SIGRA

Strengthening Investments in Gender-Responsive Climate Adaptation

Cowater Ghana

In partnership with Canada

Climate Change Risk and Vulnerability Assessment

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KUMBUNGU DISTRICT

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TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS vii

EXECUTIVE SUMMARY I

1. Introduction 1

1.1 Project Background 1
1.2 Defining Climate Change Risks and Vulnerability 2
1.2.1 Intergovernmental Panel on Climate Change Risk and Vulnerability Framework 2
1.3 Document Purpose 3

2. Progress Towards Expected Outcomes 5

2.1 Geography and Climate Related Profiles 5
2.1.1 Location and Size 5
2.1.2 Topography and Climate 6
2.1.3 Average Temperatures and Precipitation 6
2.1.4 Relief and Vegetation 8
2.2 Demographics and Gender Characteristics 9
2.2.1 Key Demographic Characteristics 9
2.2.2 Key Economic Activities 11
2.2.3 Observed Gender Gaps in the District 16
2.3 Critical Climate Related Hazards in Kumbungu District 17
2.3.1 Drought 18
2.3.2 Flooding 18
2.3.3 Water Scarcity 18
2.3.4 Bushfires 19
2.3.5 Pests and Diseases 19

3. Methodological Framework 21

3.1 Introduction 21
3.2 Phases of the Assessment Process 21
3.2.1 Stage 1: Risk Identification 21
3.2.2 Stage 2: Risk Assessment 22
3.2.3 Stage 3: Adaptation Action Plan 23
3.3 Field Data Collection Approaches 24
3.3.1 Workshop and Participatory Exercises 24
3.3.2 Focus Group Discussions 29
3.3.3 Household Questionnaire Surveys 29
3.3.4 Key Informant Interviews 30
3.4 Climate Projections Approach 30

4. Findings and Implications 33

4.1 Households Vulnerabilities 33
4.1.1 Economic Vulnerabilities 33
4.1.2 Physical Vulnerability 42
4.1.3 Social Vulnerability 48
4.2 Community-Level Variations 53
4.2.1 Economic Vulnerabilities 53
4.2.2 Physical Vulnerabilities 58
4.2.3 Social Vulnerabilities 60
4.2.4 Summary of Vulnerabilities 62
4.3 Projected Climate Trends and Implications on Vulnerability 64
4.3.1 Projected Climate Trends 64
4.3.2 Projected Climate Change Trends, Gender and Vulnerable Group Vulnerability 67
4.3.3 Inter-Community Variations in Projected Climate Change Trends and Vulnerabilities 77

5. Implications for Gender Responsive Climate Adaptation Planning and Resilience Building 81

5.1 Introduction 81
5.2 Thematic Gender-Responsive Adaptation Strategies 81
5.2.1 Social Adaptation Strategies 81
5.2.2 Economic Adaptation Strategies 83
5.2.3 Physical Adaptation Strategies 84
5.3 Community Specific Recommendations 86
5.3.1 Nawuni: Building Resilience Against Flooding 86
5.3.2 Dalun: Mitigating Flooding and Erosion 87
5.3.3 Saakuba: Addressing Drought and Water Scarcity 87
5.3.4 Zugu: Empowering Women and Enhancing Water Security 87
5.3.5 Gbullung: Addressing Seasonal Water Shortages 88
5.3.6 Kpalsogun: Managing Flood Risks and Expanding Financial Access 88
5.3.7 Voggu: Restoring Water Sources and Forests 89
5.3.8 Bagon: Reducing Land Degradation and Supporting Fisheries 89
5.3.9 Zangballung: Diversifying Livelihoods 89
5.3.10 Bognaayili: Improving Water and Infrastructure 90
5.3.11 Guppanarigu: Combating Erosion and Biodiversity Loss 90
5.3.12 Kumbungu: Enhancing Urban Resilience and Resource Access 91

6. Institutional Capacity Building and Adaptation Policy Implications 93

6.1 Introduction 93
6.1.1 Strengthening the Enabling Environment for Climate Finance 94
6.1.2 Implementing a Gender-Responsive National Adaptation Plan 94
6.1.3 Enhancing Planning and Execution of Inclusive Projects 94
6.1.4 Collaboration Between Key Institutions and Stakeholders 95

