossary (<https://apps.ipcc.ch/glossary/>)

**Figure 4 | Risk assessment framework for evaluating climate change risks (IPCC, 2015)**



Source: IPCC's Fifth Assessment Report (WGII AR5) (Field, et al., 2014)

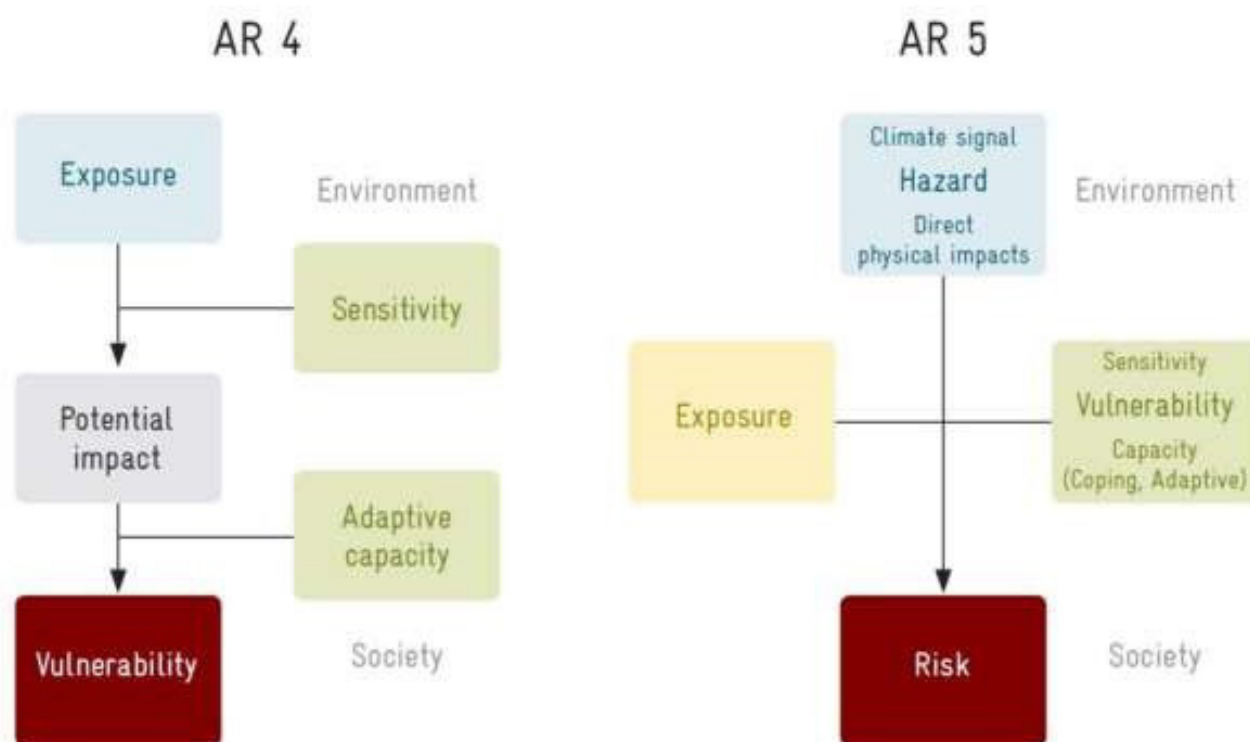
The risk of climate-related impacts emerges from the interaction between climate-related hazards (including hazardous events and trends) and the vulnerability and exposure of human and natural systems. Both changes in the climate system (left) and socioeconomic processes, including adaptation and mitigation (right), drive hazards, exposure, and vulnerability.

**The following definitions of Hazard, Exposure, Sensitivity and Adaptive Capacity are used:**

- **Hazard** is the potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources.
- **Exposure** entails the presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected.
- **Vulnerability** deals with the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including **sensitivity** or susceptibility to harm and lack of **capacity to cope and adapt**.
- **Sensitivity** refers to the degree to which a system is affected by, or responsive to a hazard. In other words, sensitivity captures the potential of a system to be impacted by a hazard. Sometimes sensitivity is determined by the criticality of the service that the system provides. For example, a community uses a road located close to the low-lying area of the coast as its main access to a major hospital. In the past, this road has been inundated during a storm event making access to the hospital difficult. Because the hospital provides such an essential service, this community should be considered more sensitive to coastal inundation event.
- **Adaptive Capacity** is the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.

Source: IPCC online glossary (<https://apps.ipcc.ch/glossary/>)

**Figure 5 | Change in the conceptual approach to climate change risk and vulnerability assessment**



Source: (Zebisch, et al., 2021)

In summary, climate risk (such as drought damage in agriculture) results from the interaction between climate-related hazards (like the frequency and intensity of droughts), exposure (such as agricultural land), and vulnerability (such as the drought resistance of crops and the presence or absence of irrigation) in natural and human systems. It is important to highlight the changes in definitions for determining vulnerability and risk between the fourth (AR4) and fifth (AR5) assessment reports, as shown in Figure 5.

### 3.2 Initial Assessment of Critical Climate Related Hazards

The preliminary critical climate related risks can be assessed using a tool like the **ThinkHazard! Tool**.

**Table 1 | Summary of critical climate related hazards for Asuogyamang District from ThinkHazard! Tool**

| HAZARD     | Drought | Urban Flooding | River Flooding | Landslide | Tsunami | Cyclones | Volcano | Extreme Heat | Water Scarcity |
|------------|---------|----------------|----------------|-----------|---------|----------|---------|--------------|----------------|
| HARD LEVEL | Medium  | Low            | Medium         | Very low  | Low     | N/A      | N/A     | Medium       | Medium         |

Source: ThinkHazard! (Global Facility for Disaster Reduction and Recovery (GFDRR), 2024)

Table 1 highlights the critical climate risks facing Asuogyaman District:

- **Drought** is rated as medium, indicating a greater than 20% chance of droughts occurring in the next decade.

- **River floods** are also rated as medium, suggesting a more than 20% likelihood of damaging and potentially life-threatening river floods within the next 10 years.
- **Extreme heat hazards** are classified as medium, meaning there is over a 25% chance that at least one period of prolonged extreme heat, resulting in heat stress, will occur in the next five years. According to the IPCC, continued greenhouse gas emissions will lead to further warming, with more frequent extreme heat events over most land areas in the next fifty years. Although the temperature increase in this region will be slightly below the global average, it will still be significant.

Despite urban and river flooding not being considered high risk by this assessment tool, anecdotal evidence suggests that increased river flooding is a major concern for Asuogyaman District and many other cities in Ghana due to climate change. This has become an almost annual occurrence, with excessive rainfall causing rivers to overflow their banks (Danso & Addo, 2017; Ansah et al., 2020). The assessment tool likely rates flooding risk as low because it relies primarily on climate models and the relative change in critical climate variables, without fully accounting for the underlying vulnerabilities of specific locations.

Therefore, it is crucial to consider local-level climate risk assessments.

### 3.3 Stakeholder Engagement

Conducting a participatory climate change risk assessment is vital for ensuring that the process addresses the diverse needs and perspectives of all members of the community, including those who are often marginalized or vulnerable, such as indigenous peoples and individuals with disabilities. It requires active engagement and commitment from a wide range of stakeholders, including local community members, government agencies, private organizations, and traditional leaders. By involving these stakeholders throughout the various phases of the assessment process, from planning to implementation and decision-making, the assessment can benefit from a broad range of knowledge, experiences, and perspectives, leading to more informed and equitable outcomes.

To initiate the climate risk assessment for the Asuogyaman District, the project team undertook a site visit on April 30, 2024. This visit served multiple purposes, including introducing stakeholders to the National Adaptation Plan (NAP) project and its objectives, providing them with a comprehensive overview of climate change and its potential impacts on the region, and presenting the findings of downscaled temperature and precipitation scenarios. Additionally, the visit aimed to identify critical climate-related risks specific to the Asuogyaman District and gather relevant data and evidence to better understand these risks, their potential impacts on communities, and the adaptive capacity of local stakeholders.

Informed by existing studies on the potential impact of climate change on critical risk domains in Asuogyaman, as well as key insights gained from interactive sessions and participatory mapping exercises by the invited stakeholders during the site visit, the project team proceeded with local-level risk assessments.

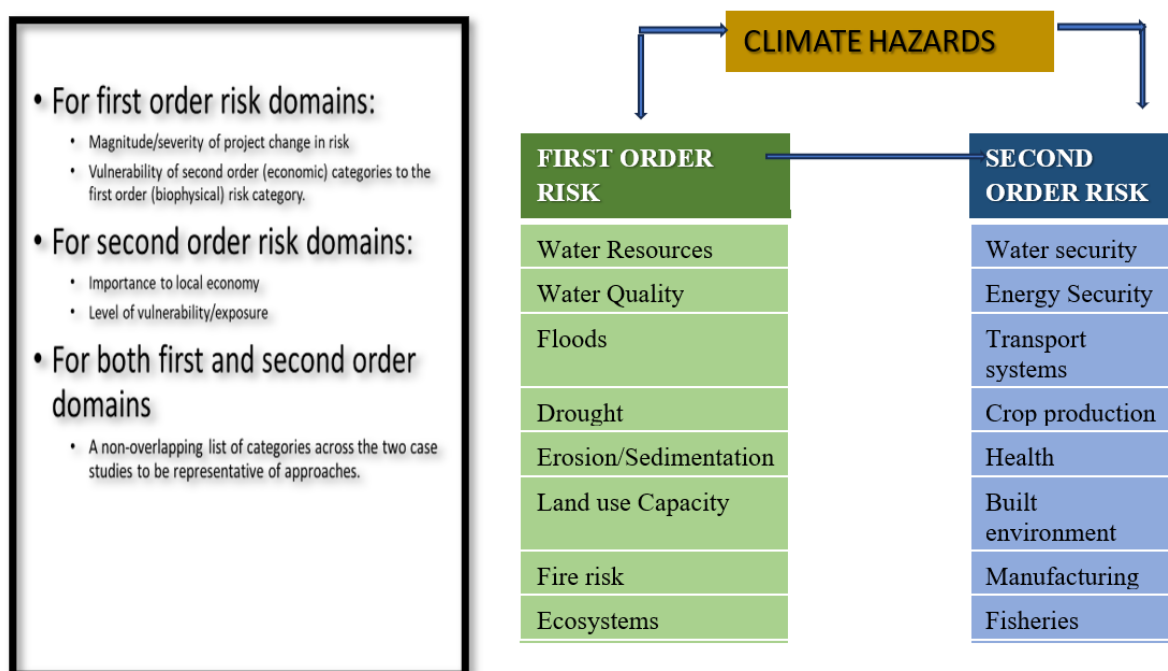
## Plate 1 Stakeholder Engagement with Experts



### 3.4 Identification of Priority Risk Domains and Critical Assets

The Asuogyaman District is distinct in its specific priority risk domains due to its unique location and economic activities. The desk review process has identified several risk domains, with a few prioritized to be addressed as part of the CCRA. The criteria for selecting first and second order risk domains are illustrated in Figure 6.

**Figure 6 | Criteria for selecting first and second order risk domains.**



A preliminary list of first and second order risk domains relevant to the Asuogyaman District was created based on a desktop study of available data (Table 2) and presented to key stakeholders to assess their relative importance to the district. This list was then discussed with the key stakeholders, and the selection of priority first and second order risk domains was finalized (Table 3).

**Table 2 | Considerations for identifying critical first and second order risk domains for ADA.**

| Second order risk domains                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | First order risk domains                                                                                                                                                                                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>An important economic sector is the crop production and fisheries industry which are area of concern due to possible climate changerisks.</p> <p>A component of this is also the potential impact on transport systems (i.e., roads and ports), mainly due to river floods on island communities, as well as the overall impact onthe settlement and tourist infrastructure.</p> <p>Energy security could be considered as a second order risk domain, given the dependency on hydropower as well as reliable water supply.</p> | <p>Critical first order risk domains that affect fisheries, crop production, transport and the built environment include river flooding and inland flooding, and in particularly areaswhere they overlap.</p> |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <p>It has been noted that there are several important tourist sites and hotels that are located on the fringes on the Volta Lake that could be impacted by river flooding.</p>                                |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <p>Water resources (availability) is an important first order risk domain that should be considered.</p>                                                                                                      |

**Table 3 | Identified priority first and second order risk domains selected for Asuogyaman.**

| First Order Risk Domain                                        | Second Order Risk Domain                                                                                           |
|----------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| <p>Water Resources</p> <p>River Flooding</p> <p>Ecosystems</p> | <p>Crop production.</p> <p>Energy Security (e.g., hydro) Transport Systems</p> <p>Settlements</p> <p>Fisheries</p> |

Through initial desk top reviews, the following critical systems and assets were identified and became the primary focus of the local level climate change risk assessment for the Asuogyaman District.

- Water Supply
- Industries
- Settlement
- Critical infrastructure
- Agriculture
- Health systems
- Biodiversity and Ecosystems



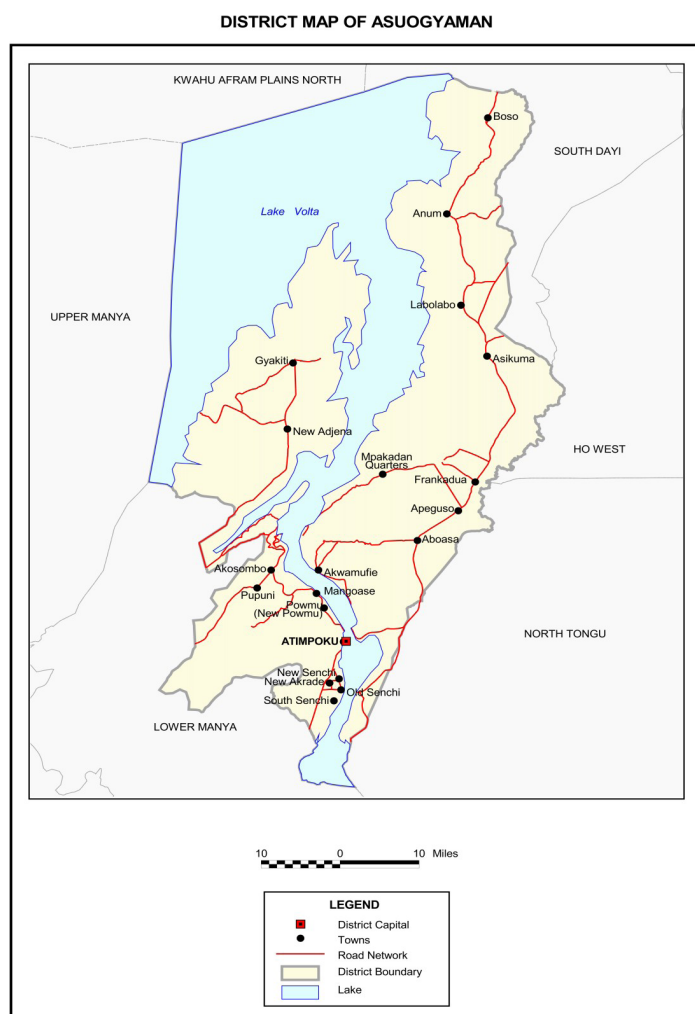
# 4

## Overview of Asuogyaman District

### 4.1 Geographical Location and Size

The Asuogyaman District is geographically positioned between latitudes 6° 34' N and 6° 10' N and longitudes 0° 1' W and 0° 14' E. It is situated at an elevation of approximately 120 meters above Mean Sea Level (MSL). The district spans a total surface area of about 1,507 square kilometers, which accounts for 5.7% of the total area of the Eastern Region. The district is bordered to the north by the Afram Plains South District and to the south and west by the Upper and Lower Manya districts. It is located between the Volta and Eastern Regions, sharing eastern borders with the Kpando, North Dayi, Ho, and North Tongu districts of the Volta Region.

**Figure 7 | Map of Asuogyaman**



## 4.2 Topography and Drainage

The Asuogyaman District features a generally undulating topography. The landscape is a mix of mountainous regions and low-lying plains. To the west and east, the terrain is interspersed with ridges and valleys, contributing to the district's varied elevation. The most notable geographic feature is the Volta River, which cuts through these ridges to form a gorge. This geographic formation was ideal for constructing the Volta Dam at Akosombo, a significant infrastructure landmark in the district. The highest peaks in the district reach elevations between 700 and 800 meters above sea level.

The drainage system in the Asuogyaman District is dominated by the Volta River and its tributaries. The presence of this major water body significantly influences the area's drainage patterns, facilitating various agricultural and hydroelectric activities. The river's flow through the district creates a natural division and provides water resources crucial for both human consumption and irrigation. The major water body in the Asuogyaman District is Volta Lake, formed by the construction of the Akosombo Dam. This district encompasses the critical area of the Volta gorge, where the lake flows through well-defined channels before expanding upstream into a vast expanse near Gyakiti and Boso, forming the largest man-made lake in the world. At Atimpoku, the lake becomes heavily braided as it traverses the district's low-lying areas and begins its journey to the sea at Ada. The Volta's passage through the district's undulating landscape creates an extensive lakefront, offering significant potential for tourism development.

## 4.3 Climatic Attributes

### Rainfall

The district is characterized by a Dry Equatorial Climate Zone. The district experiences substantial precipitation with a bimodal rainfall pattern, featuring two main rainy seasons. The major rainy season peaks between May and July, while the minor rainy season occurs from September to November.

Annual rainfall typically begins in April and concludes in November, with the peak rainfall month being June. The district receives annual rainfall ranging from 67 mm to 1130 mm. This rainfall distribution supports various agricultural activities within the district.

Additionally, the dry season spans from November or December to March, contributing to the distinct climatic cycles observed in the area. The district experiences warm temperatures throughout the year, with a maximum monthly mean temperature of 37.2°C and a minimum of 21.0°C. Relative humidity is generally high, fluctuating between 98% in June to 31% in January.

### Temperature

The Asuogyaman District experiences warm temperatures throughout the year. The climate is characterized by a maximum monthly mean temperature of 37.2°C and a minimum of 21.0°C. Relative humidity is generally high, with the highest levels reaching 98% in June and the lowest at 31% in January.

## 4.4 Biogeographical Characteristics

### Vegetation

The Asuogyaman District's vegetation is primarily classified into Tropical Savanna and Forest Zones, each contributing distinct biogeographical characteristics. The Tropical Savanna Zone is dominated by grasslands interspersed with shrubs and isolated trees, including species such as baobab, shea, and acacia. This zone undergoes significant seasonal changes, with vegetation flourishing during the rainy seasons and becoming sparse in the dry seasons. In contrast, the Forest Zone is characterized by dense, semi-deciduous forests that include a rich variety of tree species like mahogany, wawa, and odum. These forests shed their leaves during the dry season and regrow them with the onset of rains, supporting a diverse array of understory plants and

providing habitats for various wildlife. The district's vegetation cover plays a crucial role in the local ecology, enhancing soil fertility, aiding in water retention, and supplying essential resources such as timber, firewood, and non-timber forest products to the local communities.

#### **4.5 Fauna and Flora**

Asuogyaman boasts a diverse array of plant and animal life. The Volta River serves as the primary waterway in the district, flowing through a defined channel between Atimpoku and Gyakiti before expanding into a vast lake. At Atimpoku, the lake's formation is intricate, with ninety-nine islands created by heavy braiding, offering excellent potential for developing floating chalets and restaurants. The lake not only adds a refreshing touch but also provides essential nourishment for the surrounding flora and fauna. The major river draining into the lake within the district is the River Alabo.

Four forest reserves enrich the district's biodiversity: Sapawusu, Aboben Hill, Sapawusu Extension, and the Volta River Forest reserves, along with the Akwamu Hill Community Forest. The Akwamu Hill Community Forest harbors the endemic plant *Talbotiella gentii*, classified as Critically Endangered on the IUCN Red List, and the globally threatened White-necked Picathartes, listed as Vulnerable. These forests, alongside numerous farming areas, provide habitats for various animal species, including snakes, lizards, *Varanus douarrha*, antelopes, hedgehogs, squirrels, ground squirrels, and a plethora of butterfly species.

The Volta River reserves play a vital role in safeguarding the Volta Lake against erosion and siltation, particularly in critical areas like the Volta gorge. While the district lacks significant timber species such as Mahogany, Odum, Sapele, and Wawa, it boasts a variety of trees like Silk Cotton Trees, Neem, Mango, and others. Additionally, species like Senna, Siania, *Azadirachta indica*, *Sapathodea*, *Campanulata*, *Leucaena*, Rain tree, and *Tectona grandis*, introduced by the Forestry Department, thrive predominantly in the protected areas of the Volta gorge.

#### **4.6 Pedagogical characteristics**

The primary rock types found in the region are quartzite, acidic gneiss, and schist. These rocks typically exhibit coarse-grained textures, with muscovite and biotite schist and gneiss containing numerous quartz veins being prominent. Various outcrops of these rocks can be observed throughout the area.

Regarding soil composition, the region encompasses Savannah Grecol and Viosols. Along the upland slopes of the hills, soils predominantly consist of forest laterites. In the lower-lying areas adjacent to the Volta Lake, the soil type falls within the Savannah Greisol and Aluviosols categories. These soils, characterized by a hydro morphine nature, are mainly found in the extensive depressions and valley bottoms of the Volta River plains. They typically exhibit a greyish, dark red color and possess moderate nutrient levels. Due to their structure, these soils are prone to temporary flooding during periods of high water levels. While their nutrient status is moderate, ensuring sustained crop yields often necessitates the application of fertilizers.

#### **4.7 Administrative structure**

The administrative structure of the Asuogyaman District is organized under the Asuogyaman District Assembly (ADA), which serves as the highest political authority with legislative and executive powers. The district is divided into six Area Councils: Anum, Boso, Frankadua/Apeguso, Atimpoku, Gyakiti, and Akosombo. These divisions are in accordance with the Local Government Act 467 of 1993. The District Chief Executive (DCE) is the political head, representing the Central Government, while the District Coordinating Director (DCD) oversees the day-to-day administration. The district comprises one constituency with 35 electoral areas, each with its corresponding unit committees. This structure ensures local governance and community involvement in administrative processes.

## 4.8 Cultural and Social Structure

### Ethnicity and Religion

The Asuogyaman District is ethnically and religiously diverse. The Ewe ethnic group is the largest, making up 45.8% of the population, followed by the Ga-Adangbe at 28.1%, and the Akan at 11.6%. Other ethnic groups comprise the remaining population. Christianity is the predominant religion, with 89% of the residents identifying as Christians. Islam is practiced by 3.7% of the population, and Traditionalist beliefs are followed by 2.4%. Additionally, there are smaller groups of people who adhere to other religions or have no religious affiliation.

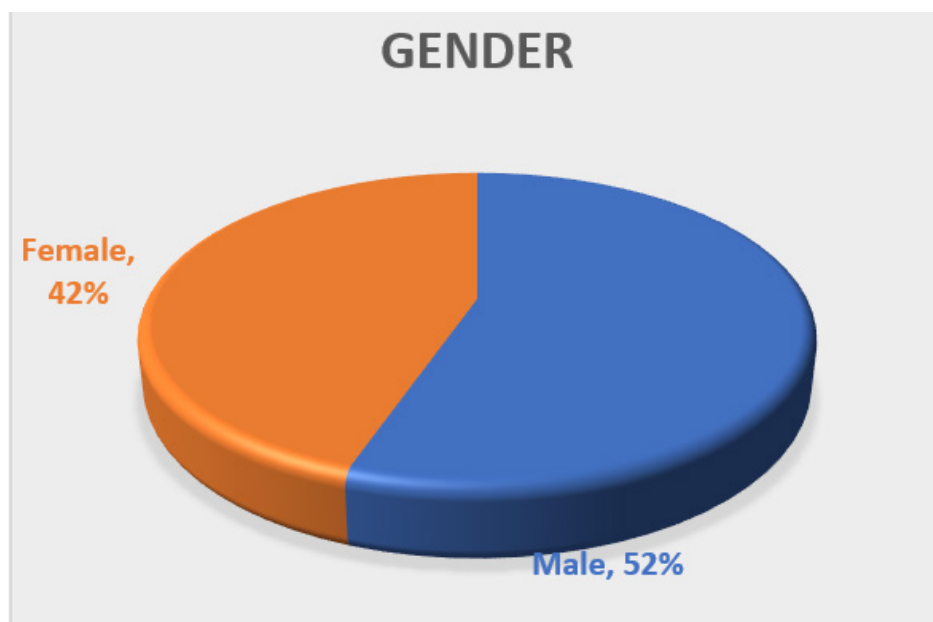
### Traditional Authority

The name Asuogyaman is an Akan term formed from 'Asegya' and 'Oman', meaning 'river bank state', aptly named because the district's major towns such as Akosombo, Atimpoku, Gyakiti, Senchi, New Akrade, Akwamufie, Anum, and Boso are located along the banks of the Volta Lake. The district is governed by three traditional councils: Boso, Anum, and Akwamus. These councils administer stool lands on behalf of the people, organize traditional festivals, and preserve traditional beliefs and customs passed down through generations. They also operate courts to adjudicate issues related to stool lands, family and lineage lands, chieftaincy disputes, violations of traditions, and conflicts among communities, families, and individuals.

## 4.9 Demographics

### Population

As of the 2021 National Population and Housing Census, the district's population is reported at 101,256, with 52,802 females (52%) and 48,723 males (48%). According to their Medium-Term Development Plan (MTDP) for 2022-2024, the population is expected to reach around 105,627.65 by the end of 2023, with the majority (71%) residing in rural areas.

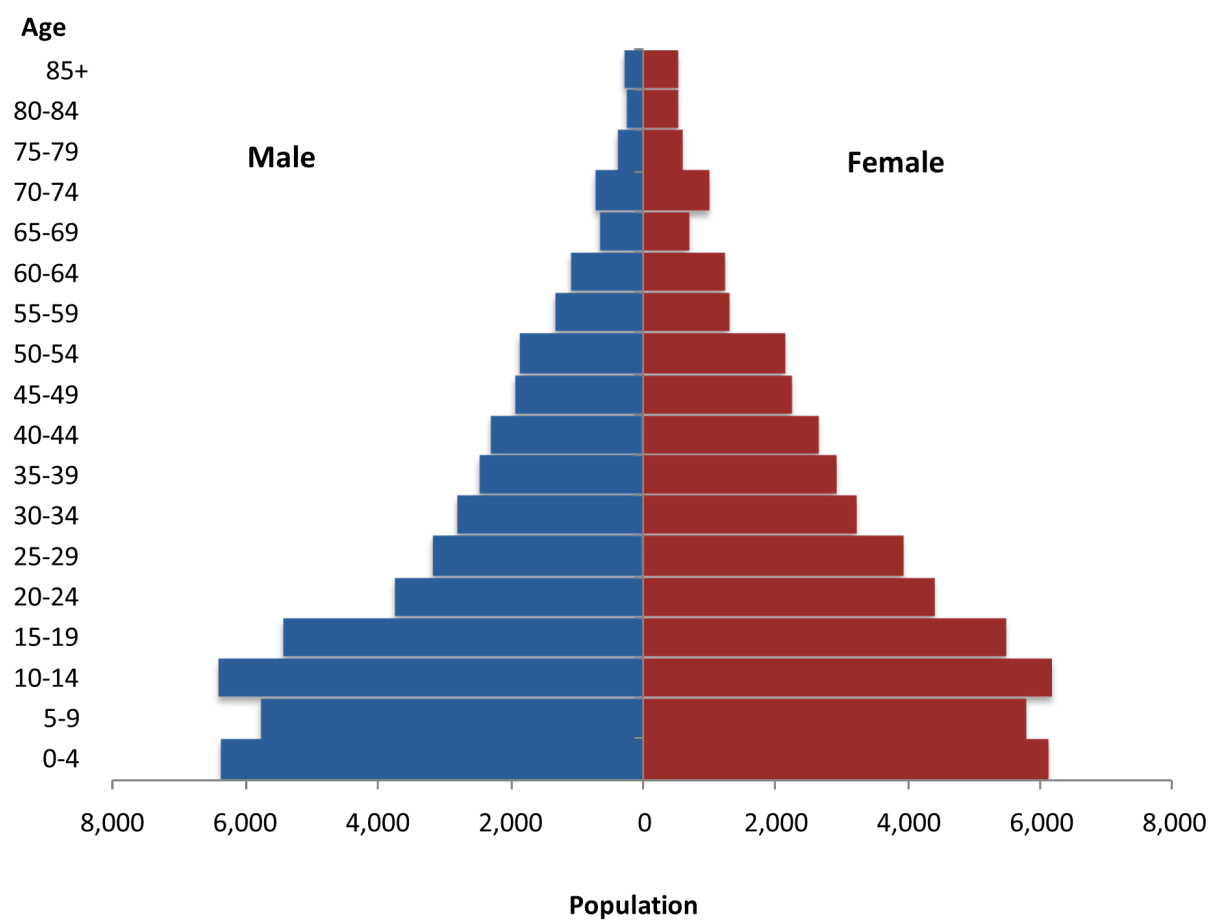


This projected population increase raises concerns due to the associated strain on ecosystem services such as land, water bodies, and vegetation. There is a risk of land fragmentation, degradation, and the conversion of important biodiverse areas like wetlands for other land uses. Therefore, rapid population growth poses a threat to the district's natural environment. Additionally, changes in land use resulting from population growth

put pressure on existing infrastructure, often causing land disturbances that weaken old buildings and make them prone to cracks and collapse.

| Age Group                   | Sex         |             |             | Type of locality |             |             |
|-----------------------------|-------------|-------------|-------------|------------------|-------------|-------------|
|                             | Both Sexes  | Male        | Female      | Sex ratio        | Urban       | Rural       |
| All Ages                    | 98,046      | 47,030      | 51,016      | 92.2             | 29.4        | 70.6        |
| 0 – 4                       | 12,478      | 6,367       | 6,111       | 104.2            | 25.8        | 74.2        |
| 5 – 9                       | 11,559      | 5,760       | 5,799       | 99.3             | 26.5        | 73.5        |
| 10 – 14                     | 12,584      | 6,405       | 6,179       | 103.7            | 29.9        | 70.1        |
| 15 – 19                     | 10,906      | 5,435       | 5,471       | 99.3             | 33.5        | 66.5        |
| 20 – 24                     | 8,130       | 3,737       | 4,393       | 85.1             | 30.6        | 69.4        |
| 25 – 29                     | 7,115       | 3,174       | 3,941       | 80.5             | 30.7        | 69.3        |
| 30 – 34                     | 6,054       | 2,825       | 3,229       | 87.5             | 28.8        | 71.2        |
| 35 – 39                     | 5,391       | 2,482       | 2,909       | 85.3             | 31.2        | 68.8        |
| 40 – 44                     | 4,980       | 2,314       | 2,666       | 86.8             | 31.2        | 68.8        |
| 45 – 49                     | 4,172       | 1,918       | 2,254       | 85.1             | 33.7        | 66.3        |
| 50 – 54                     | 4,032       | 1,878       | 2,154       | 87.2             | 32.0        | 68.0        |
| 55 – 59                     | 2,649       | 1,334       | 1,315       | 101.4            | 31.2        | 68.8        |
| 60 – 64                     | 2,323       | 1,093       | 1,230       | 88.9             | 25.6        | 74.4        |
| 65 – 69                     | 1,359       | 652         | 707         | 92.2             | 25.1        | 74.9        |
| 70 – 74                     | 1,732       | 722         | 1,010       | 71.5             | 23.2        | 76.8        |
| 75 – 79                     | 982         | 398         | 584         | 68.2             | 23.3        | 76.7        |
| 80 – 84                     | 789         | 259         | 530         | 48.9             | 22.8        | 77.2        |
| 85+                         | 811         | 277         | 534         | 51.9             | 21.1        | 78.9        |
| All Ages                    | 98,046      | 47,030      | 51,016      | 92.2             | 29.4        | 70.6        |
| 0-14                        | 36,621      | 18,532      | 18,089      | 102.4            | 27.4        | 72.6        |
| 15-64                       | 55,752      | 26,190      | 29,562      | 88.6             | 31.3        | 68.7        |
| 65+                         | 5,673       | 2,308       | 3,365       | 68.6             | 23.3        | 76.7        |
| <b>Age-dependency ratio</b> | <b>75.9</b> | <b>79.6</b> | <b>72.6</b> |                  | <b>65.2</b> | <b>80.7</b> |

Source: Ghana Statistical Service, 2021 Population and Housing Census





# 5



## Climate Change Vulnerability

Vulnerability to potential climate change impacts is determined based on sensitivity and adaptive capacity. The current vulnerability of the district is characterized by socio-economic conditions, including dependence on high-risk sectors such as agriculture, and the institutional capacity to manage and mitigate increasing climate change-related risks like floods and droughts. The future level of climate change vulnerability will be determined based on the socio-economic development pathway, as described in the previous section and summarized below in terms of future vulnerability. Due to its location along the Volta Lake, the Asuogyaman district is highly vulnerable and exposed to climate risks, including extreme weather events, flooding, and potential changes in water levels. Various factors, including economic, social, human, and political resources, influence the district's vulnerability to climate change. The district's reliance on agriculture, a sector susceptible to climate variability, and the capacity of local institutions to manage and mitigate these risks, play critical roles in shaping its current sensitivity and adaptive capacity.

### 5.1 Economic Vulnerability

The economic vulnerability of the Asuogyaman District to climate change is significantly influenced by its reliance on high-risk sectors, particularly agriculture, which includes livestock and fisheries. According to their medium-term development plan (2022-2024), 71% of the population residing in rural areas and heavily dependent on rain-fed agriculture, making the district's economy is highly susceptible to climate variability. Extreme weather events, prolonged droughts, and flooding lead to crop failures, reduced agricultural productivity, and substantial economic losses for farmers and the broader community reliant on this sector.

Moreover, the district's economic infrastructure and resources, such as water supply systems and transport networks, are at risk from climate change impacts. Increased rainfall and the potential spillage of the dam by the Volta River Authority (VRA) cause flooding and fluctuations in the water levels damaging infrastructure, disrupt economic activities, and result in costly repairs and maintenance. These disruptions have profound economic consequences, affecting immediate income and livelihoods as well as long-term economic development and resilience.

In addition to agriculture, the district holds significant potential as a tourism hub in Ghana, featuring key attractions like the famous Adomi Bridge. However, these tourism facilities, located along Volta Lake, are threatened by increased rainfall and flooding. The workforce in the district is predominantly engaged in service-oriented professions and artisanal trades, adding to the diverse economic landscape.

### 5.2 Physical and Environmental Vulnerability

The Asuogyaman district's physical and environmental vulnerability to climate change is closely tied to its unique topography and physical environmental characteristics. Located along the Volta Lake, the district's low-lying areas and proximity to the water body make it particularly susceptible to various climate-related risks. The district's topography includes significant portions of low-lying land, which are highly prone to flooding, especially during periods of heavy rainfall. The presence of Volta Lake exacerbates this vulnerability, as increased rainfall

and potential dam spillage by the Volta River Authority (VRA) can lead to significant water level rises. This can result in widespread flooding, which poses risks to infrastructure, agriculture, and human settlements. The flooding not only disrupts daily life but also damages homes, roads, and other critical infrastructure, leading to substantial economic costs and long-term recovery challenges. The district's topography, characterized by riverine and wetland ecosystems, further contributes to its vulnerability. Wetlands, in particular, play critical roles in regulating water flow, providing habitat for biodiversity, and buffering against flooding. However, these ecosystems are sensitive to environmental changes and human activities, making them vulnerable to degradation and loss. According to the Asuogyaman Medium Development Plan 2018-2021 report, 30 hectares of lands were degraded and lost in 2017. As of 2021 the figure had increased to 50ha, showing an annual increase of 5ha per year. Ansah et al. in 2020, emphasizes the importance of preserving wetlands for climate resilience in the district.

Furthermore, the district's physical environmental characteristics, such as soil types and land use patterns, also influence its vulnerability. In the low-lying areas along the Volta Lake, the soil type falls within the Savannah Greisol and Aluviosols. These are hydromorphic soils confined to the large depression and valley bottoms of the Volta River plains. The soil is greyish, dark red in color. It is mainly impervious and moderately supplied with nutrients. Because of its structure, the soil is liable to temporary flooding in times of high-water levels.

Additionally, soil erosion, is also worsened by steep slopes and intensive land use practices, leading to loss of fertile soil and decreased agricultural productivity, it also contributes to sedimentation in water bodies, affecting water quality and aquatic life in Volta Lake. These challenges are compounded by the district's heavy reliance on agriculture, as discussed in the Medium-Term Development Plan (MTDP) for 2022-2024.

### **5.3 Social Vulnerability and Adaptive Capacity**

Social vulnerability and adaptive capacity within the Asuogyaman district are influenced by various socio-economic factors and community resilience initiatives. The socio-economic vulnerability of the district is characterized by factors such as income inequality, poverty levels, and access to basic services. According to the 2021 National Population and Housing Census, the district's population is diverse, with a mix of urban and rural communities. However, poverty remains a significant issue, particularly in rural areas where the majority of the population resides. Limited access to education, healthcare, and other essential services further exacerbates social vulnerability. Moreover, social vulnerability is influenced by demographic factors such as age, gender, and ethnicity. Vulnerable populations, such as women, children, and the elderly, face increased risks during climate-related disasters due to factors such as limited mobility, access to resources, and decision-making power within households and communities.

The district also demonstrates resilience and adaptive capacity through community-based initiatives and local governance structures. Community-based organizations, traditional leaders, and local authorities play crucial roles in disaster preparedness, response, and recovery efforts. These initiatives are discussed in the district's Medium-Term Development Plan (MTDP) for 2022-2024, which emphasizes the importance of building community resilience to climate change impacts.

Additionally, external support from non-governmental organizations (NGOs), development agencies, and government programs contribute to enhancing adaptive capacity within the district. There have been a number of interventions by government and the District Assembly to address these vulnerability and social protection issues. These include the Livelihood Empowerment Against Poverty (LEAP), Financial Support for Persons Living with Disabilities (PWDs), the 'EBAN' Programme for the aged, the Youth Employment Programme and the School Feeding Programme. These initiatives focus on capacity building, livelihood diversification, and infrastructure development to strengthen community resilience and reduce vulnerability to climate-related risks.

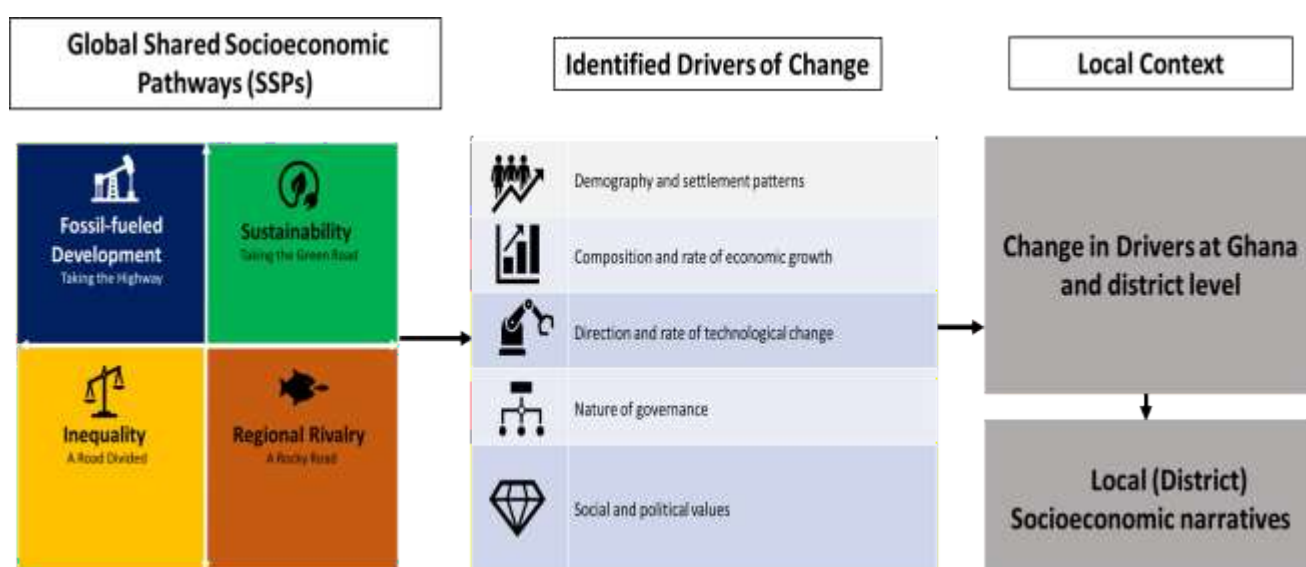
## National and Sub-National Socioeconomic Pathways

A parallel study has examined the creation of local-level socio-economic development scenarios to assess future climate change risk and vulnerability under various conditions. These national and local scenarios were based on four of the global Shared Socioeconomic Pathways (SSPs) developed by O'Neill et al. (2015). The selected SSPs are summarized as follows:

- **Sustainability – Taking the Green Road:** This pathway envisions a world with inclusive global development and better management of global commons. It features low global population growth and slower economic development, leading to relatively low resource and energy demand. The emphasis is on environmental technologies. Institutions at global, national, and regional levels are strong and adaptable, resulting in improved human well-being.
- **Fossil-fueled Development – Taking the Highway:** This SSP highlights competitive markets, innovation, and participatory societies, driving rapid technological progress and the development of human capital to achieve sustainable development. It depicts a world with intensive fossil fuel development, high energy demand, and swift technological advancements, alongside a strong focus on health, education, and institutions to enhance human and social capital.
- **Inequality – A Road Divided:** This pathway describes a world with growing inequalities both between and within countries. Power is concentrated in the hands of a small elite, while economic growth is moderate in the industrialized world, leaving a large, vulnerable population elsewhere. Technological development is uneven, and global markets are volatile due to persistent political uncertainties.
- **Regional Rivalry – A Rocky Road:** This SSP is characterized by a resurgence of nationalism and increased regionalism. The focus is on self-sufficiency and competition between regions, leading to fragmented development and cooperation, with economic growth hampered by geopolitical tensions and protectionist policies.

The five selected SSPs have been applied to identify key drivers of change at the national level for three crucial sectors: agriculture, energy, and health. Additionally, they have been tailored to the local context for Asuogyman District. While the specific details of these local socio-economic development scenarios are still being finalized, their potential impact on climate change vulnerability is assessed in the following section.

**Figure 8 | Adapted approach to develop local socioeconomic narratives**



The key drivers of change used to define the SSPs, as illustrated in Figure 12, include:

- Demography and settlement patterns
- Consumption and rate of economic growth
- Direction and rate of technological change
- Nature of governance
- Social and political values

## **5.4 Future Climate Vulnerability**

In the Sustainability future scenario, the Asuogyaman District mitigates climate change vulnerability through investments in ecological infrastructure and proactive urban planning. Improved agricultural practices and successful water resource initiatives, like the construction of small-town water systems, decrease the district's sensitivity to drought and mitigate the impacts of changing rainfall patterns. Efforts to curb deforestation and reduce plastic pollution also lessen flooding risks. Enhanced cooperation between local and national governments strengthens the protection of critical infrastructure and the provision of basic services, including better healthcare

For communities like Kudikope, Meyekpor, Aboaso, Abuma, Dodi Island, Frankadua & Ankyeasa. which are close to the Volta lake, increased investments in strengthening embankments and the restoration of wetlands and mangroves address climate-related risks of flooding.