6.2 Strengthening Institutional Capacity 95
6.2.1 Building Capacity of Local Governance Structures 95
6.2.2 Expanding Gender-Sensitive Budgeting Strategies 96
6.2.3 Fostering Collaboration Between Local and Regional Agencies 96
6.3 Policy Implications 97
6.3.1 Integrating Gender-Responsive Approaches into Adaptation Policies 97
6.3.2 Addressing Systemic Barriers to Resource Access 97
6.3.3 Aligning Local Adaptation Efforts with National and International Frameworks 98
6.4 Conclusion 99

7. Way Forward 101

7.1 Introduction 101
7.2 Strengthening Gender-Responsive Governance 101
7.3 Leveraging Climate Finance and Community-Led Mechanisms 102
7.4 Building Resilience Across Sectors 103

REFERENCES 105

List of Tables

Table 1: Selected communities for quantitative and qualitative data collection....28
Table 2: Frequency distribution of surveyed households across the 12 communities 29
Table 3: ETCCDI climate indices 31
Table 4: Matrix of marginalized groups economic vulnerabilities in the Kumbungu District....39
Table 5: Summary of community vulnerability findings from focus group discussions and key informant interviews....63
Table 6: Summary of projected climate trends in Kumbungu District....66
Table 7: Projected impacts of changing climate on livelihoods and economic activities stratified by gender and vulnerable groups....68
Table 8: Projected impacts of changing climate on access to resources stratified by gender and vulnerable groups 72
Table 9: Projected impacts of changing climate on responsibilities within households and communities....75
Table 10: Summary of projected community vulnerabilities to climate trends....79
Table 11: Strategies to address social vulnerabilities in Kumbungu District 82
Table 12: Strategies to enhance economic resilience to climate impacts in Kumbungu District....83
Table 13: Strategies to mitigate physical climate vulnerabilities....85
Table 14: Recommendation for building resilience against flooding in Nawuni....86
Table 15: Recommendations for mitigating flooding and erosion in Dalun 87
Table 16: Recommendations for addressing drought and water scarcity in Saakuba....87
Table 17: Recommendations for empowering women and enhancing water security in Zugu community 88
Table 18: Recommendations for addressing seasonal water shortages in Gbullung community 88
Table 19: Recommendations for managing flood risks and expanding financial access in Kpalsogun community 88
Table 20: Recommendations for restoring water resources and forests in Voggu community 89
Table 21: Recommendations for reducing land degradation and supporting fisheries in Bagon community 89
Table 22: Recommendations for diversifying livelihoods in Zangballung community....90
Table 23: Recommendations for improving water and infrastructure in Bognayili community 90
Table 24: Recommendations for combating erosion and biodiversity loss in Guppanarigu community 90
Table 25: Recommendation for enhancing urban resilience and resource access in Kumbungu community 91
Table 26: Key actions, expected outcomes, and collaborators for strengthening the enabling environment for climate finance....94
Table 27: Key actions, expected outcomes, and collaborators for implementing a gender-responsive NAP....94
Table 28: Key actions, expected outcomes, and collaborators for enhanced planning and execution of inclusive projects 95
Table 29: Key institutions and their roles for collaboration between key institutions and stakeholders 95
Table 30: Policy recommendations for integrating gender-responsive approaches into adaptation plans 97
Table 31: Policy recommendations for addressing systematic barriers to resource access 98
Table 32: Policy recommendation for aligning local adaptation efforts with national and international frameworks 98
Table 33: Leveraging climate finance and community-led mechanisms 102
Table 34: Key action for building resilience across sectors 103

List of Figures

Figure 1: The IPCC risk and vulnerability framework illustrating the interaction of hazards, exposure, and vulnerability in shaping climate risks, with socio-economic processes influencing overall resilience 2
Figure 2: Map of Kumbungu District showing the location of major towns and in relation to other districts in the Northern Region 5
Figure 3: Annual rainfall regime in Kumbungu District....6
Figure 4: Distribution of cloudy, sunny, and precipitation days in Kumbungu 7
Figure 5: Monthly precipitation amounts in the Kumbungu District....7
Figure 6: Maximum temperature patterns in Kumbungu District 8
Figure 7: Population of Kumbungu District, stratified by gender....9
Figure 8: Marital status of households in the Kumbungu District....10
Figure 9: Characteristics of persons with disabilities in Kumbungu District....10
Figure 10: Multidimensional poverty and its intensity in Kumbungu, Northern Region, and Ghana 12
Figure 11: Deprivation and its contribution to multidimensional poverty in Kumbungu District compared to Northern Region and Ghana 13
Figure 12: Multidimensional poverty hotspots across Kumbungu District 14
Figure 13: Map showing the main economic activities and their areas of concentration in the Kumbungu District 16
Figure 14: Phases for the assessment process....22
Figure 15: Three-stage process for gender-responsive approach to climate vulnerabilities assessment 23
Figure 16: Households source of income by gender 33
Figure 17: Average monthly income by gender 34
Figure 18: Asset ownership by households stratified by gender 35
Figure 19: Venn diagram highlights disparities in land ownership based on focus group discussions 35
Figure 20: Households' engagement in alternative income-generating livelihood activities 36
Figure 21: Specific other income-generating activities 36
Figure 22: Income distribution from alternative income generating activities 37
Figure 23: Access to agricultural extension agents 37
Figure 24: Households' practice of dry season farming....38
Figure 25: Households' access to irrigation system on their farm 38
Figure 26: Marginalized groups economic vulnerabilities in the Kumbungu District....39
Figure 27: Exposure to floods and impacts in past 5 years stratified by gender 43
Figure 28: Exposure to drought and impacts in past 5 years 43
Figure 29: Exposure to extreme heat and impacts in the past 5 years 44
Figure 30: Exposure to windstorms and impacts in past 5 years 44
Figure 31: Sensitivity of agriculture sector to key climate-induced hazards 45
Figure 32: Sensitivity of the infrastructural sector to key climate-induced hazards 46
Figure 33: Sensitivity of health sector to key climate-induced hazards 46
Figure 34: Sensitivity of water resources sector to key climate-induced hazards 47
Figure 35: Overall sectoral sensitivity to climate hazards in Kumbungu District 48
Figure 36: Gender roles in household decision-making and resource management 49
Figure 37: How climate change affects women 50
Figure 38: Do women have equal decision-making power for climate change adaptation 50
Figure 39: Barriers to women's access to resources for climate change adaptation 51
Figure 40: Access to resources for coping with climate change impacts 51
Figure 41: Presence of local organizations supporting women 52
Figure 42: Type of support provided by local organizations 52

Figure 43: Main income courses for households across the surveyed communities 53
Figure 44: Average monthly income from main livelihood activities 54
Figure 45: Asset ownership by communities 54
Figure 46: Households' involvement in dry season farming 55
Figure 47: Farmers access irrigation systems on their farms 56
Figure 48: Type of irrigation system being employed by farmers in Kumbungu.....56
Figure 49: Communities experience of floods in the Kumbungu District 58
Figure 50: Communities experience extreme heat in the Kumbungu District.....59
Figure 51: Communities experience of drought in the past 5 years 59
Figure 52: Climate change impact on women in Kumbungu District 60
Figure 53: Availability of local organizations supporting women in adapting to climate change 61
Figure 54: Women's involvement in household decision-making on climate adaptation 61
Figure 55: Access to resources and barriers for women 62
Figure 56: Projected monthly rainfall climatology for Kumbungu District under SSP2-4.5 and SSP5-8.5 scenarios: near-future, mid-future, and far-future.....64
Figure 57: Historical and projected mean precipitation patterns under SSP 5-8.5 and SSP 2-4.5 scenarios for Kumbungu.....65
Figure 58: Climate indices for Kumbungu District.....65
Figure 59: Projected mean temperature trends for Kumbungu District under SSP5-8.5 and SSP2-4.5 scenarios 66

List of Photos

Photo 1: A landscape typical of Kumbungu District, featuring shea trees scattered across farmland ...9
Photo 2: View of the Botanga irrigation scheme 11
Photo 3: View of canal and irrigable areas around the Botanga dam 11
Photo 4: Women sorting and cleaning shea nuts in Kumbungu District.....12
Photo 5: Fishing and transportation canoes on the Black Volta at Nawuni Community.....14
Photo 6: Heaps of sand gathered in the Nawuni Community for transportation.....15
Photo 7: Photocall of participations in the first stakeholder engagement workshop at the Kumbungu District Assembly building.....25
Photo 8: Participatory resource map of Kumbungu District 26
Photo 9: Participatory hazard mapping of Kumbungu District 26
Photo 10: Kumbungu District seasonal calendar.....27
Photo 11: Participants working on seasonal calendar 27
Photo 12: Assessment team engaging with planning officer at Kumbungu to identify and select communities.....28