### **Inequality - Divided Path Scenario:**

In the Asuogyaman District, limited support from the central government forces the district to rely on its own resources to address pressing issues. While this may encourage some local innovations to reduce climate vulnerability, it is more likely to deepen inequality. Wealthier residents who have the means may install private water supply systems or build their own flood defenses, allowing them to better cope with increasing climate risks. Meanwhile, the majority of the population, lacking such resources, would become even more vulnerable to climate impacts like droughts and floods, widening the gap between the rich and poor in the district.

### **Regional Rivalry – Competitive Struggle Scenario:**

In a world marked by competition and declining international cooperation, the Asuogyaman District faces a reduction in foreign aid and financial support, making it difficult to fund critical climate resilience projects. Without international commitments, deforestation and the destruction of mangroves in the district would continue unchecked, exacerbating both inland and lakeside flooding risks. Moreover, the lack of financial resources would prevent the district from safeguarding vital infrastructure, including roads, power facilities, and key economic hubs. This would severely impact the local economy as service disruptions increase, making it harder for the district to sustain development and respond to climate-related threats.



# 6



## Observed Climate and Trends

### 6.1 Observed Climate

Ghana's climate is tropical, featuring high temperatures and significant variability in rainfall across different regions. Average annual temperatures generally range from 26°C to 29°C, with the Atlantic Ocean providing a moderating influence in coastal areas. In the southern part of the country, there are two distinct rainy seasons, occurring from April to June and again from September to November. In contrast, the northern regions experience a single rainy season from April to October, followed by an extended dry period. Rainfall patterns vary significantly, with annual precipitation in the north averaging around 1,100 mm, while the southwestern regions can receive over 2,000 mm of rain. Humidity levels are typically high in coastal and forest areas, though they drop during the Harmattan season in the north.

Over the past few decades, Ghana has seen noticeable changes in its climate. Average temperatures have risen by approximately 1°C over the last 30 years, resulting in more frequent hot days and nights and a reduction in cooler days and nights. Rainfall has become increasingly unpredictable, with variations in both its timing and intensity. Some areas, particularly in the north, have seen a decline in overall annual rainfall, while the timing of the rainy seasons has shifted, complicating agricultural planning and the management of water resources.

The country has also witnessed a rise in extreme weather events, such as floods and droughts. The Asuogyaman District and other regions have experienced a notable increase in extreme weather events, particularly floods and droughts, making it highly vulnerable to climate-related risks. The district, due to its proximity to the Volta Lake and other rivers bodies, is particularly susceptible to storm surges and heavy rainfall, which have caused more frequent and severe flooding. These events have not only damaged infrastructure but also disrupted the livelihoods of local communities, highlighting the district's heightened vulnerability to the impacts of climate change.

These climate changes have significant impacts on agriculture, a crucial sector of Ghana's economy. Changes in growing seasons, reduced crop yields, and higher incidences of pests and diseases are some of the challenges faced by farmers. In response, many are adopting more resilient agricultural practices. Overall, the observed climatic shifts call for adaptive strategies to reduce the negative effects and strengthen Ghana's resilience to both current and future climate risks.

The monthly climatology data in Figure 11 presents a comprehensive overview of temperature and precipitation patterns in Ghana from 1991 to 2022, illustrating distinct seasonal variations.

- **Temperature Trends:**

- The average maximum surface air temperature peaks at around 35°C during March and April, with a secondary peak in November. The lowest maximum temperatures, approximately 31°C, occur in August.

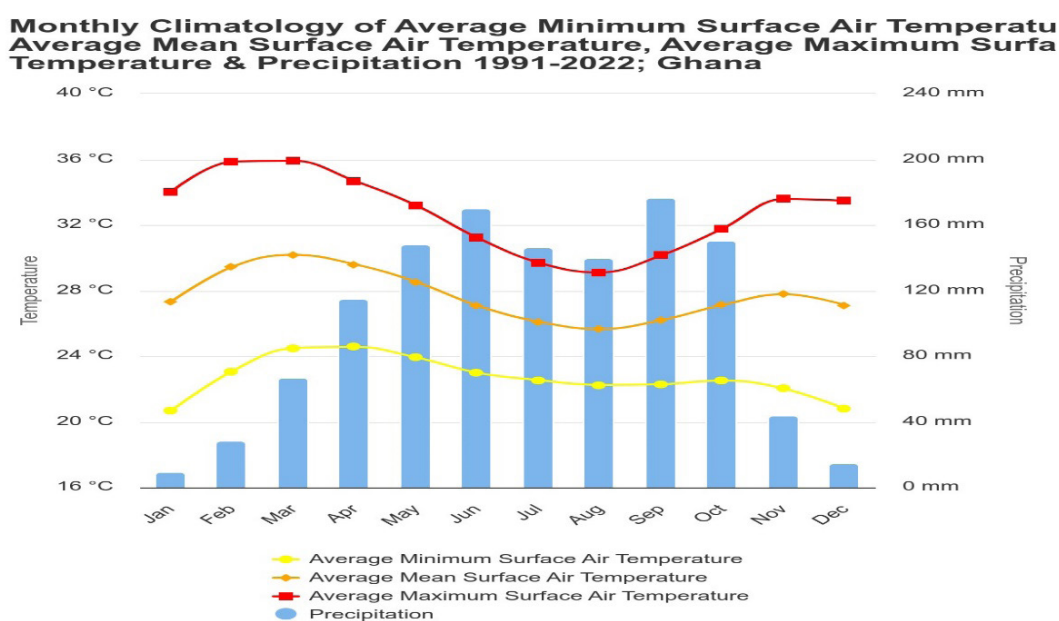
- Similarly, the average mean surface air temperature follows a similar pattern, reaching its highest point at about 30°C in April and October, and dropping to its lowest, around 27°C, in August.
- The average minimum surface air temperature also shows seasonal fluctuations, peaking at approximately 25°C in April and October and dropping to its lowest, around 22°C, in August.

- **Precipitation Patterns:**

- The rainfall patterns demonstrate strong seasonality, with June and September recording the highest precipitation, reaching up to 200 mm.
- The dry season runs from November to March, with January and February showing minimal rainfall, often close to 0 mm.
- The wet season extends from April to October, providing critical rainfall needed for agriculture and water resources.

Monthly climatology of Average Minimum Surface Air Temperature, Average Mean Surface Air Temperature, Average Maximum Surface Temperature & Precipitation 1991 – 2022; Ghana

**Figure 9 | Monthly Climatology of Average Minimum, Maximum, and Mean Surface Air Temperature.**



Source: Climate Knowledge Portal

## 6.2 Observed Climate Trends

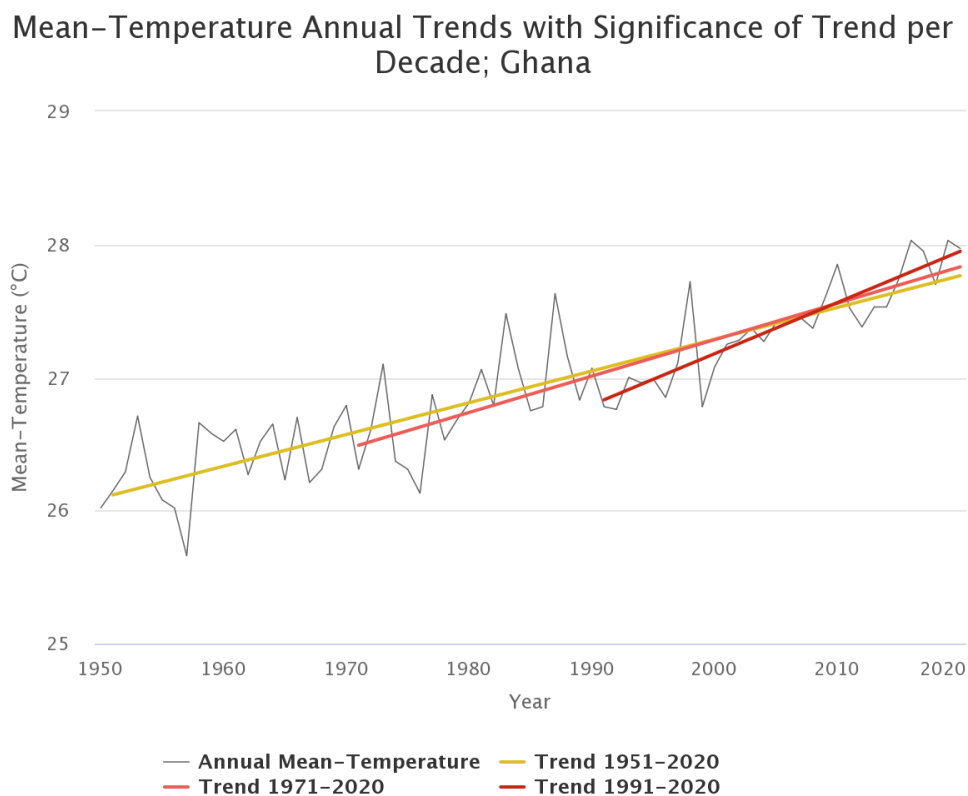
Ghana has experienced a noticeable rise in temperatures over recent decades. Since 1960, the country's mean annual temperature has increased by approximately 1.0°C, averaging a rise of 0.21°C per decade. The most pronounced temperature increases occurred between April and July, with a rate of +0.27°C per decade. This warming trend has been more intense in the northern regions compared to the southern parts of the country.

Furthermore, the frequency of 'hot' days has grown significantly across all seasons, except during the December to February period. Similarly, 'hot' nights have seen a notable increase in all seasons, rising by 13.2% for hot

days and 20% for hot nights between 1960 and 2003. In contrast, the occurrence of 'cold' days and 'cold' nights has decreased, dropping by 3.3% and 5.1% respectively over the same timeframe.

Figure 10 illustrates the steady rise in the country's average annual temperature, while Figure 13 highlights the significant increase in the number of days with heat index values exceeding 35°C. Both figures clearly demonstrate the growing impact of higher temperatures in Ghana over the years.

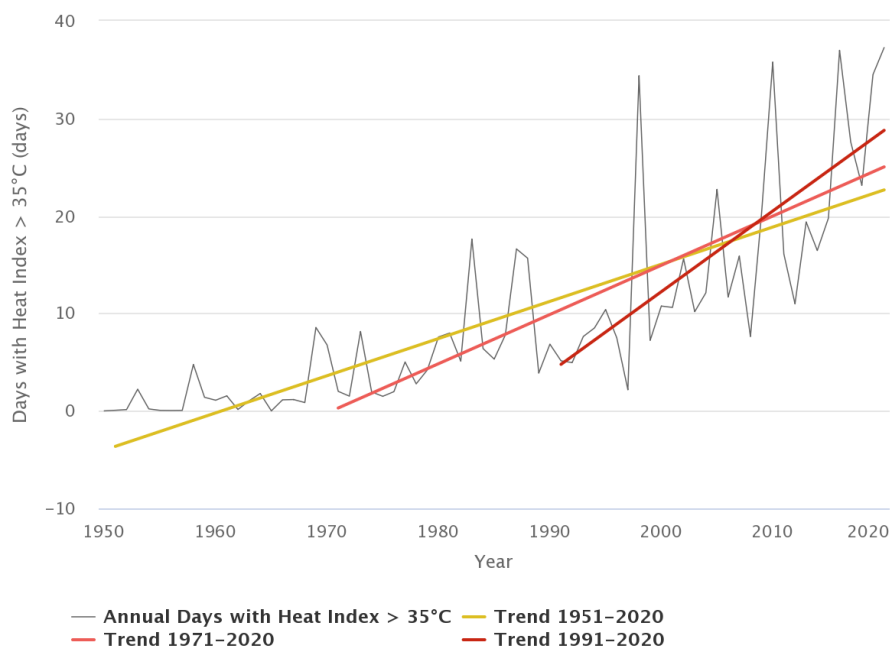
**Figure 10 Mean Annual Temperature trends for Ghana.**



Source: CCKP.

**Figure 11 | Days with Heat Index > 35°C trends for Ghana.**

Days with Heat Index > 35°C Annual Trends with Significance of Trend per Decade; Ghana



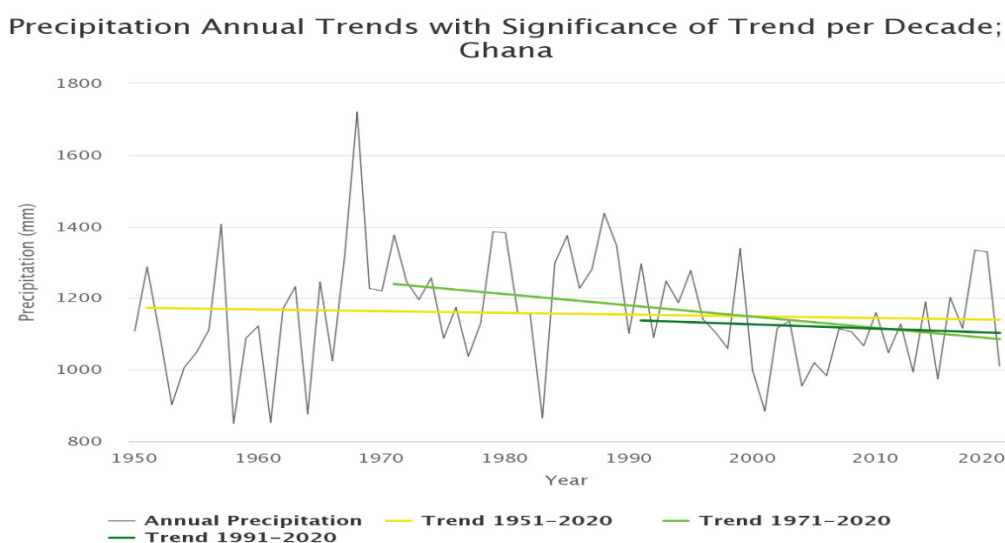
Source: CCKP

## Observed Precipitation Trends

Figure 14 from the CCKP presents the trends in mean annual precipitation for Ghana, showing a slight long-term decline; however, this trend is not considered statistically significant. Notably, there has been a gradual increase in annual rainfall since around 2000.

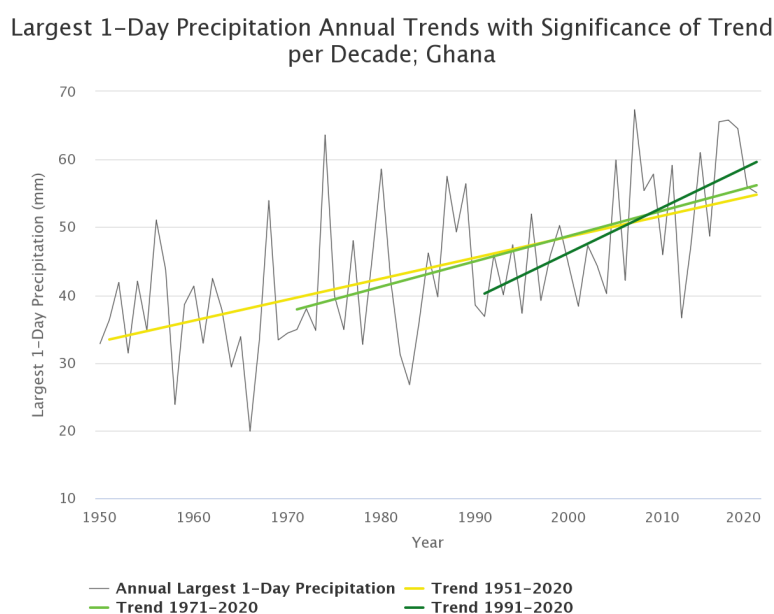
These findings differ from earlier studies, such as USAID's 2017 report, which suggested a "well-defined cumulative reduction of 2.4 percent per decade." In contrast, the recent data hints at the possibility of future increases in rainfall. On the other hand, Figure 9 shows a significant rise in maximum daily rainfall since the 1990s, signaling that while overall precipitation trends remain uncertain, the intensity of rainfall and the risk of flooding may become more pronounced in Ghana.

**Figure 12 | Annual precipitation trends for Ghana.**



Source: CCKP

**Figure 13 Annual largest 1-day precipitation trends for Ghana.**



Source: CCKP

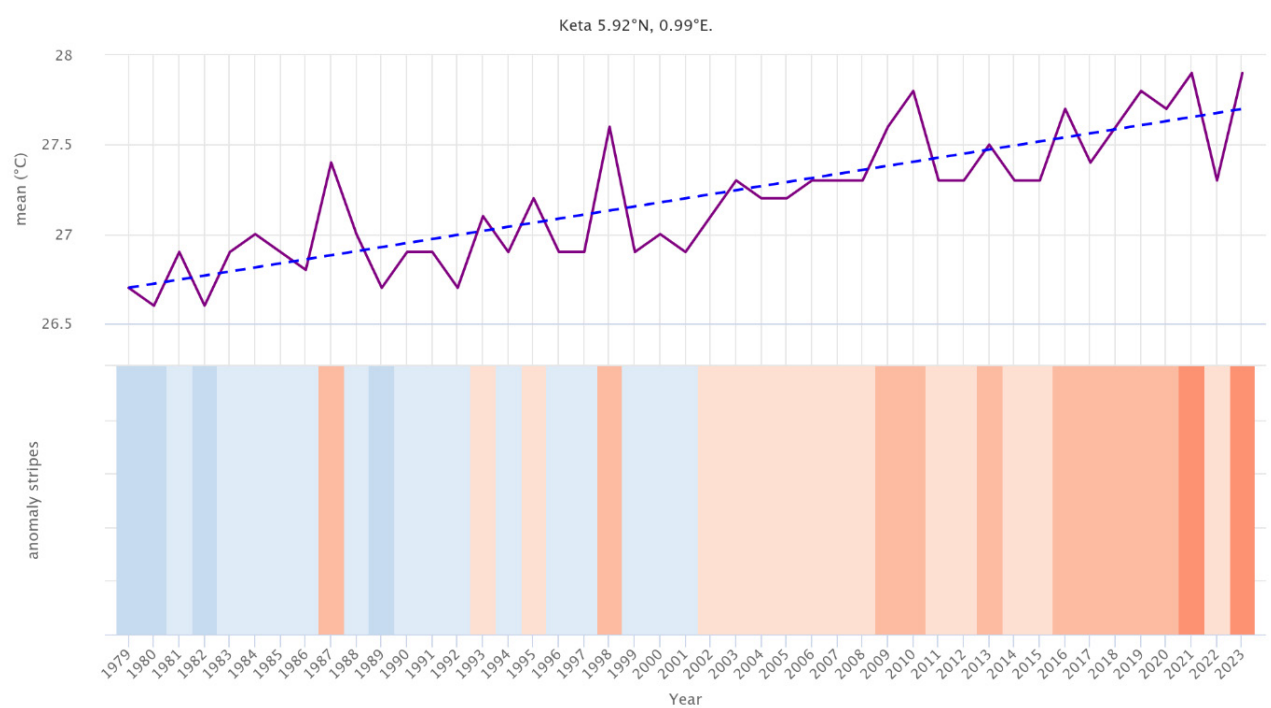
## 6.3 Local Climate Trends

An analysis of the mean annual temperatures in Asougyaman, from 1979 to 2023 reveals a clear upward trend in warming (Figure 16). Over the past four decades, the average temperature has risen from around **26.5°C** in the early 1980s to approximately **27.5°C** by 2023. This increase of about **1°C** over the 44-year period highlights the significant impact of global climate change on local temperature patterns.

Temperature anomalies further emphasize this warming trend. Between 1979 and the mid-1990s, the data is characterized by predominantly blue stripes, representing years with temperatures below the long-term average. However, from the late 1990s onward, a distinct shift to red stripes occurs, indicating years with

above-average temperatures. This transition from cooler to warmer anomalies vividly illustrates the ongoing local climate changes.

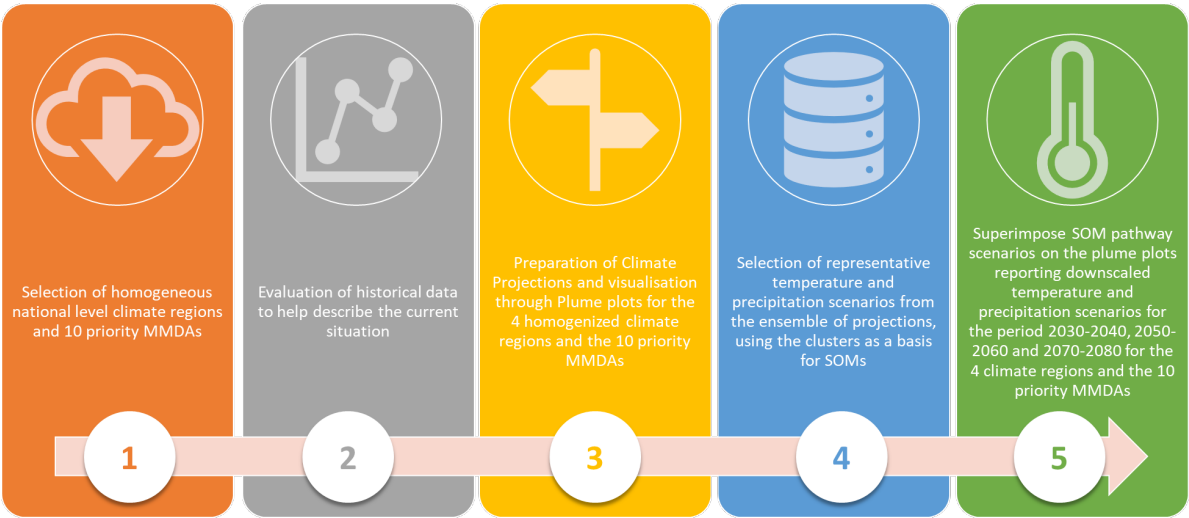
**Figure 14 | Mean yearly temperature, trend, and anomaly in Asougyaman district.**



Source: meteoblue.com, 2024.

### 6.4 Projections of Future Climate Change

This evaluation incorporates future climate change scenarios as outlined in Ghana’s National Climate Change Risk Assessment conducted by UNEP. The methodology employed for analyzing these climate scenarios is outlined as follows



The clustering of current climate patterns and anticipated changes in climate variables, derived from downscaled climate scenarios using the CORDEX data set, was utilized to categorize four distinct climate zones. For the purposes of this analysis, the Asuogyaman District falls within the semideciduous region, and the projections for this zone are applicable to the district.

The overall trends in expected climate changes for the remainder of the century are presented in Figure 19 and Table 5 below. These trends are based on the CMIP5 ensemble mean **results** and are expressed as the degree Celsius (°C) change per decade for annual average temperatures, and the percentage change per decade for annual rainfall. Statistically significant changes at the 5% level are highlighted in bold italics.

**Table 4 | Overall trends in climate for the remainder of the century in °C/decade and %/decade**

|                  | Temperature °C/decade |              |              | Rainfall %/decade |               |               |
|------------------|-----------------------|--------------|--------------|-------------------|---------------|---------------|
|                  | RCP2.6                | RCP4.5       | RCP8.5       | RCP2.6            | RCP4.5        | RCP8.5        |
| <b>North</b>     | <i>+0.09</i>          | <i>+0.24</i> | <i>+0.57</i> | -0.1 %            | +0.1 %        | <i>+0.6 %</i> |
| <b>Central</b>   | <i>+0.08</i>          | <i>+0.23</i> | <i>+0.55</i> | -0.0 %            | +0.0 %        | <i>+0.6 %</i> |
| <b>Southwest</b> | <i>+0.08</i>          | <i>+0.23</i> | <i>+0.52</i> | +0.1 %            | +0.1 %        | <i>+0.6 %</i> |
| <b>Coastal</b>   | <i>+0.08</i>          | <i>+0.22</i> | <i>+0.50</i> | -0.1 %            | <i>+0.3 %</i> | <i>+0.8 %</i> |



# 7



## Potential Impacts on Key Risk Areas

The potential impacts of climate change on key risk areas in the Asuogyaman are outlined below, focusing on the following critical sectors:

- Water Resources
- Flooding
- Ecosystems and Biodiversity
- Agriculture and Crop Production
- Transport Systems
- Human Settlements and Housing
- Gender and Social Vulnerabilities
- Fisheries and Aquatic Life

### 7.1 Water Resources

The Asuogyaman District is endowed with rich water resources, including the expansive Volta Lake, underground water sources, and various rivers. These resources are essential for multiple uses, such as electricity production, fishing, potable water supply, irrigation, industrial applications, and domestic needs (Community Water and Sanitation Agency, 2023). The Volta Lake, created by the Akosombo Dam, plays a pivotal role in hydroelectric power generation, providing a significant portion of Ghana's electricity (Volta River Authority, 2023). However, climate change poses serious challenges to these vital water resources. Increased rainfall variability and extreme weather events have led to significant impacts on water availability and quality. For instance, the recent controlled spillage from the Akosombo Dam due to rising water levels has resulted in catastrophic flooding in several communities which include Kokonte Kpedzi, Abume, Kudikope, Ahenbrom, Dzidzokope and Mama Kope etc (GhanaWeb, 2023)

This flooding has caused extensive damage to homes and infrastructure, displacing residents and disrupting local livelihoods dependent on fishing and agriculture. Local fishermen reported substantial losses due to fish deaths caused by high turbidity and shock from the floodwaters (GhanaWeb, 2023). Moreover, climate change exacerbates existing vulnerabilities in water management systems. The increased frequency of extreme weather events overwhelm infrastructure designed for typical conditions, leading to inadequate responses to both floods and droughts (Asuogyaman District Assembly, 2018). The reliance on surface water sources like the Afram river, Pawnpawn River and the Volta lake makes communities particularly susceptible to contamination during flooding events, which compromise drinking water quality (Community Water and Sanitation Agency, 2023). Additionally, the impacts of climate change extend to groundwater resources. Changes in precipitation patterns affect recharge rates for aquifers, potentially leading to decreased availability of clean groundwater in the future (Eastern Regional Water Resources Management Plan, 2020).

### 7.1.1 Flooding

Flooding is a major issue in the Asuogyaman District, primarily due to its proximity to Volta Lake and nearby rivers, making several communities highly susceptible to flooding during heavy rains. Areas such as Kudikope, Meyekpor, Aboaso, Abuma, Dodi Island, Frankadua, and Ankyeasa are particularly affected. These communities, which depend heavily on agriculture, face significant disruptions when floods damage crops, wash away vital soil nutrients, and cause soil erosion, undermining food production and threatening local economic stability.

The causes of flooding in Asuogyaman are both natural and human-induced. Heavy rainfall during the rainy season often leads to the overflow of rivers and Volta Lake, inundating agricultural lands and settlements. This is exacerbated by poor drainage systems and deforestation, which reduce the land's capacity to absorb excess water. Furthermore, the operational activities at the Akosombo Dam can cause fluctuations in water levels, contributing to occasional flooding.

The impact of flooding extends beyond agricultural damage. Roads, bridges, homes, and other critical infrastructure are frequently damaged, disrupting transportation and limiting access to essential services. The stagnant floodwaters also lead to the spread of waterborne diseases, posing serious health risks, particularly in rural areas with inadequate healthcare facilities. Additionally, livestock, an essential source of income, is affected as grazing lands become waterlogged and animals face increased exposure to diseases.



#### Data on flooding in Asuogyaman

| DATE          | EVENT                         | IMPACT                                                                                                                          | REFERENCE                                                                                                                                                                                                                           |
|---------------|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| June 2010     | Heavy rainfall causing floods | Extensive flooding in southern Ghana, including Asuogyaman District; significant property damage and displacement of residents. | <a href="https://reliefweb.int/sites/reliefweb.int/files/resources/7C0465B033F05F8D8525776D00699FE5-Full_Report.pdf">https://reliefweb.int/sites/reliefweb.int/files/resources/7C0465B033F05F8D8525776D00699FE5-Full_Report.pdf</a> |
| November 2010 | Akosombo Dam spillage         | Spillage from Akosombo Dam led to flooding in downstream communities, including Asuogyaman; over 600 residents displaced.       | <a href="https://www.myjoyonline.com/akosombo-dam-spillage-national-catastrophe-nadmo-official/">https://www.myjoyonline.com/akosombo-dam-spillage-national-catastrophe-nadmo-official/</a>                                         |

|              |                       |                                                                                                                                                                |                                                                                                                                                                                                                                               |
|--------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| October 2023 | Akosombo Dam spillage | Controlled spillage from Akosombo Dam due to high inflows resulted in flooding of communities in Asuogyaman District; homes submerged and residents displaced. | <a href="https://www.ghanaweb.com/GhanaHomePage/NewsArchive/Akosombo-Dam-spillage-triggers-disaster-in-Asuogyaman-homes-">https://www.ghanaweb.com/GhanaHomePage/NewsArchive/Akosombo-Dam-spillage-triggers-disaster-in-Asuogyaman-homes-</a> |
|--------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### 7.1.2 Ecosystems and Biodiversity

Biodiversity in the Asuogyaman District is essential for both ecological balance and economic stability, particularly due to its proximity to Volta Lake and its diverse forested areas. This region supports a wide array of species, including aquatic life, birds, and terrestrial animals, all thriving in the rich ecosystems provided by wetlands, forests, and the lake itself. The Volta River, which flows from Atimpoku to Gyakiti before expanding into the lake, contributes to the area's ecological richness. The Alabo River drains into the lake, further enhancing the biodiversity in the region.

The district is also home to several key forest reserves—Sapawusu, Aboben Hill, Sapawusu Extension, and the Volta River Forest reserves—as well as the Akwamu Hill Community Forest. These forests provide critical habitats for various species, including the critically endangered *Talbotiella gentii* and the globally threatened White-necked Picathartes, both listed on the IUCN Red List. The reserves also support a range of wildlife, including snakes, lizards, antelopes, hedgehogs, squirrels, and numerous butterfly species.

However, Asuogyaman's biodiversity is increasingly threatened by deforestation, illegal farming, and tree felling, which hinder conservation efforts. Additionally, the fluctuating water levels of Volta Lake exacerbated by rainfall variability and the operations of the Akosombo Dam have disrupted aquatic habitats, particularly around Dodi Island, affecting fish populations and their breeding grounds. Birds such as vultures and herons are also impacted by habitat degradation and climate change, resulting in shifts in their migration and breeding patterns.

The decline in biodiversity poses significant risks not only to wildlife but also to local communities that depend on these natural resources for their livelihoods, including fishing, agriculture, and eco-tourism. Therefore, efforts to conserve the district's biodiversity are critical for sustaining its ecosystems and ensuring the well-being of its inhabitants, ultimately promoting a resilient and thriving community.

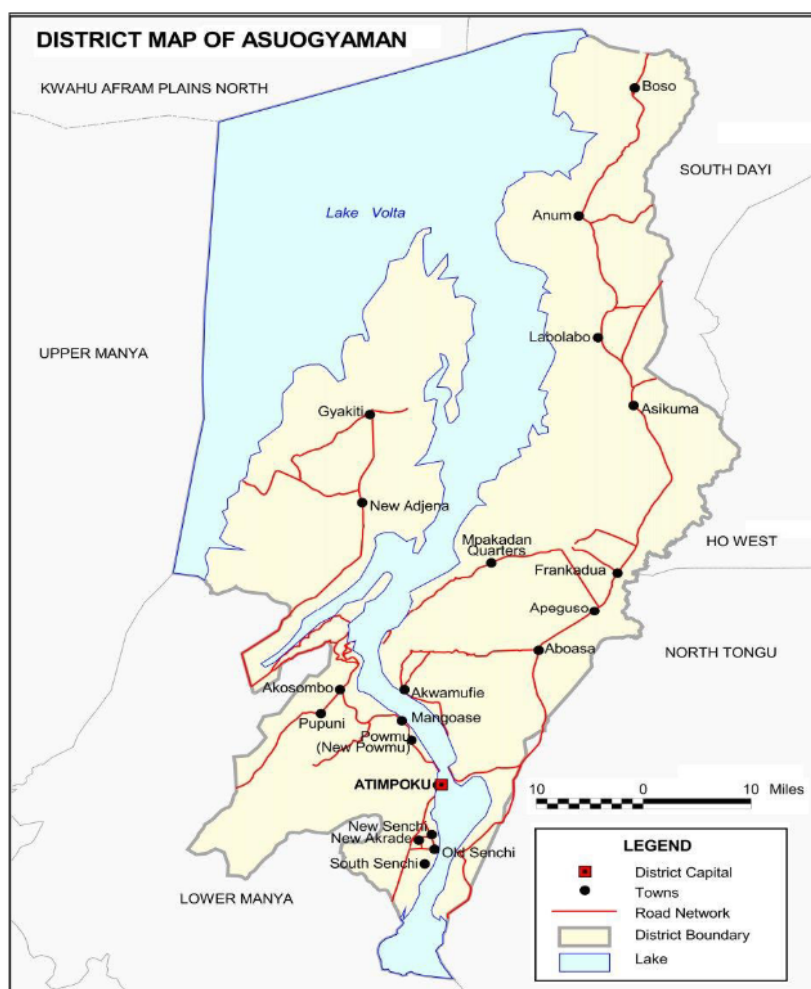
### 7.1.3 Transport Systems

Transport infrastructures in the District are mainly road. The Asuogyaman District features several main trunk roads, including the Akosombo-Akrade road corridor, Atimpoku-Asikumah road, Asikumah Junction to Anum Road, and Akosombo-Gyakiti roads. The Akosombo-New Akrade road connects to the Tema roundabout, while the Atimpoku-Asikumah road provides access to the Volta Region. Despite the importance of these roads, most have experienced significant deterioration over the years, with minimal rehabilitation efforts. The Akosombo-Gyakiti road, heavily used by local farming communities to transport their produce to Akosombo and beyond, is particularly in poor condition. There is an urgent need to expedite repairs on this road to lower transportation costs and improve business viability.

In terms of town roads, Akosombo boasts the best infrastructure, featuring a well-designed drainage system. However, this is the exception rather than the rule, as many peri-urban areas lack tarred roads or have roads in poor condition. Many community road networks have deteriorated significantly, showing clear signs of gully erosion with exposed rocks and stones. A considerable number of rural communities

rely on feeder roads and footpaths, which become nearly impassable during the rainy season. During the dry season, these roads generate excessive dust, posing health risks for both commuters and residents.

**Figure 15: Map of Asuogyaman showing Road Network**



Extreme weather events, such as heavy rainfall, often lead to the overflow of these water bodies, resulting in widespread flooding that disrupts transportation networks and damages critical infrastructure. For instance, communities like Kudikope, Dodi Island, Frankadua, and Ankyeasa have experienced severe flooding, causing destruction to roads, bridges, and public buildings. This situation not only hampers emergency response efforts but also limits access to essential services, thereby exacerbating the vulnerability of these communities during climate-related events.

Flooding has multiple causes, including increased rainfall intensity and altered seasonal patterns linked to climate change. As noted in previously, the CMIP5 projections indicate rising temperatures and potential changes in precipitation, which contribute to more frequent and severe flooding events. The impact of flooding on transport systems is profound in Asuogyaman; it washes away roads, render bridges impassable, and disrupt supply chains, hindering both economic activities and community resilience. The resulting displacement of populations strain existing infrastructure and lead to overcrowded living conditions, which increase the risk of waterborne diseases.

### 7.1.4 Agriculture (Crop Production /Livestock/Fishing)

The majority of residents in the Asuogyaman District are involved in agriculture and related trades, with three main types of agricultural activities dominating the region: livestock rearing, food cropping, and cash cropping. However, the focus is primarily on food crop production, with key crops including maize, cassava, plantain, yam, and vegetables. Most farmers in the district operate small-scale farms, and many are engaged in both crop cultivation and livestock rearing. The predominant farming methods used are bush fallowing and intercropping, and major farming areas include Tortibo, Domeabra, Mpakadan, Frankadua, Fintey, Gyakiti, Ankyease, and Survey Line. These areas offer large tracts of land suitable for commercial farming and agribusiness opportunities. The table below show some major crops and their areas of cultivation in the district.

#### Crops Grown and Major Production Areas

| Major Crops | Area of Cultivation                                       |
|-------------|-----------------------------------------------------------|
| Maize       | Frankadua, Asikuma, Mpakadan, Yeniam, Sarp                |
| Cassava     | Apeguso, Mpakadan, Frankadua, South –Senchi, Yeniam, Sarp |
| Yam         | Frankadua, Fintey, Apenkwa, Adjena,                       |
| Plantain    | Nnudu, Aboasa, Sarp, Yeniam                               |
| Pepper      | Mpakadan, Old Akra, South – Senchi                        |
| Cocoa       | Nnudu, Aboasa, Apeguso, Opokuase – Anum                   |
| Oil Palm    | Aboasa, Nnudu, Tortibo, Frankadua, Sarp, Apeguso, Asikuma |

Livestock farming, while less prominent, involves about 8% of the district's farmers. Commonly raised livestock include cattle, goats, sheep, poultry, and pigs. Most livestock farming is carried out on a subsistence level, with notable kraals located in Asikuma and Nkwakaben. Challenges affecting agriculture in the district include low prices for produce, lack of funding, irregular rainfall, and pest and disease outbreaks.

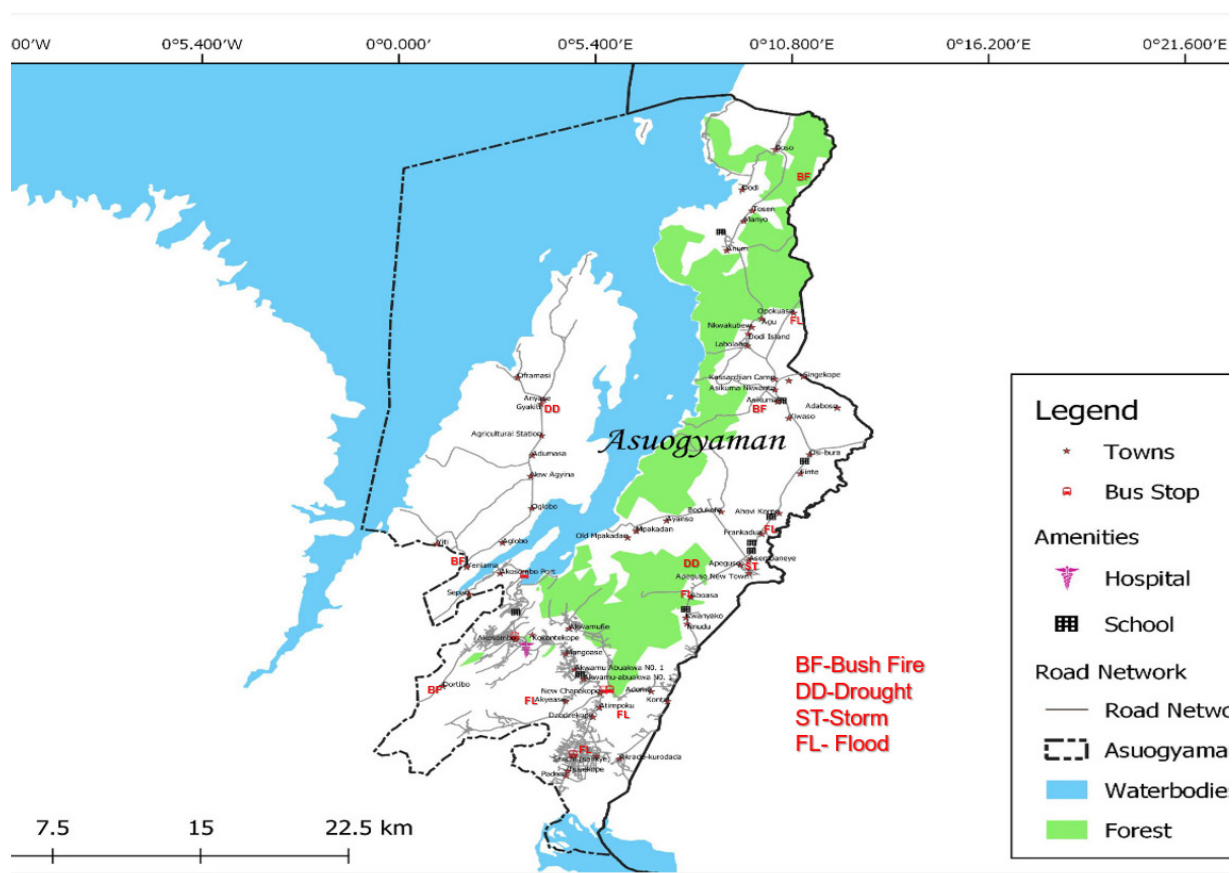
Fishing along the Volta Lake plays a vital role in the district's agriculture sector. It is mainly practiced in communities located along the 141 km shoreline, including Dzidzokope, Atimpoku, Abume, Akosombo, Survey Line, Adomi, Dodi Asantekrom, Asikuma, Mpakadan, Senchi Ferry, and Old Akra. Fishing in these areas forms an important livelihood for many local communities, particularly around the Kpong headwaters.

The district's fertile lands, especially near the Volta Lake, are ideal for cultivating staple crops like cassava, maize, yam, and plantain. However, climate change poses a growing threat to the region's agriculture, with erratic rainfall patterns and flooding becoming more frequent. Communities such as Kudikope, Meyekpor, Aboaso, and Abume have experienced severe flooding, which not only destroys crops but also erodes the soil and depletes essential nutrients, making it increasingly difficult for farmers to sustain productivity. On the other hand, areas like Small London, Ampanawu, and Apeguso have suffered from prolonged dry seasons and droughts, reducing water availability for irrigation and increasing vulnerability to pests and diseases. (MacCarthy et al 2015) highlighted that maize cultivation in areas like Asuogyaman is particularly vulnerable to seasonal climate changes. During the secondary growing season, which often experiences prolonged droughts, maize yields become more unstable. They recommend that farmers in the district prioritize the main growing season and adjust nitrogen fertilizer applications to better align with changing weather patterns.

In Asuogyaman, food production, much like in other parts of Ghana, depends heavily on rainfall during both the major and minor growing seasons. However, the observed climatic shifts, including rising temperatures and increasingly unpredictable precipitation, are negatively affecting agricultural output. These environmental fluctuations introduce uncertainties for local farmers, creating risks for crop yields and, consequently, threatening food security in the district.