ACRONYMS AND ABBREVIATIONS

AF	Adaptation Fund
AR	Assessment Report
CAMFED	Campaign for Female Education
CARE	Cooperative for Assistance and Relief Everywhere
CBO	Community-Based Organization
CCAF	Community Climate Adaptation Fund
CDD	Consecutive Dry Days
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station Data
CIF	Climate Investment Funds
CMIP6	Coupled Model Intercomparison Project - Phase 6
CRIP	Climate Resilience Improvement Project (World Bank)
CRVA	Climate Change Risk and Vulnerability Assessment
CSO	Civil Society Organization
CVCA	Climate Vulnerability and Capacity Analysis
CWD	Consecutive Wet Days
DA	District Assembly
DUR	Department of Urban Road
EPA	Environmental Protection Agency
ETCCDI	Expert Team on Climate Change Detection and Indices
FAO	Food and Agriculture Organization
FC	Forestry Commission
FF	Far-Future
FGD	Focus Group Discussion
GAC	Global Affairs Canada
GCF	Green Climate Fund
GCX	Ghana Commodity Exchange
GES	Ghana Education Service
GHAMFIN	Ghana Microfinance Institutions Network
GHS	Ghana Health Service
GIDA	Ghana Irrigation Development Authority
GIZ	*Deutsche Gesellschaft für Internationale Zusammenarbei*t (German Agency for International Development)
GMet	Ghana Meteorological Agency
GoG	Government of Ghana
GSOP	Ghana Social Opportunities Project
GSS	Ghana Statistical Service
GWCL	Ghana Water Company Limited
IFAD	International Fund for Agricultural Development
IOM	International Organization for Migration (UN)
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter-Tropical Convergence Zone
IWMI	International Water Management Institute
KII	Key Informant Interview
M&E	Monitoring and Evaluation
MDAs	Ministries, Departments and Agencies
MF	Mid-Future

MMDAs	Metropolitan, Municipal and District Assemblies
MoF	Ministry of Finance
MoF	Matrix of Function
MoFA	Ministry of Food and Agriculture
MoFAD	Ministry of Fisheries and Aquaculture Development
MoGCSP	Ministry of Gender, Children and Social Protection
MRH	Ministry of Roads and Highways
MTDP	Medium-Term Development Plan
MWH	Ministry of Works, Housing and Water Resources
MWRS	Ministry of Water Resources and Sanitation
NADMO	National Disaster Management Organization
NAP	National Adaptation Plan
NDC	Nationally Determined Contribution
NF	Near-Future
NGO	Non-Governmental Organization
NVTI	National Vocational Training Institute
PHC	Population and Housing Census
PWD	Person with Disability
R95p	Rainfall above the 95th percentile
R95pTOT	Very Wet Days' Contribution to Total Precipitation
RCC	Regional Coordinating Council
RR	Rainfall Rate
Rx1day	Maximum 1-day precipitation
Rx5day	Maximum 5-day precipitation
SADA	Savannah Accelerated Development Authority
SARI	Savanna Agriculture Research Institute
SDG	Sustainable Development Goal
SDII	Simple Daily Intensity Index
SIGRA	Strengthening Investments in Gender-Responsive Climate Adaptation
SNV	Netherlands Development Organisation
SSPs	Shared Socio-Economic Pathways
TNn	Minimum daily minimum temperature
TNx	Maximum daily minimum temperature
TXn	Minimum daily maximum temperature
TXx	Maximum daily maximum temperature
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
VSLA	Village Savings and Loan Associations
WFP	World Food Programme
WHO	World Health Organization
WRC	Water Resources Commission

EXECUTIVE SUMMARY

Background

Climate change presents varied challenges to the socio-economic development agenda of Ghana at various levels. The changing climate has a wide-range implications for cities, local communities, indigenous businesses, industry and government at different levels. The government of Ghana, through the national adaptation planning (NAP) process, with technical and financial support from the Global Affairs Canada (GAC), under auspices of the "Strengthening Investments in Gender-Responsive Climate Adaptation" (SIGRA) project commissioned a Climate Change Risk and Vulnerability Assessment (CRVA) in the Kumbungu District of the Northern region of Ghana to support evidence-based decision making and planning in climate change adaptation at the local level. This report presents the findings of the CRVA conducted by the SIGRA project in the Kumbungu District.

The Assessment aimed at understanding how climate change impacts different socio-economic groups, particularly marginalized and vulnerable populations. Climate change is intensifying environmental and livelihood challenges, with erratic rainfall, prolonged droughts, floods, water scarcity, bushfires, and pest infestations increasingly threatening agriculture, food security, and economic stability. A core focus of this CRVA is gender dynamics, recognizing that women, youth, elderly individuals, persons with disabilities (PWDs), and migrant communities experience climate risks differently due to systemic socio-economic inequalities. Women, for example, are often disproportionately burdened with caregiving and food security responsibilities, while youth face migration pressures due to declining rural job opportunities. The adoption of a socially inclusive and gender-responsive approach ensures that this assessment informs equitable climate adaptation policies and strategies at both the district and national levels. The SIGRA project aligns with Ghana's National Adaptation Plan (NAP) and broader international climate resilience frameworks by providing local-level insights into vulnerability profiles and adaptation challenges. The findings contribute directly to national and subnational climate action planning, ensuring that adaptation strategies reflect the lived realities of vulnerable communities in Ghana's semi-arid regions.

District Profile

The Kumbungu District, located in Ghana's Northern Region, covers approximately 1,599 square kilometers, strategically bordered by Mamprugu/Moagduri, Tolon, North Gonja, Sagnarigu, and Savelugu Municipal districts. It features a predominantly flat to gently undulating terrain characteristic of the Guinea Savannah ecological zone, interspersed with drought-resistant vegetation and significant water bodies, notably the White Volta River. The climate is tropical savanna, experiencing distinct wet (May–October, annual rainfall ~1,000mm) and dry (November-April) seasons, with temperatures ranging between 20°C and 39°C, peaking in March and April.

According to the 2021 Population and Housing Census, the Kumbungu District has a total population of 110,586 (50.1% female) people. The district's socio-economic structure is largely rural and agricultural-based, with about 90% of the workforce engaged in subsistence farming and related activities, supplemented by fishing, sand mining, and agro-processing (particularly shea and groundnut processing by women). Despite agricultural potential, widespread poverty persists, marked by limited access to quality housing, sanitation, and stable employment. The district exhibits multidimensional poverty (45%), notably above the national average (24.3%), driven significantly by unemployment, poor health access, and educational challenges.

Methodology

This CRVA combines qualitative and quantitative approaches to analyze climate risks and vulnerabilities in 12 communities across Kumbungu District. Household surveys captured data on livelihoods, climate risks, and adaptation strategies, while focus group discussions (FGDs) engaged women, youth, migrants, and PWDs to highlight social disparities. Key informant interviews (KIIs) with local authorities and agricultural officers provided institutional perspectives, and field observations assessed environmental conditions such as soil erosion and water access. Additionally, secondary data reviews aligned local findings with national climate projections and policy frameworks.

Key Findings

Climate Hazards and Community Vulnerability

- The Kumbungu District faces erratic rainfall, prolonged droughts, intense flooding, rising temperatures, and soil erosion, leading to severe agricultural losses, food insecurity, and economic instability.
- Soil degradation and poor irrigation access further limit agricultural productivity, making smallholder farmers highly vulnerable.
- Bushfires and pest infestations have increased in frequency, destroying crops, grazing lands, and forests, threatening livelihoods and biodiversity.
- Flooding damages critical infrastructure including roads, homes, disrupting market access, education, and healthcare delivery.

Economic Vulnerabilities

- **Gendered Income Disparities**: Men primarily engage in crop and livestock farming (81.2%), while women focus mainly on shea processing, petty trading, and informal activities. This difference stems from limited access for women to productive resources like land and capital.
- **Income Inequality**: Women predominantly occupy the lowest income bracket (below 500 GHS/month), with limited participation in higher-earning activities due to structural barriers, lack of capital, and caregiving responsibilities. Men have more diverse income ranges and greater access to profitable ventures.
- **Asset Ownership Disparities**: Men own higher-value productive assets like land, livestock, and vehicles, enhancing their mobility and productivity. Women have more ownership in poultry and small-scale assets, reflecting their role in low-capital activities.
- **Dry Season Farming**: Women's engagement in dry season farming is significantly lower than men's due to barriers such as limited access to irrigation, capital, and domestic responsibilities.