### 7.1.5 Risk Mapping in Asuogyaman

During the consultation workshop with stakeholders in the Asuogyaman District, printed maps were provided to facilitate the identification of hazards, exposures, and impacts within the district. These maps enabled participants to actively map out areas most vulnerable to environmental risks, such as flooding and erosion. The Figure below summarizes the identified hazards and highlights the locations or communities, that are expected to be most affected by these risks. This exercise helped to visually capture the potential impact zones and informed future mitigation strategies for the district.





# 8

## Climate Change Risk Assessment

### 8.1 Identifying Critical Climate-Related Hazards

The Asuogyaman District is experiencing an increase in the frequency and intensity of extreme climate-related events—particularly flooding, drought and changes in precipitation patterns. The climate analysis indicate that these climatic events are likely to worsen in the future.

| Sectors                    | Identified climate risks                             | Climate Risk and Potential Impacts                                                                                                                                                                                                                                          |
|----------------------------|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Agriculture & Biodiversity | River flooding                                       | Due to its proximity to the Volta Lake and various rivers, parts of Asuogyaman District are susceptible to flooding, particularly during heavy rainfall in areas like Kudikope, Meyekpo, Aboaso, Abuma, Dodi Island, Frankadua & Ankyeasa                                   |
|                            | Flooding                                             | Flooding has destroyed crops, eroded soil, and wash away seeds and nutrients necessary for agriculture                                                                                                                                                                      |
|                            | Drought                                              | Flooding has posed a threat to livestock through the spread of waterborne diseases and loss of grazing land.                                                                                                                                                                |
|                            | Changes in rainfall patterns                         | Drought conditions has severely impact towns like: Small London, Ampanawu, Apeguso especially given its agricultural reliance.                                                                                                                                              |
|                            | Extreme rainfall                                     | Drought has led to reduced water availability for irrigation, affecting crop yields and increasing the vulnerability of crops to diseases and pests. This has led to Fluctuations in agricultural productivity leading to increased food prices                             |
|                            | Increased temperatures                               | For biodiversity, droughts have reduced the habitat quality and availability of water resources for wildlife, leading to decreased biodiversity and disrupting ecological balances.                                                                                         |
|                            | Extreme weather events such as storms and heatwaves. | Changes in rainfall patterns, including unpredictable seasonal shifts and intensity of rainfall, has disrupted planting and harvesting cycles of main staple crops such as cassava, maize, yam, and plantain in the district.                                               |
|                            |                                                      | Crops may be planted too early or too late, leading to poor yields. Additionally, intense rainfall has led to soil erosion, nutrient leaching, and damage to crops, which further reduces agricultural productivity                                                         |
|                            |                                                      | For aquatic systems like those in the Volta Lake, increased runoff has led to eutrophication, adversely affecting water quality and aquatic life in areas like Mpakadam Quarter, Dodi Asantekrom                                                                            |
|                            |                                                      | For wildlife, increased temperatures has led to changes in migration patterns of birds like the vultures and herons, breeding cycles, and habitat suitability, thus affecting the overall biodiversity of the towns closer to the lake .                                    |
|                            |                                                      | The frequency and intensity of extreme weather events such as storms and heatwaves have caused the immediate and severe damage to agricultural infrastructure (such as irrigation systems and storage facilities), leading to crop failures, and disturb ecological systems |

|      |                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------|---------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| WASH | Drought                                                             | Extended periods of drought, which are becoming more frequent and severe. It has reduced water availability. This scarcity affects the ability to meet domestic, agricultural, and industrial water demands                                                                                                                                                                                                                                 |
|      | Flooding, particularly during periods of heavy rainfall             | Given its location near Volta Lake and the numerous rivers and streams in the area, the district frequently experiences seasonal flooding, particularly during periods of heavy rainfall                                                                                                                                                                                                                                                    |
|      |                                                                     | Floodwaters often carry pollutants, waste, and pathogens, contaminating water bodies that are sources of drinking water. This contamination lead to waterborne diseases, posing serious health risks.                                                                                                                                                                                                                                       |
|      | Higher temperatures                                                 | Higher temperatures promote the growth of harmful algae in water bodies, which toxify water and hinder its usability for drinking and sanitation.                                                                                                                                                                                                                                                                                           |
|      | Prolonged dry periods                                               | Prolonged dry periods lead to reduced water levels in the Volta Lake and other water bodies, impacting water availability for drinking, agriculture, and other uses. This scarcity exacerbates hygiene issues, as less water is available for cleaning and sanitation.                                                                                                                                                                      |
|      | Heavy rains.                                                        | Heavy rains lead to increased erosion, resulting in more sediments in water bodies, which complicates water treatment and reduces the quality of water.                                                                                                                                                                                                                                                                                     |
|      | Changes in rainfall Patterns                                        | Fluctuating weather patterns also influence the breeding patterns of disease vectors such as mosquitoes (malaria), increasing the risk of vector-borne diseases                                                                                                                                                                                                                                                                             |
|      | Increasing temperatures                                             | Changes in rainfall have led to water scarcity, affecting clean water supply and sanitation, which are crucial for maintaining health standards in the district                                                                                                                                                                                                                                                                             |
|      | Heatwaves                                                           | Increasing temperatures worsen heat-related illnesses and influence the spread of diseases sensitive to heat, leading to symptoms such as headaches, dizziness, weakness, cramping, and nausea in warmer conditions.                                                                                                                                                                                                                        |
|      | Extreme weather events such as severe storms and prolonged flooding | Heatwaves contribute to heat exhaustion and heatstroke, particularly among vulnerable populations such as the elderly, children, and those with pre-existing health conditions                                                                                                                                                                                                                                                              |
|      |                                                                     | Expected changes in rainfall patterns are likely to increase river flooding and erosion along riverbanks. While there is uncertainty about how often and how severe the driest events each year will become, suggesting limited changes in drought frequency and severity, the shifting rainfall patterns, together with higher average yearly temperatures, could raise the chances of droughts occurring                                  |
|      |                                                                     | Extreme weather events such as severe storms or prolonged flooding cause displacement, forcing people to relocate temporarily or permanently. Such displacement often leads to overcrowded living conditions, straining existing health facilities and increasing the transmission of communicable diseases. The recent spillage of the dam as a result of excessive rainfall from lead to relocation of communities around the volta lake. |
|      |                                                                     | Floods or storms damage infrastructure, disrupt power supplies, and impede access to healthcare services, thereby reducing the quality of care and accessibility during critical times.                                                                                                                                                                                                                                                     |
|      |                                                                     | Unpredictable rainfall patterns, droughts, and flooding lead to crop failures, reducing food availability and leading to malnutrition and related health issues. This is particularly critical as the district relies heavily on local agriculture for food security.                                                                                                                                                                       |
|      |                                                                     | Reduced rainfall and increased evaporation lead to lower water levels in the Volta Lake, affecting water supply for domestic use, agriculture, and hydropower generation                                                                                                                                                                                                                                                                    |

|                                    |                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------------------|----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disaster and Infrastructure</b> | Extreme weather events such as floods, Intense rainfall, | Critical infrastructure like roads, bridges, and School buildings, markets, Port, Hotels in the district are vulnerable to extreme weather events such as floods, impacting both emergency response efforts and community resilience.                                                                                                                                                                                          |
|                                    | Flooding                                                 | The district experiences periods of intense rainfall, especially during the rainy seasons. The excessive rainfall lead to the overflowing of the Volta Lake and rivers, causing floods that damage homes, farmland, and roads, shools etc                                                                                                                                                                                      |
|                                    | Severe storms,                                           | The Volta Lake's levels fluctuate dramatically, especially in response to heavy rains and the operational management of the Akosombo Dam. High water levels lead to flooding of nearby communities and infrastructure                                                                                                                                                                                                          |
|                                    | High winds and heavy rainfall.                           | The Floods wash away roads, bridges, and other critical infrastructure, disrupting transportation and access to services in the district.                                                                                                                                                                                                                                                                                      |
|                                    | Strong winds                                             | Flooding often displaces communities, forcing people to leave their homes and leading to the need for temporary shelters and aid.                                                                                                                                                                                                                                                                                              |
|                                    |                                                          | The district experience severe storms, particularly associated with the transitional periods between rainy and dry seasons                                                                                                                                                                                                                                                                                                     |
|                                    |                                                          | High winds and heavy rainfall during storms damage buildings, power lines, and communication infrastructure, leading to service disruptions.                                                                                                                                                                                                                                                                                   |
|                                    |                                                          | Strong winds lead to accidents on Volta Lake primarily through their impact on water conditions and boat stability.                                                                                                                                                                                                                                                                                                            |
|                                    |                                                          | Strong winds and lightning pose direct safety risks to the population and lead to accidents and casualties.                                                                                                                                                                                                                                                                                                                    |
| <b>Gender (cross cutting)</b>      | floods droughts                                          | The women, particularly those in rural areas in the district, bear a heavier burden during extreme weather events such as floods or droughts. In many households, women are primarily responsible for water collection, food provision, and caregiving. During floods or droughts, these tasks become more arduous and time-consuming, increasing their workload and reducing time for other economic activities or education. |
|                                    | Higher temperatures                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                    | Heat increase                                            | In the district Men are engaged in agriculture and fishing, they see their primary sources of income severely disrupted by extreme weather. This lead to increased stress and potential migration to urban areas in search of employment, altering family structures and increasing pressures on women.                                                                                                                        |
|                                    | Extreme weather                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                    | Erractic rainfall                                        | Higher temperatures exacerbate health problems, particularly for pregnant women and the elderly. Women's responsibilities for caring for these vulnerable populations increase, adding to their burden                                                                                                                                                                                                                         |
|                                    |                                                          | Heat increase affect men working outdoors, such as in agriculture and fishing, directly impacting their health and productivity. Long exposure to high temperatures lead to heat stress and other heat-related illnesses.                                                                                                                                                                                                      |
|                                    |                                                          | Resource degradation lead to reduced fish stocks and less fertile farming lands, directly impacting the livelihoods that many men in the district depend on. This lead to economic instability and increased competition for resources, potentially leading to conflicts.                                                                                                                                                      |
|                                    |                                                          | Biodiversity loss affects herbal medicines and local plants that women often use for health care and nutrition. Losing these resources impact family health and increase dependency on external markets.                                                                                                                                                                                                                       |
|                                    |                                                          | Flooding and droughts damage school infrastructure and lead to school closures, interrupting children's education. Additionally, in times of crisis, children might be needed at home to help with increased domestic burdens, further limiting their educational opportunities.                                                                                                                                               |
|                                    |                                                          | Extreme weather events lead to outbreaks of waterborne diseases, which are especially dangerous for children who are more susceptible to dehydration and malnutrition.                                                                                                                                                                                                                                                         |
|                                    |                                                          | Inconsistent rainfall lead to crop failures, reducing food availability and leading to malnutrition among children, which have long-term effects on their physical and cognitive development                                                                                                                                                                                                                                   |

## 8.2 Impact Storylines for Critical Assets and Risk Domains

Asuogyaman, like many regions near large water bodies, is increasingly vulnerable to the impacts of climate change. To better understand the climate-related hazards, vulnerabilities, and exposures affecting critical assets in the district, individual impact chains were developed. These chains were based on information obtained through desk reviews and validated by stakeholders. The following priority risks have been identified for the Asuogyaman District:

- **Risk 1: Displacement and relocation**

Communities near the Volta Lake face increased risk of displacement due to rising water levels and flooding.

- **Risk 2: Fisheries Impacts - Potential decline in fish populations and increasing costs**

Changes in water temperature and lake conditions may lead to a decline in fish populations, which would directly affect livelihoods and increase operational costs for local fishers.

- **Risk 3: Economic and social disruptions and loss of livelihoods**

Flooding, droughts, and other climate hazards could disrupt agriculture and other local industries, leading to significant economic and social upheaval.

- **Risk 4: Community health: Increase in the spread of disease and loss of life**

Flooding and poor water quality may contribute to the spread of waterborne diseases, while heat stress and other climate impacts could exacerbate health risks.

- **Risk 5: Decline in local ecosystems**

Flooding and erosion threaten critical ecosystems near the Volta Lake, including agricultural lands, forest areas, and aquatic ecosystems.

- **Risk 6: Water security**

Prolonged droughts, erratic rainfall, and increasing sedimentation due to flooding will challenge the district's water resources, affecting both supply and quality

### Risk 1: Displacement and Relocation

Communities situated along the shores of the Volta Lake, such as Kudikope, Meyekpor, and Aboaso, are at high risk of displacement due to rising water levels and increased flooding events. As water levels in the lake continue to rise, homes, farmlands, and infrastructure are increasingly at risk of being submerged or damaged. Seasonal flooding has already forced some residents to relocate temporarily, and prolonged displacement could become a recurring issue. The increasing frequency and intensity of floods also threaten property and agricultural land, leading to loss of livelihoods and necessitating costly relocations. The combination of these factors contributes to the growing risk of displacement, especially for vulnerable populations with limited resources.

Moreover, the economic burden of rebuilding damaged infrastructure, restoring farmland, and relocating displaced individuals creates long-term challenges for the district. As climate change continues to accelerate, addressing displacement through proactive measures such as constructing flood defenses, improving land-use planning, and developing relocation plans will be critical to minimizing future disruptions.

## **Risk 2: Fisheries Impacts – Potential Decline in Fish Populations and Increasing Costs**

The fishing industry in Asuogyaman is a vital source of livelihood for many residents. However, climate change is threatening this sector due to changes in water temperature, nutrient levels, and lake conditions. Warmer water temperatures in the Volta Lake alter the composition of fish species, leading to a decline in key fish populations. This is particularly problematic for communities that rely on fishing as a primary source of income and food security.

Additionally, extreme weather events and erratic rainfall patterns disrupt fishing activities, making it more difficult for fishers to predict optimal fishing times and locations. Increased costs associated with maintaining fishing equipment, handling fluctuating fish stocks, and adapting to changing lake conditions drive up operational expenses. As a result, the economic viability of the fishing industry may decline, pushing more households into poverty. The situation is further exacerbated by the introduction of invasive species, which thrive in warmer waters and compete with native fish populations. These species can cause significant disruptions to the local ecosystem, further reducing fish stocks and increasing the cost of fishery management.

## **Risk 3: Economic and Social Disruptions and Loss of Livelihoods**

Asuogyaman's economy is heavily dependent on agriculture, fishing, and tourism, all of which are vulnerable to climate change. Prolonged droughts, erratic rainfall, and extreme heat events disrupt crop production, reduce fish populations, and negatively impact tourism activities centered on the Volta Lake. These disruptions can lead to widespread economic losses, pushing many families into food insecurity and poverty.

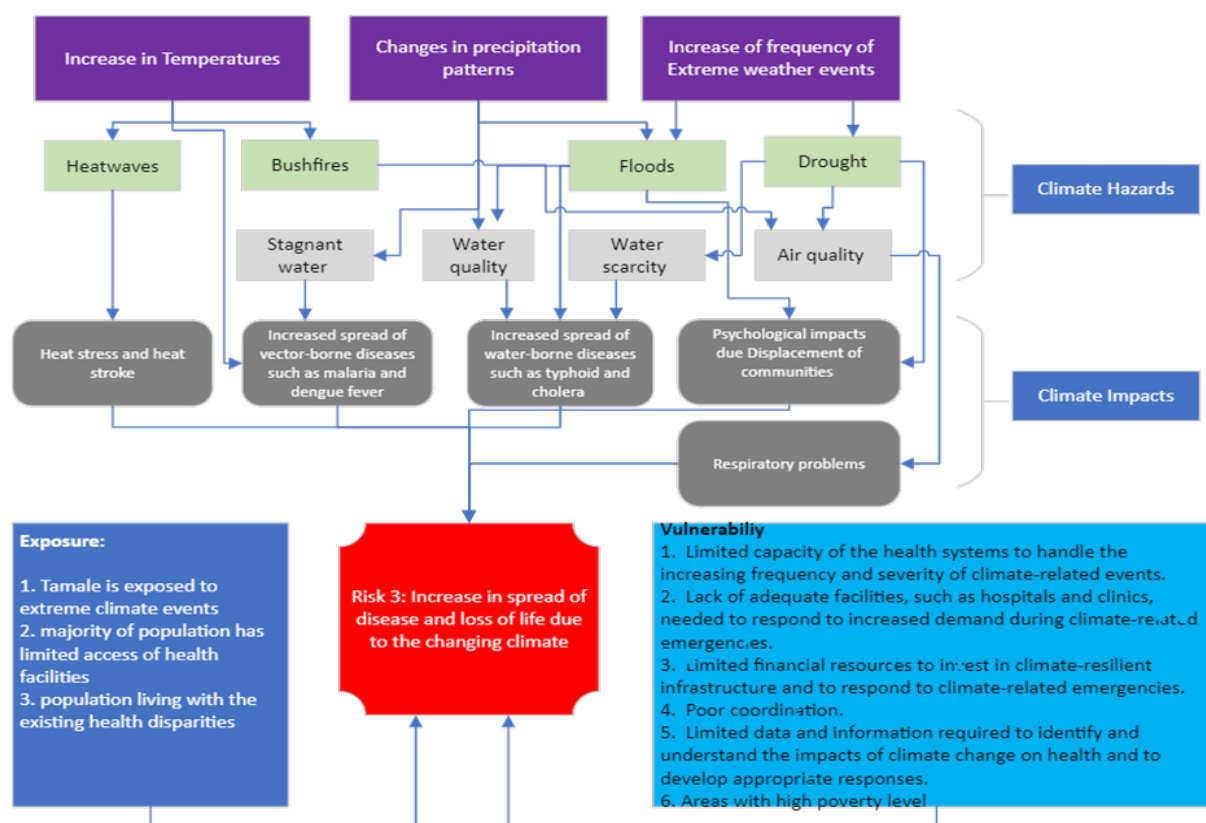
For instance, farmers in the district are experiencing reduced yields due to unpredictable weather patterns, with staple crops such as maize, cassava, and yam being particularly affected. The frequent occurrence of floods damages crops and erodes soil, while droughts lead to water shortages, impacting both crop growth and livestock health. These challenges are compounded by pest infestations and diseases that thrive in the changing climate, further reducing agricultural productivity. The loss of agricultural and fishing livelihoods could drive migration to urban areas, creating social and economic strain. Unemployment and underemployment may rise as traditional livelihoods are no longer viable, leading to increased crime, poverty, and social unrest. As such, developing climate-resilient agricultural practices and alternative income-generating activities is essential to mitigating these economic and social risks.

## **Risk 4: Community Health: Increase in Spread of Disease and Loss of Life**

Climate change in Asuogyaman is expected to exacerbate public health risks, particularly in relation to waterborne diseases, heat stress, and vector-borne illnesses. Flooding caused by intense rainfall leads to water contamination, increasing the prevalence of diseases such as cholera, typhoid, and diarrheal infections. Communities with limited access to clean water and sanitation facilities are especially vulnerable to these outbreaks.

Moreover, changes in temperature and precipitation patterns are expected to affect the distribution and breeding cycles of disease-carrying vectors like mosquitoes, potentially increasing the incidence of malaria and other mosquito-borne diseases. As temperatures rise, the habitat for malaria-carrying mosquitoes could expand, putting more people at risk of infection. Extreme heat events also pose a significant health risk, particularly for the elderly, children, and those with pre-existing health conditions. Heat stress can lead to dehydration, respiratory issues, and even death. Furthermore, climate-induced displacement and destruction of healthcare infrastructure during floods or storms may limit access to essential health services, further compounding health risks.

**Figure 15 Health System Impact Chain Diagram**



### **Risk 5: Decline in Local Ecosystems**

The ecosystems around the Volta Lake, which include wetlands, forests, and aquatic systems, are under increasing pressure due to climate change. Flooding and erosion degrade these ecosystems, reducing their ability to provide vital services such as water filtration, carbon sequestration, and habitat for wildlife. The loss of these services has far-reaching consequences for both the environment and the communities that depend on them for livelihoods, such as agriculture and tourism.

Ecosystem decline also increases vulnerability to future climate impacts. For example, wetlands serve as natural buffers against flooding by absorbing excess water, but as these ecosystems are degraded, the region becomes more susceptible to flood damage. Similarly, soil erosion from deforested areas reduces agricultural productivity and contributes to further environmental degradation. In the long term, the decline of local ecosystems could lead to biodiversity loss, making the region more vulnerable to climate-related shocks and reducing its capacity to adapt to changing conditions.

### **Risk 6: Water Security**

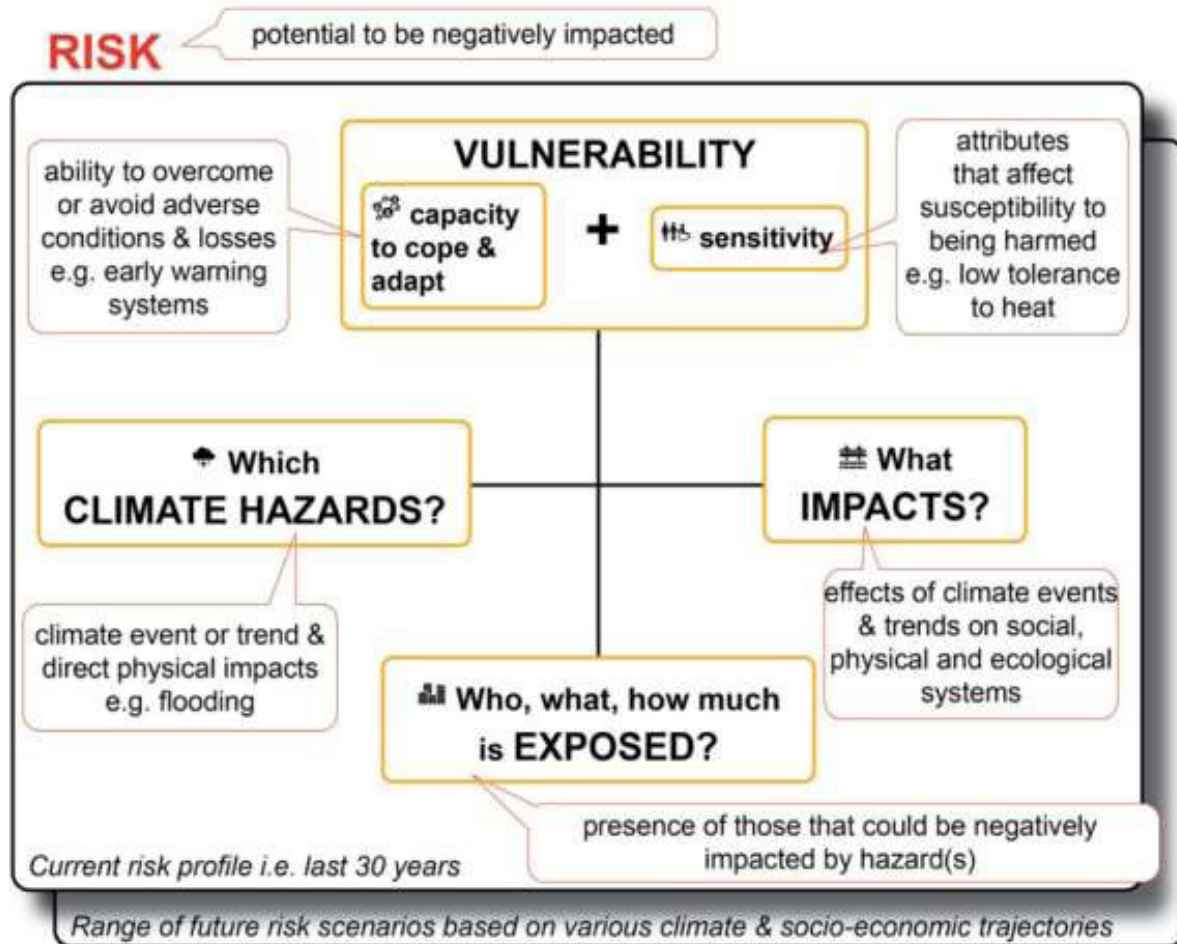
Water security in the Asuogyaman District is already being impacted by climate change, with prolonged droughts, erratic rainfall, and flooding threatening both the availability and quality of water resources. As water levels in the Volta Lake fluctuate, access to clean water becomes more unpredictable, affecting households, agriculture, and industries. Droughts reduce the amount of water available for irrigation, drinking, and industrial use, while floods can contaminate water sources with sediment and pollutants. Additionally, climate-induced changes in evaporation rates and rainfall patterns are expected to reduce groundwater levels, further limiting water access during dry periods.

Water insecurity poses significant risks to food production, public health, and economic development. Ensuring a reliable water supply will require investment in water management infrastructure, such as dams, reservoirs, and irrigation systems, as well as efforts to protect and restore natural water systems. Developing strategies to increase water efficiency and promoting sustainable water use will also be crucial in safeguarding water resources for future generations

### 8.3 Risk Assessment Methodology

To assess the key climate risks to communities in the Asuogyaman District, a high-level, qualitative risk assessment was conducted. This assessment was guided by the principles outlined in the IPCC’s Fifth Assessment Report (AR5) (2014), which emphasizes risk as a central concept, with vulnerability as a key component. The critical step in understanding climate-related risk is identifying who and what is exposed to climate hazards, such as flooding, drought, and extreme weather events, and determining how these hazards may impact or harm the district’s people, infrastructure, and ecosystems. This includes identifying those elements that are most vulnerable to climate change, such as communities living along the Volta Lake, agricultural land, and water supply systems (Department of Environment, Forestry, and Fisheries, 2020).

**Figure 16 The component of climate Vulnerability and Climate risk, adapted from IPCC AR5**



In this study, risk is defined as a function of hazard, exposure, and vulnerability, and is assessed as the probable harm that could be inflicted on biophysical or socio-economic systems by anticipated climate threats. This approach is adapted from the National Climate Risk and Vulnerability (CRV) Assessment Framework (2020) and the IPCC AR5.

The vulnerability component of risk focuses on the sensitivity and adaptive capacity of the people, infrastructure, and ecosystems exposed to climate hazards such as flooding, droughts, and extreme weather events. The risk assessment process involved gathering and analyzing information from stakeholder consultations and existing literature, paying attention to the three core elements that define risk:

- **Hazard (H):** The identification and characterization of climate hazards affecting the Asuogyaman District, including extreme weather, temperature increases, and changing rainfall patterns.
- **Exposure (E):** Assessing what and who is exposed to these hazards, such as the communities, agricultural lands, water sources, and infrastructure.
- **Vulnerability (V):** Evaluating the sensitivity and adaptive capacity of the district's social, economic, and ecological systems.

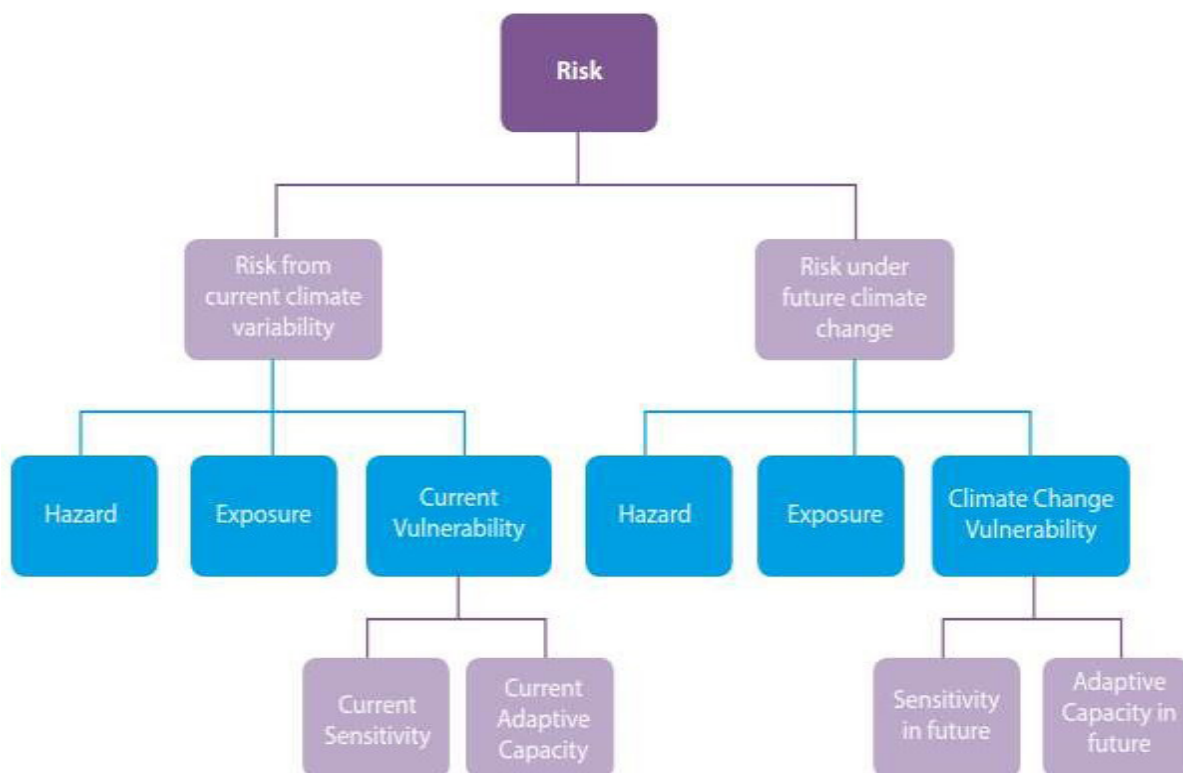
The formula used for risk assessment is expressed as:

$$\text{Risk} = f(H, E, V)$$

The assessment process included:

- **Hazard identification and characterization:** Analyzing the types of climate hazards affecting the region, their likelihood, and potential intensity.
- **Exposure characterization:** Determining the communities, assets, and systems at risk from the identified hazards.
- **Vulnerability assessment:** Evaluating the systems' sensitivity to climate hazards and their ability to adapt or cope with these changes.

**Figure 17 | Climate change risk assessment variables**



### 8.3.1 Climate Change Hazard in Asuogyaman

In the Asuogyaman District, the level of climate hazards is determined by assessing individual climate change parameters, such as temperature increases and changes in precipitation patterns. Additionally, derived variables such as increased drought frequency, extreme rainfall events, changes in mean annual runoff, impacts on water supply, heat stress, and effects on crop productivity are also analyzed to assess the extent of climate hazards in the region.

The severity of these potential impacts is characterized based on specific thresholds that help determine the level of risk to the district's socio-economic and biophysical systems. These thresholds, which are used to quantify the severity of impacts, include factors such as the frequency and intensity of droughts and floods, the reduction in water availability, increased temperatures, and declining agricultural productivity.

**Table 12** outlines climate hazard thresholds that can be used to characterize the severity of potential impacts in Asuogyaman, providing a framework for understanding how various climate hazards may affect the district.

| Climate Hazard       | Climate change parameter used                    | L <sup>1</sup> | M <sup>1</sup> | H <sup>1</sup> | VH <sup>1</sup> |
|----------------------|--------------------------------------------------|----------------|----------------|----------------|-----------------|
| <b>Temperatures</b>  | Change in Mean Temperatures                      | 0°C            | + 1°C          | 1.5°C          | 2°C             |
| <b>Precipitation</b> | Change in Mean Annual Rainfall                   | 100            | 50             | 0              | -50             |
| <b>Droughts</b>      | Change in SPEI                                   | 2              | 1              | 0              | -1              |
| <b>Floods</b>        | Change in maximum daily rainfall                 | -10%           | -5%            | 0%             | 5%              |
| <b>Wildfires</b>     | Change in extreme temperatures                   | 0%             | 10%            | 50%            | 100%            |
| <b>Agriculture</b>   | Change in crop suitability                       |                | -              | -              | —               |
| <b>Livestock</b>     | Change in heat index (HI)/max temperature        | 0%             | 10%            | 50%            | 100%            |
| <b>Human Health</b>  | <b>Change in heat index (HI)/max temperature</b> | <b>0%</b>      | <b>10%</b>     | <b>50%</b>     | <b>100%</b>     |

Some of the values for the above variables can be derived directly from climate risk maps (for example changes in mean annual temperature or precipitation) or from derived hazard maps such as drought hazard, water resource availability and crop suitability for primary crops under different climate change scenarios. The criteria to define the magnitude of the hazard is included in Appendix B.

### 8.3.2 Exposure in Asuogyaman

Exposure to climate hazards, such as increasing flood risks, in the Asuogyaman District can be supported by hazard mapping. For example, flood hazard mapping studies, such as the Ghana: Roadmap for Resilient Infrastructure in a Changing Climate report, provide valuable data to assess the level of exposure for people and infrastructure. These maps are used to determine how vulnerable communities, buildings, and infrastructure are to flood risks.

The analysis in Asuogyaman shows that while the overall exposure of people and assets to flood risk may not drastically increase under different climate scenarios, the frequency and intensity of extreme weather events, especially rainfall, are likely to change. This means that although the areas exposed to flooding may not expand significantly, the magnitude of these floods may intensify due to shifts in extreme weather patterns.

In evaluating exposure in Asuogyaman, historical data on past and recent weather events were analyzed. When secondary data was insufficient, information gathered through stakeholder engagement was used

to complement quantitative indicators, such as estimates of the number of people or buildings located in flood-prone areas. These analyses help paint a clearer picture of how exposed the district is to current and future climate risks.

The criteria used to determine exposure levels are detailed in **Appendix A**.

### 8.3.3 Vulnerability in Asuogyaman

Vulnerability in the Asuogyaman District is conceptualized as an integral part of the system or assets being exposed to climate hazards. It is primarily a function of two factors: the system's sensitivity to climate risks and its current lack of adaptive capacity to mitigate the adverse impacts of those risks. In assessing vulnerability, the aim is to evaluate both the sensitivity and adaptive capacity of the district's communities, infrastructure, and natural systems. Sensitivity refers to the physical environment, socio-economic conditions, and cultural dynamics of the area, while adaptive capacity refers to the ability of these systems to reduce or withstand the impacts of climate hazards.

A profiling exercise was conducted for critical sectors and assets within Asuogyaman to establish their current status, including their biophysical and socio-economic conditions. It is important to note that vulnerability to climate change is not solely determined by climate-related hazards but also by existing socio-economic challenges. Climate change is expected to exacerbate many of the socio-economic problems already faced by communities in the district, including poverty, limited access to resources, and inadequate infrastructure. The vulnerability of communities in Asuogyaman was analysed using feedback from stakeholder engagement sessions, as well as reviews of relevant published sources. This information was used to estimate the adaptive capacity of the systems in place to minimize the impacts of climate risks. Key elements such as knowledge, technology, economic resources, and institutional capacity all of which are directly or indirectly linked to climate risks—were considered in this assessment.

The vulnerability of natural ecosystems and socio-economic systems in Asuogyaman is thus assessed as a function of both their sensitivity to hazards and their adaptive capacity. High vulnerability is expressed as a situation where a system exposed to climate risks has high sensitivity but low adaptive capacity. In this context, vulnerability can be described using the following formula:

**Vulnerability = (Sensitivity-Adaptive Capacity)**

In Asuogyaman, high vulnerability indicates that systems or communities are highly sensitive to climate risks (e.g., extreme floods or droughts) and have limited capacity to adapt or respond effectively to these challenges. The assessment helps identify which areas or sectors require more targeted interventions to build resilience against climate change.

### Evaluating Risk

Finally, the final risk evaluation for the Asuogyaman District involved combining the results that reflect the current status of the different components that contribute to climate risk. This comprehensive assessment of potential risks from climate change on both natural and human systems was conducted by analyzing the matrix of **hazard**, **exposure**, and **vulnerability**.



This potential risk assessment matrix makes it possible to rank exposure and vulnerability to climate change. The final risk assessment matrix helps to identify the priorities and systems and sectors at risk (Fall, Correa, & Sarr, 2011). In Appendix C is the matrix used to rank the potential risks of the hazards associated with climate change on natural and human systems, based on exposure to identified climate hazards and the vulnerability of key natural systems, socio-economic sectors and local livelihoods

## **8.4 Risk Assessment Results for Asuogyaman District**

### **8.4.1 Current and Future Climate-Related Risks**

Understanding climate-related risks at the local level requires an integrative approach that considers both physical climate hazards and the social dimensions of vulnerability. In Asuogyaman, the identification of critical assets and systems exposed to climate hazards was initially conducted through desk reviews. These findings will be shared with local stakeholders during a validation workshop to gather their insights and experiences regarding climate events that have impacted their systems of interest and the challenges they have faced as a result.

The desk review highlighted that the district assembly is increasingly aware of climate change issues and is taking steps to prepare for climate-related disasters. Several actions have already been proposed in the district's Medium Term Development Plan and Annual Action Plan, which reflect the assembly's commitment to addressing climate challenges. These actions include:

- Establishing early warning systems to alert residents of impending disasters such as floods, which will enhance adaptive capacity.
- Educating residents about high-risk areas to increase awareness and preparedness.
- Conducting climate change sensitization programs and offering farming education to improve resilience.
- Procuring and distributing agricultural inputs to support farmers in adapting to climate variability.
- Conducting pest and disease surveillance for livestock and poultry to reduce vulnerability in the agricultural sector.
- Promoting aquaculture development, including pest

The discussions in Asuogyaman led to the results presented in Table 12 and Table 13, which outline both the current and potential future climate-related risks facing the district. These tables highlight the areas of greatest concern based on observed climate impacts and expected future scenarios. In addition to analyzing historical and current climate data, the assessment also incorporated outputs from climate models to predict future risks. These models allowed for the consideration of various climate scenarios, providing a more comprehensive understanding of how different levels of climate change may impact the district.

### **8.4.2 Adaptive Capacity and Residual Climate Change Risks**

Asuogyaman District, like many areas in Ghana, is vulnerable to climate extremes, including increased rainfall variability, floods, and droughts. Climate change projections for the district indicate rising average temperatures. Under high-emission scenarios (RCP 8.5), temperature increases are expected to range between 3 and 4.5°C, while under a moderate scenario (RCP 4.5), a mid-point increase of about 2.0°C is

expected. In addition to rising temperatures, more frequent heatwave events and changes in evaporation rates could significantly affect water bodies like the Volta Lake.

However, there is some uncertainty in the climate models regarding future changes to rainfall patterns. Some models project increases in seasonal and annual precipitation levels, while others predict decreases. This uncertainty complicates planning but underscores the importance of preparing for a wide range of possible outcomes. Based on the assessment of current and future climate risks, as well as the district's sensitivity, exposure, and vulnerability, several critical climate-related risks have been identified for Asuogyaman. These risks include extreme flooding, water scarcity, and disruptions to agriculture and fisheries. Under current and projected future conditions, these risks are rated from high to extreme. However, with the implementation of appropriate risk mitigation measures, such as improving water management and strengthening agricultural resilience, the level of risk can be reduced.

The residual climate change risk assessment results, presented in Table 13, rank current, future, and residual risks from low to extreme. These results indicate that while climate adaptation measures can reduce certain elements of risk—such as sensitivity to flooding—they also enhance the district's adaptive capacity. Reducing overall risk requires modifying existing policies and programs to explicitly address climate variability and future climate change scenarios.