Physical Vulnerabilities

- **Exposure to Climate Hazards:** Communities experience severe exposure to droughts, floods, extreme heat, and windstorms, impacting agricultural productivity, infrastructure, and health. Women and marginalized groups face higher exposure to extreme events like floods and heat waves due to location, housing quality, and limited coping resources.
- **Sector Sensitivity:** Agriculture, infrastructure, health, and water sectors are critically sensitive, with floods and droughts identified as the most disruptive hazards. Agriculture, being heavily rain-fed, is particularly vulnerable, impacting food security and livelihoods severely.

Social Vulnerabilities

- **Gender Roles and Decision-Making:** Traditional norms result in men controlling finances and farming decisions, while women bear domestic responsibilities such as water collection and caregiving. This restricts women's participation in key decisions affecting their economic and adaptive capacities.
- **Specific Vulnerabilities to Climate Change:** Women experience increased workloads, reduced incomes, health issues, safety risks, and heightened caregiving responsibilities during climate crises. Their decision-making power in climate adaptation is limited, exacerbating vulnerability. Youth are increasingly migrating to urban areas due to limited local livelihood opportunities, leaving rural communities with labor shortages.
- **Barriers to Resource Access:** Cultural traditions, financial constraints, lack of legal rights, and low education severely limit women's access to essential adaptive resources like credit, land, and information.

Community-Level Variations in Vulnerabilities

- **Agricultural Dependency:** Communities like *Gbullung, Zangballung, and Voggu* heavily depend on rain-fed agriculture, making them highly vulnerable to climate-induced droughts and floods.
- **Economic Diversification:** Towns such as *Kumbungu and Dalun* show relatively higher economic diversification and better market access, enhancing their resilience compared to isolated communities.
- **Limited Irrigation Infrastructure:** Only a few communities (*Kpalsogun, Sakuba*) have meaningful access to irrigation for dry-season farming; most areas face significant water scarcity, limiting agricultural productivity.

- **Gender Inequality in Decision-Making:** Significant gender disparities persist, with low involvement of women in climate-related decision-making, particularly in traditional communities like *Dalun, Guppanarigu, and Zugu.*
- **Exposure to Climate Hazards:** Communities like Nawuni, Voggu, and Sakuba frequently experience floods, while *Dalun and Kpalsogun* suffer intense droughts and extreme heat, affecting infrastructure, livelihoods, and health.
- **Barriers to Women's Resource Access:** Across all communities, cultural traditions, financial constraints, and limited education severely restrict women's access to vital resources needed for effective climate adaptation.

Projected Climate Trends and Future Risks

- **Rainfall and Temperature Changes:** Projected climate scenarios indicate increased rainfall variability and intensity, particularly under higher emissions scenarios (SSP5-8.5). Temperatures are expected to rise significantly by the end of the century, exacerbating heat stress and drought conditions in the Kumbungu District. Under these scenarios, more intense flooding, leading to higher risks of crop losses, displacement, and water contamination are expected in the district.
- **Future Vulnerabilities Exacerbated:** Anticipated climatic changes will intensify existing vulnerabilities in the district, particularly for women, youth, migrants, and the elderly. Women's economic and social burdens are expected to increase significantly, necessitating targeted interventions.

Recommendations

Social Adaptation Strategies

- Establish -inclusive decision-making platforms to ensure women, youth, and marginalized groups participate in climate adaptation planning.
- Develop childcare and healthcare support systems during climate crises to alleviate caregiving burdens.
- Strengthen education and skills training programs to enhance youth employability and reduce migration pressures.

Economic Adaptation Strategies

- Expand access to climate finance for women, smallholder farmers, and cooperatives to support climate-smart farming, irrigation, and alternative livelihoods.
- Strengthen market linkages for shea processing, agroforestry, and climate-resilient crops.
- Promote income diversification and introduce drought-tolerant crops and water-efficient farming techniques.

Physical Adaptation Strategies

- Invest in flood-proof roads, improved drainage systems, and irrigation infrastructure to mitigate flood risks and support dry-season farming.
- Expand rainwater harvesting systems and boreholes to improve water security during droughts.
- Promote reforestation and land restoration programs to combat soil erosion, bushfires, and desertification.

Institutional and Policy Actions

- Strengthen local governance capacity to implement gender-responsive climate adaptation policies.
- Integrate climate vulnerabilities and proposed adaptation options into Medium-Term Development Plans
- Align district-level adaptation efforts with Ghana's National Adaptation Plan (NAP) and international climate frameworks.
- Develop monitoring and evaluation (M&E) systems to track adaptation progress and ensure equitable resource distribution.