**Table 5 | Assessment of current climate change risks**

| System                 | Hazard Description                                                                                                                                                                                                                                                                                                           | H:<br>Hazard | E:<br>Exposure | H*E:<br>Hazard x<br>Exposure | AC:<br>Adaptive<br>Capacity | S: Sensitivity | V:<br>Vulnerability<br>= AC*S | Comment - Impacts<br>(with Gender<br>Consideration)                                                                 | CCR: Climate<br>Change Risk |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|----------------|------------------------------|-----------------------------|----------------|-------------------------------|---------------------------------------------------------------------------------------------------------------------|-----------------------------|
| <b>Agriculture</b>     | Rising temperatures, unpredictable rainfall, affecting crop yields and livestock health.                                                                                                                                                                                                                                     | High         | High           | High                         | Low                         | High           | High                          | Decreased crop yields, loss of livestock, food insecurity, women and men in agriculture face different impacts.     | High                        |
|                        | Rising temperatures are affecting fish habitats in the Volta Lake, leading to reduced fish stocks and economic losses for fishermen who rely on fishing as their primary livelihood.                                                                                                                                         | High         | High           | High                         | Low                         | High           | High                          | Decline in fish stocks, loss of income, increased poverty, both men and women in fishing impacted.                  | High                        |
| <b>Biodiversity</b>    | Climate change, coupled with human activities such as overexploitation of natural resources, is leading to habitat degradation and species displacement in the district. Wetland areas and other critical ecosystems are under increasing pressure, reducing biodiversity and threatening the balance of natural ecosystems. | High         | High           | High                         | Low                         | High           | High                          | Loss of biodiversity, impacts on ecosystem services, gender roles in conservation and resource management affected. | High                        |
| <b>Water Resources</b> | The district is facing significant challenges with water resources due to prolonged droughts, flooding, and water pollution. These factors are reducing the availability and quality of water for both domestic use and agricultural activities.                                                                             | High         | High           | High                         | Low                         | High           | High                          | Water scarcity, increased disease burden, women face greater challenges in water collection and use.                | High                        |

|                                |                                                                                                                                                                                                                               |      |      |      |            |      |      |                                                                                                                    |      |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------------|------|------|--------------------------------------------------------------------------------------------------------------------|------|
| <b>Sanitation and Health</b>   | Rising temperatures and flooding increasing the spread of vector- and water-borne diseases, especially in vulnerable communities.                                                                                             | High | High | High | Medium-Low | High | High | Increased healthcare costs, reduced resilience, women and children face higher health risks.                       | High |
| <b>Critical Infrastructure</b> | Flooding and extreme weather in Asuogyaman are damaging homes, schools, markets, and tourism infrastructure, particularly in areas near the Volta Lake. This destruction hampers economic activities and disrupts daily life. | High | High | High | Low        | High | High | Damage to critical infrastructure, displacement, economic losses, women's livelihoods disproportionately affected. | High |
| <b>Gender</b>                  | Increased vulnerability of women and marginalized groups due to unequal access to resources, financial support, and decision-making.                                                                                          | High | High | High | Low        | High | High | Increased gender disparities, women face barriers in adaptation and recovery from climate impacts.                 | High |

**Table 6 | Assessment of future climate change risks**

| Asset / System      | Future Hazard Description                                                                                                                                                                                                                                                                                                                 | H: Hazard | E: Exposure | H*E: Hazard x Exposure | AC: Adaptive Capacity | S: Sensitivity | V: Vulnerability = AC*S | Comment - Impacts (with Gender Consideration)                                                                                        | CCR: Climate Change Risk |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|------------------------|-----------------------|----------------|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| <b>Agriculture</b>  | <p>Increasing temperatures, more frequent and unpredictable droughts, and fluctuations in water levels are significantly impacting crop yields and livestock health in Asuogyaman.</p> <p>These climate shifts are making agricultural activities harder, decreasing food production and weakening the district's farming resilience.</p> | Very High | High        | Very High              | Low                   | Very High      | Extreme                 | Increased food insecurity, greater reliance on climate-resilient crops, women in agriculture face compounded challenges.             | Extreme                  |
| <b>Biodiversity</b> | <p>Rapid habitat loss and species extinction are being driven by intensified climate change impacts, such as more frequent extreme weather events and fluctuating water levels in Asuogyaman.</p> <p>These changes are severely affecting the region's ecosystems.</p>                                                                    | Very High | High        | Very High              | Low                   | Very High      | Extreme                 | Further degradation of ecosystems, loss of biodiversity, gender roles in conservation and resource management increasingly impacted. | Extreme                  |

|                                |                                                                                                                                                                                                                                                                    |           |      |           |     |           |         |                                                                                                                                |         |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------|-----------|-----|-----------|---------|--------------------------------------------------------------------------------------------------------------------------------|---------|
| <b>Water Resources</b>         | More frequent and intense droughts, along with increased water pollution and intrusion of unwanted materials, are further diminishing water availability and quality in Asuogyaman. These factors are putting additional strain on the district's water resources. | Very High | High | Very High | Low | Very High | Extreme | Worsening water scarcity, higher risk of water-borne diseases, women face even greater challenges in water collection and use. | Extreme |
| <b>Sanitation and Health</b>   | Increased temperatures and more intense flooding events leading to a higher incidence of vector- and water-borne diseases, exacerbating health challenges in vulnerable communities.                                                                               | Very High | High | Very High | Low | Very High | Extreme | Significant increase in healthcare needs, women and children remain disproportionately affected by health risks.               | Extreme |
| <b>Critical Infrastructure</b> | Rising temperatures and more severe flooding are increasing the spread of vector- and water-borne diseases, worsening health issues in vulnerable communities in Asuogyaman. These conditions are making it harder to manage public health risks.                  | Very High | High | Very High | Low | Very High | Extreme | Extensive damage to critical infrastructure, higher displacement rates, women's livelihoods increasingly threatened.           | Extreme |

|               |                                                                                                                                                                                                                                                                                         |           |      |           |     |           |         |                                                                                                                                    |         |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------|-----------|-----|-----------|---------|------------------------------------------------------------------------------------------------------------------------------------|---------|
| <b>Gender</b> | Worsening climate impacts are deepening gender disparities, with women and marginalized groups in Asuogyaman facing greater challenges in adapting to and recovering from these effects. Limited access to resources and decision-making makes adaptation even harder for these groups. | Very High | High | Very High | Low | Very High | Extreme | Intensified gender inequalities, women continue to face significant challenges in adapting to and recovering from climate impacts. | Extreme |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------|-----------|-----|-----------|---------|------------------------------------------------------------------------------------------------------------------------------------|---------|

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

| SECTORS     | MEASURE TYPE                        | ADAPTATION MEASURES                                                                                                                                                                                                                                                       | RESIDUAL RISK ASSESSMENT |             |          |               |               |
|-------------|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|-------------|----------|---------------|---------------|
|             |                                     |                                                                                                                                                                                                                                                                           | Residual Adaptive        | Sensitivity | Exposure | Vulnerability | Residual Risk |
| Agriculture | Technological/ Engineering Measures | Strengthen and elevate embankments along rivers and lake shores; construct flood barriers and proper drainage systems where necessary                                                                                                                                     | High                     | Medium      | High     | Medium        | Medium        |
|             |                                     | Build elevated platforms for critical infrastructure like storage facilities and even homes to prevent damage during floods                                                                                                                                               | High                     | Medium      | High     | Medium        | Medium        |
|             |                                     | Encourage the adoption of more flexible cropping calendars that allow farmers to adjust their planting and harvesting times according to weather predictions and current climate conditions.                                                                              | High                     | Medium      | High     | Medium        | High          |
|             | Nature-Based Solutions (NBS)        | Mangrove Restoration and Nature-Based Solutions<br><br>Restoration of Mangroves and Wetlands and Nature Based solutions: Restore and maintain mangroves, wetlands, and riparian buffers that naturally absorb floodwaters and reduce the speed and impact of floodwaters. | High                     | Medium      | High     | Low           | Medium        |
|             |                                     | Diversify crop systems through intercropping and agroforestry practices                                                                                                                                                                                                   | Very High                | Medium      | High     | Low           | High          |

|                     |                                                 |                                                                                                                                                                                                                                                                        |           |        |      |        |        |
|---------------------|-------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------|------|--------|--------|
|                     |                                                 | Implement soil conservation techniques such as mulching, use of cover crops, and reduced tillage to improve water retention and soil fertility                                                                                                                         | Very High | Low    | High | Medium | Medium |
|                     |                                                 | Plant trees and other vegetation along the shores of rivers and the lake to create natural buffer zones                                                                                                                                                                | High      | Medium | High | Medium | Medium |
|                     |                                                 | Climate-Resilient Agricultural Practices: Promote the use of drought -resistant crop varieties that can survive in lower water conditions, reducing the vulnerability of agricultural production to drought                                                            | High      | Medium | High | Low    | Medium |
|                     | Policy/<br>Institutional/<br>Social<br>Measures | Implement strict zoning laws that restrict construction in flood-prone areas and promote the development of higher-ground settlements.                                                                                                                                 | High      | Medium | High | Low    | High   |
|                     |                                                 | Develop and support alternative livelihood programs such as aquaculture, small-scale agriculture, or eco-tourism.                                                                                                                                                      | Very High | Medium | High | Medium | Medium |
|                     |                                                 | Conduct regular training and workshops for local fishers on adaptive fishing methods, sustainable fishing practices, and water management                                                                                                                              | High      | Low    | High | Medium | High   |
|                     |                                                 | Promote diversification of livelihoods including the development of aquaculture as an alternative or complement to wild fisheries                                                                                                                                      | Very High | Low    | High | Medium | Medium |
|                     |                                                 | Climate-Resilient Agricultural Practices: Promote and support the adoption of flood-resistant crop varieties and sustainable agricultural techniques such as raised planting beds                                                                                      | High      | Medium | High | Medium | High   |
| <b>Biodiversity</b> | Technological/<br>Engineering<br>Measures       | Early Warning Systems: Develop early warning systems for drought and other climate-related events to anticipate and mitigate their impacts on biodiversity. This can include automated weather stations, drought forecasting models, and community-based alert systems | Very High | Low    | High | Low    | Medium |

|  |                                        |                                                                                                                                                                                                                                                                                |           |     |      |     |        |
|--|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----|------|-----|--------|
|  |                                        | Remote Sensing and GIS: Implement remote sensing technologies and Geographic Information Systems (GIS) to monitor changes in habitat quality, water availability, and biodiversity in real time. This data can inform timely interventions and adaptive management strategies. | High      | Low | High | Low | Medium |
|  | Nature-Based Solutions (NBS)           | Engage in large-scale planting and replanting of mangrove trees and wetland vegetation to enhance fish stock. Use native species that are well adapted to the local environment to ensure higher survival rates and ecological compatibility                                   | High      | Low | High | Low | Medium |
|  | Policy/ Institutional/ Social Measures | Empower local communities to manage and protect their natural resources through participatory approaches.                                                                                                                                                                      | High      | Low | High | Low | Medium |
|  |                                        | Establish community conservation areas where locals have the authority and responsibility to enforce conservation rules and practices.                                                                                                                                         | Very High | Low | High | Low | Medium |
|  |                                        | Enforce regulations that prevent over-extraction of water from rivers and lakes, ensuring sufficient water remains to support wildlife                                                                                                                                         | High      | Low | High | Low | Medium |
|  |                                        | Establish local conservation groups that can take active roles in monitoring wildlife and reporting any illegal activities, such as poaching or habitat destruction.                                                                                                           | High      | Low | High | Low | Medium |
|  |                                        | Develop and implement a comprehensive Integrated Water Resource Management plan that includes sustainable water use practices, conservation of water resources, and protection of aquatic habitats.                                                                            | High      | Low | High | Low | Medium |
|  |                                        | Encourage local communities to participate in habitat restoration projects, such as tree planting and wetland restoration.                                                                                                                                                     | High      | Low | High | Low | Medium |

|                                |                                        |                                                                                                                                                                                                                                                                                                       |        |        |      |        |        |
|--------------------------------|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--------|------|--------|--------|
| Water resources                | Technological/ Engineering Measures    | Promote rainwater harvesting in communities to increase water storage capacity.                                                                                                                                                                                                                       | High   | Medium | High | Medium | Medium |
|                                | Nature-Based Solutions (NBS)           | Explore alternative water sources such as groundwater, where feasible, to reduce dependency on surface water.                                                                                                                                                                                         | High   | Medium | High | Low    | Medium |
|                                | Policy/ Institutional/ Social Measures | Develop a comprehensive water management framework that involves all stakeholders, including local communities, industries, and agricultural sectors, in managing water resources holistically                                                                                                        | High   | Low    | High | Low    | Medium |
| <b>Health &amp; Sanitation</b> | Technological/ Engineering Measures    | Promote and install water-efficient sanitation solutions such as dry toilets, low-flow toilets, and waterless urinals in both residential and public facilities                                                                                                                                       | High   | Low    | High | Low    | Medium |
|                                |                                        | Improve and maintain access routes to healthcare facilities to ensure they remain accessible during emergencies                                                                                                                                                                                       | High   | Low    | High | Low    | Medium |
|                                |                                        | Improve and enlarge drainage systems to better handle heavy rainfall and prevent flooding. Make sewage systems stronger to stop waste from flowing into water sources during floods, keeping water clean and safe for people. This will help prevent waterborne diseases and keep communities healthy | High   | Low    | High | Medium | Medium |
|                                | Nature-Based Solutions (NBS)           | Integrate green spaces, urban forests, and reflective materials in city planning to reduce urban heat island effects                                                                                                                                                                                  | Medium | Medium | High | High   | Medium |
|                                | Policy/ Institutional/ Social Measures | Conduct continuous public health education campaigns focusing on hygiene practices, especially during climate-induced emergencies like floods and droughts                                                                                                                                            | High   | Low    | High | Low    | Medium |

|                                         |                                        |                                                                                                                                                                                                                                             |        |        |      |        |        |
|-----------------------------------------|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--------|------|--------|--------|
|                                         |                                        | Establish mobile health units to reach remote areas quickly during outbreaks                                                                                                                                                                | High   | Low    | High | Low    | Medium |
| <b>Disaster Risk and Infrastructure</b> | Technological/ Engineering Measures    | Implement an advanced early warning system that can alert communities to flooding or severe weather conditions. Enhance local disaster response capacities                                                                                  | High   | Low    | High | Low    | Medium |
|                                         |                                        | Construction of Resilient Market Structures and Schools: Market structures and school buildings must be constructed or rehabilitated using materials and designs capable of withstanding high winds, severe storms, and flooding.           | High   | Low    | High | Low    | Medium |
|                                         | Nature-Based Solutions (NBS)           | Encourage tree planting to act as windbreaks to reduce the wind speed and mitigate its impact                                                                                                                                               | High   | Low    | High | Low    | Medium |
|                                         | Policy/ Institutional/ Social Measures | Educate the community on emergency preparedness for flooding, including safe shelters and necessary precautions during severe weather.                                                                                                      | High   | Low    | High | Low    | Low    |
|                                         |                                        | Establish regular maintenance schedules for all key infrastructure including the regular inspection and maintenance and of high-tension electric cables and water supply systems to identify and address weaknesses before rainstorms occur | High   | Medium | High | Medium | Low    |
| <b>Gender</b>                           | Technological/ Engineering Measures    | Improve access to healthcare with mobile clinics and community health workers who can reach remote areas, ensuring women and men have equal access to health services, including those related to climate-induced health risks              | Medium | Low    | High | Low    | Medium |
|                                         |                                        | Implement systems at community and household levels to collect and store rainwater. This can relieve the burden on women who are primarily responsible for water collection, especially during dry spells                                   | High   | Low    | High | Low    | Medium |

|  |                                        |                                                                                                                                                                                                                                                                               |      |     |      |        |        |
|--|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----|------|--------|--------|
|  | Nature-Based Solutions (NBS)           | Incorporate native tree planting to augment the shaded rest area and provide natural shade and cooler air. This integrated approach will reduce heat stress among                                                                                                             | High | Low | High | Low    | Medium |
|  |                                        | Encourage urban greening such as planting more trees                                                                                                                                                                                                                          | High | Low | High | Medium | Low    |
|  | Policy/ Institutional/ Social Measures | Integrate climate change education into the school curriculum to teach children about the causes, effects, and adaptation strategies related to climate change. This education should empower them with knowledge and practical skills to adapt to their changing environment | High | Low | High | Low    | Medium |
|  |                                        | Implement school-based nutrition programs that provide meals fortified with essential nutrients to combat malnutrition, exacerbated by crop failures due to erratic weather patterns                                                                                          | High | Low | High | Medium | Medium |
|  |                                        | Increase the capacity of health services to handle outbreaks by improving disease surveillance, stocking essential medicines, and training healthcare workers in handling climate-related health issues                                                                       | High | Low | High | Low    | Medium |

**Table 8 | Climate change risk assessment results matrix and short narrative explaining the risk**

| SECTORS                               | RISK DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Current Risk | Future Risk | Residual Risk |
|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------|---------------|
| <b>Agriculture &amp; Biodiversity</b> | <ul style="list-style-type: none"> <li>Due to its proximity to the Volta Lake and various rivers, parts of Asuogyaman District are susceptible to flooding, particularly during heavy rainfall in areas like Kudikope, Meyekpo, Aboaso, Abuma, Dodi Isalnd, Frankadua &amp; Ankyeasa.</li> <li>Flooding has destroyed crops, eroded soil, and wash away seeds and nutrients necessary for agriculture.</li> <li>It has posed a threat to livestock through the spread of waterborne diseases and loss of grazing land.</li> <li>Drought conditions has severely impact towns like : Small London, Ampanawu, Apeguso especially given its agricultural reliance.</li> <li>It has lead to reduced water availability for irrigation, affecting crop yields and increasing the vulnerability of crops to diseases and pests. This has led to Fluctuations in agricultural productivity leading to increased food prices.</li> <li>For biodiversity, droughts has reduced the habitat quality and availability of water resources for wildlife, leading to decreased biodiversity and disrupting ecological balances.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | High         | Extreme     | Medium        |
|                                       | <ul style="list-style-type: none"> <li>Hotter temperatures lead to more bushfires that contribute to poor air quality and increased exposure to pollutants, which exacerbate respiratory and cardiovascular illnesses</li> <li>Changes in rainfall patterns, including unpredictable seasonal shifts and intensity of rainfall, has disrupted planting and harvesting cycles of main staple crops such as cassava, maize, yam, and plantain in the district .</li> <li>Crops may be planted too early or too late, leading to poor yields. Additionally, intense rainfall has lead to soil erosion, nutrient leaching, and damage to crops, which further reduces agricultural productivity.</li> <li>For aquatic systems like those in the Volta Lake, increased runoff has lead to eutrophication, adversely affecting water quality and aquatic life in areas like Mpakadam Quarter, Dodi Asantekrom</li> <li>Higher temperatures increase the population and activity levels of pests and diseases, which is detrimental to both agriculture and natural ecosystems.</li> <li>For wildlife, increased temperatures has lead to changes in migration patterns of birds like the vultures and herons, breeding cycles, and habitat suitability, thus affecting the overall biodiversity of the towns closer to the lake .</li> <li>The frequency and intensity of extreme weather events such as storms and heatwaves have caused the immediate and severe damage to agricultural infrastructure (such as irrigation systems and storage facilities), leading to crop failures, and disturb ecological systems.</li> </ul> |              |             |               |

| SECTORS | RISK DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Current Risk | Future Risk | Residual Risk |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------|---------------|
| WASH    | <ul style="list-style-type: none"> <li>Extended periods of drought, which are becoming more frequent and severe. It has reduce water availability. This scarcity affects the ability to meet domestic, agricultural, and industrial water demands.</li> <li>Given its location near Volta Lake and the numerous rivers and streams in the area, the district frequently experiences seasonal flooding, particularly during periods of heavy rainfall</li> <li>Floodwaters often carry pollutants, waste, and pathogens, contaminating water bodies that are sources of drinking water. This contamination lead to waterborne diseases, posing serious health risks.</li> <li>Higher temperatures promote the growth of harmful algae in water bodies, which toxify water and hinder its usability for drinking and sanitation.</li> <li>Prolonged dry periods lead to reduced water levels in the Volta Lake and other water bodies, impacting water availability for drinking, agriculture, and other uses. This scarcity exacerbate hygiene issues, as less water is available for cleaning and sanitation.</li> <li>Heavy rains lead to increased erosion, resulting in more sediments in water bodies, which complicates water treatment and reduces the quality of water.</li> <li>Fluctuating weather patterns also influence the breeding patterns of disease vectors such as mosquitoes (malaria), increasing the risk of vector-borne diseases.</li> <li>Apart from spreading infectious diseases, flooding also displace communities, strain health services, and create conditions conducive to outbreaks of vector-borne diseases like malaria.</li> <li>Changes in rainfall have led to water scarcity, affecting clean water supply and sanitation, which are crucial for maintaining health standards in the District</li> <li>Increasing temperatures worsen heat-related illnesses and influence the spread of diseases sensitive to heat, leading to symptoms such as headaches, dizziness, weakness, cramping, and nausea in warmer conditions.</li> <li>Heatwaves contribute to heat exhaustion and heatstroke, particularly among vulnerable populations such as the elderly, children, and those with pre-existing health conditions</li> </ul> | High         | Extreme     | Medium        |

| SECTORS | RISK DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Current Risk | Future Risk | Residual Risk |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------|---------------|
|         | <ul style="list-style-type: none"> <li>Expected changes in rainfall patterns are likely to increase river flooding and erosion along riverbanks. While there is uncertainty about how often and how severe the driest events each year will become, suggesting limited changes in drought frequency and severity, the shifting rainfall patterns, together with higher average yearly temperatures, could raise the chances of droughts occurring</li> <li>Extreme weather events such as severe storms or prolonged flooding cause displacement, forcing people to relocate temporarily or permanently. Such displacement often leads to overcrowded living conditions, straining existing health facilities and increasing the transmission of communicable diseases. The recent spillage of the dam as a result of excessive rainfall from lead to relocation of communities around the volta lake.</li> <li>Floods or storms damage infrastructure, disrupt power supplies, and impede access to healthcare services, thereby reducing the quality of care and accessibility during critical times.</li> <li>Unpredictable rainfall patterns, droughts, and flooding lead to crop failures, reducing food availability and leading to malnutrition and related health issues. This is particularly critical as the district relies heavily on local agriculture for food security.</li> <li>Reduced rainfall and increased evaporation lead to lower water levels in the Volta Lake, affecting water supply for domestic use, agriculture, and hydropower generation</li> </ul> |              |             |               |

| SECTORS                            | RISK DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Current Risk | Future Risk | Residual Risk |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------|---------------|
| <b>Disaster and Infrastructure</b> | <p>Critical infrastructure like roads, bridges, and School buildings, markets, Port, Hotels in the district are vulnerable to extreme weather events such as floods, impacting both emergency response efforts and community resilience.</p> <p>The district experiences periods of intense rainfall, especially during the rainy seasons. The excessive rainfall lead to the overflowing of the Volta Lake and rivers, causing floods that damage homes, farmland, and roads, shools etc</p> <p>The Volta Lake's levels fluctuates dramatically, especially in response to heavy rains and the operational management of the Akosombo Dam. High water levels lead to flooding of nearby communities and infrastructure</p> <p>The Floods wash away roads, bridges, and other critical infrastructure, disrupting transportation and access to services in the district.</p> <p>Flooding often displaces communities, forcing people to leave their homes and leading to the need for temporary shelters and aid.</p> <p>The district experience severe storms, particularly associated with the transitional periods between rainy and dry seasons</p> <p>High winds and heavy rainfall during storms damage buildings, power lines, and communication infrastructure, leading to service disruptions.</p> <p>Strong winds lead to accidents on Volta Lake primarily through their impact on water conditions and boat stability.</p> <p>Strong winds and lightning pose direct safety risks to the population and lead to accidents and casualties.</p> <p>Increase in extreme events such as storms and heavy precipitation and strong winds, lead to floods and damage of properties</p> | High         | Extreme     | Medium        |

| SECTORS                 | RISK DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Current Risk | Future Risk | Residual Risk |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------|---------------|
| Gender (cross cutting ) | <p>The women, particularly those in rural areas in the district, bear a heavier burden during extreme weather events such as floods or droughts. In many households, women are primarily responsible for water collection, food provision, and caregiving. During floods or droughts, these tasks become more arduous and time-consuming, increasing their workload and reducing time for other economic activities or education.</p> <p>In the district Men are engaged in agriculture and fishing, they see their primary sources of income severely disrupted by extreme weather. This lead to increased stress and potential migration to urban areas in search of employment, altering family structures and increasing pressures on women.</p> <p>Higher temperatures exacerbate health problems, particularly for pregnant women and the elderly. Women's responsibilities for caring for these vulnerable populations increase, adding to their burden</p> <p>Heat increase affect men working outdoors, such as in agriculture and fishing, directly impacting their health and productivity. Long exposure to high temperatures lead to heat stress and other heat-related illnesses.</p> <p>Resource degradation lead to reduced fish stocks and less fertile farming lands, directly impacting the livelihoods that many men in the district depend on. This lead to economic instability and increased competition for resources, potentially leading to conflicts.</p> <p>Biodiversity loss affects herbal medicines and local plants that women often use for health care and nutrition. Losing these resources impact family health and increase dependency on external markets.</p> <p>Extreme weather events lead to outbreaks of waterborne diseases, which are especially dangerous for children who are more susceptible to dehydration and malnutrition.</p> <p>Flooding and droughts damage school infrastructure and lead to school closures, interrupting children's education. Additionally, in times of crisis, children might be needed at home to help with increased domestic burdens, further limiting their educational opportunities.</p> <p>Inconsistent rainfall lead to crop failures, reducing food availability and leading to malnutrition among children, which have long-term effects on their physical and cognitive development.</p> | High         | Extreme     | Medium        |



# 9



## Conclusion and Recommendations

### 9.1 Overview of Future Climate Change Scenarios for Asuogyaman

The Asuogyaman District is facing significant risks from climate change, particularly due to its reliance on climate-sensitive sectors such as agriculture, fisheries, and tourism, as well as its proximity to the Volta Lake. Observed climate trends indicate that average annual temperatures in the district have risen by approximately 1°C over the past few decades, with rainfall patterns becoming increasingly erratic. Future projections suggest continued warming, with temperature increases of 1.5°C to 3.5°C by the year 2100 under various emission scenarios (RCP 2.6 to RCP 8.5). This warming, coupled with changing rainfall patterns, is expected to exacerbate the district's vulnerability to flooding, droughts, and heat stress.

### 9.2 Priority Climate-Related Hazards and Risks

#### Flooding and Erosion

Asuogyaman's location near the Volta Lake makes it particularly vulnerable to inland flooding, especially during periods of intense rainfall or when the lake's water levels rise due to spillage from upstream dams such as the Akosombo Dam. Flood events have increased in frequency, causing damage to homes, agricultural land, and infrastructure in low-lying communities such as Kudikope, Meyekpor, and Aboaso. Erosion along the lakeshore is also a growing concern, as it threatens agricultural land and displaces communities. The rising water levels, driven by climate change, are expected to worsen these challenges, leading to more frequent and severe flood events.

#### Lake Flooding:

The Volta Lake, a critical water resource for the district, frequently floods its banks during periods of intense rainfall. Water spillage from the Akosombo Dam, such as that which occurred in recent years, heightens the risk of lake flooding, threatening agricultural land, infrastructure, and the livelihoods of those living near the lakeshore. Communities such as Mpakadan and Aboaso are particularly vulnerable to these events. Human-induced changes to water management and land use around the lake also contribute to the increased flooding risk.

#### Extreme Heat:

Rising annual temperatures in Asuogyaman, observed from 1979 to 2023, are leading to more frequent and intense heatwaves. These extreme heat events pose significant risks to agriculture and public health. The increase in temperature is expected to negatively impact crop yields, increase water demand for irrigation, and pose heat stress risks to both humans and livestock. Projections suggest that Asuogyaman could experience temperature increases of up to 3.5°C by the end of the century under high-emission scenarios, further intensifying these risks.

### **Water Scarcity and Pollution:**

Increasing temperatures and erratic rainfall patterns are contributing to water scarcity in Asuogyaman. Higher evaporation rates from the Volta Lake and irregular rainfall have led to reduced water availability for agriculture, domestic use, and industry. Water pollution from runoff and sedimentation caused by flooding further degrades water quality, exacerbating the water scarcity issue. This presents a significant challenge for communities dependent on consistent water supplies for their livelihoods.

### **Wildfire Risk:**

While wildfires are not yet a major concern in the district, prolonged dry spells and increased temperatures could raise the risk of wildfires in rural areas. These fires could further degrade farmlands and natural vegetation, particularly in more arid regions of the district. Forested areas and farmland are increasingly susceptible to wildfires, which could devastate crops and vegetation. Human activities, such as deforestation and the burning of vegetation for farming, further elevate this risk, particularly during long dry periods when vegetation becomes dry and highly flammable.

## **9.3 Climate Change Risk Assessment Results**

The risk assessment for Asuogyaman highlights its significant exposure and vulnerability to climate-related hazards, particularly flooding and extreme heat. Asuogyaman's economy, which relies heavily on agriculture, hydropower generation and local businesses, is increasingly at risk due to changing climatic conditions. If adaptation measures are not taken, climate change could lead to substantial economic losses, displace communities, and degrade ecosystems critical to the district's environmental and socio-economic stability.

## **9.4 Potential Adaptation Options and Recommendations**

To address the prevailing and future impacts of climate change, the following measures have been identified based on the findings from the study and several stakeholder engagement.

### **Erosion Control and Water Resource Management**

**Erosion Control Measures:** Building on existing defense efforts, erosion control measures such as the restoration of riparian vegetation along the Volta Lake and enhancing natural barriers like forests should be prioritized. These actions can help reduce the risk of lake flooding and protect vulnerable communities and infrastructure from rising water levels.

**Water Resource Management:** Better management of water resources, including improved drainage systems and floodgates to regulate water levels in the Volta Lake, is essential to reduce the risk of flooding. Investments in rainwater harvesting systems, small-scale water reservoirs, and improved irrigation methods will be crucial in managing water scarcity, especially during periods of drought.

### **Climate-Resilient Agriculture**

**Promotion of Climate-Resilient Agriculture:** Encouraging climate-resilient agricultural practices, such as adopting drought-resistant crop varieties and efficient irrigation techniques, is key to sustaining agricultural productivity in Asuogyaman. Farmers should also be supported in diversifying their income through ventures like eco-tourism and aquaculture to reduce dependence on climate-sensitive sectors.

### **Infrastructure Development**

**Strengthening Infrastructure:** Upgrading and retrofitting key infrastructure, such as roads, bridges, and public buildings, to withstand extreme weather events like floods and landslides is essential. Future urban

planning should avoid high-risk areas near the Volta Lake that are prone to flooding and erosion, ensuring the long-term safety of communities.

### **Public Health and Early Warning Systems**

**Healthcare and Early Warning Systems:** Improving healthcare services and establishing robust early warning systems for flooding and heatwaves will help mitigate health risks from climate change. Special consideration should be given to vulnerable populations, such as the elderly and those with limited access to mobility, ensuring they have equitable access to emergency services and health care.

### **Restoration of Ecosystems**

**Restoring Ecosystems:** Restoring riparian forests and other local ecosystems will provide natural defenses against flooding and erosion while enhancing biodiversity. These ecosystems play an important role in supporting fisheries and agriculture, creating natural buffers that strengthen local livelihoods against climate impacts.

### **Community Engagement and Capacity Building**

**Empowering Communities:** Raising awareness of climate risks and fostering community-driven adaptation strategies will empower local populations to take proactive action. Workshops and training programs should be provided to build the capacity of local stakeholders, including women and marginalized groups, to actively engage in climate adaptation planning and decision-making

By implementing these recommendations, Asuogyaman District can enhance its resilience to climate change impacts, protect its essential resources, and promote sustainable development for future generations. These actions will ensure that the district's communities, economy, and environment are better prepared to face the challenges posed by a changing climate.

## **PART II**

# **ADAPTATION ACTION PLAN FOR THE ASOUGYAMAN DISTRICT ASSEMBLY**



# 10

## Adaptation action plan for the Asuogyaman District Assembly

### 10.1 Introduction

Evidence of climate change and associated impacts have become pervasive and verifiably evident in Ghana. The Asuogyaman District is not an exception as it faces the brutish impacts of climate change in most communities and across sectors to make planned adaptation an urgent imperative. Ghana's National Adaptation Plan (NAP) process acknowledges this urgency and has initiated various processes aimed at building national and subnational capacity to effectively manage associated challenges. Intentional adaptation planning in local communities has therefore become a necessary intervention action, which Ghana's NAP process is currently providing the organizational structure to enhance the capacity of local governance systems to make the bold efforts required to build human and institutional capacity to increase local community resilience.

The first step to effective adaptation planning is to understand current and future climate risks and vulnerabilities and use this knowledge as a basis to explore adaptation options. Such knowledge also provides deeper illumination of the nature and distribution of vulnerabilities in multiple contexts. The district-specific vulnerability assessment approach is consistent with the guidance set out in Ghana's NAP Framework (Environmental Protection Agency [EPA], 2018). This approach provides opportunities for tailor-made and context-specific adaptation responses premised on sound, up-to-date knowledge.

Phase I of the vulnerability assessment process focused on profiling the socio-economic context and establishing prevailing climate change impacts in the Asuogyaman District. Phase II focused on a qualitative assessment of vulnerabilities in specific places and key climate-sensitive sectors. Phase III provided a quantitative data assessment and described district-specific climate projections to facilitate understanding of current and future climate scenarios. The resulting Climate Change Vulnerability Assessment for the Asuogyaman District Assembly deep insights into the level and extent of climate change-induced vulnerabilities in the district.

The assessment of various data determined that the agricultural sector is the most vulnerable to the impacts of climate change in Asuogyaman, which is primarily an agricultural district with the majority of residents obtaining their livelihood from subsistence farming. However, the heavy reliance on rainfall and the lack of irrigation systems have made the agricultural sector susceptible to climate variability and change. This vulnerability is also a function of other drivers, such as rising temperatures, long dry spells, and very intense precipitation events with attendant flooding events, which very often cause severe damage and disruption to be farming activities and infrastructure such as access roads.

The target audience for the adaptation plan is the Asuogyaman District Assembly and the EPA, who are responsible for executing it. In addition, the plan will provide guidance to stakeholders in the District who will contribute to its implementation. It also provides a framework to guide the preparation of adaptation plans in other metropolitan, municipal, and district assemblies (MMDAs) across the country.

This adaptation plan aims to build on the evidence of the vulnerability assessment to build the capacity of the BMA to manage climate-related threats both now and in the future. Consistent with the guidance of the Least Developed Countries Expert Group (2012) of the United Nations Framework Convention on Climate Change (UNFCCC), the Bekwai Adaptation Plan aims to

- reduce vulnerability to the adverse impacts of climate change by identifying priority actions to build adaptive capacity and climate resilience.
- facilitate the integration of climate change adaptation into policies, programs, and activities of the BMA.

### **Expected Outcomes**

The adaptation plan and accompanying evidence base, as contained in the District VA findings will assist the Asuogyaman District to:

- respond to material climate-related threats in a timely and appropriate manner by facilitating the identification of adaptation actions that are proportional, effective, cost-effective, measurable, and timely:
- develop business and operational plans (near and long term) based on findings from the vulnerability assessment study:
- enhance the capacity of the Asuogyaman District Assembly and its staff to effectively manage the complex threats and opportunities presented by climate change:
- prepare an adaptation plan that provides carefully evaluated adaptation options with clear pathways for implementation:
- facilitate a seamless alignment of the plan with the prioritized actions in the assembly's Mid-Term Development Plans (MTDPs), both now and in the future.

### **Timeframe**

- The time frame for the implementation of Asuogyaman Adaptation Plan is 2024–2030, which is in alignment with Ghana's revised nationally determined contribution (NDC) period (2020–2030). This time frame also coincides with the next iteration of the Municipality's MTDP, 2025–2030. Such timing provides opportunities for intentional mainstreaming of the adaptation strategy into programs, policies, and activities.

### **Guiding Principles**

**Builds on Ghana's NAP Process:** Ghana's NAP Framework provides the overarching roadmap for climate change adaptation planning and implementation. The NAP process has identified stakeholder institutions and agencies, such as the Ministry of Agriculture (MoFA),

**Gender Responsive:** Notions of gender are socially constructed. As a result, in Ghana, much as the normative implications of gender are acknowledged and respected, gender is also conceived broadly to include women, children, youth, and persons with disabilities. These groups are recognized as being uniquely vulnerable to climate change impacts, and these unique particularities were taken into serious consideration in the plan development.

**Incorporates Nature-Based Adaptation Solutions:** Adaptation solutions can often be found in nature, and the use of nature-based solutions is increasingly proving to positively impact the environment and build resilience against climate change.

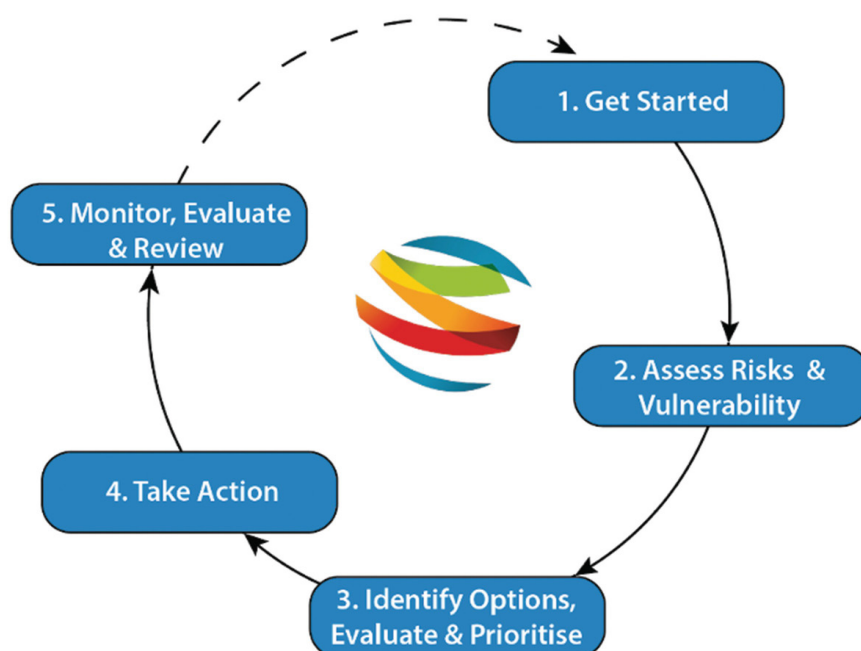
**Informed by Science:** It is very important that adaptation actions are informed by current and future understanding of climate change impacts. This understanding, therefore, comes from a scientific appreciation of climate vulnerabilities and the vulnerability assessment process.

**Uses 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.

**Figure 18 Approach to ADA adaptation planning**



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

#### Methodological Approach

Figure 1 sets out the process used to prepare this adaptation plan. The process ensures that the climate adaptation plan remains relevant as a living plan. It incorporates different stages covering the whole decision-making process, from problem or scope definition to implementation, to monitoring, evaluation, and learning from adaptation action decisions taken. The adaptation plan was developed through a three-stage process that included a desk review, stakeholder consultation, and district validation, as illustrated in Figure 1 and discussed below.

**Figure 19 Adaptation plan development process (Source: generated by author)**



### Adaptation Plan Development Process

- **Phase I** included an extensive review of adaptation priorities and measures in national and sectoral climate change documents (such as Ministry of Environment, Science, Technology and Innovation [MESTI], 2013, 2015), the Asuogyaman District Assembly (ADA, 2022), available academic literature, and recommendations from the district-specific VA. This was to ensure that the plan was premised on science and aligned with national and district priorities as stipulated in the MTDP to make it context specific. The findings from the desk review were used to create a catalogue of sectoral adaptation actions.
- **Phase II** evaluated the initial adaptation option proposals from the consultants using participatory stakeholder multicriteria analysis in specially organized workshops in the district. The consultation process took place in Asuogyaman district with four key stakeholder consultation groups that analyzed adaptation options in the following priority sectors:
  - agriculture and forestry (ecosystems and biodiversity)
  - water, sanitation, and health
  - infrastructure and trade
  - gender and marginalized groups

Each group constituted key players from the ADA's different departments, non-governmental organizations (NGOs), and the private sector, who were experts in their particular sectors. The identified stakeholders included 23 women and 41 men with longstanding experience and expertise in the specific sectors. The information from the vulnerability assessment was used to generate possible adaptation options that were presented at each of the four stakeholder consultation workshops.

The consultation groups were relatively small, ranging from 15 to 20 people and were carefully created to include the right stakeholders with the relevant knowledge and insights. The small groups were created

deliberately to reduce the tendency for dominant and controlling voices of certain individuals to influence the discussions and to create an enabling group environment that allowed all to contribute with confidence.

The objectives of the stakeholder consultations were to

- explain the adaptation planning process
- present suggested adaptation options for review, screening, evaluation, and ranking
- solicit stakeholder views and input on the suggested adaptation options
- discuss implementation implications and approaches
- **Phase III** validated the adaptation plan and was carried out through a stakeholder validation workshop that brought together relevant stakeholders, consisting of 25 women and 43 men, many of whom had been consulted in Phase II to provide inputs, comments, and feedback on the draft plan. This fostered ownership of the process and plan. Stakeholder inputs were incorporated, and the final adaptation plan was produced.

### Identification and Compilation of Sector-Specific Adaptation Actions

The comprehensive climate change adaptation plan for the Asuogyaman District Assembly outlined and identified specific adaptation strategies tailored to the district's unique needs. This process facilitated the evaluation of various potential adaptation approaches and the selection of the most suitable actions. The planning team utilized the methods outlined in the table below to determine these adaptation options.

**Table 9 Methodology to identify adaptation options**

|                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Vulnerability assessment report recommendations</b> | The climate change vulnerability assessment for the ADA made recommendations regarding adaptation measures that could be explored to build resilience, increase adaptive capacity, and reduce vulnerability. These recommendations were well considered in the planning process.                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Literature review</b>                               | An extensive review of optimal solutions and practices was conducted through a desk review of government documents, scientific publications, grey literature, and district reports. This process aimed to identify adaptation actions that address similar impacts and vulnerabilities effectively                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Stakeholder consultation</b>                        | <p>Identified stakeholders in the Asuogyaman District were engaged and consulted through participatory workshops, enabling open and equitable discussions on adaptation options based on climate scenarios. These workshops focused on identifying current and future impacts and vulnerabilities. Sector-specific stakeholders were also consulted and organized into six groups, each addressing a specific sector of concern.</p> <ul style="list-style-type: none"> <li>• Agriculture</li> <li>• Gender (cross-cutting sector)</li> <li>• Biodiversity</li> <li>• Water Resource</li> <li>• Health and Sanitation</li> <li>• Disaster risk reduction and Infrastructure</li> </ul> |

*Source: Author diagram based on the ADA Adaptation Plan.*

A total of 107 adaptation options were identified across six key sectors in the Asuogyaman District (ADA). These options were carefully developed to address the district's specific vulnerabilities and enhance its resilience to

climate change impacts. Agriculture accounted for the largest share of actions (41), highlighting its vital role in the district's economy, livelihoods, and food security. This was followed by the Gender sector, which included 18 targeted actions aimed at addressing the unique vulnerabilities of women and marginalized groups to the impacts of climate change, including those exacerbated by extreme weather events.

**Table 10 Distribution of adaptation actions by sector**

| Sector                           | Number of Adaptation actions | Rank |
|----------------------------------|------------------------------|------|
| Agriculture                      | 41                           | 1    |
| Gender                           | 18                           | 2    |
| Biodiversity                     | 17                           | 3    |
| Disaster Risk and Infrastructure | 13                           | 4    |
| Health and Sanitation            | 12                           | 5    |
| Water Resource                   | 6                            | 6    |

## 10.2 Methodological Approach for Ranking Adaptation Options

In response to the key vulnerabilities and climate risks identified in the Asuogyaman District, a detailed list of potential adaptation options was developed. This was achieved through a thorough review of relevant literature and active engagement with stakeholders. These adaptation measures were subsequently validated and refined during participatory workshops, where stakeholders were grouped based on their expertise and interests to evaluate, prioritize, and rank the proposed options. The evaluation process was guided by well-defined criteria and clear information to ensure informed decision-making. The assessment focused on identifying adaptation measures that were well-suited to the district's specific context, capable of enhancing resilience, and effective in addressing the vulnerabilities highlighted in the district's vulnerability assessment (discussed in Section A of this report). Consideration was also given to the potential contribution of these measures to sustainable development in the district.

The prioritization process aimed to ensure the selection of effective and appropriate adaptation strategies while avoiding maladaptive outcomes. To achieve this, a diverse group of stakeholders was actively involved in the evaluation process, ensuring the selected measures were relevant and devoid of potential negative impacts. Stakeholders were organized into six groups—Agriculture, biodiversity, water Resource, Sanitation and Health, Disaster Risk and Infrastructure, and Gender—to evaluate the adaptation options using a Multicriteria Decision-Making (MCDM) Analysis. This approach was essential, as different adaptation options may perform variably across multiple criteria and could involve trade-offs. A critical and systematic evaluation ensured that the results of the analysis were effectively incorporated into the prioritization of key adaptation measures.

**Plate 2 Consultation with the sector stakeholders using the MCA for ranking**



**Multicriteria Decision-Making (MCDM) Analysis** is a structured methodology used to evaluate and rank multiple options based on various criteria. It involves identifying relevant criteria, assigning weights to reflect their importance, and scoring each option against these criteria. This approach enables balanced and well-informed decisions, particularly in complex scenarios with diverse stakeholders and competing objectives (Dixit & McGray, 2013). Details of the criteria used for evaluating adaptation strategies are outlined in the table.



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

| S/N | Dimension                                                                              | Indicators                                         | Description                                                                                                                                                                                                                                  |
|-----|----------------------------------------------------------------------------------------|----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | <b>Technological</b>                                                                   | Effectiveness                                      | Effectiveness of importance describes how well effective an adaptation option can mitigate climate damage. In essence, an effective option yields considerable benefits in terms of avoided consequences, albeit potentially at a high cost. |
| 2   | <b>Economic</b>                                                                        | Affordability (cost efficiency)                    | This refers to the cost of implementing the adaptation option                                                                                                                                                                                |
| 3   | <b>Institutional</b>                                                                   | Institutional feasibility                          | Institutional feasibility refers to institutional and legal capacity. The preferred adaptation option aligns with laws, regulations, and institutional structures.                                                                           |
|     |                                                                                        | Alignment with district and/or national priorities | The extent to which does this measure supports other development priorities of the district or the country?                                                                                                                                  |
| 4   | <b>Technological</b>                                                                   | Technical feasibility                              | Technical feasibility focuses on evaluating the technological expertise and the availability of necessary human, financial, and administrative resources for a specific option.                                                              |
| 5   | <b>Social</b>                                                                          | Traditional acceptance of adaptation               | Traditional acceptance refers to the degree of acceptability of an adaptation strategy aligning with the context of traditional values.                                                                                                      |
| 6   | <b>Social</b>                                                                          | Social co-benefits                                 | This entails evaluating whether the proposed adaptation aligns with existing social practices and customs and whether it is likely to be embraced by the affected community or population.                                                   |
| 7   | <b>Environmental</b>                                                                   | Flexibility                                        | Flexibility refers to the ability to change behaviour in response to changing conditions.                                                                                                                                                    |
| 8   | <b>Environmental</b>                                                                   | Environmental considerations                       | This evaluates the potential of the intervention to improve GHG emissions, biodiversity, human health, soil quality, water quality, air quality, climate, and landscape.                                                                     |
| 9   | <b>Social</b>                                                                          | Gender responsiveness                              | This evaluates the extent to which the adaptation options address gender-related issues.                                                                                                                                                     |
| 10  | <b>Social</b>                                                                          | Equity                                             | The extent to which the adaptation option will benefit vulnerable groups and communities.                                                                                                                                                    |
| 11  | <b>Technological</b>                                                                   | Replicability or scalability                       | This defines the ability or possibility of the intervention to be replicated elsewhere in the country or scaled up.                                                                                                                          |
| 12  | <b>Technological/<br/>Economic/<br/>Institutional/<br/>Environmental<br/>or social</b> | Barriers to implementation                         | This identifies potential institutional, economic, technological, and social barriers to the implementation of the adaptation option.                                                                                                        |

Source: Adapted from Dixit & McGray (2013)

Assigning appropriate weights to the ranked indicators was a critical step in reflecting their relative importance. An unequal weighting system was adopted, recognizing that not all indicators carry the same level of

significance. This approach was informed by methodologies outlined in the works of Zobeidi et al. (2024), Antwi-Agyei et al. (2013), and the UNFCCC (2011). To establish these weights, a five-point Likert scale (Table 11) was employed. Climate change experts, as well as specialists in agriculture and food systems, assessed the indicators based on their perceived importance, following a methodology similar to Antwi-Agyei et al. (2013). The weighting system was developed by analyzing the frequency with which each indicator was cited, ensuring that the process accurately captured expert perspectives and priorities (Zobeidi et al., 2024; Antwi-Agyei et al., 2013; UNFCCC, 2011).

**Table 12 Ranking of adaptation options based**

|               |                                                                 |
|---------------|-----------------------------------------------------------------|
| <b>1</b>      | Low                                                             |
| <b>2</b>      | Neutral                                                         |
| <b>3</b>      | Medium                                                          |
| <b>4</b>      | High                                                            |
| <b>(....)</b> | Enclose a number in a bracket to show high <b>uncertainty</b> . |



# 11



## Adaptation Options

This section outlines the prioritized adaptation options, providing a detailed overview of each adaptation objective, the justification behind its selection, and the key considerations necessary for successful implementation. These options have been carefully chosen based on their potential to mitigate the risks posed by climate change across affected communities and sectors in the Asuogyaman District.

### 11.1 Agriculture

Agriculture is the primary livelihood for most residents of the Asuogyaman District, with the sector dominated by three main activities: food cropping, cash cropping, and livestock rearing. Food crop production is the primary focus, with key crops including maize, cassava, plantain, yam, and various vegetables. Most farmers operate small-scale farms, often combining crop cultivation with livestock rearing. Common farming practices in the district include bush fallowing and intercropping, with major farming areas such as Tortibo, Domeabra, Mpakadan, Frankadua, Fintey, Gyakiti, Ankyease, and Survey Line. Fishing also plays a significant role in the district's agricultural economy, particularly along the 141 km shoreline of the Volta Lake. Communities such as Dzidzokope, Atimpoku, Abume, Akosombo, Survey Line, Adomi, Dodi Asantekrom, Asikuma, Mpakadan, Senchi Ferry, and Old Akrade rely heavily on fishing as a key livelihood activity, especially near the Kpong headwaters. This dual engagement in farming and fishing highlights the importance of natural resources to the district's economy and sustenance.

From the Climate Change Rapid Risk Assessment for Asuogyaman District agriculture stands out as the most vulnerable sector, requiring urgent attention. Out of the forty-one (41) adaptation actions identified and assessed, eight (8) key actions have been selected and prioritized. These initiatives specifically target small-scale farmers, who largely depend on rain-fed agriculture, and aim to enhance or sustain agricultural productivity amidst changing climate conditions.

In Asougyaman severe weather, particularly flooding from heavy rainfall and fluctuating Volta Lake water levels affect agriculture in the district. These floods have consistently harmed farmland, resulting in crop losses and posing a threat to food security. Encouraging the adoption of climate-resilient agricultural practices, such as using flood-resistant crops and raised planting beds, can mitigate these risks. Flood-tolerant crop varieties can survive periods of inundation, while raised beds enhance drainage and protect plants from waterlogging (Kaur et al., 2020). These technique help stabilize crop yields despite unpredictable weather, protecting farmers' incomes and strengthening the district's food supply.

Also, a significant portion of the population in the Asuogyaman District engage in small-scale crop production, focusing on maize, cassava, vegetables, and yam in key areas like Tortibo, Domeabra, Mpakadan, and Gyakiti. However, prolonged droughts have reduced water levels in the Volta Lake, threatening irrigation, domestic water supplies, agricultural productivity, and food security. Promoting drought-resistant crops offers a viable solution to mitigate these challenges and enhance resilience to water scarcity.

Furthermore Climate-related risk, such as floods, droughts, and soil erosion, significantly impact agricultural productivity and food security in the district. Mono-cropping systems are particularly susceptible to these

issues; the failure of a single crop can lead to considerable financial setbacks for farmers (Ijaz et al., 2019). To address these risks, crop diversification through intercropping and agroforestry presents an effective solution. Intercropping involves planting multiple crops together, while agroforestry integrates trees and shrubs into farming practices. Both methods offer several benefits: they enhance soil fertility, reduce erosion, improve water retention, and create more favorable microclimates for crops.

The Vulnerability Risk Assessment report also indicates that the district is experiencing increasingly unpredictable weather patterns, including changes in the timing and duration of rainy seasons and more frequent extreme weather events. These shifts disrupt traditional farming practices, leading to crop failures and reduced yields. To adapt, farmers can use flexible cropping calendars based on real-time weather forecasts and climate data. This approach helps optimize planting and harvesting times, reduces losses, ensures efficient water use, and ultimately enhances crop yields, reduces production costs, and increases overall productivity.

Implementing soil conservation strategies is crucial for strengthening the resilience of farming systems in Asuogyaman District. Given the district's susceptibility to erosion in its mountainous and hilly areas, as well as the risk of flooding in its low-lying plains, these measures are essential. Soil conservation techniques like mulching, cover cropping, and reduced tillage offer numerous benefits. Mulching aids in moisture retention, weed suppression, and temperature regulation. Cover crops provide protection against erosion, improve soil structure, and contribute valuable organic matter as they decompose. Reduced tillage preserves soil integrity, enhances water absorption, and minimizes disturbances to beneficial soil organisms.

Agriculture is the primary economic activity in the district, employing nearly 60% of the working population (MTD Plan 2018-2021). However, climate change and economic instability are disrupting traditional livelihoods, particularly for those dependent on rain-fed farming and natural resources. To address these challenges, alternative livelihood programs are essential for fostering economic resilience. Sectors like aquaculture, small-scale agriculture, and eco-tourism offer promising alternatives that leverage the district's natural assets and human resources. These sectors can enhance food security, promote environmental sustainability, and drive economic growth, creating local jobs and reducing migration to urban areas.

Additionally, Fishing communities in the Asuogyaman District are increasingly threatened by climate change, overfishing, and changes in aquatic ecosystems. These challenges are jeopardizing fish populations and the livelihoods of local fishers. To address these issues, the district can support fishers by offering regular training sessions and workshops focused on adaptive fishing techniques, sustainable practices, and effective water management. This would equip fishers with the necessary skills and knowledge to navigate these challenges successfully.

Water bodies in the district are facing significant challenges, including erosion, sedimentation, and pollution, worsened by climate change and human activities. These issues threaten water quality, aquatic ecosystems, and livelihoods. A practical solution is the creation of natural buffer zones by planting trees and vegetation along riverbanks and lake shores. These buffers filter out sediments and pollutants, improve water quality, stabilize soil, and reduce erosion (Anbumozhi, Radhakrishnan, & Yamaji, 2005). Additionally, they provide habitats for wildlife, enhance biodiversity, and contribute to carbon capture. This nature-based approach helps protect water resources, improve resilience to climate impacts, and strengthen the landscape.

**Table 13 Ranking of adaptation options for the agriculture sector**

| Adaptation option                                                                                                                                                                                           | Final score from stakeholders | Rank |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|------|
| Encourage the adoption of more flexible cropping calendars that allow farmers to adjust their planting and harvesting times according to weather predictions and current climate conditions.                | 48                            | 1    |
| Climate-Resilient Agricultural Practices: Promote the use of drought -resistant crop varieties that can survive in lower water conditions, reducing the vulnerability of agricultural production to drought | 48                            | 1    |
| Diversify crop systems through intercropping and agroforestry practices.                                                                                                                                    | 47                            | 3    |
| Encourage the adoption of more flexible cropping calendars that allow farmers to adjust their planting and harvesting times according to weather predictions and current climate conditions.                | 47                            | 3    |
| Implement soil conservation techniques such as mulching, use of cover crops, and reduced tillage to improve water retention and soil fertility                                                              | 47                            | 3    |
| Develop and support alternative livelihood programs such as aquaculture, small-scale agriculture, or eco-tourism.                                                                                           | 46                            | 6    |
| Conduct regular training and workshops for local fishers on adaptive fishing methods, sustainable fishing practices, and water management                                                                   | 45                            | 7    |
| Plant trees and other vegetation along the shores of rivers and the lake to create natural buffer zones                                                                                                     | 45                            | 7    |

**Table 14 Summary of the Adaptation Actions for the Agricultural Sector**

| ADAPTATION ACTIONS                                                                                                                                                                           | OBJECTIVES                                                                                                     | INDICATORS OF SUCCESS                                                | TIME FRAME<br>Short, Medium, or Long Term) | RESOURCES<br>(Finance, Human, Technology)     | IMPLEMENTING PARTNERS |                                                                                                     | Estimated costs |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|--------------------------------------------|-----------------------------------------------|-----------------------|-----------------------------------------------------------------------------------------------------|-----------------|
|                                                                                                                                                                                              |                                                                                                                |                                                                      |                                            |                                               | Lead                  | Collaborating                                                                                       |                 |
| Diversify crop systems through intercropping and agroforestry practices.                                                                                                                     | Enhance agricultural resilience by diversifying production systems to mitigate risks from climate variability. | Increased in the diversity of crops and trees on farms.              | Medium-term                                | Human<br>Finance<br>Technology                | MoFA                  | Forestry Commission<br>Farmer Cooperatives<br>Research Institutions (e.g., UG, KNUST)<br>Local NGOs |                 |
|                                                                                                                                                                                              |                                                                                                                | Improvement in soil fertility and water retention.                   |                                            |                                               |                       |                                                                                                     |                 |
|                                                                                                                                                                                              |                                                                                                                | Reduction in crop failure rates due to climate variability.          |                                            |                                               |                       |                                                                                                     |                 |
|                                                                                                                                                                                              |                                                                                                                | Enhanced biodiversity on agricultural lands                          |                                            |                                               |                       |                                                                                                     |                 |
| Encourage the adoption of more flexible cropping calendars that allow farmers to adjust their planting and harvesting times according to weather predictions and current climate conditions. | Improve agricultural productivity by aligning farming activities with changing climatic conditions.            | Higher proportion of farmers adopting flexible cropping calendars.   | Short Term                                 | Human<br>Technical /<br>Technology<br>Finance | MoFA                  | GMet<br>FAO<br>Farmer Cooperatives<br>NGOs<br>CSIR-Crops<br>Research Institute                      |                 |
|                                                                                                                                                                                              |                                                                                                                | Reduction in losses from mismatched planting and harvesting periods. |                                            |                                               |                       |                                                                                                     |                 |
|                                                                                                                                                                                              |                                                                                                                | Increased yields in line with climatic conditions,                   |                                            |                                               |                       |                                                                                                     |                 |
|                                                                                                                                                                                              |                                                                                                                | Improved farmer satisfaction and resilience to weather variability   |                                            |                                               |                       |                                                                                                     |                 |
| Implement soil conservation techniques such as mulching, use of cover crops, and reduced tillage to improve water retention and soil fertility                                               | Improve soil health and water retention to support sustainable agriculture.                                    | Increase in organic matter content in soil                           | Short Term                                 | Human<br>Technology<br>Finance                | MoFA                  | NGOs<br>CSIR-Soil Research<br>Institute<br>Local Farmer<br>Organizations<br>FAO                     |                 |
|                                                                                                                                                                                              |                                                                                                                | Reduction in soil erosion rates                                      |                                            |                                               |                       |                                                                                                     |                 |
|                                                                                                                                                                                              |                                                                                                                | Improvement in crop yields over time.                                |                                            |                                               |                       |                                                                                                     |                 |
|                                                                                                                                                                                              |                                                                                                                | Greater adoption of soil conservation practices by farmers           |                                            |                                               |                       |                                                                                                     |                 |

|                                                                                                                                                                                    |                                                                                         |                                                                                  |             |                          |       |                                                                                                |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|-------------|--------------------------|-------|------------------------------------------------------------------------------------------------|--|
| Introduce and promote a variety of crop species that have different planting and harvesting times and are resilient to various climate conditions.                                 | Increase agricultural resilience through the adoption of climate-adapted crop species.  | Increase in the cultivation of climate-resilient crop varieties.                 | Medium Term | Human Technology Finance | MoFA  | Private Sector (Seed Companies)<br>CGIAR, CSIR-Crops Research Institute<br>Farmer Cooperatives |  |
|                                                                                                                                                                                    |                                                                                         | Reduction in agricultural losses due to pest, drought, or flooding               |             |                          |       |                                                                                                |  |
|                                                                                                                                                                                    |                                                                                         | Improved household food security through staggered harvests.                     |             |                          |       |                                                                                                |  |
|                                                                                                                                                                                    |                                                                                         | Enhanced income diversification of farmers.                                      |             |                          |       |                                                                                                |  |
| Implement strict zoning laws that restrict construction in flood-prone areas and promote the development of higher-ground settlements.                                             | Minimize flood risks and protect lives and property through regulated land use.         | Reduction in the number of new constructions in flood-prone areas.               | Long Term   | Human Technology Finance | ADA   | EPA<br>Urban Planning Agencies<br>NADMO<br>Community Groups<br>NGOs                            |  |
|                                                                                                                                                                                    |                                                                                         | Increase in the development of infrastructure on higher ground.                  |             |                          |       |                                                                                                |  |
|                                                                                                                                                                                    |                                                                                         | Fewer flood-related damages to property and loss of lives.                       |             |                          |       |                                                                                                |  |
|                                                                                                                                                                                    |                                                                                         | Improved compliance with zoning regulations.                                     |             |                          |       |                                                                                                |  |
| Climate-Resilient Agricultural Practices: Promote and support the adoption of flood-resistant crop varieties and sustainable agricultural techniques such as raised planting beds. | Strengthen agricultural resilience against flood impacts                                | Higher adoption rates of flood-resistant crop varieties.                         | Medium term | Human Technology Finance | MoFA  | CGIAR<br>NGOs<br>FAO<br>Farmer-Based Organizations<br>CSIR-Water Research Institute            |  |
|                                                                                                                                                                                    |                                                                                         | Reduction in crop losses during flooding events.                                 |             |                          |       |                                                                                                |  |
|                                                                                                                                                                                    |                                                                                         | Increase in agricultural productivity in flood-prone areas.                      |             |                          |       |                                                                                                |  |
|                                                                                                                                                                                    |                                                                                         | Positive feedback from farmers on the effectiveness of the techniques            |             |                          |       |                                                                                                |  |
| Conduct regular educational campaigns on fire safety, prevention practices, and the health risks associated with poor air quality                                                  | Increase community awareness and preparedness for fire and air quality-related hazards. | Increase in public awareness and knowledge of fire safety and air quality risks. | Short term  | Human Technology Finance | NADMO | ADA<br>WHO<br>NGOs<br>Community-Based Organizations<br>Forestry Commission                     |  |
|                                                                                                                                                                                    |                                                                                         | Reduction in fire incidents and related property losses.                         |             |                          |       |                                                                                                |  |

|                                                                                                                                                                                                             |                                                                                        |                                                                         |             |                          |                     |                                                                                                           |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|-------------------------------------------------------------------------|-------------|--------------------------|---------------------|-----------------------------------------------------------------------------------------------------------|--|
| Plant trees and other vegetation along the shores of rivers and the lake to create natural buffer zones                                                                                                     | Reduce flood and erosion impacts through the restoration of natural buffers.           | Increase in the number of trees and vegetation planted in buffer zones. | Medium-term | Human Technology Finance | Forestry Commission | EPA<br>UNEP<br>Local Communities<br>NGOs<br>Ministry of Lands and Natural Resources                       |  |
|                                                                                                                                                                                                             |                                                                                        | Reduction in soil erosion and sedimentation into water bodies.          |             |                          |                     |                                                                                                           |  |
|                                                                                                                                                                                                             |                                                                                        | Improvement in water quality in rivers and lakes.                       |             |                          |                     |                                                                                                           |  |
| Promote diversification of livelihoods including the development of aquaculture as an alternative or complement to wild fisheries                                                                           | Reduce vulnerability by expanding livelihood options beyond traditional practices.     | Increase in household income from diversified livelihoods.              | Medium Term | Human Technology Finance | MoFA                | FAO<br>Private Sector (Aquaculture Companies)<br>NGOs<br>CSIR-Water Research Institute                    |  |
|                                                                                                                                                                                                             |                                                                                        | Increase in household income from diversified livelihoods               |             |                          |                     |                                                                                                           |  |
|                                                                                                                                                                                                             |                                                                                        | Reduction in pressure on wild fisheries.                                |             |                          |                     |                                                                                                           |  |
|                                                                                                                                                                                                             |                                                                                        | Improved food security in communities reliant on fisheries.             |             |                          |                     |                                                                                                           |  |
| Climate-Resilient Agricultural Practices: Promote the use of drought -resistant crop varieties that can survive in lower water conditions, reducing the vulnerability of agricultural production to drought | Enhance agricultural resilience to drought conditions.                                 | Higher adoption rates of drought-resistant crop varieties.              | Medium-term | Human Technology Finance | MoFA                | CGIAR<br>Private Sector (Seed Companies)<br>FAO<br>CSIR-Crops Research Institute                          |  |
|                                                                                                                                                                                                             |                                                                                        | Increase in agricultural productivity during drought periods.           |             |                          |                     |                                                                                                           |  |
|                                                                                                                                                                                                             |                                                                                        | Improved water-use efficiency in agriculture.                           |             |                          |                     |                                                                                                           |  |
| Develop and support alternative livelihood programs such as aquaculture, small-scale agriculture, or eco-tourism.                                                                                           | Improve community resilience by providing sustainable income-generating opportunities. | Increase in participation in alternative livelihood programs.           | Medium Term | Human Technology Finance | MoFA                | Fisheries Commission<br>Tourism Board<br>NGOs<br>Private Sector<br>Research Institutions (e.g., UNU-INRA) |  |
|                                                                                                                                                                                                             |                                                                                        | Growth in income levels from diversified activities.                    |             |                          |                     |                                                                                                           |  |

|                                                                                                                                                                                                                    |                                                                             |                                                                                |            |                                |                         |                                                                                            |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------------------------|------------|--------------------------------|-------------------------|--------------------------------------------------------------------------------------------|--|
| Conduct regular training and workshops for local fishers on adaptive fishing methods, sustainable fishing practices, and water management                                                                          | Enhance the sustainability of fisheries in the face of climate variability. | Increase in the number of workshops conducted annually.                        | Short term | Human<br>Technology<br>Finance | Fisheries<br>Commission | FAO<br>CSIR-Water<br>Research Institute<br>Local Communities<br>NGOs                       |  |
|                                                                                                                                                                                                                    |                                                                             | Improvement in fishers' knowledge and application of adaptive fishing methods. |            |                                |                         |                                                                                            |  |
|                                                                                                                                                                                                                    |                                                                             | Reduction in unsustainable fishing practices.                                  |            |                                |                         |                                                                                            |  |
|                                                                                                                                                                                                                    |                                                                             | Reduction in unsustainable fishing practices.                                  |            |                                |                         |                                                                                            |  |
| Restoration of Mangroves and Wetlands and Nature Based solutions: Restore and maintain mangroves, wetlands, and riparian buffers that naturally absorb floodwaters and reduce the speed and impact of floodwaters. | Mitigate flood risks through the restoration of natural ecosystems.         | Increase in the area of mangroves and wetlands restored.                       | Long term  | Human<br>Technology<br>Finance | Forestry<br>Commission  | EPA<br>UNEP<br>Local Communities<br>CSIR-Forestry<br>Research Institute<br>(Ghana)<br>NGOs |  |
|                                                                                                                                                                                                                    |                                                                             | Reduction in flood impacts in restored areas.                                  |            |                                |                         |                                                                                            |  |
|                                                                                                                                                                                                                    |                                                                             | Improvement in biodiversity within restored ecosystems.                        |            |                                |                         |                                                                                            |  |
|                                                                                                                                                                                                                    |                                                                             | Greater community involvement in maintaining restored areas.                   | Long term  | Human<br>Technology<br>Finance | ADA                     | Construction<br>Companies<br>UNDP<br>NADMO<br>Community-Based<br>Organizations             |  |
| Build elevated platforms for critical infrastructure like storage facilities and even homes to prevent damage during flood                                                                                         | Protect infrastructure from flood damage by elevating it above flood levels | Increase in the number of elevated platforms constructed.                      |            |                                |                         |                                                                                            |  |
|                                                                                                                                                                                                                    |                                                                             | Reduction in flood-related damage to critical infrastructure.                  |            |                                |                         |                                                                                            |  |
|                                                                                                                                                                                                                    |                                                                             | Positive feedback from beneficiaries on the utility of elevated structures.    |            |                                |                         |                                                                                            |  |

|                                                                                                                                                              |                                                                         |                                                                       |             |                             |                      |                                                                                    |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|-----------------------------------------------------------------------|-------------|-----------------------------|----------------------|------------------------------------------------------------------------------------|--|
| Integrate pest management strategies that focus on maintaining the health of crops through adequate water management and the use of pest-resistant varieties | Improve crop health and productivity by minimizing pest-related losses. | Reduction in crop losses due to pests.                                | Medium Term | Human Technology<br>Finance | MoFA                 | CGIAR<br>Farmer Cooperatives<br>CSIR-Crops<br>Research Institute<br>Private Sector |  |
|                                                                                                                                                              |                                                                         | Increase in the adoption of pest-resistant crop varieties.            |             |                             |                      |                                                                                    |  |
|                                                                                                                                                              |                                                                         | Improvement in crop yields through integrated pest management.        |             |                             |                      |                                                                                    |  |
|                                                                                                                                                              |                                                                         | Greater farmer knowledge of pest control practices.                   |             |                             |                      |                                                                                    |  |
| Conduct regular training workshops on safety measures, emergency procedures, and best practices for fishing before and after storms.                         | Enhance fisher preparedness and safety during extreme weather events.   | Increase in the number of workshops conducted.                        | Short Term  | Human Technology<br>Finance | Fisheries Commission | NADMO<br>Local Communities<br>FAO<br>NGOs                                          |  |
|                                                                                                                                                              |                                                                         | Improvement in fishers' preparedness for storms.                      |             |                             |                      |                                                                                    |  |
|                                                                                                                                                              |                                                                         | Positive feedback from participants on the relevance of training.     |             |                             |                      |                                                                                    |  |
|                                                                                                                                                              |                                                                         | Reduction in fishing-related accidents during extreme weather events. |             |                             |                      |                                                                                    |  |
| Implement regular vaccination programs and health checks to prevent and control waterborne and other flood-related diseases.                                 | Improve public health by reducing disease outbreaks linked to floods.   | Increase in the number of people vaccinated in flood-prone areas.     | Short term  | Human Technology<br>Finance | Ministry of Health   | WHO<br>Local Health Facilities<br>UNICEF<br>NGOs                                   |  |
|                                                                                                                                                              |                                                                         | Reduction in cases of waterborne diseases during flood seasons.       |             |                             |                      |                                                                                    |  |
|                                                                                                                                                              |                                                                         | Improved access to health checks in vulnerable communities.           |             |                             |                      |                                                                                    |  |
|                                                                                                                                                              |                                                                         | Greater community awareness of disease prevention measures.           |             |                             |                      |                                                                                    |  |

|                                                                                                                                                                          |                                                                                 |                                                                                         |             |                          |                      |                                                                      |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------|--------------------------|----------------------|----------------------------------------------------------------------|--|
| Strengthen and elevate embankments along rivers and lake shores; construct flood barriers and proper drainage systems where necessary                                    | Reduce flood risks through improved physical defenses.                          | Increase in the length of embankments and flood barriers constructed or strengthened.   | Long Term   | Human Technology Finance | ADA                  | EPA<br>Water Resources Commission<br>Construction Companies<br>NADMO |  |
|                                                                                                                                                                          |                                                                                 | Reduction in flood damage in protected areas.                                           |             |                          |                      |                                                                      |  |
|                                                                                                                                                                          |                                                                                 | Improved drainage in flood-prone regions.                                               |             |                          |                      |                                                                      |  |
|                                                                                                                                                                          |                                                                                 | Enhanced community satisfaction with flood protection measures.                         |             |                          |                      |                                                                      |  |
| Encourage the use of technology such as GPS and fish finders among local fishers to more effectively locate fish populations as they shift due to environmental changes. | Improve fishing efficiency and sustainability through modern technologies.      | Increase in the number of fishers using GPS and fish finders.                           | Medium Term | Human Technology Finance | Fisheries Commission | FAO<br>Technology Companies<br>CSIR-Water Research Institute<br>NGOs |  |
|                                                                                                                                                                          |                                                                                 | Improvement in fishers' ability to locate and catch fish sustainably.                   |             |                          |                      |                                                                      |  |
|                                                                                                                                                                          |                                                                                 | Reduction in time spent locating fish.                                                  |             |                          |                      |                                                                      |  |
|                                                                                                                                                                          |                                                                                 | Greater fisher awareness of technology's benefits in adapting to environmental changes. |             |                          |                      |                                                                      |  |
| Develop and enhance early warning systems and community-based alerts for storms to ensure timely evacuation and preparedness                                             | Enhance community preparedness and reduce disaster risks through timely alerts. | Increase in the coverage and functionality of early warning systems.                    | Medium Term | Human Technology Finance | NADMO                | GMet<br>ADA<br>UNDP<br>NGOs                                          |  |
|                                                                                                                                                                          |                                                                                 | Positive feedback from communities on the reliability of the alert systems.             |             |                          |                      |                                                                      |  |
|                                                                                                                                                                          |                                                                                 | Reduction in storm-related casualties and damages.                                      |             |                          |                      |                                                                      |  |

|                                                                                                                                           |                                                                                      |                                                                         |             |                             |                     |                                                               |  |
|-------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-------------------------------------------------------------------------|-------------|-----------------------------|---------------------|---------------------------------------------------------------|--|
| Construct raised or elevated livestock shelters that are above the typical flood level.                                                   | Protect livestock from flood damage.                                                 | Increase in the number of elevated livestock shelters constructed.      | Medium Term | Human Technology<br>Finance | MoFA                | Construction Companies<br>Farmer Organizations<br>NGOs<br>ADA |  |
|                                                                                                                                           |                                                                                      | Reduction in livestock losses during floods.                            |             |                             |                     |                                                               |  |
|                                                                                                                                           |                                                                                      | Improved animal welfare in flood-prone areas.                           |             |                             |                     |                                                               |  |
|                                                                                                                                           |                                                                                      | Greater farmer satisfaction with the shelters.                          |             |                             |                     |                                                               |  |
| Implement ecological buffers such as windbreaks, shelterbelts, and buffer zones with native vegetation around agricultural fields.        | Reduce soil erosion and enhance ecosystem resilience around farmlands.               | Increase in the area covered by ecological buffers.                     | Medium Term | Human Technology<br>Finance | Forestry Commission | EPA<br>Farmer Cooperatives<br>NGOs<br>FAO                     |  |
|                                                                                                                                           |                                                                                      | Reduction in soil erosion and wind damage to crops.                     |             |                             |                     |                                                               |  |
|                                                                                                                                           |                                                                                      | Improvement in biodiversity and ecosystem services.                     |             |                             |                     |                                                               |  |
|                                                                                                                                           |                                                                                      | Greater adoption of buffer zones by farmers.                            |             |                             |                     |                                                               |  |
| Enhance meteorological capabilities to provide farmers with accurate and timely weather forecasts to better plan agricultural activities. | Improve agricultural planning and decision-making with accurate weather information. | Increase in the accuracy and timeliness of weather forecasts.           | Long Term   | Human Technology<br>Finance | GMeT                | WMO<br>Research Institutions<br>ADA<br>FAO                    |  |
|                                                                                                                                           |                                                                                      | Greater farmer reliance on weather forecasts for agricultural planning. |             |                             |                     |                                                               |  |
|                                                                                                                                           |                                                                                      | Reduction in agricultural losses due to unforeseen weather events.      |             |                             |                     |                                                               |  |
|                                                                                                                                           |                                                                                      | Positive feedback from farmers on the utility of forecast services.     |             |                             |                     |                                                               |  |

|                                                                                                                                                                           |                                                                                    |                                                                                        |             |                                |       |                                                                                          |  |
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| Establish a community-based system that disseminates weather warnings through various channels, including SMS, local radio stations, and loudspeakers.                    | Ensure effective communication of weather-related risks to vulnerable populations. | Increase in the number of households receiving weather warnings.                       | Short Term  | Human<br>Technology<br>Finance | NADMO | Telecommunication Companies<br>Local Authorities<br>NGOs<br>Research Institutions        |  |
|                                                                                                                                                                           |                                                                                    | Reduction in disaster-related casualties due to timely warnings.                       |             |                                |       |                                                                                          |  |
|                                                                                                                                                                           |                                                                                    | Greater community trust in the warning system.                                         |             |                                |       |                                                                                          |  |
|                                                                                                                                                                           |                                                                                    | Enhanced use of diverse communication channels for dissemination.                      |             |                                |       |                                                                                          |  |
| Promote and support sustainable agricultural practices upstream. This can include reduced use of chemical fertilizers and pesticides, contour plowing, and cover cropping | Reduce downstream impacts of unsustainable farming activities.                     | Increase in the adoption of sustainable agricultural practices upstream.               | Medium Term | Human<br>Technology<br>Finance | MoFA  | Farmer Cooperatives<br>FAO<br>Research Institutions<br>Local NGOs                        |  |
|                                                                                                                                                                           |                                                                                    | Reduction in chemical runoff and soil degradation.                                     |             |                                |       |                                                                                          |  |
|                                                                                                                                                                           |                                                                                    | Improvement in downstream water quality.                                               |             |                                |       |                                                                                          |  |
| Build artificial wetlands and sediment traps along watercourses feeding into the lake                                                                                     | Improve water quality and manage sedimentation effectively                         | Increase in the number and area of artificial wetlands and sediment traps constructed. | Long Term   | Human<br>Technology<br>Finance | EPA   | Water Resources Commission<br>CSIR-Water Research Institute<br>UNEP<br>Local Authorities |  |
|                                                                                                                                                                           |                                                                                    | Improvement in water quality in watercourses feeding into the lake.                    |             |                                |       |                                                                                          |  |
|                                                                                                                                                                           |                                                                                    | Greater biodiversity in artificial wetland areas.                                      |             |                                |       |                                                                                          |  |

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| Develop and promote access to crop insurance and financial support programs that cover losses from extreme weather events.                                                                                  | Reduce financial losses from extreme weather events.                    |                                                                                                     | Medium Term | Human Technology Finance | MoFA | Private Sector (Insurance Companies)<br>World Bank<br>FAO<br>Farmer Cooperatives                     |  |
|                                                                                                                                                                                                             |                                                                         | Increase in the number of farmers enrolled in crop insurance programs.                              |             |                          |      |                                                                                                      |  |
|                                                                                                                                                                                                             |                                                                         | Reduction in financial losses for farmers after extreme weather events.                             |             |                          |      |                                                                                                      |  |
|                                                                                                                                                                                                             |                                                                         | Greater farmer awareness of insurance and financial support options.                                |             |                          |      |                                                                                                      |  |
|                                                                                                                                                                                                             |                                                                         | Positive feedback from beneficiaries on the ease of access and utility of the programs.             |             |                          |      |                                                                                                      |  |
| Contour Farming and Terracing practices: These practices help prevent soil erosion and improve water retention in areas prone to heavy rains.                                                               | Prevent soil erosion and improve water retention in agricultural areas. | Increase in the area of agricultural lands adopting contour farming and terracing.                  | Medium Term | Human Technology Finance | MoFA | CSIR-Soil Research Institute<br>Farmer Cooperatives<br>FAO<br>Local Authorities                      |  |
|                                                                                                                                                                                                             |                                                                         | Reduction in soil erosion rates in hilly or sloped areas.                                           |             |                          |      |                                                                                                      |  |
|                                                                                                                                                                                                             |                                                                         | Improvement in water retention and crop yields in terraced fields.                                  |             |                          |      |                                                                                                      |  |
|                                                                                                                                                                                                             |                                                                         | Greater adoption of these practices by farmers.                                                     |             |                          |      |                                                                                                      |  |
| Implement controlled irrigation systems like drip irrigation to manage water use efficiently and construct runoff management structures such as swales and retention basins to capture and use excess water | Optimize water use for sustainable crop production.                     | Increase in the number of controlled irrigation systems and runoff management structures installed. | Medium Term | Human Technology Finance | MoFA | Private Sector (Irrigation Companies)<br>FAO<br>CSIR-Water Research Institute<br>Farmer Cooperatives |  |
|                                                                                                                                                                                                             |                                                                         | Reduction in water wastage and improved water use efficiency.                                       |             |                          |      |                                                                                                      |  |
|                                                                                                                                                                                                             |                                                                         | Enhanced availability of water for crops during dry spells.                                         |             |                          |      |                                                                                                      |  |
|                                                                                                                                                                                                             |                                                                         | Positive feedback from farmers on the effectiveness of these systems.                               |             |                          |      |                                                                                                      |  |

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| Facilitate access to agricultural insurance schemes that cover flood risks and provide financial support for the adoption of flood resilience practices. | Provide financial security to farmers against climate-induced losses. | Increase in farmer participation in agricultural insurance schemes.                                | Medium Term | Human Technology Finance | MoFA | Private Sector (Insurance Companies) NGOs World Bank Farmer-Based Organizations            |  |
|                                                                                                                                                          |                                                                       | Reduction in financial vulnerability of farmers to flood-related losses.                           |             |                          |      |                                                                                            |  |
|                                                                                                                                                          |                                                                       | Positive community perception of insurance program effectiveness.                                  |             |                          |      |                                                                                            |  |
| Develop and maintain efficient drainage systems around grazing fields and livestock enclosures to prevent waterlogging.                                  | Prevent waterlogging and protect livestock areas.                     | Increase in the number of grazing fields and livestock enclosures with efficient drainage systems. | Medium Term | Human Technology Finance | MoFA | Water Resources Commission CSIR-Animal Research Institute Local Authorities Private Sector |  |
|                                                                                                                                                          |                                                                       | Reduction in waterlogging incidents in grazing areas.                                              |             |                          |      |                                                                                            |  |
|                                                                                                                                                          |                                                                       | Improved health and productivity of livestock.                                                     |             |                          |      |                                                                                            |  |
|                                                                                                                                                          |                                                                       | Positive feedback from livestock owners on the effectiveness of drainage systems.                  |             |                          |      |                                                                                            |  |
| Identify and develop higher ground areas for grazing that are less prone to flooding.                                                                    | Reduce livestock vulnerability to flooding.                           | Increase in the number of grazing areas relocated to higher ground.                                | Short Term  | Human Technology Finance | MoFA | Land Use Planning Agencies NGOs Local Authorities Farmer Cooperatives                      |  |
|                                                                                                                                                          |                                                                       | Reduction in livestock losses and damages caused by flooding.                                      |             |                          |      |                                                                                            |  |
|                                                                                                                                                          |                                                                       | Improved accessibility and usability of designated grazing lands.                                  |             |                          |      |                                                                                            |  |
|                                                                                                                                                          |                                                                       | Enhanced satisfaction among livestock owners with new grazing areas.                               |             |                          |      |                                                                                            |  |

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| Develop infrastructure to capture and store rainwater during periods of excess rainfall for use during dry spells. This includes building reservoirs, dams, and rain barrels.                                                              | Improve water availability during dry spells.                                               | Increase in the number of rainwater harvesting structures constructed.                                | Medium Term | Human Technology Finance | MoFA                | Private Sector (Engineering Firms)<br>CSIR-Water Research Institute<br>FAO<br>NGOs             |  |
|                                                                                                                                                                                                                                            |                                                                                             | Greater availability of water for agricultural and domestic use during dry periods.                   |             |                          |                     |                                                                                                |  |
|                                                                                                                                                                                                                                            |                                                                                             | Reduction in reliance on external water sources during dry spells.                                    |             |                          |                     |                                                                                                |  |
|                                                                                                                                                                                                                                            |                                                                                             | Positive community feedback on water storage infrastructure.                                          |             |                          |                     |                                                                                                |  |
| Implement water-efficient irrigation techniques such as drip irrigation to minimize water use while maintaining crop productivity                                                                                                          | Optimize water use to enhance agricultural productivity under water-scarce conditions.      | Increase in the adoption of drip irrigation systems by farmers.                                       | Medium Term | Human Technology Finance | MoFA                | Private Sector (Irrigation Companies)<br>FAO<br>CSIR-Crops Research Institute<br>Farmer Groups |  |
|                                                                                                                                                                                                                                            |                                                                                             | Reduction in water usage per unit of crop yield.                                                      |             |                          |                     |                                                                                                |  |
|                                                                                                                                                                                                                                            |                                                                                             | Improvement in agricultural productivity in water-scarce areas.                                       |             |                          |                     |                                                                                                |  |
| Implement proactive land management strategies that include controlled burns (where safe and feasible), the removal of excess dry vegetation, and the planting of fire-resistant plant species along the boundaries of agricultural lands. | Reduce wildfire risks and enhance land resilience through sustainable management practices. | Increase in the number of agricultural lands adopting fire-resistant vegetation and controlled burns. | Medium Term | Human Technology Finance | Forestry Commission | EPA<br>CSIR-Forestry Research Institute<br>FAO<br>Local Communities                            |  |
|                                                                                                                                                                                                                                            |                                                                                             | Reduction in wildfire occurrences and damages to agricultural lands.                                  |             |                          |                     |                                                                                                |  |
|                                                                                                                                                                                                                                            |                                                                                             | Improvement in land health and resilience to fire hazards.                                            |             |                          |                     |                                                                                                |  |
|                                                                                                                                                                                                                                            |                                                                                             | Greater awareness of land management practices among farmers.                                         |             |                          |                     |                                                                                                |  |

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| Implement advanced irrigation technologies such as drip irrigation, which are less vulnerable to damage and more efficient in water use.                                                                                                                             | Improve irrigation efficiency to reduce vulnerability to extreme weather impacts.     | Increase in the adoption of advanced irrigation technologies.                  | Medium Term | Human Technology Finance | MoFA | Private Sector (Technology Providers)<br>FAO<br>CSIR-Crops Research Institute<br>NGOs                                    |  |
|                                                                                                                                                                                                                                                                      |                                                                                       | Reduction in water wastage and irrigation system maintenance costs.            |             |                          |      |                                                                                                                          |  |
|                                                                                                                                                                                                                                                                      |                                                                                       | Improved crop yields with optimized water use.                                 |             |                          |      |                                                                                                                          |  |
|                                                                                                                                                                                                                                                                      |                                                                                       | Positive farmer feedback on the reliability of advanced irrigation systems.    |             |                          |      |                                                                                                                          |  |
| Upgrade and reinforce agricultural infrastructure, including irrigation systems, storage facilities, and greenhouses, to withstand extreme weather conditions. This can involve the use of durable materials, secure anchoring systems, and water-resistant designs. | Enhance the resilience of agricultural infrastructure against extreme weather events. | Increase in the number of upgraded agricultural infrastructures.               | Long Term   | Human Technology Finance | MoFA | Private Sector (Construction Companies)<br>UNDP<br>CSIR-Building and Road Research Institute (BRRI)<br>Local Authorities |  |
|                                                                                                                                                                                                                                                                      |                                                                                       | Reduction in damages to agricultural facilities during extreme weather events. |             |                          |      |                                                                                                                          |  |
|                                                                                                                                                                                                                                                                      |                                                                                       | Improved functionality and durability of infrastructure.                       |             |                          |      |                                                                                                                          |  |
|                                                                                                                                                                                                                                                                      |                                                                                       | Positive feedback from users on the quality and effectiveness of the upgrades. |             |                          |      |                                                                                                                          |  |

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| Restore and maintain ecological buffers such as hedgerows, forest margins, and wetlands around agricultural lands. These features can mitigate the impact of storms and provide habitat for beneficial species that support agriculture. | Protect agricultural lands and biodiversity by restoring natural barriers to storm impacts.     | Increase in the area covered by ecological buffers.                          | Medium Term | Human Technology<br>Finance | EPA                           | EPA<br>UNEP<br>CSIR-Forestry Research Institute<br>NGOs                                          |  |
|                                                                                                                                                                                                                                          |                                                                                                 | Reduction in storm-related damages to agricultural lands.                    |             |                             |                               |                                                                                                  |  |
|                                                                                                                                                                                                                                          |                                                                                                 | Improvement in biodiversity and ecosystem services in buffer zones.          |             |                             |                               |                                                                                                  |  |
|                                                                                                                                                                                                                                          |                                                                                                 | Greater farmer adoption of ecological buffer restoration practices.          |             |                             |                               |                                                                                                  |  |
| Develop and maintain vegetated buffer zones along the banks of rivers feeding into the lake and around the lake itself. Where feasible, construct artificial wetlands near the lake                                                      | Reduce flood risks and improve water quality through natural and artificial ecological buffers. | Increase in the area of vegetated buffer zones established and maintained.   | Medium Term | Human Technology<br>Finance | EPA                           | Forestry Commission<br>UNEP<br>Local Authorities<br>CSIR-Forestry Research Institute             |  |
|                                                                                                                                                                                                                                          |                                                                                                 | Reduction in soil erosion and sedimentation into the lake.                   |             |                             |                               |                                                                                                  |  |
|                                                                                                                                                                                                                                          |                                                                                                 | Improvement in water quality in rivers and the lake.                         |             |                             |                               |                                                                                                  |  |
|                                                                                                                                                                                                                                          |                                                                                                 | Positive community feedback on the effectiveness of buffer zones.            |             |                             |                               |                                                                                                  |  |
| Implement a schedule for dredging the lake to remove excess sediments and vegetation that contribute to poor water conditions                                                                                                            | Improve water quality and prevent sedimentation-related issues in the lake ecosystem.           | Increase in the frequency and effectiveness of dredging activities.          | Long Term   | Human Technology<br>Finance | Water Resources<br>Commission | EPA<br>Local Authorities<br>Private Sector (Dredging Companies)<br>CSIR-Water Research Institute |  |
|                                                                                                                                                                                                                                          |                                                                                                 | Reduction in sediment levels and vegetation overgrowth in the lake.          |             |                             |                               |                                                                                                  |  |
|                                                                                                                                                                                                                                          |                                                                                                 | Improvement in water flow and quality in the lake ecosystem.                 |             |                             |                               |                                                                                                  |  |
|                                                                                                                                                                                                                                          |                                                                                                 | Greater satisfaction among stakeholders reliant on the lake for livelihoods. |             |                             |                               |                                                                                                  |  |

## 11.2 Gender

Asuogyaman District has an estimated population of 115,058, based on the 2021 Population and Housing Census. Of this total, 55,190 (48%) are male, while 59,868 (52%) are female. Despite women making up the majority, they are often excluded from decision-making processes at the local level. Out of thirteen (13) proposed adaptation strategies, four (4) have been prioritized, emphasizing the importance of addressing the challenges women face and promoting gender-sensitive approaches to building climate resilience. For instance, Asuogyaman faces growing challenges in water scarcity, exacerbated by climate change, rapid population growth, and inadequate water infrastructure. These challenges disproportionately impact women and girls, who often bear the responsibility of water collection—a task that is both physically demanding and time-consuming (UN Women, 2021). By implementing rainwater harvesting systems at the household and community levels, the district can significantly improve access to water, especially during dry seasons.