Way Forward

The next step should be the development of a comprehensive Climate Action Plan for Kumbungu District. This plan will detail prioritized adaptation actions addressing key vulnerabilities, ensuring gender sensitivity and inclusivity. It will also identify practical financial options to fund interventions, thereby enhancing climate resilience and sustainable development across communities.

1. Introduction

1.1 Project Background

In support of Ghana's NAP, the SIGRA Project (Strengthening Investments in Gender-Responsive Climate Adaptation) has commissioned Climate Change Risk and Vulnerability Assessments (CRVAs) for its five partner Districts. SIGRA (2023-2028) is a Global Affairs Canada funded project that seeks to advance climate action and inclusive governance in Ghana. Its ultimate outcome is to improve the resilience of Ghanaian citizens, particularly women, girls, and vulnerable groups through increased investments in inclusive and gender-responsive climate adaptation initiatives.

The SIGRA project provides technical assistance to strengthen governance and national systems with key central Ministries, Departments and Agencies (MDAs) while providing direct grants to five MMDAs funding local gender responsive climate adaptation projects. The project supports Regional Coordinating Councils (RCCs) in the Northern and Volta regions and strengthens the ability of targeted MMDAs to plan, implement, and report on climate adaptation initiatives. Additionally, SIGRA seeks to strengthen the participation, voice and influence of women led CSOs in government decision-making.

The project, which is currently being implemented by Cowater International, complements current national climate adaptation and resilience-building efforts in Ghana by recognizing the far-reaching consequences and implications of current and projected future climate change impacts on Ghana's sustainable development aspirations. As climate impacts become more pervasive, verifiable and pernicious in local communities across the country, the imperative for intentional interventions in the form of adaptation planning has also become an urgent policy concern, which has attracted several responses.

The National Adaptation Planning (NAP) as one such response is a flagship national program led by the Environmental Protection Agency (EPA) of Ghana and aims to identify climate impact manifestations and associated risks and vulnerabilities across sectors and in local communities, and to put in place proactive adaptation interventions that build resilience. Ghana's NAP thus serves as an organizing avenue for subnational adaptation and resilience building through its use of place-based risk and vulnerability assessments, or what is described as a district-specific adaptation planning. The primary objective, as outlined in Ghana's NAP Framework (Antwi-Agyei, 2018), is to reduce vulnerability to climate change impacts by enhancing adaptive capacity and resilience within local communities. Implicit in the district-focused approach is the recognition of the fact that climate change impacts are place-specific; that they are not homogeneous and require carefully considered adaptation measures that are also place-responsive.

The SIGRA Project complements Ghana's NAP processes by helping to address the growing impacts of climate change especially in local communities. The gendered focus of the project is particularly instructive as it highlights differential experiences of climate change impacts and how that also demonstrate differences in adaptive capacity levels, especially as they relate to women, young people, migrants and Persons with Disability (PWDs). While the project aims generally at improving the lives, livelihoods and well-being of people living in their different places and facing climate change risks and vulnerabilities, the intentional focus on marginalization and differential adaptive capacity provides deeper insights that will inform adaptation planning (Antwi-Agyei et al., 2015). Such an approach does not only enhance understandings around gender-responsive adaptation planning, but also, and perhaps more importantly, they facilitate the development of place-specific knowledge that may guide the direction of future investments in the implementation of adaptation options.

It becomes imperative, therefore, that Ghana's adaptation planning processes foster knowledge building, learning and capacity building (Manteaw et al., 2022). The SIGRA project with its emphasis on specific vulnerabilities, rather than generalized vulnerabilities, affirms the fact that climate adaptation is both a learned and learning process, which requires intentional processes that creates the enabling environment for people to learn to adapt. Adaptation only happens when people have learned to live differently or made the necessary adjustments to their lives to become resilient. The logical process entails utilizing the completed CRVA for the Kumbungu District as the foundational basis for developing

a costed adaptation plan and its corresponding intervention projects. A district-specific adaptation plan will ultimately serve as a major tool in the hands of the Assembly to develop innovative and bankable projects as they source funds (climate finance) for implementation.