Furthermore, the District faces significant challenges in providing adequate healthcare, especially to remote and underserved areas, exacerbated by climate change, which introduces new health risks and worsens existing conditions. Mobile clinics and community health workers offer a cost-effective solution by delivering essential healthcare directly to communities, addressing climate-related issues like heat illnesses, vector-borne diseases, and respiratory problems. This approach also promotes gender equality by overcoming barriers to healthcare access for women, fostering a more equitable and responsive healthcare system capable of meeting the district’s evolving needs in a climate-impacted world.

Also, implementing school-based nutrition programs that provide meals fortified with essential nutrients will help combat malnutrition, which is exacerbated by crop failures due to unpredictable weather patterns. Integrating climate change education into the school curriculum will equip children with knowledge about the causes, effects, and adaptation strategies related to climate change. This education will empower them with the skills needed to adapt to the changing environment and contribute to building a more resilient community.

**Table 15 Ranking of adaptation options for the gender sector**

| Adaptation option                                                                                                                                                                                                                                                             | Final score from stakeholders | Rank |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|------|
| Integrate climate change education into the school curriculum to teach children about the causes, effects, and adaptation strategies related to climate change. This education should empower them with knowledge and practical skills to adapt to their changing environment | 48                            | 1    |

|                                                                                                                                                                                                                                |    |   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|---|
| Implement systems at community and household levels to collect and store rainwater. This can relieve the burden on women who are primarily responsible for water collection, especially during dry spells                      | 45 | 2 |
| Improve access to healthcare with mobile clinics and community health workers who can reach remote areas, ensuring women and men have equal access to health services, including those related to climate-induced health risks | 41 | 3 |
| Implement school-based nutrition programs that provide meals fortified with essential nutrients to combat malnutrition, exacerbated by crop failures due to erratic weather patterns                                           | 41 | 3 |

**Table 16 Summary of the adaptation actions for the Gender sector**

| ADAPTATION ACTIONS                                                                                                                                                                                                                                                            | OBJECTIVES                                                                                       | INDICATORS OF SUCCESS                                                                       | TIME FRAME<br>(Short, Medium and Long Term) | RESOURCES<br>(Finance, Human, Technology) | IMPLEMENTING PARTNERS |                                                                                                | Estimated costs |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|---------------------------------------------|-------------------------------------------|-----------------------|------------------------------------------------------------------------------------------------|-----------------|
|                                                                                                                                                                                                                                                                               |                                                                                                  |                                                                                             |                                             |                                           | Lead                  | Collaborating                                                                                  |                 |
| Integrate climate change education into the school curriculum to teach children about the causes, effects, and adaptation strategies related to climate change. This education should empower them with knowledge and practical skills to adapt to their changing environment | Equip students with knowledge and skills to adapt to and mitigate the impacts of climate change. | Number of schools implementing climate change topics in their curriculum.                   | Medium-term                                 | Human<br>Technology<br>Finance            | Ministry of Education | NGOs<br>UNICEF<br>UNESCO<br>Ghana Education Service (GES)<br>CSIR-Education Research Institute |                 |
|                                                                                                                                                                                                                                                                               |                                                                                                  | Increase in students' knowledge about climate change (measured via assessments or surveys). |                                             |                                           |                       |                                                                                                |                 |
|                                                                                                                                                                                                                                                                               |                                                                                                  | Practical adaptation projects initiated by students in schools or communities.              |                                             |                                           |                       |                                                                                                |                 |

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| Improve access to healthcare with mobile clinics and community health workers who can reach remote areas, ensuring women and men have equal access to health services, including those related to climate-induced health risks | Ensure equitable access to healthcare services, particularly in remote areas, to address climate-induced health risks. | Number of mobile clinics and community health workers deployed                   | Short term  | Human Technology Finance | Ministry of Health    | WHO<br>Local Health Facilities<br>NGOs<br>Red Cross Ghana<br>International Development Agencies (e.g., UNDP) |  |
|                                                                                                                                                                                                                                |                                                                                                                        | Reduction in healthcare disparities between urban and remote populations.        |             |                          |                       |                                                                                                              |  |
|                                                                                                                                                                                                                                |                                                                                                                        | Increase in diagnoses and treatment of climate-related illnesses in rural areas. |             |                          |                       |                                                                                                              |  |
|                                                                                                                                                                                                                                |                                                                                                                        | Improved patient satisfaction with access to healthcare services.                |             |                          |                       |                                                                                                              |  |
| Implement school-based nutrition programs that provide meals fortified with essential nutrients to combat malnutrition, exacerbated by crop failures due to erratic weather patterns                                           | Combat malnutrition exacerbated by climate-related crop failures.                                                      | Number of schools providing fortified meals.                                     | Short term  | Human Technology Finance | Ministry of Education | Ministry of Health<br>World Food Program (WFP)<br>Local NGOs<br>Parent-Teacher Associations                  |  |
|                                                                                                                                                                                                                                |                                                                                                                        | Reduction in malnutrition rates among children.                                  |             |                          |                       |                                                                                                              |  |
|                                                                                                                                                                                                                                |                                                                                                                        | Improvement in students' academic performance linked to nutrition.               |             |                          |                       |                                                                                                              |  |
|                                                                                                                                                                                                                                |                                                                                                                        | Positive feedback from parents and school staff on the program.                  |             |                          |                       |                                                                                                              |  |
| Encourage urban greening such as planting more trees                                                                                                                                                                           | Reduce urban heat and enhance environmental resilience through increased green cover.                                  | Increase in the number of trees planted in urban areas.                          | Medium-term | Human Technology Finance | ADA                   | Forestry Commission<br>Environmental Protection Agency (EPA)<br>UNEP<br>Local NGOs<br>Community Groups       |  |
|                                                                                                                                                                                                                                |                                                                                                                        | Reduction in urban heat island effects (temperature measurements).               |             |                          |                       |                                                                                                              |  |
|                                                                                                                                                                                                                                |                                                                                                                        | Improvement in air quality.                                                      |             |                          |                       |                                                                                                              |  |
|                                                                                                                                                                                                                                |                                                                                                                        | Positive feedback from urban residents.                                          |             |                          |                       |                                                                                                              |  |

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| Implement systems at community and household levels to collect and store rainwater. This can relieve the burden on women who are primarily responsible for water collection, especially during dry spells | Improve water security and alleviate the burden of water collection, particularly for women, during dry spells. | Number of rainwater harvesting systems installed.                      | Medium-term | Human Technology<br>Finance | Ministry of Sanitation and Water Resources | NGOs<br>Local Authorities<br>UNICEF<br>Private Sector (Water Storage Companies)<br>Community-Based Organizations |  |
|                                                                                                                                                                                                           |                                                                                                                 | Increase in water availability during dry spells.                      |             |                             |                                            |                                                                                                                  |  |
|                                                                                                                                                                                                           |                                                                                                                 | Reduction in time spent collecting water by women and children.        |             |                             |                                            |                                                                                                                  |  |
|                                                                                                                                                                                                           |                                                                                                                 | Improved household and community water security.                       |             |                             |                                            |                                                                                                                  |  |
| Increase the capacity of health services to handle outbreaks by improving disease surveillance, stocking essential medicines, and training healthcare workers in handling climate-related health issues   | Strengthen healthcare systems to effectively manage climate-related health crises.                              | Increase in essential medicines stockpiled in facilities.              | Medium term | Human Technology<br>Finance | Ministry of Health                         | WHO<br>Ghana Health Service (GHS)<br>Local Health Facilities<br>NGOs<br>Red Cross Ghana                          |  |
|                                                                                                                                                                                                           |                                                                                                                 | Improved public satisfaction with health services.                     |             |                             |                                            |                                                                                                                  |  |
|                                                                                                                                                                                                           |                                                                                                                 | Number of healthcare workers trained on climate-related health issues. |             |                             |                                            |                                                                                                                  |  |
|                                                                                                                                                                                                           |                                                                                                                 | Reduction in response times to disease outbreaks.                      |             |                             |                                            |                                                                                                                  |  |

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| Increase tree cover in the district by planting native and drought-resistant tree species along streets, in parks, and around residential and commercial buildings. Trees provide shade and reduce temperatures.                             | Reduce local temperatures and improve environmental resilience through increased tree cover. | Reduction in local temperatures in tree-covered areas.    | Medium term | Human Technology Finance | Forestry Commission                     | ADA<br>EPA<br>UNEP<br>NGOs<br>Community-Based Organizations                                            |  |
|                                                                                                                                                                                                                                              |                                                                                              | Decrease in soil erosion rates.                           |             |                          |                                         |                                                                                                        |  |
|                                                                                                                                                                                                                                              |                                                                                              | Increase in biodiversity in planted areas.                |             |                          |                                         |                                                                                                        |  |
| Develop small-scale irrigation projects that can support agricultural activities during inconsistent rainfall. Prioritize access for women farmers to these resources to ensure they too can benefit from improved agricultural productivity | Enhance agricultural productivity and support equitable access to irrigation resources.      | Increase in agricultural productivity for women farmers.  | Medium term | Human Technology Finance | Ministry of Food and Agriculture (MoFA) | FAO<br>Local Farmer Cooperatives<br>NGOs<br>Private Sector (Irrigation Companies)<br>Local Authorities |  |
|                                                                                                                                                                                                                                              |                                                                                              | Reduction in crop failures due to inconsistent rainfall.  |             |                          |                                         |                                                                                                        |  |
|                                                                                                                                                                                                                                              |                                                                                              | Increase in women farmers accessing irrigation resources. |             |                          |                                         |                                                                                                        |  |
|                                                                                                                                                                                                                                              |                                                                                              | Number of small-scale irrigation systems established.     |             |                          |                                         |                                                                                                        |  |

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| Tranings on NBS:<br>Provide training for both men and women in climate-resilient farming techniques such as drought-resistant crops, proper soil management, and sustainable agriculture practices | Empower farmers with knowledge to adopt sustainable and resilient agricultural practices. | Adoption rates of sustainable farming techniques.                  | Short-term  | Human Technology<br>Finance | Ministry of Food and Agriculture (MoFA) | FAO<br>CGIAR<br>Local Farmer Organizations<br>NGOs<br>Research Institutions                                             |  |
|                                                                                                                                                                                                    |                                                                                           | Increase in agricultural yields.                                   |             |                             |                                         |                                                                                                                         |  |
|                                                                                                                                                                                                    |                                                                                           | Reduction in reliance on traditional, less sustainable methods.    |             |                             |                                         |                                                                                                                         |  |
|                                                                                                                                                                                                    |                                                                                           | Number of farmers trained, disaggregated by gender.                |             |                             |                                         |                                                                                                                         |  |
| Revise local building codes to require these climate-resilient features in new school construction and major renovations.                                                                          | Ensure schools are safe and resilient against climate-related hazards.                    | Percentage of new schools built with climate-resilient features.   | Long Term   | Human Technology<br>Finance | Ministry of Works and Housing           | Ministry of Education<br>Construction Companies<br>UNDP<br>Research Institutions (e.g., UG, KNUST)<br>Local Authorities |  |
|                                                                                                                                                                                                    |                                                                                           | Reduction in school damage during extreme weather events.          |             |                             |                                         |                                                                                                                         |  |
|                                                                                                                                                                                                    |                                                                                           | Improved safety ratings for school structures.                     |             |                             |                                         |                                                                                                                         |  |
|                                                                                                                                                                                                    |                                                                                           | Positive feedback from communities on school safety.               |             |                             |                                         |                                                                                                                         |  |
| Develop flexible learning modules and distance learning options (e.g., radio, online platforms) to ensure education continuity during closures                                                     | Ensure continuity of education during disruptions caused by climate-related events.       | Increase in student engagement during closures.                    | Medium Term | Human Technology<br>Finance | Ministry of Education                   | UNESCO<br>NGOs<br>Ghana Education Service (GES)<br>Private Sector (Technology Providers)<br>UNICEF                      |  |
|                                                                                                                                                                                                    |                                                                                           | Continuity of education during climate-related disruptions.        |             |                             |                                         |                                                                                                                         |  |
|                                                                                                                                                                                                    |                                                                                           | Positive feedback from students and parents.                       |             |                             |                                         |                                                                                                                         |  |
|                                                                                                                                                                                                    |                                                                                           | Number of schools offering flexible and distance learning modules. |             |                             |                                         |                                                                                                                         |  |

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| Promote the cultivation of alternative medicinal and nutritional plants that are more resilient to extreme weather conditions. This could include introducing species that can withstand drought or flooding, depending on the local climate risks | Enhance food and health security through the cultivation of climate-resilient plant species. | Number of communities adopting alternative plants.          | Medium Term | Human Technology Finance | Ministry of Food and Agriculture (MoFA) | CSIR-Crops Research Institute<br>Local Farmer Organizations<br>NGOs<br>FAO<br>Local Authorities |  |
|                                                                                                                                                                                                                                                    |                                                                                              | Increase in plant yields suitable for climate conditions.   |             |                          |                                         |                                                                                                 |  |
|                                                                                                                                                                                                                                                    |                                                                                              | Improved food and health security in households.            |             |                          |                                         |                                                                                                 |  |
|                                                                                                                                                                                                                                                    |                                                                                              | Reduction in dependency on climate-vulnerable crops.        |             |                          |                                         |                                                                                                 |  |
| Schools, especially in flood-prone areas, should be built on elevated grounds or incorporate elevated foundations to avoid water damage during flooding                                                                                            | Protect school infrastructure from flood damage.                                             | Number of schools constructed on elevated grounds.          | Long Term   | Human Technology Finance | Ministry of Education                   | ADA<br>Construction Companies<br>NADMO<br>UNDP<br>Community-Based Organizations                 |  |
|                                                                                                                                                                                                                                                    |                                                                                              | Reduction in school closures due to flooding.               |             |                          |                                         |                                                                                                 |  |
|                                                                                                                                                                                                                                                    |                                                                                              | Reduction in flood-related damage to school infrastructure. |             |                          |                                         |                                                                                                 |  |

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| Designate areas within the school that can serve as safe havens during emergencies. These areas should be structurally reinforced to provide additional protection                                                 | Provide structural protection and safety for students and staff during emergencies. | Reduction in injuries and fatalities during emergencies.                   | Medium Term | Human Technology Finance | National Disaster Management Organization (NADMO)   | Ministry of Education<br>Local Authorities<br>UNDP<br>Construction Companies<br>Community Groups      |  |
|                                                                                                                                                                                                                    |                                                                                     | Increased confidence among parents in school safety measures.              |             |                          |                                                     |                                                                                                       |  |
|                                                                                                                                                                                                                    |                                                                                     | Improved capacity for schools to respond to emergencies.                   |             |                          |                                                     |                                                                                                       |  |
|                                                                                                                                                                                                                    |                                                                                     | Number of schools with designated and structurally reinforced safe havens. |             |                          |                                                     |                                                                                                       |  |
| Create platforms for children and youth to participate in community discussions on climate change adaptation. This empowers them and ensures their specific needs and ideas are included in local adaptation plans | Empower youth to contribute to local adaptation planning and decision-making.       | Number of community discussions involving youth.                           | Short Term  | Human Technology Finance | Ministry of Gender, Children, and Social Protection | UNICEF<br>NGOs<br>Local Youth Organizations<br>Community-Based Organizations<br>Ministry of Education |  |
|                                                                                                                                                                                                                    |                                                                                     | Increase in youth-led adaptation initiatives                               |             |                          |                                                     |                                                                                                       |  |
|                                                                                                                                                                                                                    |                                                                                     | Greater inclusion of youth perspectives in adaptation plans.               |             |                          |                                                     |                                                                                                       |  |
|                                                                                                                                                                                                                    |                                                                                     | Positive feedback from youth participants.                                 |             |                          |                                                     |                                                                                                       |  |

|                                                                                                                                                                                          |                                                                                  |                                                                   |             |                                |                                                     |                                                                                 |  |
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| Provide and promote the use of lightweight, breathable, and UV-protective clothing for outdoor workers. Include wide-brimmed hats and sunglasses to protect against direct sun exposure. | Reduce health risks associated with prolonged sun exposure for outdoor workers.  | Increase in availability and usage of protective clothing.        | Short Term  | Human<br>Technology<br>Finance | Ministry of<br>Employment<br>and Labor<br>Relations | NGOs<br>WHO<br>Local Worker Associations<br>Private Sector (Clothing Companies) |  |
|                                                                                                                                                                                          |                                                                                  | Reduction in heat-related illnesses.                              |             |                                |                                                     |                                                                                 |  |
|                                                                                                                                                                                          |                                                                                  | Positive feedback from workers about comfort and effectiveness.   |             |                                |                                                     |                                                                                 |  |
|                                                                                                                                                                                          |                                                                                  | Increased productivity among outdoor workers.                     |             |                                |                                                     |                                                                                 |  |
| Incorporate hidden roofs that are less likely to catch wind, alongside other wind-resistant features like sloped designs that deflect winds upward and away from the building.           | Enhance structural resilience to wind damage.                                    | Positive feedback from communities on building safety.            | Medium Term | Human<br>Technology<br>Finance | Ministry of<br>Works and<br>Housing                 | ADA<br>Construction Companies<br>UNDP<br>Research Institutions<br>EPA           |  |
|                                                                                                                                                                                          |                                                                                  | Reduction in wind damage to structures.                           |             |                                |                                                     |                                                                                 |  |
|                                                                                                                                                                                          |                                                                                  | Number of buildings constructed with wind-resistant designs.      |             |                                |                                                     |                                                                                 |  |
|                                                                                                                                                                                          |                                                                                  | Increased adoption of wind-resistant designs in new construction. |             |                                |                                                     |                                                                                 |  |
| Encourage flexible work hours and shifts for outdoor workers, including starting earlier in the day and incorporating more frequent and longer breaks during the hottest hours           | Protect outdoor workers from heat stress and other weather-related health risks. | Improved morale and productivity among outdoor workers.           | Short Term  | Human<br>Technology<br>Finance | Ministry of<br>Employment<br>and Labor<br>Relations | Local Employers' Associations<br>NGOs<br>WHO<br>Worker Advocacy Groups          |  |
|                                                                                                                                                                                          |                                                                                  | Positive worker feedback on schedule adjustments.                 |             |                                |                                                     |                                                                                 |  |
|                                                                                                                                                                                          |                                                                                  | Reduction in heat-related illnesses among workers.                |             |                                |                                                     |                                                                                 |  |
|                                                                                                                                                                                          |                                                                                  | Increase in employers adopting flexible schedules.                |             |                                |                                                     |                                                                                 |  |

### 11.3 Water Resources

Asuogyaman District boasts of abundant water resources, including the Volta Lake, underground reserves, and rivers. These resources play a crucial role in generating electricity, supporting fishing activities, providing potable water, enabling irrigation, and fulfilling both industrial and domestic needs. Following the climate vulnerability and risk assessments, literature reviews, and consultations with local stakeholders, five adaptation measures were identified, out of which three (3) were prioritized through a Multi-Criteria Analysis (MCA) conducted by water management experts.

Despite being near a vast water source, many communities in Asuogyaman face inconsistent, insufficient, or unsafe water supplies, with only Akosombo, Atimpoku, Boso, and Anum having access to pipe-borne water, primarily from the Ghana Water Company. Akosombo remains the most reliably served area. The district is grappling with challenges like prolonged droughts, declining water quality, and damage to water infrastructure due to extreme weather, which threaten water availability for domestic, agricultural, and industrial needs. A comprehensive water management plan, involving key stakeholders such as local communities, industries, and agricultural groups, is crucial for addressing these issues.

With most of Asuogyaman relying on surface water sources, the unpredictability of weather patterns has intensified pressure on these already limited resources. A practical adaptation strategy for the district would be to explore and develop alternative water sources, such as groundwater. Groundwater offers a more reliable and resilient option during droughts, as it is less affected by fluctuations in rainfall compared to surface water.

Lastly, Water scarcity in Asuogyaman is worsening due to prolonged droughts and erratic climate patterns, making it more challenging to meet the growing demand for water across households, agriculture, and industry. A promising solution is rainwater harvesting, an affordable and decentralized method that can supplement local water supplies. By collecting and storing rainwater during the wet season, communities can create reserves to use during drier periods, easing the strain on traditional water sources.

**Table 17 Ranking of adaptation options for the water and sanitation sector**

| Adaptation option                                                                                                                                                                               | Final score from stakeholders | Rank |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|------|
| Develop a comprehensive water management framework that involves all stakeholders, including local communities, industries, and agricultural sectors, in managing water resources holistically. | 47                            | 1    |
| Explore alternative water sources such as groundwater, where feasible, to reduce dependency on surface water.                                                                                   | 46                            | 2    |
| Promote rainwater harvesting in communities to increase water storage capacity.                                                                                                                 | 45                            | 3    |

**Table 18 Summary of the Adaptation Actions for the Water Resources**

| ADAPTATION ACTIONS                                                                                                                                                                              | OBJECTIVES                                                                                        | INDICATORS OF SUCCESS                                                  | TIME FRAME (Short, Medium or Long Term) | RESOURCES (Finance, Human, Technology) | IMPLEMENTING PARTNERS                      |                                                                                                                                  | Estimated costs |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|-----------------------------------------|----------------------------------------|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|-----------------|
|                                                                                                                                                                                                 |                                                                                                   |                                                                        |                                         |                                        | Lead                                       | Collaborating                                                                                                                    |                 |
| Develop a comprehensive water management framework that involves all stakeholders, including local communities, industries, and agricultural sectors, in managing water resources holistically. | Ensure sustainable and equitable management of water resources through stakeholder collaboration. | Establishment of a functional water management framework.              | Long Term                               | Human<br>Technology<br>Finance         | Ministry of Sanitation and Water Resources | Water Resources Commission<br>EPA<br>ADA<br>NGOs<br>Community-Based Organizations                                                |                 |
|                                                                                                                                                                                                 |                                                                                                   | Increase in stakeholder participation in water management processes.   |                                         |                                        |                                            |                                                                                                                                  |                 |
|                                                                                                                                                                                                 |                                                                                                   | Reduction in conflicts over water resource allocation.                 |                                         |                                        |                                            |                                                                                                                                  |                 |
|                                                                                                                                                                                                 |                                                                                                   | Improvement in water availability and usage efficiency.                |                                         |                                        |                                            |                                                                                                                                  |                 |
| Explore alternative water sources such as groundwater, where feasible, to reduce dependency on surface water.                                                                                   | Diversify water sources to enhance water security and reduce reliance on surface water.           | Increase in the proportion of water supplied from alternative sources. | Medium Term                             | Human<br>Technology<br>Finance         | Water Resources Commission                 | CSIR-Water Research Institute,<br>Geological Survey Department<br>NGOs, Private Sector (Borehole Companies)<br>Local Authorities |                 |
|                                                                                                                                                                                                 |                                                                                                   | Reduction in dependency on surface water resources.                    |                                         |                                        |                                            |                                                                                                                                  |                 |
|                                                                                                                                                                                                 |                                                                                                   | Improved groundwater monitoring and management systems.                |                                         |                                        |                                            |                                                                                                                                  |                 |
|                                                                                                                                                                                                 |                                                                                                   | Positive feedback from communities on water access and reliability.    |                                         |                                        |                                            |                                                                                                                                  |                 |

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| Promote rainwater harvesting in communities to increase water storage capacity.                                                                                                 | Increase community-level water availability through enhanced rainwater collection and storage.    | Increase in the number of rainwater harvesting systems installed.                | Short Term | Human Technology Finance | Ministry of Sanitation and Water Resources | ADA<br>NGOs<br>UNICEF<br>Private Sector (Water Storage Companies)<br>Community Groups                                                 |  |
|                                                                                                                                                                                 |                                                                                                   | Growth in water storage capacity at the community and household levels.          |            |                          |                                            |                                                                                                                                       |  |
|                                                                                                                                                                                 |                                                                                                   | Reduction in water shortages during dry seasons.                                 |            |                          |                                            |                                                                                                                                       |  |
|                                                                                                                                                                                 |                                                                                                   | Positive community feedback on the benefits of rainwater harvesting.             |            |                          |                                            |                                                                                                                                       |  |
| Build additional reservoirs, improve dam facilities.                                                                                                                            | Expand and improve water storage infrastructure to meet growing water demands.                    | Increase in the number of functional reservoirs and improved dams.               | Long Term  | Human Technology Finance | Ghana Water Company Limited (GWCL)         | Ministry of Sanitation and Water Resources<br>Volta River Authority<br>Private Sector (Engineering Firms)<br>FAO<br>Local Authorities |  |
|                                                                                                                                                                                 |                                                                                                   | Enhanced water storage capacity for domestic, industrial, and agricultural use.  |            |                          |                                            |                                                                                                                                       |  |
|                                                                                                                                                                                 |                                                                                                   | Reduction in water supply disruptions during droughts.                           |            |                          |                                            |                                                                                                                                       |  |
| Implement stricter pollution control measures, restore wetlands that naturally filter pollutants, and manage agricultural runoff to reduce nutrient loads entering water bodies | Protect and improve water quality by reducing pollution and restoring natural filtration systems. | Reduction in pollutant levels in water bodies (e.g., nutrient loads, sediments). | Medium     | Human Technology Finance | Environmental Protection Agency (EPA)      | Ministry of Food and Agriculture (MoFA)<br>Forestry Commission<br>NGOs<br>UNEP<br>Local Communities                                   |  |
|                                                                                                                                                                                 |                                                                                                   | Increase in the area of restored wetlands.                                       |            |                          |                                            |                                                                                                                                       |  |
|                                                                                                                                                                                 |                                                                                                   | Improvement in water quality for human and ecosystem use.                        |            |                          |                                            |                                                                                                                                       |  |
|                                                                                                                                                                                 |                                                                                                   | Reduction in agricultural runoff entering water bodies.                          |            |                          |                                            |                                                                                                                                       |  |

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| Strengthen and upgrade water infrastructure to withstand extreme weather events, such as reinforcing embankments, enhancing flood defenses, and using more durable materials for water transport and storage systems | Enhance the resilience of water infrastructure to climate-induced extreme weather events. | Increase in the number of water infrastructure projects upgraded or strengthened. | Long term | Human Technology Finance | Ministry of Works and Housing | Ghana Water Company Limited (GWCL)<br>Ministry of Sanitation and Water Resources<br>NADMO, Private Sector (Construction Firms)<br>Local Authorities |  |
|                                                                                                                                                                                                                      |                                                                                           | Reduction in flood-related damages to water systems.                              |           |                          |                               |                                                                                                                                                     |  |
|                                                                                                                                                                                                                      |                                                                                           | Positive feedback from communities on infrastructure resilience.                  |           |                          |                               |                                                                                                                                                     |  |

## 11.4 Health and Sanitation

In Asuogyaman District, climate change is impacting public health through both direct effects, such as heatwaves and storms, and indirect consequences related to sectors like waste management and sanitation among the twelve proposed adaptation actions, three have been prioritized for immediate implementation. The district is grappling with climate-related health challenges, including extreme heat, waterborne diseases, and the impacts of food shortages and displacement caused by severe weather events like floods and droughts. A recent spillage at the Akosombo Dam led to flooding in communities such as Abume, Kudikope, Kpedzi, Ahenbrom, and Dzidzokope, creating conditions that facilitated the spread of waterborne diseases due to contaminated water and poor sanitation. Overcrowding in shelters from displacement further heightened the risk of communicable diseases (Dumevi et al., 2024). To address these health risks, public health campaigns focused on hygiene education are essential to equip communities with the knowledge needed to prevent the spread of both waterborne and communicable diseases during emergencies. Additionally, mobile health units provide a flexible and efficient solution by delivering vital healthcare services, monitoring disease outbreaks, and offering timely interventions in remote areas. This approach improves healthcare access during critical times and strengthens the district's capacity to respond quickly to health crises.

Enhancing and preserving access routes to healthcare facilities ensures that critical services remain available during severe weather conditions. This adaptation strategy tackles the problem of infrastructure damage and disrupted access to healthcare directly, while also indirectly addressing other health issues like heat-related illnesses, waterborne diseases, and complications from displacement.

**Table 19 Ranking of adaptation options for Health and Sanitation Sector**

| Adaptation option                                                                                                                                          | Final score from stakeholders | Rank |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|------|
| Improve and maintain access routes to healthcare facilities to ensure they remain accessible during emergencies                                            | 47                            | 1    |
| Conduct continuous public health education campaigns focusing on hygiene practices, especially during climate-induced emergencies like floods and droughts | 47                            | 1    |
| Establish mobile health units to reach remote areas quickly during outbreaks                                                                               | 46                            | 3    |

**Table 20 Summary of the Adaptation Actions for the Health and Sanitation Sector**

| ADAPTATION ACTIONS                                                                                                                                         | OBJECTIVES                                                                                          | INDICATORS OF SUCCESS                                                              | TIME FRAME (Short, Medium, and Long Term) | RESOURCES (Finance, Human, Technology) | IMPLEMENTING PARTNERS          |                                                                                         | Estimated costs |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------|----------------------------------------|--------------------------------|-----------------------------------------------------------------------------------------|-----------------|
|                                                                                                                                                            |                                                                                                     |                                                                                    |                                           |                                        | Lead                           | Collaborating                                                                           |                 |
| Improve and maintain access routes to healthcare facilities to ensure they remain accessible during emergencies                                            | Ensure uninterrupted access to healthcare facilities during emergencies and extreme weather events. | Increase in the number of healthcare facilities with year-round accessible routes. | Medium-term                               | Human<br>Technology<br>Finance         | Ministry of Roads and Highways | Ghana Health Service (GHS)<br>ADA<br>Ministry of Health<br>NGOs<br>Community Groups     |                 |
|                                                                                                                                                            |                                                                                                     | Reduction in delays in accessing healthcare during emergencies.                    |                                           |                                        |                                |                                                                                         |                 |
|                                                                                                                                                            |                                                                                                     | Improvement in the structural condition of healthcare access roads.                |                                           |                                        |                                |                                                                                         |                 |
|                                                                                                                                                            |                                                                                                     | Positive feedback from communities on access to healthcare facilities.             |                                           |                                        |                                |                                                                                         |                 |
| Conduct continuous public health education campaigns focusing on hygiene practices, especially during climate-induced emergencies like floods and droughts | Improve public awareness and adoption of hygiene practices to prevent disease outbreaks.            | Number of public health education campaigns conducted annually.                    | Short Term                                | Human<br>Technology<br>Finance         | Ministry of Health             | UNICEF<br>WHO<br>NGOs<br>Ghana Education Service (GES)<br>Community-Based Organizations |                 |
|                                                                                                                                                            |                                                                                                     | Increase in public awareness of hygiene practices (via surveys).                   |                                           |                                        |                                |                                                                                         |                 |
|                                                                                                                                                            |                                                                                                     | Reduction in disease outbreaks during emergencies.                                 |                                           |                                        |                                |                                                                                         |                 |
|                                                                                                                                                            |                                                                                                     | Positive community feedback on campaign effectiveness.                             |                                           |                                        |                                |                                                                                         |                 |

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| Establish mobile health units to reach remote areas quickly during outbreaks                                                                                    | Provide timely healthcare services to remote and underserved communities during health emergencies. | Increase in the number of mobile health units deployed.                   | Short term  | Human Technology Finance | Ghana Health Service (GHS)                                                    | WHO<br>Red Cross Ghana<br>NGOs<br>Local Authorities<br>Community Health Volunteers                |  |
|                                                                                                                                                                 |                                                                                                     | Reduction in response time to health emergencies in remote areas.         |             |                          |                                                                               |                                                                                                   |  |
|                                                                                                                                                                 |                                                                                                     | Increase in the number of people served by mobile health units.           |             |                          |                                                                               |                                                                                                   |  |
|                                                                                                                                                                 |                                                                                                     | Positive feedback from remote communities on healthcare accessibility.    |             |                          |                                                                               |                                                                                                   |  |
| Integrate green spaces, urban forests, and reflective materials in city planning to reduce urban heat island effects                                            | Mitigate urban heat effects and improve environmental resilience through sustainable city planning. | Increase in the number and coverage of green spaces and urban forests.    | Medium Term | Human Technology Finance | Ministry of Local Government, Decentralization and Rural Development (MLGDRD) | Forestry Commission<br>Environmental Protection Agency (EPA)<br>NGOs<br>UNEP<br>Local Communities |  |
|                                                                                                                                                                 |                                                                                                     | Reduction in urban heat island effects (measured by temperature changes). |             |                          |                                                                               |                                                                                                   |  |
|                                                                                                                                                                 |                                                                                                     | Improvement in air quality in urban areas.                                |             |                          |                                                                               |                                                                                                   |  |
| Promote and install water-efficient sanitation solutions such as dry toilets, low-flow toilets, and waterless urinals in both residential and public facilities | Conserve water resources and improve sanitation through efficient and sustainable solutions.        | Increase in public adoption of water-efficient systems.                   | Medium Term | Human Technology Finance | Ministry of Sanitation and Water Resources                                    | UNICEF<br>Private Sector (Sanitation Companies)<br>NGOs<br>ADA<br>Community Groups                |  |
|                                                                                                                                                                 |                                                                                                     | Reduction in water consumption for sanitation purposes.                   |             |                          |                                                                               |                                                                                                   |  |
|                                                                                                                                                                 |                                                                                                     | Increase in the number of water-efficient sanitation systems installed.   |             |                          |                                                                               |                                                                                                   |  |

|                                                                                                                                                                                |                                                                                                         |                                                                             |             |                          |                                         |                                                                                                     |  |
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| Implement advanced surveillance systems to track disease outbreaks in real-time.                                                                                               | Enhance the ability to detect, track, and respond to disease outbreaks in real-time.                    | Installation and operationalization of advanced surveillance systems.       | Medium Term | Human Technology Finance | Ministry of Health                      | WHO<br>CDC<br>NGOs<br>Ghana Health Service (GHS)<br>Private Technology Providers                    |  |
|                                                                                                                                                                                |                                                                                                         | Reduction in the response time to reported disease outbreaks.               |             |                          |                                         |                                                                                                     |  |
|                                                                                                                                                                                |                                                                                                         | Increase in the number of health facilities using surveillance systems.     |             |                          |                                         |                                                                                                     |  |
|                                                                                                                                                                                |                                                                                                         | Positive feedback from health workers on system effectiveness.              |             |                          |                                         |                                                                                                     |  |
| Implement programs that educate the public on maintaining a nutritious diet during times of climate-induced food scarcity.                                                     | Improve public knowledge on nutrition to combat food insecurity and malnutrition during climate crises. | Number of nutrition education programs conducted annually.                  | Short Term  | Human Technology Finance | Ministry of Food and Agriculture (MoFA) | WFP<br>NGOs<br>Local Farmer Organizations<br>Community-Based Organizations                          |  |
|                                                                                                                                                                                |                                                                                                         | Increase in public awareness of nutrition practices (measured via surveys). |             |                          |                                         |                                                                                                     |  |
|                                                                                                                                                                                |                                                                                                         | Reduction in malnutrition rates during food scarcity.                       |             |                          |                                         |                                                                                                     |  |
| Upgrade and expand drainage systems to effectively handle increased runoff during heavy rainfall. Reinforce sewage systems to prevent overflow during floods into water bodies | Reduce flooding risks and prevent water contamination through improved drainage and sewage systems.     | Increase in the length and capacity of drainage systems upgraded.           | Long Term   | Human Technology Finance | Ministry of Works and Housing           | Environmental Protection Agency (EPA)<br>Ghana Water Company Limited (GWCL)<br>NADMO<br>NGOs<br>ADA |  |
|                                                                                                                                                                                |                                                                                                         | Reduction in flooding incidents in upgraded areas.                          |             |                          |                                         |                                                                                                     |  |
|                                                                                                                                                                                |                                                                                                         | Improvement in water quality due to reduced sewage overflows.               |             |                          |                                         |                                                                                                     |  |
|                                                                                                                                                                                |                                                                                                         | Positive community feedback on drainage improvements.                       |             |                          |                                         |                                                                                                     |  |

|                                                                                                                                                                                                                                  |                                                                                                    |                                                                                                          |             |                          |                                       |                                                                                                   |  |
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| Ensure that healthcare facilities are built or renovated to withstand extreme weather events, including elevated buildings in flood-prone areas and reinforced structures in storm-prone areas, and also hidden roofs to prevent | Protect healthcare infrastructure from extreme weather events and ensure uninterrupted operations. | Increase in the number of healthcare facilities constructed or renovated to climate-resilient standards. | Long Term   | Human Technology Finance | Ministry of Health                    | NADMO<br>Ghana Health Service (GHS)<br>Construction Companies<br>UNDP<br>Local Authorities        |  |
|                                                                                                                                                                                                                                  |                                                                                                    | Reduction in structural damage to healthcare facilities during extreme weather events.                   |             |                          |                                       |                                                                                                   |  |
|                                                                                                                                                                                                                                  |                                                                                                    | Improvement in facility operational continuity during emergencies.                                       |             |                          |                                       |                                                                                                   |  |
|                                                                                                                                                                                                                                  |                                                                                                    | Positive feedback from facility users on infrastructure durability.                                      |             |                          |                                       |                                                                                                   |  |
| Develop and enforce stricter regulations on sanitation practices, ensuring that all new developments incorporate climate-resilient sanitation systems                                                                            | Enhance public health by integrating climate-resilient sanitation systems in urban development.    | Increase in the number of developments incorporating climate-resilient sanitation systems.               | Medium Term | Human Technology Finance | Environmental Protection Agency (EPA) | Ministry of Works and Housing<br>Ministry of Sanitation and Water Resources<br>NGOs<br>ADA<br>EPA |  |
|                                                                                                                                                                                                                                  |                                                                                                    | Reduction in sanitation-related disease outbreaks.                                                       |             |                          |                                       |                                                                                                   |  |
|                                                                                                                                                                                                                                  |                                                                                                    | Positive feedback from communities on sanitation improvements.                                           |             |                          |                                       |                                                                                                   |  |
|                                                                                                                                                                                                                                  |                                                                                                    | Enforcement of regulations monitored through inspection reports.                                         |             |                          |                                       |                                                                                                   |  |

|                                                                                                                                                                                                                                                                                                                                   |                                                                                                                      |                                                                                   |                    |                                 |                                                          |                                                                                                                      |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|--------------------|---------------------------------|----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|--|
| <p>Improve the early warning systems for severe weather and potential dam spillages by incorporating more sophisticated meteorological tools and community alert systems. Ensure that these systems are accessible and understood by all members of the community, including non-native speakers and those with disabilities.</p> | <p>Enhance community preparedness and response to severe weather events through effective early warning systems.</p> | <p>Installation of advanced meteorological tools and alert systems.</p>           | <p>Medium-term</p> | <p>Human Technology Finance</p> | <p>National Disaster Management Organization (NADMO)</p> | <p>Ghana Meteorological Agency (GMeT)<br/>NADMO<br/>Local Authorities<br/>NGOs<br/>Community-Based Organizations</p> |  |
|                                                                                                                                                                                                                                                                                                                                   |                                                                                                                      | <p>Increase in the percentage of community members receiving timely warnings.</p> |                    |                                 |                                                          |                                                                                                                      |  |
|                                                                                                                                                                                                                                                                                                                                   |                                                                                                                      | <p>Reduction in casualties and damages during severe weather events.</p>          |                    |                                 |                                                          |                                                                                                                      |  |

|                                                                                                                                                                                                                                    |                                                                                                        |                                                                             |             |                          |                                                   |                                                                                                                 |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-------------|--------------------------|---------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|--|
| Prepare for displacement by pre-designating emergency shelters with adequate space and sanitation facilities. Develop plans for quick-deployment housing units that can be rapidly set up in the event of widespread displacement. | Ensure the safety and well-being of displaced populations through planned emergency housing solutions. | Increase in the number of pre-designated emergency shelters.                | Medium Term | Human Technology Finance | National Disaster Management Organization (NADMO) | UNHCR<br>Ghana Red Cross<br>Ministry of Works and Housing<br>Local Authorities<br>Community-Based Organizations |  |
|                                                                                                                                                                                                                                    |                                                                                                        | Improvement in shelter capacity and sanitation facilities.                  |             |                          |                                                   |                                                                                                                 |  |
|                                                                                                                                                                                                                                    |                                                                                                        | Reduction in time to deploy quick-housing units during displacement events. |             |                          |                                                   |                                                                                                                 |  |
|                                                                                                                                                                                                                                    |                                                                                                        | Positive feedback from displaced persons on shelter adequacy.               |             |                          |                                                   |                                                                                                                 |  |

## 11.5 Biodiversity

According to the Asuogyaman Climate Vulnerability and Risk Assessment report, the vulnerability of this sector is primarily driven by drought, which has diminished habitat quality and reduced water resources for wildlife, leading to decreased biodiversity and disrupted ecological balances. Rising temperatures have also altered the migration patterns of birds such as vultures and herons, while higher temperatures have increased the prevalence of pests and diseases, negatively impacting both agriculture and natural ecosystems. Of the fourteen (14) adaptation actions identified and assessed using the Multi-Criteria Analysis (MCA), four (4) have been selected as priorities for implementation.

For instance, empowering local communities to manage and protect their natural resources through hands-on approaches, ecosystem degradation can be prevented, soil fertility can be safeguarded, which is vital for farming success, boosting of biodiversity conservation is ensured. When communities oversee forests and water resources, they help regulate water cycles and maintain soil moisture, which is particularly important in areas like Apeguso, Ankyease and Gyakiti facing unpredictable rainfall and potential dry spells. In addition, by putting resource management in local hands, Asuogyaman tackles its unique environmental and social challenges head-on. This grassroots approach not only protects nature but also strengthens community bonds and preserves local traditions tied to the land and water.

Secondly involving local communities in habitat restoration efforts, such as reforestation degraded areas and revitalizing wetlands, serves as a key adaptation strategy for the Asuogyaman District. This district is particularly prone to climate-related challenges, including erosion, irregular rainfall, and the drying of water sources. Wetlands, particularly those around the Volta Lake, play a critical role in maintaining water flow, reducing flood risks, and preserving wildlife.

Also, the district should utilize remote sensing technologies and Geographic Information Systems (GIS) to monitor real-time changes in habitat quality, water availability, and biodiversity. These tools can provide accurate, spatially detailed data to identify trends, predict potential risks, and assess the impacts of climate change on natural ecosystems. By integrating this information into decision-making processes, stakeholders and local communities can develop targeted interventions, such as habitat restoration or water resource management, and prioritize areas most at risk. Additionally, these technologies enhance early warning systems for droughts, floods, and other extreme weather events, enabling proactive measures to protect ecosystems and ensure sustainable land use planning.

Lastly, establishing community conservation group where locals have the authority and responsibility to enforce conservation rules and practices is a transformative adaptation strategy for the area. The benefits of this adaptation action reach beyond just environmental protection. Community conservation areas nurture a deep sense of local ownership and responsibility among residents, revitalizing traditional ecological knowledge that has sustained these lands for generations. Placing the power of conservation in the hands of those who know the land best, Asuogyaman District is not just adapting to climate change – it's building a model of sustainable development that could inspire communities across Ghana and beyond.

**Table 21 Ranking of adaptation options for the biodiversity sector**

| Adaptation Option                                                                                         | Final score from stakeholders | Rank |
|-----------------------------------------------------------------------------------------------------------|-------------------------------|------|
| Empower local communities to manage and protect their natural resources through participatory approaches. | 42                            | 1    |

|                                                                                                                                                                                                                                                                                |    |   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|---|
| Encourage local communities to participate in habitat restoration projects, such as tree planting and wetland restoration.                                                                                                                                                     | 41 | 2 |
| Remote Sensing and GIS: Implement remote sensing technologies and Geographic Information Systems (GIS) to monitor changes in habitat quality, water availability, and biodiversity in real time. This data can inform timely interventions and adaptive management strategies. | 40 | 3 |
| Establish community conservation areas where locals have the authority and responsibility to enforce conservation rules and practices.                                                                                                                                         | 40 | 3 |

**Table 22 Summary of the Adaptation Actions for the Biodiversity Sector**

| ADAPTATION ACTIONS                                                                                                                                                                                                                                                             | OBJECTIVES                                                                                               | INDICATORS OF SUCCESS                                                          | TIME FRAME (Short, Medium and Long Term) | RESOURCES (Finance, Human, Technology) | IMPLEMENTING PARTNERS                                                |                                                                                             | Estimated costs |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|------------------------------------------|----------------------------------------|----------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------|
|                                                                                                                                                                                                                                                                                |                                                                                                          |                                                                                |                                          |                                        | Lead                                                                 | Collaborating                                                                               |                 |
| Empower local communities to manage and protect their natural resources through participatory approaches.                                                                                                                                                                      | Enhance the sustainable management and conservation of natural resources by involving local communities. | Number of communities actively participating in resource management.           | Medium-term                              | Human<br>Technology<br>Finance         | Ministry of Lands and Natural Resources                              | Forestry Commission<br>NGOs<br>Community-Based Organizations<br>ADA<br>EPA                  |                 |
|                                                                                                                                                                                                                                                                                |                                                                                                          | Reduction in illegal resource extraction activities.                           |                                          |                                        |                                                                      |                                                                                             |                 |
|                                                                                                                                                                                                                                                                                |                                                                                                          | Improvement in the health and sustainability of natural resources.             |                                          |                                        |                                                                      |                                                                                             |                 |
| Remote Sensing and GIS: Implement remote sensing technologies and Geographic Information Systems (GIS) to monitor changes in habitat quality, water availability, and biodiversity in real time. This data can inform timely interventions and adaptive management strategies. | Enable data-driven decision-making and adaptive management of ecosystems through real-time monitoring    | Increase in the number of remote sensing and GIS tools operationalized.        | Medium Term                              | Human<br>Technology<br>Finance         | Ministry of Environment, Science, Technology, and Innovation (MESTI) | CSIR, EPA<br>Ghana Meteorological Agency<br>Research Institutions (e.g., UG, KNUST)<br>NGOs |                 |
|                                                                                                                                                                                                                                                                                |                                                                                                          | Frequency and accuracy of habitat quality and biodiversity monitoring reports. |                                          |                                        |                                                                      |                                                                                             |                 |
|                                                                                                                                                                                                                                                                                |                                                                                                          | Reduction in response time to habitat degradation events.                      |                                          |                                        |                                                                      |                                                                                             |                 |
|                                                                                                                                                                                                                                                                                |                                                                                                          | Improved decision-making informed by real-time data.                           |                                          |                                        |                                                                      |                                                                                             |                 |

|                                                                                                                                                                                                     |                                                                                              |                                                                                        |             |                          |                                            |                                                                                         |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|-------------|--------------------------|--------------------------------------------|-----------------------------------------------------------------------------------------|--|
| Develop and implement a comprehensive Integrated Water Resource Management plan that includes sustainable water use practices, conservation of water resources, and protection of aquatic habitats. | Ensure sustainable and equitable use of water resources while conserving aquatic ecosystems. | Completion and implementation of the Integrated Water Resource Management (IWRM) plan. | Long Term   | Human Technology Finance | Ministry of Sanitation and Water Resources | Water Resources Commission<br>EPA<br>FAO<br>NGOs<br>Local Authorities                   |  |
|                                                                                                                                                                                                     |                                                                                              | Increase in the adoption of sustainable water use practices.                           |             |                          |                                            |                                                                                         |  |
|                                                                                                                                                                                                     |                                                                                              | Improvement in water quality and availability.                                         |             |                          |                                            |                                                                                         |  |
|                                                                                                                                                                                                     |                                                                                              | Reduction in conflicts over water resources.                                           |             |                          |                                            |                                                                                         |  |
| Establish community conservation areas where locals have the authority and responsibility to enforce conservation rules and practices.                                                              | Strengthen local stewardship over conservation areas to protect biodiversity and habitats.   | Number of conservation areas established and actively managed by communities.          | Medium-term | Human Technology Finance | Forestry Commission                        | Ministry of Lands and Natural Resources<br>Community-Based Organizations<br>NGOs<br>ADA |  |
|                                                                                                                                                                                                     |                                                                                              | Reduction in illegal activities within conservation areas.                             |             |                          |                                            |                                                                                         |  |
|                                                                                                                                                                                                     |                                                                                              | Improvement in biodiversity and ecosystem health in conservation areas.                |             |                          |                                            |                                                                                         |  |
|                                                                                                                                                                                                     |                                                                                              | Increase in community participation in conservation efforts.                           |             |                          |                                            |                                                                                         |  |

|                                                                                                                                                                      |                                                                                       |                                                                 |             |                          |                                        |                                                                                         |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|-----------------------------------------------------------------|-------------|--------------------------|----------------------------------------|-----------------------------------------------------------------------------------------|--|
| Encourage local communities to participate in habitat restoration projects, such as tree planting and wetland restoration.                                           | Restore and enhance degraded ecosystems through active community engagement.          | Number of habitat restoration projects initiated and completed. | Medium Term | Human Technology Finance | Forestry Commission                    | EPA<br>NGOs<br>Community Groups<br>Ministry of Lands and Natural Resources<br>UNEP      |  |
|                                                                                                                                                                      |                                                                                       | Increase in the number of trees planted and wetlands restored.  |             |                          |                                        |                                                                                         |  |
|                                                                                                                                                                      |                                                                                       | Improvement in biodiversity in restored areas.                  |             |                          |                                        |                                                                                         |  |
|                                                                                                                                                                      |                                                                                       | Positive feedback from community participants.                  |             |                          |                                        |                                                                                         |  |
| Establish local conservation groups that can take active roles in monitoring wildlife and reporting any illegal activities, such as poaching or habitat destruction. | Improve wildlife conservation and law enforcement through community-based monitoring. | Increase in the number of active conservation groups formed.    | Short Term  | Human Technology Finance | Wildlife Division, Forestry Commission | ADA<br>NGOs<br>Community-Based Organizations<br>Ministry of Lands and Natural Resources |  |
|                                                                                                                                                                      |                                                                                       | Frequency of illegal activities reported and addressed.         |             |                          |                                        |                                                                                         |  |
|                                                                                                                                                                      |                                                                                       | Improvement in wildlife population trends.                      |             |                          |                                        |                                                                                         |  |

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|-------------|--------------------------|----------------------------|---------------------------------------------------------------------------------------------------|--|
| Early Warning Systems: Develop early warning systems for drought and other climate-related events to anticipate and mitigate their impacts on biodiversity. This can include automated weather stations, drought forecasting models, and community-based alert systems | Enhance preparedness and reduce biodiversity impacts of climate-related events through timely alerts. | Installation and operationalization of early warning systems.           | Medium Term | Human Technology Finance | NADMO                      | Ghana Meteorological Agency<br>NGOs<br>Community-Based Organizations<br>Local Authorities<br>UNDP |  |
|                                                                                                                                                                                                                                                                        |                                                                                                       | Increase in the percentage of communities receiving timely alerts.      |             |                          |                            |                                                                                                   |  |
|                                                                                                                                                                                                                                                                        |                                                                                                       | Reduction in biodiversity impacts during climate-related events.        |             |                          |                            |                                                                                                   |  |
| Enforce regulations that prevent over-extraction of water from rivers and lakes, ensuring sufficient water remains to support wildlife.                                                                                                                                | Maintain ecological balance by ensuring sustainable water extraction practices.                       | Increase in the enforcement actions against over-extraction activities. | Medium Term | Human Technology Finance | Water Resources Commission | EPA<br>Ministry of Sanitation and Water Resources<br>NGOs<br>Local Authorities                    |  |
|                                                                                                                                                                                                                                                                        |                                                                                                       | Maintenance of ecological flow levels in rivers and lakes.              |             |                          |                            |                                                                                                   |  |
|                                                                                                                                                                                                                                                                        |                                                                                                       | Improvement in wildlife populations dependent on water bodies.          |             |                          |                            |                                                                                                   |  |
|                                                                                                                                                                                                                                                                        |                                                                                                       | Reduction in reported cases of illegal water extraction.                |             |                          |                            |                                                                                                   |  |

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|----------------------------------------------------------------------------|-------------|--------------------------|-----------------------------------------|----------------------------------------------------------------------------|--|
| Restore and maintain critical habitats that are important for the breeding, feeding, and sheltering of affected bird species and other wildlife. This includes the reforestation of lake shores and riverbanks, and the restoration of wetlands and other natural habitats | Safeguard critical habitats essential for the survival of wildlife and bird species. | Increase in the area of habitats restored or maintained.                   | Long Term   | Human Technology Finance | Forestry Commission                     | EPA<br>NGOs<br>Ministry of Lands and Natural Resources<br>Community Groups |  |
|                                                                                                                                                                                                                                                                            |                                                                                      | Growth in populations of key wildlife and bird species.                    |             |                          |                                         |                                                                            |  |
|                                                                                                                                                                                                                                                                            |                                                                                      | Reduction in habitat degradation trends.                                   |             |                          |                                         |                                                                            |  |
|                                                                                                                                                                                                                                                                            |                                                                                      | Positive feedback from ecological monitoring reports.                      |             |                          |                                         |                                                                            |  |
| Introduce or enhance the presence of natural predators or competitors of common pests and pathogens in the aquatic ecosystem                                                                                                                                               | Regulate aquatic pests and pathogens naturally to maintain ecosystem health.         | Increase in the population of natural predators or competitors introduced. | Medium term | Human Technology Finance | Ministry of Food and Agriculture (MoFA) | CSIR-Water Research Institute<br>NGOs<br>FAO<br>Local Authorities          |  |
|                                                                                                                                                                                                                                                                            |                                                                                      | Reduction in pest and pathogen levels in aquatic ecosystems.               |             |                          |                                         |                                                                            |  |
|                                                                                                                                                                                                                                                                            |                                                                                      | Improvement in aquatic ecosystem health.                                   |             |                          |                                         |                                                                            |  |

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|----------------------------------------------------------------|-------------|--------------------------|----------------------------------------------------------------------|-----------------------------------------------------------------------------------------|--|
| Implement measures to manage and restore critical aquatic habitats to improve natural resilience against pests and diseases. This could include the reestablishment of mangroves, wetlands, and other natural barriers | Increase the resilience of aquatic ecosystems to pests and diseases through habitat restoration. | Increase in the area of aquatic habitats restored.             | Long term   | Human Technology Finance | Ministry of Environment, Science, Technology, and Innovation (MESTI) | CSIR<br>EPA<br>UNEP<br>NGOs<br>Local Communities                                        |  |
|                                                                                                                                                                                                                        |                                                                                                  | Reduction in pest and disease prevalence in aquatic habitats.  |             |                          |                                                                      |                                                                                         |  |
|                                                                                                                                                                                                                        |                                                                                                  | Improvement in water quality and ecosystem health.             |             |                          |                                                                      |                                                                                         |  |
|                                                                                                                                                                                                                        |                                                                                                  | Positive feedback from local communities and stakeholders.     |             |                          |                                                                      |                                                                                         |  |
| Designate and enforce protected areas around crucial breeding and nesting sites to minimize disturbance during critical periods of the life cycle of these birds                                                       | Protect sensitive wildlife breeding and nesting sites to ensure species survival.                | Increase in the number of protected areas designated.          | Medium term | Human Technology Finance | Wildlife Division, Forestry Commission                               | EPA<br>NGOs<br>Community-Based Organizations<br>Ministry of Lands and Natural Resources |  |
|                                                                                                                                                                                                                        |                                                                                                  | Reduction in disturbances during breeding and nesting periods. |             |                          |                                                                      |                                                                                         |  |
|                                                                                                                                                                                                                        |                                                                                                  | Growth in bird populations utilizing protected areas.          |             |                          |                                                                      |                                                                                         |  |

|                                                                                                                                                                                             |                                                                                             |                                                                               |             |                          |                                         |                                                                            |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|-------------|--------------------------|-----------------------------------------|----------------------------------------------------------------------------|--|
| Implement sustainable land-use practices within the watershed to reduce erosion and runoff, promote groundwater recharge, and prevent sedimentation that can degrade water bodies           | Protect water bodies and promote ecosystem health through sustainable watershed management. | Increase in the adoption of sustainable land-use practices within watersheds. | Medium Term | Human Technology Finance | Ministry of Food and Agriculture (MoFA) | Water Resources Commission<br>NGOs<br>FAO<br>ADA                           |  |
|                                                                                                                                                                                             |                                                                                             | Reduction in sedimentation and erosion rates.                                 |             |                          |                                         |                                                                            |  |
|                                                                                                                                                                                             |                                                                                             | Improvement in water quality and groundwater recharge rates.                  |             |                          |                                         |                                                                            |  |
| Encourage the adoption of fishing practices that are adaptable to changing water conditions, such as adjustable fishing schedules and locations, and gear that minimizes ecological impact. | Ensure sustainable fisheries while minimizing the ecological impact of fishing practices.   | Increase in the number of fishers adopting sustainable fishing practices.     | Medium Term | Human Technology Finance | Fisheries Commission                    | Ministry of Food and Agriculture (MoFA)<br>NGOs<br>Community Groups<br>ADA |  |
|                                                                                                                                                                                             |                                                                                             | Reduction in ecological impact from fishing activities.                       |             |                          |                                         |                                                                            |  |
|                                                                                                                                                                                             |                                                                                             | Improvement in fish populations and aquatic biodiversity.                     |             |                          |                                         |                                                                            |  |

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| Restore degraded wetlands and establish new ones. Enhance the natural water retention capabilities of these ecosystems to counteract the effects of droughts                                                             | Increase water retention and ecosystem resilience through wetland restoration and establishment. | Increase in the area of wetlands restored or newly established. | Long Term   | Human Technology Finance | Forestry Commission                     | EPA<br>UNEP<br>Ministry of Lands and Natural Resources<br>NGOs<br>ADA       |  |
|                                                                                                                                                                                                                          |                                                                                                  | Improvement in water retention capacity in restored wetlands.   |             |                          |                                         |                                                                             |  |
|                                                                                                                                                                                                                          |                                                                                                  | Growth in biodiversity within wetlands.                         |             |                          |                                         |                                                                             |  |
|                                                                                                                                                                                                                          |                                                                                                  | Reduction in the impacts of droughts on surrounding ecosystems. |             |                          |                                         |                                                                             |  |
| Construction of Artificial Waterholes: Build artificial ponds and waterholes in strategic locations to provide reliable water sources for wildlife. These can be lined with materials to prevent seepage and evaporation | Ensure water availability for wildlife during droughts through artificial water sources.         | Increase in the number of artificial waterholes constructed.    | Medium Term | Human Technology Finance | Ministry of Food and Agriculture (MoFA) | CSIR<br>NGOs<br>Community Groups<br>Ministry of Lands and Natural Resources |  |
|                                                                                                                                                                                                                          |                                                                                                  | Reduction in water scarcity for wildlife during droughts.       |             |                          |                                         |                                                                             |  |
|                                                                                                                                                                                                                          |                                                                                                  | Improvement in wildlife health and populations.                 |             |                          |                                         |                                                                             |  |

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|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|------------------------------------------------------------------|-------------|--------------------------------|----------------------------------|---------------------------------------------------------------------------|--|
| Maintain Existing Water Bodies:<br>Regularly dredge and maintain existing natural water bodies to increase their capacity and ensure they can store more water during rainy seasons, making it available during droughts. | Improve water storage capacity and availability through maintenance of natural water bodies. | Increase in the capacity of dredged and maintained water bodies. | Medium Term | Human<br>Technology<br>Finance | Water<br>Resources<br>Commission | Ministry of<br>Sanitation<br>and Water<br>Resources<br>ADA<br>EPA<br>NGOs |  |
|                                                                                                                                                                                                                           |                                                                                              | Reduction in water shortages during drought periods.             |             |                                |                                  |                                                                           |  |
|                                                                                                                                                                                                                           |                                                                                              | Improvement in water quality in maintained water bodies.         |             |                                |                                  |                                                                           |  |
|                                                                                                                                                                                                                           |                                                                                              | Positive feedback from water users and stakeholders.             |             |                                |                                  |                                                                           |  |

## 11.6 Disaster Risk & Infrastructure

The Asuogyaman District faces severe climate risks, including floods, storms, and droughts, which disrupt essential services and damage key infrastructure such as roads, bridges, schools, and markets. Fluctuating water levels in the Volta Lake, intensified by rainfall and Akosombo Dam operations, cause severe flooding, particularly affecting communities along the Akosombo-Atimpoku-Akrade corridor, such as Akwamufie and Senchi Ferry. Prolonged droughts worsen water shortages, impacting hydropower, irrigation, and domestic use. Additionally, deforestation in areas like the Taposu and Aboben reserves and insufficient tree cover expose infrastructure to strong winds and storms. To address these challenges highlighted in the Climate Vulnerability and Risk Assessment Report, stakeholders at the validation workshop have prioritized three (3) of the ten (10) proposed adaptation measures to mitigate flooding, droughts, and infrastructure damage, ensuring greater resilience for the district.

Implementing tree planting as windbreaks in Asuogyaman District presents a proactive approach to managing the climate challenges the area faces. This nature-based solution helps address vulnerabilities to extreme weather, such as windstorms and floods, which have caused damage to key infrastructure like schools and markets. Acting as natural barriers, these windbreaks protect buildings and vital structures from strong winds, boosting the district's resilience. Furthermore, educating the community about emergency protocols such as locating safe shelters, understanding evacuation routes, and following safety procedures can greatly mitigate the impacts of flooding. Enhanced preparedness reduces both loss of life and property, improve the effectiveness of emergency responses, and foster quicker recovery, thereby building greater resilience against future climate-related events in the district.

Lastly, Early warning systems and climate information services are vital in managing the risks associated with climate change, particularly in disaster-prone areas like Akwamufie, Abume, Kokontekpedzi, Mangoase, Tusker, Atimpoku, Adome, Maamewater, Dzidzokope etc. The overflow from the Akosombo Dam has demonstrated the urgent need for improved early warning systems and climate information services. These tools can provide critical insights into extreme weather patterns, including the timing and intensity of rainfall, which are essential for disaster preparedness and response. By integrating such systems into disaster management and infrastructure planning, the district can enhance its ability to respond to flooding and other climate-related challenges.

The importance of early warning and climate information services is recognized in several major climate change policies and strategies, including the National Climate Change Adaptation Strategy 2012 and the Ghana National Climate Change Policy 2013. These frameworks emphasize the need for accessible and actionable climate information to support sustainable development and resilience-building efforts.

**Table 23 Ranking of adaptation options for Disaster Risk and Infrastructure**

| Adaptation option                                                                                                                                          | Final score from stakeholders | Rank |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|------|
| Encourage tree planting to act as windbreaks to reduce the wind speed and mitigate its impact                                                              | 48                            | 1    |
| Educate the community on emergency preparedness for flooding, including safe shelters and necessary precautions during severe weather.                     | 48                            | 1    |
| Implement an advanced early warning system that can alert communities to flooding or severe weather conditions. Enhance local disaster response capacities | 47                            | 3    |

**Table 24 Summary of the Adaptation Actions for Disaster Risk and Infrastructure**

| ADAPTATION ACTIONS                                                                                                                     | OBJECTIVES                                                                                       | INDICATORS OF SUCCESS                                                     | TIME FRAME (Short, Medium and Long Term) | RESOURCES (Finance, Human, Technology) | IMPLEMENTING PARTNERS                             |                                                                                       | Estimated costs |
|----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|------------------------------------------|----------------------------------------|---------------------------------------------------|---------------------------------------------------------------------------------------|-----------------|
|                                                                                                                                        |                                                                                                  |                                                                           |                                          |                                        | Lead                                              | Collaborating                                                                         |                 |
| Encourage tree planting to act as windbreaks to reduce the wind speed and mitigate its impact                                          | Reduce wind speed and mitigate its impacts on infrastructure, agriculture, and communities.      | Increase in the number of trees planted as windbreaks.                    | Medium-term                              | Human<br>Technology<br>Finance         | Forestry Commission                               | EPA<br>Ministry of Food and Agriculture (MoFA)<br>ADA<br>NGOs<br>Community Groups     |                 |
|                                                                                                                                        |                                                                                                  | Reduction in wind speed impacts on infrastructure and agriculture.        |                                          |                                        |                                                   |                                                                                       |                 |
|                                                                                                                                        |                                                                                                  | Improvement in soil erosion control in areas with tree windbreaks.        |                                          |                                        |                                                   |                                                                                       |                 |
| Educate the community on emergency preparedness for flooding, including safe shelters and necessary precautions during severe weather. | Enhance community knowledge and readiness to respond effectively to flooding and severe weather. | Increase in the number of community training sessions conducted annually. | Short term                               | Human<br>Technology<br>Finance         | National Disaster Management Organization (NADMO) | Ministry of Information<br>Local Authorities<br>NGOs<br>Community-Based Organizations |                 |
|                                                                                                                                        |                                                                                                  | Growth in community knowledge of flooding preparedness (via surveys).     |                                          |                                        |                                                   |                                                                                       |                 |
|                                                                                                                                        |                                                                                                  | Increase in the use of designated safe shelters during flooding.          |                                          |                                        |                                                   |                                                                                       |                 |
|                                                                                                                                        |                                                                                                  | Reduction in flood-related casualties and damages.                        |                                          |                                        |                                                   |                                                                                       |                 |

|                                                                                                                                                                                                                               |                                                                                                 |                                                                       |             |                          |                                                   |                                                                                                   |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|-------------|--------------------------|---------------------------------------------------|---------------------------------------------------------------------------------------------------|--|
| Implement an advanced early warning system that can alert communities to flooding or severe weather conditions. Enhance local disaster response capacities                                                                    | Improve disaster preparedness and response through timely alerts and enhanced local capacities. | Installation and operationalization of early warning systems.         | Medium-term | Human Technology Finance | National Disaster Management Organization (NADMO) | Ghana Meteorological Agency<br>Local Authorities<br>NGOs<br>Community-Based Organizations<br>UNDP |  |
|                                                                                                                                                                                                                               |                                                                                                 | Increase in the percentage of the population receiving timely alerts. |             |                          |                                                   |                                                                                                   |  |
|                                                                                                                                                                                                                               |                                                                                                 | Reduction in casualties and damages during severe weather events.     |             |                          |                                                   |                                                                                                   |  |
|                                                                                                                                                                                                                               |                                                                                                 | Improved local disaster response times and efficiency.                |             |                          |                                                   |                                                                                                   |  |
| Strengthen the emergency response capabilities around Volta Lake, including better-equipped and strategically located rescue stations, faster deployment of rescue teams, and clear communication channels during emergencies | Ensure timely and effective emergency response to protect lives and property around Volta Lake. | Increase in the number of well-equipped rescue stations.              | Medium-term | Human Technology Finance | National Disaster Management Organization (NADMO) | Ministry of Transport<br>Ghana Maritime Authority<br>NGOs<br>Red Cross<br>Ghana Local Authorities |  |
|                                                                                                                                                                                                                               |                                                                                                 | Reduction in response time for emergency rescues.                     |             |                          |                                                   |                                                                                                   |  |
|                                                                                                                                                                                                                               |                                                                                                 | Improvement in communication systems during emergencies.              |             |                          |                                                   |                                                                                                   |  |
|                                                                                                                                                                                                                               |                                                                                                 | Positive feedback from stakeholders on response effectiveness.        |             |                          |                                                   |                                                                                                   |  |

|                                                                                                                     |                                                                                                    |                                                                        |             |                          |                                                                                |                                                                                                   |  |
|---------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|-------------|--------------------------|--------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|--|
| Enforce zoning regulations that restrict construction in flood-prone areas along the Volta Lake and riverbanks      | Minimize the risks of flooding and property damage by regulating construction in vulnerable areas. | Increase in compliance with zoning regulations.                        | Long Term   | Human Technology Finance | Ministry of Local Government, Decentralization, and Rural Development (MLGDRD) | EPA<br>NADMO<br>ADA<br>Community Groups                                                           |  |
|                                                                                                                     |                                                                                                    | Reduction in new developments in flood-prone areas.                    |             |                          |                                                                                |                                                                                                   |  |
|                                                                                                                     |                                                                                                    | Decrease in flood-related damages in regulated areas.                  |             |                          |                                                                                |                                                                                                   |  |
|                                                                                                                     |                                                                                                    | Improved monitoring and enforcement of zoning laws.                    |             |                          |                                                                                |                                                                                                   |  |
| Ensure that building codes are updated to reflect the need for structures to withstand high winds and severe storms | Enhance the resilience of buildings to withstand high winds and severe storms.                     | Number of building codes revised to include wind and storm resilience. | Medium-term | Human Technology Finance | Ministry of Works and Housing                                                  | Local Authorities<br>Construction Companies<br>UNDP<br>Ghana<br>Institution of Engineers<br>NADMO |  |
|                                                                                                                     |                                                                                                    | Increase in the number of buildings constructed to updated standards.  |             |                          |                                                                                |                                                                                                   |  |
|                                                                                                                     |                                                                                                    | Reduction in structural damages during severe storms.                  |             |                          |                                                                                |                                                                                                   |  |
|                                                                                                                     |                                                                                                    | Positive feedback from builders and residents on new codes.            |             |                          |                                                                                |                                                                                                   |  |

|                                                                                                                                                                                                                               |                                                                                              |                                                                                  |           |                                |                                            |                                                                                                            |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|-----------|--------------------------------|--------------------------------------------|------------------------------------------------------------------------------------------------------------|--|
| Build new water storage facilities such as reservoirs and expand existing ones to increase water storage capacity. Promote and implement water conservation measures across all sectors (domestic, agricultural, industrial). | Increase water storage capacity and promote efficient use of water resources.                | Increase in the number of new or expanded water storage facilities.              | Long term | Human<br>Technology<br>Finance | Ministry of Sanitation and Water Resources | Ghana Water Company Limited (GWCL)<br>Ministry of Food and Agriculture (MoFA)<br>NGOs<br>Local Authorities |  |
|                                                                                                                                                                                                                               |                                                                                              | Improvement in water availability during dry spells.                             |           |                                |                                            |                                                                                                            |  |
|                                                                                                                                                                                                                               |                                                                                              | Reduction in water wastage across sectors.                                       |           |                                |                                            |                                                                                                            |  |
| Strengthen and elevate critical infrastructure such as roads, bridges, and buildings to withstand flooding. Construct flood barriers and retention basins where necessary                                                     | Protect critical infrastructure and communities from flooding and enhance climate resilience | Reduction in flood-related damages to infrastructure.                            | Long term | Human<br>Technology<br>Finance | Ministry of Roads and Highways             | Ministry of Works and Housing<br>NADMO<br>Construction Companies<br>Local Authorities<br>EPA               |  |
|                                                                                                                                                                                                                               |                                                                                              | Increase in the number of critical infrastructure projects upgraded or elevated. |           |                                |                                            |                                                                                                            |  |
|                                                                                                                                                                                                                               |                                                                                              | Improvement in transportation and connectivity during floods.                    |           |                                |                                            |                                                                                                            |  |

|                                                                                                                                                            |                                                                                                 |                                                                         |             |                          |                                            |                                                                                                           |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|-------------|--------------------------|--------------------------------------------|-----------------------------------------------------------------------------------------------------------|--|
| Develop alternative water sources such as rainwater harvesting, and groundwater, and diversify the water supply portfolio.                                 | Ensure water security by diversifying water sources and reducing reliance on a single supply.   | Increase in the number of alternative water supply systems implemented. | Medium term | Human Technology Finance | Ministry of Sanitation and Water Resources | CSIR-Water Research Institute<br>NGOs<br>Private Sector (Water Technology Companies)<br>Local Authorities |  |
|                                                                                                                                                            |                                                                                                 | Growth in community access to diversified water sources.                |             |                          |                                            |                                                                                                           |  |
|                                                                                                                                                            |                                                                                                 | Reduction in reliance on a single water source.                         |             |                          |                                            |                                                                                                           |  |
| Establish a robust system to monitor weather conditions and provide timely warnings to lake users about strong winds and other adverse weather conditions. | Protect lake users through real-time weather monitoring and timely warnings.                    | Installation and operationalization of weather monitoring systems.      | Medium term | Human Technology Finance | Ghana Meteorological Agency                | NADMO<br>Ghana Maritime Authority<br>NGOs<br>Local Authorities, UNDP                                      |  |
|                                                                                                                                                            |                                                                                                 | Increase in the percentage of lake users receiving timely warnings.     |             |                          |                                            |                                                                                                           |  |
|                                                                                                                                                            |                                                                                                 | Reduction in accidents and damages caused by adverse weather.           |             |                          |                                            |                                                                                                           |  |
| Restore and conserve wetlands which can act as natural buffers that absorb excess rainwater                                                                | Reduce flood risks and enhance ecosystem services through wetland restoration and conservation. | Increase in the area of wetlands restored and conserved.                | Long term   | Human Technology Finance | Forestry Commission                        | EPA<br>Ministry of Lands and Natural Resources<br>NGOs<br>UNEP<br>Community Groups                        |  |
|                                                                                                                                                            |                                                                                                 | Reduction in flood risks in areas with restored wetlands.               |             |                          |                                            |                                                                                                           |  |
|                                                                                                                                                            |                                                                                                 | Improvement in biodiversity and ecosystem services.                     |             |                          |                                            |                                                                                                           |  |
|                                                                                                                                                            |                                                                                                 | Positive feedback from local communities on wetland benefits.           |             |                          |                                            |                                                                                                           |  |

|                                                                                                                                                                                                                                    |                                                                                                  |                                                                          |             |                                |                          |                                                                                                          |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|-------------|--------------------------------|--------------------------|----------------------------------------------------------------------------------------------------------|--|
| Build more robust and wind-resistant docking and mooring facilities. Improving the physical infrastructure around the lake to withstand adverse weather conditions better and provide safer harbors for boats during strong winds. | Enhance the safety and durability of lake infrastructure to withstand adverse weather conditions | Increase in the number of wind-resistant docking facilities constructed. | Medium term | Human<br>Technology<br>Finance | Ministry of<br>Transport | Ghana<br>Maritime<br>Authority<br>NADMO<br>Construction<br>Companies<br>Local<br>Authorities<br>Agencies |  |
|                                                                                                                                                                                                                                    |                                                                                                  | Reduction in damage to boats and harbors during strong winds.            |             |                                |                          |                                                                                                          |  |
|                                                                                                                                                                                                                                    |                                                                                                  | Improvement in the safety of lake users.                                 |             |                                |                          |                                                                                                          |  |
|                                                                                                                                                                                                                                    |                                                                                                  | Positive feedback from boat operators and lake users.                    |             |                                |                          |                                                                                                          |  |



# 12

## Framework for Adaptation, Monitoring Evaluation and Learning

Monitoring, Evaluation, and Learning (MEL) are essential components for ensuring the success of adaptation actions in the Asuogyaman District. These processes offer several critical benefits:

- **Tracking Progress:** MEL systems enable continuous monitoring of adaptation actions, ensuring they align with their objectives and remain on track for successful implementation (European Environment Agency, 2024).
- **Evaluating Effectiveness:** By systematically assessing the outcomes of adaptation measures, MEL identifies what works, what does not, and the underlying reasons. This facilitates the refinement of strategies to improve their effectiveness and relevance.
- **Informed Decision-Making:** Insights gained through MEL activities provide evidence-based guidance for future planning and decision-making, ensuring adaptation actions are more likely to succeed and are responsive to changing conditions (NAP Global Network, 2024).
- **Learning and Improvement:** MEL fosters a culture of learning by analyzing successes and challenges in past interventions. For Asuogyaman, this ensures continuous improvement in strategies and policies to address climate risks more effectively.
- **Accountability and Transparency:** Regular monitoring and evaluation promote accountability and transparency in the implementation of adaptation actions, which is essential for maintaining public trust and securing ongoing support.
- **Resource Optimization:** MEL ensures efficient allocation of resources by identifying the most cost-effective and impactful adaptation measures, maximizing the benefits of investments in climate adaptation.
- **Stakeholder Engagement:** Inclusive MEL processes engage various stakeholders, including local communities, government agencies, and non-governmental organizations. This builds trust and ensures adaptation actions are equitable and address the diverse needs of affected groups.

According to the European Environment Agency (2024), robust MEL frameworks in adaptation planning are critical for improving resilience in vulnerable regions. Similarly, NAP Global Network (2024) emphasizes the importance of MEL in fostering a collaborative approach to adaptation, enhancing learning, and ensuring accountability. For Asuogyaman, integrating MEL into adaptation efforts is vital for achieving sustainable and inclusive climate resilience.

### 12.1 Building on Existing Structures to Facilitate Mainstreaming

MEL can leverage existing structures in the Asuogyaman District to effectively mainstream adaptation actions in several ways. Integrating MEL processes into the district's current data collection and management systems

ensures adaptation efforts are informed by accurate, up-to-date information, improving decision-making and resource allocation. By building on existing institutional frameworks, MEL can enhance the capacity of district staff through training and skill development initiatives. This approach fosters a competent workforce capable of implementing and monitoring adaptation actions effectively. MEL also facilitates better coordination among various departments and stakeholders by utilizing existing communication channels and collaborative platforms, ensuring all relevant parties are engaged and informed about adaptation efforts.

The district can incorporate MEL into established reporting mechanisms, such as annual progress reports and development plans. This integration ensures adaptation actions are regularly reviewed and adjusted based on performance and feedback. Additionally, MEL can draw on existing community engagement structures to involve local communities in the adaptation planning process, ensuring actions are inclusive and aligned with residents' needs and priorities. By leveraging existing knowledge-sharing platforms, MEL can promote the dissemination of best practices and lessons learned, fostering a culture of continuous learning and improvement within the district. Integrating MEL into these existing structures ensures adaptation actions are effectively mainstreamed, leading to more resilient and sustainable development in the Asuogyaman District.

**Table 25 Outline of approach to MEL of ADA's adaptation actions**

| Steps                                                                                             | Indicative activities—to be led by the ADA Planning Coordination Unit                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1. Monitoring the adaptation actions</b>                                                       | <ul style="list-style-type: none"> <li>Identify adaptation activities to be monitored using both qualitative and quantitative performance measures to assess progress toward achieving the adaptation objectives.</li> <li>Establish clear metrics and indicators to track and document progress for the selected adaptation activities.</li> <li>Gather data on these metrics and indicators consistently throughout the adaptation process to ensure accurate monitoring and evaluation.</li> </ul>    |
| <b>2. Reviewing the adaptation process to assess progress, effectiveness, and gaps Evaluation</b> | <ul style="list-style-type: none"> <li>Develop methods for measuring and communicating the effectiveness of adaptation activities while identifying and addressing any gaps.</li> <li>Integrate findings from recent studies, emerging scientific advancements, and feedback from ongoing adaptation efforts to evaluate and refine the current strategy.</li> <li>Update and adjust adaptation activities based on evaluation results and performance metrics to enhance their effectiveness</li> </ul> |
| <b>3. Iteratively updating the NAP – Learning</b>                                                 | <ul style="list-style-type: none"> <li>Record key insights on successful and unsuccessful aspects of the adaptation activities.</li> <li>Analyse and establish the factors contributing to their success or failure.</li> <li>Develop and implement corrective measures to address identified challenges.</li> <li>Ensure that the lessons learned and adjustments made are aligned with the broader objectives outlined in the Asuogyaman District Medium-Term Development Plan (MTDP).</li> </ul>      |

|                                                                                                                                       |                                                                                                                                                                                                                                                                                       |
|---------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>4. Steps Communication</b><br><b>Report progress, process effectiveness, outreach, and knowledge and information dissemination</b> | <ul style="list-style-type: none"> <li>• Share adaptation documents and learning materials to promote knowledge dissemination.</li> <li>• Include updates on the progress and effectiveness of the adaptation process in the Asuogyaman District's annual progress report.</li> </ul> |
|---------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

*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.*



# 13



## Conclusion and Recommendation

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### 13.1 Conclusion

The Adaptation Action Plan for the Asuogyaman District represents a pivotal step toward addressing the mounting challenges posed by climate change. This plan provides a structured framework for enhancing the district's resilience, reducing vulnerabilities, and promoting sustainable development across multiple sectors. By adopting an integrated approach to adaptation, the plan not only aligns with local development priorities but also contributes to national and international climate resilience goals.

Throughout the plan, six key sectors were examined: agriculture, gender, biodiversity, water resources, health and sanitation, and disaster risk and infrastructure. Each sector was analyzed for its unique vulnerabilities, and specific, actionable adaptation measures were prioritized based on their feasibility, impact, and alignment with the district's Medium-Term Development Plan (MTDP). These measures reflect a commitment to evidence-based decision-making, stakeholder inclusivity, and long-term sustainability.

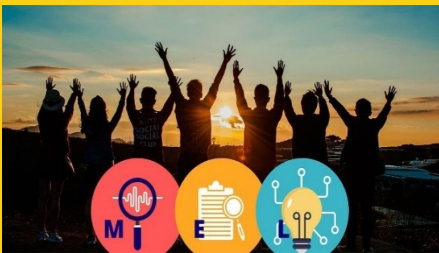
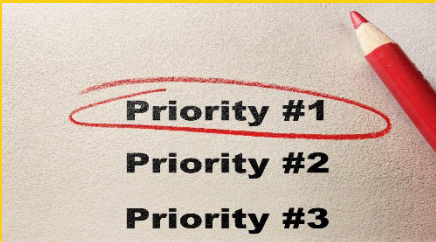
Key takeaways from the plan include the need for robust Monitoring, Evaluation, and Learning (MEL) systems to ensure the effectiveness of adaptation measures. MEL systems enable continuous tracking of progress, provide insights for informed decision-making, and foster a culture of learning that ensures the plan remains dynamic and responsive to emerging challenges. Additionally, leveraging existing institutional frameworks, engaging local communities, and promoting cross-sector collaboration are critical for successful implementation.

The identified adaptation measures address both immediate and long-term needs. For instance, flexible cropping calendars and climate-resilient agricultural practices target immediate threats to food security, while actions like reforestation and habitat restoration contribute to long-term ecological sustainability. Similarly, strategies such as mobile health units and public health campaigns address acute health risks, while enhancing healthcare infrastructure and access routes ensures resilience against future climatic events.

Despite these promising strategies, challenges remain, including resource constraints, institutional capacity limitations, and the need for continuous stakeholder engagement. Addressing these barriers requires sustained commitment from the Asuogyaman District Assembly, partnerships with national and international organizations, and the active participation of local communities.

### 13.2 Recommendations

To ensure the successful implementation and sustainability of the Adaptation Action Plan, the following recommendations are proposed:

|                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                |
|------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <p><b>Strengthen Institutional Capacity</b></p>                    | <ul style="list-style-type: none"> <li>• Invest in training and capacity-building programs for district staff and stakeholders to enhance their ability to implement and monitor adaptation measures effectively.</li> <li>• Foster inter-departmental collaboration to ensure a coordinated approach to adaptation planning and execution</li> </ul>          |
|  <p><b>Enhance Funding Mechanisms</b></p>                           | <ul style="list-style-type: none"> <li>• Mobilize resources through partnerships with national governments, international donors, and private sector actors.</li> <li>• Establish a dedicated adaptation fund within the district to finance high-priority actions and address unforeseen challenges</li> </ul>                                                |
|  <p><b>Leverage Monitoring, Evaluation, and Learning (MEL)</b></p> | <ul style="list-style-type: none"> <li>• Integrate MEL systems into existing reporting mechanisms, such as annual progress reports, to track the effectiveness of adaptation measures.</li> <li>• Use MEL insights to iteratively update the adaptation plan, ensuring it remains relevant and impactful.</li> </ul>                                           |
|  <p><b>Promote Community Engagement</b></p>                       | <ul style="list-style-type: none"> <li>• Involve local communities in the planning, implementation, and monitoring of adaptation measures to ensure they address the needs and priorities of residents.</li> <li>• Conduct regular public awareness campaigns to build community resilience and foster a culture of climate consciousness</li> </ul>           |
|  <p><b>Implement Priority Adaptation Actions</b></p>              | <ul style="list-style-type: none"> <li>• Focus on high-impact measures such as developing flexible cropping calendars, promoting rainwater harvesting, and restoring wetlands to achieve immediate benefits.</li> <li>• Scale up successful pilot projects, such as mobile health units and adaptive fishing techniques, to reach more communities.</li> </ul> |

|                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <p><b>Develop Strategic Partnerships</b></p>                | <ul style="list-style-type: none"> <li>• Collaborate with national and international organizations to access technical expertise, financial resources, and innovative solutions.</li> <li>• Partner with academic and research institutions to leverage data and insights for evidence-based decision-making</li> </ul>               |
|  <p><b>Focus<br/>on Nature-Based Solutions</b></p>           | <ul style="list-style-type: none"> <li>• Prioritize reforestation, agroforestry, and the establishment of buffer zones to enhance biodiversity, reduce erosion, and improve water quality.</li> <li>• Promote the use of indigenous knowledge and practices in ecosystem management to build locally appropriate solutions</li> </ul> |
|  <p><b>Improve Disaster Preparedness</b></p>                | <ul style="list-style-type: none"> <li>• Strengthen early warning systems and community alert mechanisms to mitigate the impacts of extreme weather events.</li> <li>• Enhance infrastructure resilience through measures like elevated buildings, flood barriers, and reinforced embankments.</li> </ul>                             |
|  <p><b>Integrate Gender and Social Inclusion</b></p>       | <ul style="list-style-type: none"> <li>• Address the unique vulnerabilities of women and marginalized groups by promoting gender-sensitive adaptation actions.</li> <li>• Ensure equitable access to resources and opportunities for all community members.</li> </ul>                                                                |
|  <p><b>Promote Knowledge Sharing and Collaboration</b></p> | <ul style="list-style-type: none"> <li>• Establish platforms for sharing best practices, lessons learned, and success stories among stakeholders.</li> <li>• Encourage regional and national collaboration to address cross-cutting climate challenges.</li> </ul>                                                                    |

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## Appendix A : Risk Description and Proposed Adaptation Measures for Asuogyaman District Assembly

| SECTORS     | IDENTIFIED CLIMATE RISKS                                                                                                                                                                                                                                                                                                         | PROPOSED ADAPTATION ACTIONS                                                                                                                                                                                                                                                                                                      | ASSESSMENT OF THE IMPACT OF PROPOSED ACTIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | SUPPORTING POLICIES                                                                                                                                                                                              |
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| Agriculture | <p>Due to its proximity to the Volta Lake and various rivers, parts of Asuogyaman District are susceptible to flooding, particularly during heavy rainfall in areas like Kudikope, Meyekpor, Aboaso, Abuma, Dodi Island, Frankadua &amp; Ankyeasa.</p> <p>These communities rely heavily on agriculture for their livelihood</p> | <p><b>Technological/Engineering Measures</b></p> <p>Strengthen and elevate embankments along rivers and lake shores; construct flood barriers and proper drainage systems where necessary</p> <p>Build elevated platforms for critical infrastructure like storage facilities and even homes to prevent damage during floods</p> | <p>The implementation of this adaption strategy and modification aims to control and divert floodwaters away from vulnerable communities closer to the volta Lake</p> <p>Restoring Wetlands in the Asuogyaman District will act as natural buffers, absorbing excess rainfall and runoff, reducing the velocity of floodwaters, and mitigating the impact of floods</p> <p>Adaptation strategies like implementing strict zoning laws will help protect communities like Kudikope, Meyekpor, Aboaso, Abuma, etc from the immediate dangers posed by floods. By reducing these risks, these communities can avoid loss of life and significant economic damage to their livelihood</p> | <p>Asuogyaman district assembly</p> <p>The 2022 annual action plan</p> <p>National Climate-Smart Agriculture and Food Security Action Plan</p> <p>Ghana's Revised Nationally Determined Contributions (NDCs)</p> |
|             |                                                                                                                                                                                                                                                                                                                                  | <p>Nature-Based Solutions (NBS)</p> <p>Mangrove Restoration and Nature-Based Solutions</p> <p><b>Restoration of Mangroves and Wetlands and Nature Based solutions</b> :Restore and maintain mangroves, wetlands, and riparian buffers that naturally absorb floodwaters and reduce the speed and impact of floodwaters.</p>      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                  |

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|  |                                                                                                                 | <p>Policy/Institutional/Social Measures</p> <p>Implement strict zoning laws that restrict construction in flood-prone areas and promote the development of higher-ground settlements.</p>                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |
|  | <p>Flooding has destroyed crops, eroded soil, and washed away seeds and nutrients necessary for agriculture</p> | <p>Nature-Based Solutions (NBS)</p> <p><b>Climate-Resilient Agricultural Practices:</b> Promote and support the adoption of flood-resistant crop varieties and sustainable agricultural techniques such as raised planting beds.</p> <p>Contour Farming and Terracing practices: These practices help prevent soil erosion and improve water retention in areas prone to heavy rains.</p> | <p>Implementing the adoption of flood -resistant crops helps minimizes waterlogging and controls soil erosion, making better use of floodwaters for agricultural purposes.</p> <p>For Asuogyaman District, where agriculture plays a critical role in the economy and community livelihoods, and where flooding can disrupt agricultural productivity, implementing controlled irrigation and construction of runoff management structures helps reduce the direct impact of floodwaters on crops, prevents soil erosion, and improves drainage which are crucial for sustainable agriculture.</p> <p>For farmers in Asuogyaman, reducing economic vulnerability through these measures is not just about surviving the next flooding event—it's about building a foundation for sustainable growth, resilience, and prosperity in an increasingly uncertain climate. This approach helps in securing not only their livelihoods but also the ecological and economic health of the larger community.</p> |  |

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|  |                                                                                                             | <p>Technological/Engineering Measures</p> <p>Implement controlled irrigation systems like drip irrigation to manage water use efficiently and construct runoff management structures such as swales and retention basins to capture and use excess water</p>                   |                                                                                                                                                                                                                                                                                                                       |  |
|  |                                                                                                             | <p>Policy/Institutional/Social Measures</p> <p>Facilitate access to agricultural insurance schemes that cover flood risks and provide financial support for the adoption of flood resilience practices.</p>                                                                    |                                                                                                                                                                                                                                                                                                                       |  |
|  | Flooding has posed a threat to livestock through the spread of waterborne diseases and loss of grazing land | <p><b>Technological/Engineering Measures</b></p> <p>Construct raised or elevated livestock shelters that are above the typical flood level.</p> <p>Develop and maintain efficient drainage systems around grazing fields and livestock enclosures to prevent waterlogging.</p> | <p>Livestock farming is a significant source of income for many families in the district. protecting this sector against flooding</p> <p>guards it against the scarcity of feed and contamination of water sources during prolonged flooding, ensuring the health and nutrition of livestock are not compromised.</p> |  |
|  |                                                                                                             | <p>Identify and develop higher ground areas for grazing that are less prone to flooding.</p> <p>Policy/Institutional/Social Measures</p> <p>Implement regular vaccination programs and health checks to prevent and control waterborne and other flood-related diseases.</p>   |                                                                                                                                                                                                                                                                                                                       |  |
|  |                                                                                                             | <p>Policy/Institutional/Social Measures</p> <p>Implement regular vaccination programs and health checks to prevent and control waterborne and other flood-related diseases.</p>                                                                                                |                                                                                                                                                                                                                                                                                                                       |  |

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|  | Drought conditions have severely impacted towns like Small London, Ampanawu, and Apeguso especially given its agricultural reliance.                                           | <p>Nature-Based Solutions (NBS)</p> <p><b>Climate-Resilient Agricultural Practices:</b><br/>Promote the use of drought -resistant crop varieties that can survive in lower water conditions, reducing the vulnerability of agricultural production to drought</p>                     | These measures collectively contribute to making agricultural practices in Asuogyaman more sustainable and less vulnerable to drought. This not only secures food production and farmers' livelihoods but also supports the local economy and enhances community resilience against climate variability and change |  |
|  | Drought has led to reduced water availability for irrigation, affecting crop yields and increasing the vulnerability of crops to diseases and pests.                           | <p><b>Technological/Engineering Measures</b></p> <p>Develop infrastructure to capture and store rainwater during periods of excess rainfall for use during dry spells. This includes building reservoirs, dams, and rain barrels.</p>                                                 |                                                                                                                                                                                                                                                                                                                    |  |
|  | Drought has led to Fluctuations in agricultural productivity leading to increased food prices.                                                                                 | Implement water-efficient irrigation techniques such as drip irrigation to minimize water use while maintaining crop productivity                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                    |  |
|  | Drought stress has weakened plants, making them more susceptible to pests and diseases, which proliferate under these conditions                                               | <p><b>Nature-Based Solutions (NBS)</b></p> <p>Integrate pest management strategies that focus on maintaining the health of crops through adequate water management and the use of pest-resistant varieties</p>                                                                        |                                                                                                                                                                                                                                                                                                                    |  |
|  | Hotter temperatures led to more bushfires that contributed to poor air quality and increased exposure to pollutants, which exacerbate respiratory and cardiovascular illnesses | <p>Nature-Based Solutions (NBS)</p> <p>Implement proactive land management strategies that include controlled burns (where safe and feasible), the removal of excess dry vegetation, and the planting of fire-resistant plant species along the boundaries of agricultural lands.</p> | Implementing an integrated approach to fire management and air quality monitoring in the Asuogyaman District not only addresses the immediate threats posed by bushfires and associated air pollution but also contributes to long-term agricultural sustainability and public health.                             |  |
|  |                                                                                                                                                                                | <p>Policy/Institutional/Social Measures</p> <p>Conduct regular educational campaigns on fire safety, prevention practices, and the health risks associated with poor air quality</p>                                                                                                  |                                                                                                                                                                                                                                                                                                                    |  |

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|  | <p>The frequency and intensity of extreme weather events such as storms and heatwaves have caused immediate and severe damage to agricultural infrastructure (such as irrigation systems and storage facilities), leading to crop failures, and disturbing ecological systems</p> | <p><b>Technological/Engineering Measures</b></p> <p>Implement advanced irrigation technologies such as drip irrigation, which are less vulnerable to damage and more efficient in water use</p> <p>Upgrade and reinforce agricultural infrastructure, including irrigation systems, storage facilities, and greenhouses, to withstand extreme weather conditions. This can involve the use of durable materials, secure anchoring systems, and water-resistant designs.</p>                                          | <p>these adaptation measures not only address current challenges but also prepare the district for future climatic uncertainties</p> |  |
|  |                                                                                                                                                                                                                                                                                   | <p><b>Nature-Based Solutions (NBS)</b></p> <p>Implement ecological buffers such as windbreaks, shelterbelts, and buffer zones with native vegetation around agricultural fields.</p> <p>Diversify crop systems through intercropping and agroforestry practices.</p> <p>Restore and maintain ecological buffers such as hedgerows, forest margins, and wetlands around agricultural lands. These features can mitigate the impact of storms and provide habitat for beneficial species that support agriculture.</p> |                                                                                                                                      |  |
|  |                                                                                                                                                                                                                                                                                   | <p><b>Policy/Institutional/Social Measures</b></p> <p>Develop and promote access to crop insurance and financial support programs that cover losses from extreme weather events.</p> <p>Develop and enhance early warning systems and community-based alerts for storms to ensure timely evacuation and preparedness</p>                                                                                                                                                                                             |                                                                                                                                      |  |

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|  | Changes in rainfall patterns, including unpredictable seasonal shifts and intensity of rainfall, have disrupted planting and harvesting cycles of main staple crops such as cassava, maize, yam, and plantain in the district                                                                           | <b>Nature-Based Solutions (NBS)</b><br><br>Encourage the adoption of more flexible cropping calendars that allow farmers to adjust their planting and harvesting times according to weather predictions and current climate conditions.                                                                                                              | These strategic interventions address the immediate challenges posed by unpredictable rainfall patterns and also set a foundation for sustainable agricultural development in the face of ongoing climate change. This holistic approach is crucial for the resilience and prosperity of the Asuogyaman District.                                                   |  |
|  |                                                                                                                                                                                                                                                                                                         | <b>Policy/Institutional/Social Measures</b><br><br>Enhance meteorological capabilities to provide farmers with accurate and timely weather forecasts to better plan agricultural activities.                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                     |  |
|  | Crops are planted too early or too late, leading to poor yields. Additionally, intense rainfall has led to soil erosion, nutrient leaching, and damage to crops, which further reduces agricultural productivity                                                                                        | <b>Nature-Based Solutions (NBS)</b><br><br>Implement soil conservation techniques such as mulching, use of cover crops, and reduced tillage to improve water retention and soil fertility.<br><br>Introduce and promote a variety of crop species that have different planting and harvesting times and are resilient to various climate conditions. |                                                                                                                                                                                                                                                                                                                                                                     |  |
|  | Fluctuating water levels in Volta Lake have altered due to rainfall patterns and increased evaporation rates during hotter periods. High water levels have flooded breeding grounds or altered aquatic habitats, while low water levels have reduced fish populations in fishing areas like Dodi Island | <b>Policy/Institutional/Social Measures</b><br><br>Develop and support alternative livelihood programs such as aquaculture, small-scale agriculture, or eco-tourism.<br><br>Conduct regular training and workshops for local fishers on adaptive fishing methods, sustainable fishing practices, and water management                                | The implementation of these measures provides several crucial benefits to the fishing communities of Asuogyaman District: these measures are integral not just for protecting the natural resources of the Asuogyaman District but also for enhancing the economic, health, and social well-being of the men and women who depend on the lake for their livelihoods |  |

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|  | For aquatic systems like those in the Volta Lake, increased runoff has led to eutrophication, adversely affecting water quality and aquatic life in areas like Mpakadam Quarter, Dodi Asantekrom | <b>Nature-Based Solutions (NBS)</b><br><br>Develop and maintain vegetated buffer zones along the banks of rivers feeding into the lake and around the lake itself. Where feasible, construct artificial wetlands near the lake<br><br>Implement a schedule for dredging the lake to remove excess sediments and vegetation that contribute to poor water conditions |  |  |
|  | More frequent and severe storms and heavy rainfall events disrupt fishing activities by making fishing unsafe                                                                                    | <b>Policy/Institutional/Social Measures</b><br><br>Establish a community-based system that disseminates weather warnings through various channels, including SMS, local radio stations, and loudspeakers.<br><br>Conduct regular training workshops on safety measures, emergency procedures, and best practices for fishing before and after storms.               |  |  |
|  | Altered distribution and migration patterns of fish due to changes in water temperature and quality, as well as food availability                                                                | <b>Technological/Engineering Measures</b><br><br>Encourage the use of technology such as GPS and fish finders among local fishers to more effectively locate fish populations as they shift due to environmental changes                                                                                                                                            |  |  |
|  |                                                                                                                                                                                                  | Social/Economic Empowerment Measures<br><br>Promote diversification of livelihoods including the development of aquaculture as an alternative or complement to wild fisheries.                                                                                                                                                                                      |  |  |

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|                     | Increased rainfall led to higher runoff levels, bringing pollutants and sediments into the lake. This degrades water quality and affects fish health and numbers.                  | <p><b>Nature-Based Solutions (NBS)</b></p> <p>Plant trees and other vegetation along the shores of rivers and the lake to create natural buffer zones</p> <p>Promote and support sustainable agricultural practices upstream. This can include reduced use of chemical fertilizers and pesticides, contour plowing, and cover cropping</p> <p>Build artificial wetlands and sediment traps along watercourses feeding into the lake</p>                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                               |
| <b>Biodiversity</b> | For biodiversity, droughts have reduced the habitat quality and availability of water resources for wildlife, leading to decreased biodiversity and disrupting ecological balances | <p><b>Nature-Based Solutions (NBS)</b></p> <p>Restore degraded wetlands and establish new ones. Enhance the natural water retention capabilities of these ecosystems to counteract the effects of droughts</p> <p>Implement sustainable land-use practices within the watershed to reduce erosion and runoff, promote groundwater recharge, and prevent sedimentation that can degrade water bodies</p> <p>Encourage the adoption of fishing practices that are adaptable to changing water conditions, such as adjustable fishing schedules and locations, and gear that minimizes ecological impact.</p> <p>Technological/Engineering Measures</p> <p>Construction of Artificial Waterholes: Build artificial ponds and waterholes in strategic locations to provide reliable water sources for wildlife. These can be lined with materials to prevent seepage and evaporation</p> | Through these strategies, the fishing communities in Asuogyaman can enhance their adaptive capacity to drought conditions, ensuring long-term resilience of both their livelihoods and the ecosystems they depend on. | <p>Asuogyaman district assembly</p> <p>The 2022 annual action plan</p> <p>Asuogyaman district assembly</p> <p>Revised composite budget</p> <p>For 2022-2025</p> <p>Ghana National Climate Change Policy</p> <p>Ghana's Revised Nationally Determined Contributions (NDCs)</p> |

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|  |  | <p><b>Maintain Existing Water Bodies:</b> Regularly dredge and maintain existing natural water bodies to increase their capacity and ensure they can store more water during rainy seasons, making it available during droughts.</p> <p><b>Remote Sensing and GIS:</b> Implement remote sensing technologies and Geographic Information Systems (GIS) to monitor changes in habitat quality, water availability, and biodiversity in real time. This data can inform timely interventions and adaptive management strategies.</p> <p><b>Early Warning Systems:</b> Develop early warning systems for drought and other climate-related events to anticipate and mitigate their impacts on biodiversity. This can include automated weather stations, drought forecasting models, and community-based alert systems</p> <p>Policy/Institutional/Social Measures</p> <p>Integrated Water Resource Management (IWRM):</p> <p>Develop and implement a comprehensive Integrated Water Resource Management plan that includes sustainable water use practices, conservation of water resources, and protection of aquatic habitats.</p> |  |  |
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|  |  | <p>Enforce regulations that prevent over-extraction of water from rivers and lakes, ensuring sufficient water remains to support wildlife.</p> <p>Community-Based Natural Resource Management (CBNRM)</p> <p>Empower local communities to manage and protect their natural resources through participatory approaches.</p> <p>Establish community conservation areas where locals have the authority and responsibility to enforce conservation rules and practices.</p> <p>Community Involvement in Conservation:</p> <p>Encourage local communities to participate in habitat restoration projects, such as tree planting and wetland restoration.</p> <p>Establish local conservation groups that can take active roles in monitoring wildlife and reporting any illegal activities, such as poaching or habitat destruction.</p> |  |  |
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|  | <p>For wildlife, increased temperatures have led to changes in migration patterns of birds like the vultures and herons, breeding cycles, and habitat suitability, thus affecting the overall biodiversity of the towns closer to the lake</p> | <p><b>Nature-Based Solutions (NBS)</b></p> <p>Designate and enforce protected areas around crucial breeding and nesting sites to minimize disturbance during critical periods of the life cycle of these birds</p> <p>Restore and maintain critical habitats that are important for the breeding, feeding, and sheltering of affected bird species and other wildlife. This includes the reforestation of lake shores and riverbanks, and the restoration of wetlands and other natural habitats</p> <p>Introduce or enhance the presence of natural predators or competitors of common pests and pathogens in the aquatic ecosystem</p> <p>Implement measures to manage and restore critical aquatic habitats to improve natural resilience against pests and diseases. This could include the reestablishment of mangroves, wetlands, and other natural barriers</p> | <p>Biodiversity plays a critical role in agricultural productivity and the overall health of the environment. By implementing measures to protect natural habitats and manage ecosystems sustainably, the district can preserve biodiversity which in turn supports ecosystem services such as pollination, water purification, and flood regulation</p> |  |
|  | <p>Higher temperatures increase the population and activity levels of pests and diseases, which is detrimental to both agriculture and natural ecosystems</p>                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                          |  |

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| Water Resources | Extended periods of drought, are becoming more frequent and severe. It has reduced water availability. This scarcity affects the ability to meet domestic, agricultural, and industrial water demands. | <b>Nature-Based Solutions (NBS)</b><br><br>Explore alternative water sources such as groundwater, where feasible, to reduce dependency on surface water.                                                                                                              | Water scarcity and contamination are among the most pressing issues exacerbated by climate change in the Asuogyaman district. Implementing water conservation techniques, improving water storage, and diversifying water sources ensure that the community maintains access to clean and sufficient water | Asuogyaman district assembly<br><br>The 2022 annual action plan<br><br>Asuogyaman district assembly<br><br>Revised composite budget<br><br>For 2022-2025<br><br>Ghana National Climate Change Policy<br><br>Ghana's Revised Nationally Determined Contributions (NDCs) |
|                 |                                                                                                                                                                                                        | <b>Technological/Engineering Measures</b><br><br>Build additional reservoirs, improve dam facilities, and promote rainwater harvesting in communities to increase water storage capacity.                                                                             |                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                        |
|                 | Increased temperatures promote the growth of harmful algal blooms, while more intense rainfall leads to greater runoff, carrying pollutants and sediments that degrade water quality.                  | <b>Nature-Based Solutions (NBS)</b><br><br>Implement stricter pollution control measures, restore wetlands that naturally filter pollutants, and manage agricultural runoff to reduce nutrient loads entering water bodies                                            |                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                        |
|                 | More intense and frequent storms and floods have damaged water infrastructure such as dams, pipes, and treatment facilities, disrupting water supply                                                   | <b>Technological/Engineering Measures</b><br><br>Strengthen and upgrade water infrastructure to withstand extreme weather events, such as reinforcing embankments, enhancing flood defenses, and using more durable materials for water transport and storage systems |                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                        |

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|                       |                                                                                                                                                                                                                     | <p>Policy/Institutional/Social Measures</p> <p>Develop a comprehensive water management framework that involves all stakeholders, including local communities, industries, and agricultural sectors, in managing water resources holistically.</p>                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                 |
| Health and Sanitation | Increasing temperatures worsen heat-related illnesses and influence the spread of diseases sensitive to heat, leading to symptoms such as headaches, dizziness, weakness, cramping, and nausea in warmer conditions | <p><b>Technological/Engineering Measures</b></p> <p>Ensure that healthcare facilities are built or renovated to withstand extreme weather events, including elevated buildings in flood-prone areas and reinforced structures in storm-prone areas, and also hidden roofs to prevent</p> | <p>The health delivery system in the district is carried out by various categories of health professionals working in thirty (30) health facilities in the district. The district has a total of one (1) hospital (VRA hospital), eleven (11) Health centers, two (2) private hospitals, and Sixteen (16) functional CHP centers. The district has a total staff strength of two hundred and sixty-seven (267) as of 2021, therefore implementing the proposed adaptation measures in the Asuogyaman district, is crucial for averting damage to critical health infrastructures.</p> <p>These measures protect public health, ensure the continuity and efficiency of healthcare services, and improve the preparedness and response capabilities of health facilities and personnel in the district. This holistic approach is key to safeguarding the well-being of the community in the face of current and future challenges.</p> | <p>Asuogyaman district assembly</p> <p>The 2022 annual action plan</p> <p>Asuogyaman district assembly</p> <p>Revised composite budget</p> <p>For 2022-2025</p> |

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|  | <p>Floods or storms damage infrastructure, disrupt power supplies, and impede access to healthcare services, thereby reducing the quality of care and accessibility during critical times.</p> <p>Unpredictable rainfall patterns, droughts, and flooding lead to crop failures reducing food availability and leading to malnutrition and related health issues. This is particularly critical as the district relies heavily on local agriculture for food security</p> | <p>Improve and maintain access routes to healthcare facilities to ensure they remain accessible during emergencies</p> <p>Policy/Institutional/Social Measures</p> <p>Implement programs that educate the public on maintaining a nutritious diet during times of climate-induced food scarcity.</p>                                                                                                                                                                                                                                                                                                                         |  |  |
|  | <p>Extreme weather events such as severe storms or prolonged flooding cause displacement, forcing people to relocate temporarily or permanently. Such displacement often leads to overcrowded living conditions, straining existing health facilities and increasing the transmission of communicable diseases. The recent spillage of the dam as a result of excessive rainfall led to the relocation of communities around the volta lake.</p>                          | <p><b>Technological/Engineering Measures</b></p> <p>Improve the early warning systems for severe weather and potential dam spillages by incorporating more sophisticated meteorological tools and community alert systems. Ensure that these systems are accessible and understood by all members of the community, including non-native speakers and those with disabilities.</p> <p>Prepare for displacement by pre-designating emergency shelters with adequate space and sanitation facilities. Develop plans for quick-deployment housing units that can be rapidly set up in the event of widespread displacement.</p> |  |  |

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|  | Heatwaves contribute to heat exhaustion and heatstroke, particularly among vulnerable populations such as the elderly, children, and those with pre-existing health conditions                   | <b>Nature-Based Solutions (NBS)</b><br><br>Integrate green spaces, urban forests, and reflective materials in city planning to reduce urban heat island effects                                                                 |  |  |
|  |                                                                                                                                                                                                  | <b>Technological/Engineering Measures</b><br><br>Implement advanced surveillance systems to track disease outbreaks in real-time.<br><br>Establish mobile health units to reach remote areas quickly during outbreaks           |  |  |
|  |                                                                                                                                                                                                  |                                                                                                                                                                                                                                 |  |  |
|  | Flooding overwhelms the sanitation systems in the district, leading to the overflow and contamination of water sources with sewage. This significantly increases the risk of waterborne diseases | <b>Technological/Engineering Measures</b><br><br>Upgrade and expand drainage systems to effectively handle increased runoff during heavy rainfall. Reinforce sewage systems to prevent overflow during floods into water bodies |  |  |
|  |                                                                                                                                                                                                  | <b>Policy/Institutional/Social Measures</b><br><br>Develop and enforce stricter regulations on sanitation practices, ensuring that all new developments incorporate climate-resilient sanitation systems                        |  |  |
|  | Extended periods of drought have reduced water availability essential for sanitation purposes, such as flushing toilets and maintaining hygienic conditions, leading to increased health risks   | <b>Technological/Engineering Measures</b><br><br>Promote and install water-efficient sanitation solutions such as dry toilets, low-flow toilets, and waterless urinals in both residential and public facilities                |  |  |

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|                                                |                                                                                                                                                                                                                                                               | <p>Policy/Institutional/Social Measures</p> <p>Conduct continuous public health education campaigns focusing on hygiene practices, especially during climate-induced emergencies like floods and droughts</p>                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                  |
| <p><b>Disaster Risk and Infrastructure</b></p> | <p>Critical infrastructure like roads, bridges, and School buildings, markets, Ports, Hotels in the district are vulnerable to extreme weather events such as floods and wind storms, impacting both emergency response efforts and community resilience.</p> | <p><b>Technological/Engineering Measures</b></p> <p>Strengthen and elevate critical infrastructure such as roads, bridges, and buildings to withstand flooding. Construct flood barriers and retention basins where necessary</p> <p>Ensure that building codes are updated to reflect the need for structures to withstand high winds and severe storms</p> | <p>resource, supporting activities such as fishing, transportation, and tourism. Frequent accidents can disrupt these activities, leading to economic losses. Improved safety and infrastructure ensure continuous economic activities and help attract more tourists, boosting the local economy.</p> <p>By improving weather monitoring and boating regulations, providing safety education, and ensuring robust emergency responses, the lake becomes a safer environment for both recreational and commercial users.</p> <p>Safe boating practices and improved infrastructure help protect the lake's environment. Reducing the number of accidents helps prevent oil and fuel spills, which are detrimental to aquatic life. Additionally, proper boat maintenance and operations can minimize the ecological footprint of boating on the lake</p> | <p>National Climate Change Adaptation Strategy</p> <p>Ghana's Revised Nationally Determined Contributions (NDCs)</p> <p>Ghana National Climate Change Policy</p> |
|                                                |                                                                                                                                                                                                                                                               | <p><b>Nature-Based Solutions (NBS)</b></p> <p>Encourage tree planting to act as windbreaks to reduce the wind speed and mitigate its impact</p>                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                  |

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|  | periods of intense rainfall, especially during the rainy seasons. The excessive rainfall led to the overflowing of the Volta Lake and rivers, causing floods that damaged homes, farmland, roads, schools, etc       | <b>Nature-Based Solutions (NBS)</b><br><br>Restore and conserve wetlands which can act as natural buffers that absorb excess rainwater                                                                                     |  |  |
|  |                                                                                                                                                                                                                      | Policy/Institutional/Social Measures<br><br>Enforce zoning regulations that restrict construction in flood-prone areas along the Volta Lake and riverbanks                                                                 |  |  |
|  | The Volta Lake's levels fluctuate dramatically, especially in response to heavy rains and the operational management of the Akosombo Dam. High water levels led to flooding of nearby communities and infrastructure | Policy/Institutional/Social Measures<br><br>Educate the community on emergency preparedness for flooding, including safe shelters and necessary precautions during severe weather.                                         |  |  |
|  | The Floods washed away roads, bridges, and other critical infrastructure, disrupting transportation and access to services in the district.                                                                          | <b>Technological/Engineering Measures</b><br><br>Strengthen and elevate critical infrastructure such as roads, bridges, and buildings to withstand flooding. Construct flood barriers and retention basins where necessary |  |  |
|  | Flooding often displaces communities, forcing people to leave their homes and leading to the need for temporary shelters and aid                                                                                     | Implement an advanced early warning system that can alert communities to flooding or severe weather conditions. Enhance local disaster response capacities                                                                 |  |  |

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|  | <p>The district experienced severe storms, particularly associated with the transitional periods between rainy and dry seasons, these storms were dangerous for fishermen and other lake users.</p> | <p><b>Technological/Engineering Measures</b></p> <p>Strengthen the emergency response capabilities around Volta Lake, including better-equipped and strategically located rescue stations, faster deployment of rescue teams, and clear communication channels during emergencies</p> <p>Build more robust and wind-resistant docking and mooring facilities. Improving the physical infrastructure around the lake to withstand adverse weather conditions better and provide safer harbors for boats during strong winds.</p> <p>Establish a robust system to monitor weather conditions and provide timely warnings to lake users about strong winds and other adverse weather conditions.</p> <p>Build new water storage facilities such as reservoirs and expand existing ones to increase water storage capacity. Promote and implement water conservation measures across all sectors (domestic, agricultural, industrial).</p> |  |  |
|  | <p>Prolonged periods of drought have significantly lowered water levels in the lake, affecting water availability for hydropower, irrigation, and domestic use</p>                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |  |
|  |                                                                                                                                                                                                     | <p><b>Nature-Based Solutions (NBS)</b></p> <p>Develop alternative water sources such as rainwater harvesting, and groundwater, and diversify the water supply portfolio.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |  |

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| <p><b>Gender (Cross-cutting)</b></p> | <p>The women, particularly those in rural areas in the district, bear a heavier burden during extreme weather events such as floods or droughts. In many households, women are primarily responsible for water collection, food provision, and caregiving. During floods or droughts, these tasks become more arduous and time-consuming, increasing their workload and reducing time for other economic activities or education</p> | <p><b>Nature-Based Solutions (NBS)</b></p> <p>Implement systems at community and household levels to collect and store rainwater. This can relieve the burden on women who are primarily responsible for water collection, especially during dry spells</p> | <p>According to the 2010 National Population and Housing Census,</p> <p>the district has a population of 98,046 made up of 51,016 females (52%) and 47,030 males (48%), By providing targeted support such as microcredit facilities for both men and women, the measures help level the playing field, empowering underrepresented them, particularly women, and ensuring they have equal opportunities to contribute to and benefit from climate-resilient development.</p> <p>By strengthening water management, promoting climate-resilient agricultural practices, and enhancing early warning systems, communities become better equipped to manage and adapt to these changes, reducing their vulnerability to climate shocks.</p> <p>Encouraging women's participation in decision-making processes ensures that adaptation strategies are inclusive and effective, reflecting the needs and insights of the entire community.</p> <p>Measures addressing heat stress and improving access to healthcare mitigate the direct impact of climate change on community health. This is particularly beneficial for vulnerable populations, including children, pregnant women, and the elderly.</p> | <p>Ghana National Climate Change Policy</p> <p>Ghana's Revised Nationally Determined Contributions (NDCs)</p> <p>National Gender Policy</p> <p>Asuogyaman district assembly revised the composite budget</p> <p>For 2022-2025</p> |
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|  |                                                                                                                                                                                                               | <p>Technological/Engineering Measures</p> <p>Develop small-scale irrigation projects that can support agricultural activities during inconsistent rainfall. Prioritize access for women farmers to these resources to ensure they too can benefit from improved agricultural productivity</p> |  |  |
|  |                                                                                                                                                                                                               | <p>Nature-Based Solutions (NBS)</p> <p><b>Tranings on NBS:</b> Provide training for both men and women in climate-resilient farming techniques such as drought-resistant crops, proper soil management, and sustainable agriculture practices</p>                                             |  |  |
|  | <p>Higher temperatures exacerbate health problems, particularly for pregnant women and the elderly. Women's responsibilities for caring for these vulnerable populations increase, adding to their burden</p> | <p><b>Nature-Based Solutions (NBS)</b></p> <p>Increase tree cover in the district by planting native and drought-resistant tree species along streets, in parks, and around residential and commercial buildings. Trees provide shade and reduce temperatures.</p>                            |  |  |

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|  | Heat increase affect men working outdoors, such as in agriculture and fishing, directly impacting their health and productivity. Long exposure to high temperatures leads to heat stress and other heat-related illnesses                            | <b>Policy/Institutional/Social Measures</b><br><br>Improve access to healthcare with mobile clinics and community health workers who can reach remote areas, ensuring women and men have equal access to health services, including those related to climate-induced health risks<br><br>Provide and promote the use of lightweight, breathable, and UV-protective clothing for outdoor workers. Include wide-brimmed hats and sunglasses to protect against direct sun exposure.<br><br>Encourage flexible work hours and shifts for outdoor workers, including starting earlier in the day and incorporating more frequent and longer breaks during the hottest hours |  |  |
|  |                                                                                                                                                                                                                                                      | Nature-Based Solutions (NBS)<br><br>Encourage urban greening such as planting more trees                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |  |
|  | Biodiversity loss as a result of extreme weather conditions affects herbal medicines and local plants that women often use for health care and nutrition. Losing these resources impacts family health and increases dependency on external markets. | <b>Nature-Based Solutions (NBS)</b><br><br>Promote the cultivation of alternative medicinal and nutritional plants that are more resilient to extreme weather conditions. This could include introducing species that can withstand drought or flooding, depending on the local climate risks                                                                                                                                                                                                                                                                                                                                                                           |  |  |

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|  | <p>Extreme weather events led to outbreaks of waterborne diseases, which are especially dangerous for children who are more susceptible to dehydration and malnutrition</p>                                                                                                             | <p><b>Policy/Institutional/Social Measures</b></p> <p>Increase the capacity of health services to handle outbreaks by improving disease surveillance, stocking essential medicines, and training healthcare workers in handling climate-related health issues</p>                                                                                                                                                                                                                                                                      |  |  |
|  | <p>Flooding and droughts damaged school infrastructure and led to school closures, interrupting children's education. Additionally, in times of crisis, children might be needed at home to help with increased domestic burdens, further limiting their educational opportunities.</p> | <p><b>Technological/Engineering Measures</b></p> <p>Schools, especially in flood-prone areas, should be built on elevated grounds or incorporate elevated foundations to avoid water damage during flooding</p> <p>Incorporate hidden roofs that are less likely to catch wind, alongside other wind-resistant features like sloped designs that deflect winds upward and away from the building.</p> <p>Revise local building codes to require these climate-resilient features in new school construction and major renovations.</p> |  |  |

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|  |                                                                                                                                                                                                | <p>Policy/Institutional/Social Measures</p> <p>Designate areas within the school that can serve as safe havens during emergencies. These areas should be structurally reinforced to provide additional protection</p> <p>Develop flexible learning modules and distance learning options (e.g., radio, online platforms) to ensure education continuity during closures</p> <p>Create platforms for children and youth to participate in community discussions on climate change adaptation. This empowers them and ensures their specific needs and ideas are included in local adaptation plans</p> <p>Integrate climate change education into the school curriculum to teach children about the causes, effects, and adaptation strategies related to climate change. This education should empower them with knowledge and practical skills to adapt to their changing environment</p> <p>Implement school-based nutrition programs that provide meals fortified with essential nutrients to combat malnutrition, exacerbated by crop failures due to erratic weather patterns</p> |  |  |
|  | Inconsistent rainfall leads to crop failures, reducing food availability and leading to malnutrition among children, which have long-term effects on their physical and cognitive development. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |  |

# Appendix B Risk Assessment Methodology

## A1 | Determining the Magnitude of the Hazard

Table B. 1 present the criteria to define the magnitude of the hazard.

**Table B. 1| Criteria for determining the magnitude of the hazard**

| Exposure  | Description                                                                                                                                                        |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Very Low  | The hazard is expected to have minimal impact and unlikely to cause significant disruptions.                                                                       |
| Low       | The hazard is expected to have a low impact and may cause some minor disruptions or inconvenience, and yet can be easily managed.                                  |
| Medium    | The hazard is expected to have a moderate impact and may cause significant disruptions or inconvenience but can be managed with adequate preparation and response. |
| High      | The hazard is expected to have a high impact and may cause widespread disruptions or significant harm, requiring a significant effort to manage.                   |
| Very High | The hazard is expected to have a very high impact and may cause catastrophic damage or widespread harm, requiring an immediate and large-scale response.           |

## A2 | Determining the Level of Exposure

Table B. 2 present the criteria to determine the level of exposure.

**Table B. 2 | Criteria for assessing the level of exposure**

| Exposure  | Description                                                                                                                                            |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| Very Low  | In the past, the study area, or areas nearby, have rarely experienced extreme weather events (less than one event every 50 years).                     |
| Low       | Exposure is almost unlikely. In the past, the study area, or areas nearby, have sporadically experienced extreme weather events (1 every 20-50 years). |
| Medium    | Exposure is possible to occur. In the past, the study area, or areas nearby, have experienced extreme weather events (1 every 10-20 years).            |
| High      | Exposure is likely to occur. The study area, or areas nearby, have regularly experienced extreme weather events (1 every 5-10 years).                  |
| Very High | The exposure is almost certain. Hazard manifestation is common (1 every 1-5 years).                                                                    |

### A3 I Assessing the Systems' Vulnerability

Table B. 3, and Table B. 4 present the criteria to assess sensitivity and adaptive capacity respectively. Table B. 5 presents the matrix used to assess and categorise the level of vulnerability for each system or assets.

**Table B. 3 I Criteria to access sensitivity**

| Sensitivity      | Description                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Very Low</b>  | Extreme weather events and climate change related hazards may marginally affect the study area and there are no assets critically affected.                                                                                                                                                                                                                                                                                               |
| <b>Low</b>       | Extreme weather events (strong winds, floods, extreme temperatures, droughts, sea level rise, coastal erosion etc.) relatively more resistant population, the consequence is classified as minor.                                                                                                                                                                                                                                         |
| <b>Medium</b>    | Extreme weather events cause moderate damage to local goods and services (e.g., increased incidences of dengue, diarrhoea, malaria or other vector-borne diseases affect the health of the local community and put greater pressure on sanitation and agricultural goods; or a moderate drought may lead to some loss of household income, but may not require external assistance).                                                      |
| <b>High</b>      | Extreme weather events affect assets, reducing the capacity of local services to respond, causing damage to local communities (e.g., floods that lead to the interruption of water supply affecting communities and irrigation pump failures, reducing the productivity of agricultural productions, can have a major impact on a weak local community that has no other alternatives and cannot withstand seasonal shocks of this type). |
| <b>Very High</b> | Extreme weather events lead to the failure or destruction of local goods and services, communities must be relocated for at least several months, etc. This is a very high potential impact that could seriously affect local communities and the consequence is considered to be catastrophic.                                                                                                                                           |

**Table B. 4 I Criteria to access adaptive capacity**

| Adaptive capacity | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Very high</b>  | Existence of good knowledge, institutions that function efficiently and sufficient means and technologies to avoid or reduce the exposure and/or sensitivity of the identified climate risks. Local communities have a good understanding of climate change and its effects/impacts and adopt initiatives to increase their resilience in the short, medium and long term. Existence of action strategies for climate change at the study area level.                                                 |
| <b>High</b>       | Existence of alternative resources and capacities to diversify the local economy. Local populations have access to resilient infrastructure (built and natural/ecosystem services) that support means of production and livelihoods. Existence of technical capacity, strategies, a risk and disaster prevention plan, an action plan for climate change, etc.                                                                                                                                        |
| <b>Medium</b>     | Existence of a national/regional action plan for climate change etc., but no local climate action plan, including the participation of local communities. There is a moderate capacity to reduce sensitivity to identified climate risks and some adaptation measures are implemented at the community level to mitigate risks in the short and medium term.<br>Existence of basic energy services, water supply to communities, etc. to address the potential impacts resulting from climate change. |

|                 |                                                                                                                                                                                                                                                                                                                                                          |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Low</b>      | Lack of a legal, institutional and operational framework at the local level to mitigate climate risks and their effects on local ecosystems and livelihoods. Restricted access to resilient infrastructure (built and natural/ecosystem services) that support means of production and livelihood against the effects of variability and climate change. |
| <b>Very Low</b> | Lack of basic energy services, water supply to communities, etc. to address the potential impacts of climate change. Lack of knowledge and perception about the phenomenon of climate change and its effects on natural ecosystems and local livelihoods. Very limited and vulnerable means of survival and no alternative means.                        |

**Table B. 5 | Vulnerability Matrix**

|                   |           | Sensitivity |        |        |         |           |
|-------------------|-----------|-------------|--------|--------|---------|-----------|
|                   |           | Very Low    | Low    | Medium | High    | Very High |
| Adaptive capacity | Very High | Low         | Low    | Low    | Medium  | Medium    |
|                   | High      | Low         | Low    | Medium | Medium  | High      |
|                   | Medium    | Low         | Medium | Medium | High    | High      |
|                   | Very Low  | Medium      | Medium | High   | High    | Extreme   |
|                   | Low       | Medium      | High   | High   | Extreme | Extreme   |

#### A4 | Evaluating Priority Risks

Table B. 6 presents the matrix used to rank the potential risks of the hazards associated with climate change on natural and human systems, based on exposure to identified climate hazards and the vulnerability of key natural systems, socio-economic sectors and local livelihoods.

**Table B. 6 | Risk Matrix**

|               |         | Hazard x Exposure |        |         |         |
|---------------|---------|-------------------|--------|---------|---------|
|               |         | Low               | Medium | High    | Extreme |
| Vulnerability | Low     | Low               | Low    | Medium  | High    |
|               | Medium  | Low               | Medium | High    | High    |
|               | High    | Medium            | High   | High    | Extreme |
|               | Extreme | High              | High   | Extreme | Extreme |