1.2 Defining Climate Change Risks and Vulnerability

1.2.1 Intergovernmental Panel on Climate Change Risk and Vulnerability Framework

The Intergovernmental Panel on Climate Change (IPCC) defines climate risk as the interaction of three core components: hazards, exposure, and vulnerability **(Figure 1)**. Hazards refer to climate-related events or conditions (*e.g.,* droughts, floods), while exposure reflects the presence of people, ecosystems, and assets in areas at risk. Vulnerability encompasses the susceptibility to harm and the capacity to adapt, shaped by socio-economic, cultural, and environmental factors (IPCC, 2014; 2022).

The IPCC framework emphasizes that climate risk is not only determined by the magnitude of hazards but also by the socio-economic processes influencing exposure and vulnerability. For instance, in the Kumbungu District, systemic inequalities such as limited land ownership among women exacerbate their vulnerability to droughts and floods, while inadequate governance structures hinder adaptive capacity.

The IPCC also highlights the concept of compound and cascading risks, where multiple hazards interact to amplify vulnerabilities. For example, in the Kumbungu District, a prolonged drought can lead to water scarcity, reducing agricultural productivity and increasing women's workload in water collection, which in turn limits their participation in income-generating activities. This interconnectedness underscores the need for integrated and inclusive adaptation strategies.

The IPCC framework (**Figure 1**) provides a theoretical backbone for understanding climate risks, offering a basis for assessing hazards, exposure, and vulnerability.

Figure 1: The IPCC risk and vulnerability framework illustrating the interaction of hazards, exposure, and vulnerability in shaping climate risks, with socio-economic processes influencing overall resilience

1.3 Document Purpose

This CRVA is designed to identify, analyze, and prioritize the gendered perspective of climate vulnerability within the Kumbungu District in the Ghana's Northern region in line with the NAP framework. This assessment incorporates sector-specific analysis, integrating gender dynamics based on both local, district and national contexts.

Consultations with MMDA staff, community-based organizations, communities' leadership and members, women, and vulnerable groups have been integral to incorporating localized adaptation needs. Using a systematic approach aligned with Assessment Report (AR5) framework of the Intergovernmental Panel on Climate Change (IPCC), the assessment evaluates district-specific climate risks and impacts by examining three core dimensions: hazard, exposure, and vulnerability. The AR5 framework defines climate risk as the result of the interaction between climate-related hazards (*e.g.*, floods, droughts), the exposure of people and assets to those hazards, and the underlying vulnerability of communities shaped by social, economic, and environmental conditions. This framing allows for a comprehensive and nuanced analysis of how climate change affects different populations, particularly marginalized groups. Specifically, the document through this assessment aims to:

1. **Provide a Comprehensive Overview of Climate Risks:** To capture a detailed picture of the climate hazards specific to Kumbungu District including the gendered dimensions of their current and potential future impacts on people, livelihoods, and ecosystems. This entails a rapid but thorough collection of information that informs adaptation planning and decision-making processes.
2. **Enhance Understanding of Vulnerabilities:** To deepen the understanding of the district's vulnerabilities, considering gender considerations and the multifaceted nature of climate risks that affect social, economic, and environmental dimensions.
3. **Support Adaptation Planning:** To offer a foundational basis for developing targeted and effective adaptation strategies and measures that address the prioritized risks, thereby strengthening the resilience of the Kumbungu District to climate change.
4. **Promote Stakeholder Engagement and Collaboration:** To facilitate an inclusive process that engages a wide range of stakeholders, including government agencies, local communities, NGOs, and private sector actors, ensuring that the CRVA process is grounded in local realities and benefits from diverse perspectives and expertise.
5. **Align with National and Regional Climate Change Frameworks:** To ensure that the findings and recommendations of the CRVA for the district are consistent with national climate change strategies and action plans, contributing to the broader efforts to mitigate and adapt to climate change in Ghana.
6. **Build Institutional Capacity:** To strengthen the capacities of Assembly staff and relevant stakeholders. This will equip them with the knowledge and skills needed to effectively govern adaptation efforts, including conducting future climate risk and vulnerability assessments and developing comprehensive adaptation plans.

This CRVA aligns global frameworks that emphasize the importance of equity and resilience in addressing climate change. Sustainable Development Goal (SDG) 5 on Gender Equality highlights the need to address gender disparities in adaptation efforts and to empower women as key leaders in building climate resilience. Similarly, SDG 13 (Climate Action) underscores the urgency of strengthening adaptation strategies to enhance the resilience of communities that are most vulnerable to the impacts of climate change. Together, these goals provide a foundation for integrating gender-responsive and inclusive approaches into climate adaptation planning in Kumbungu District.

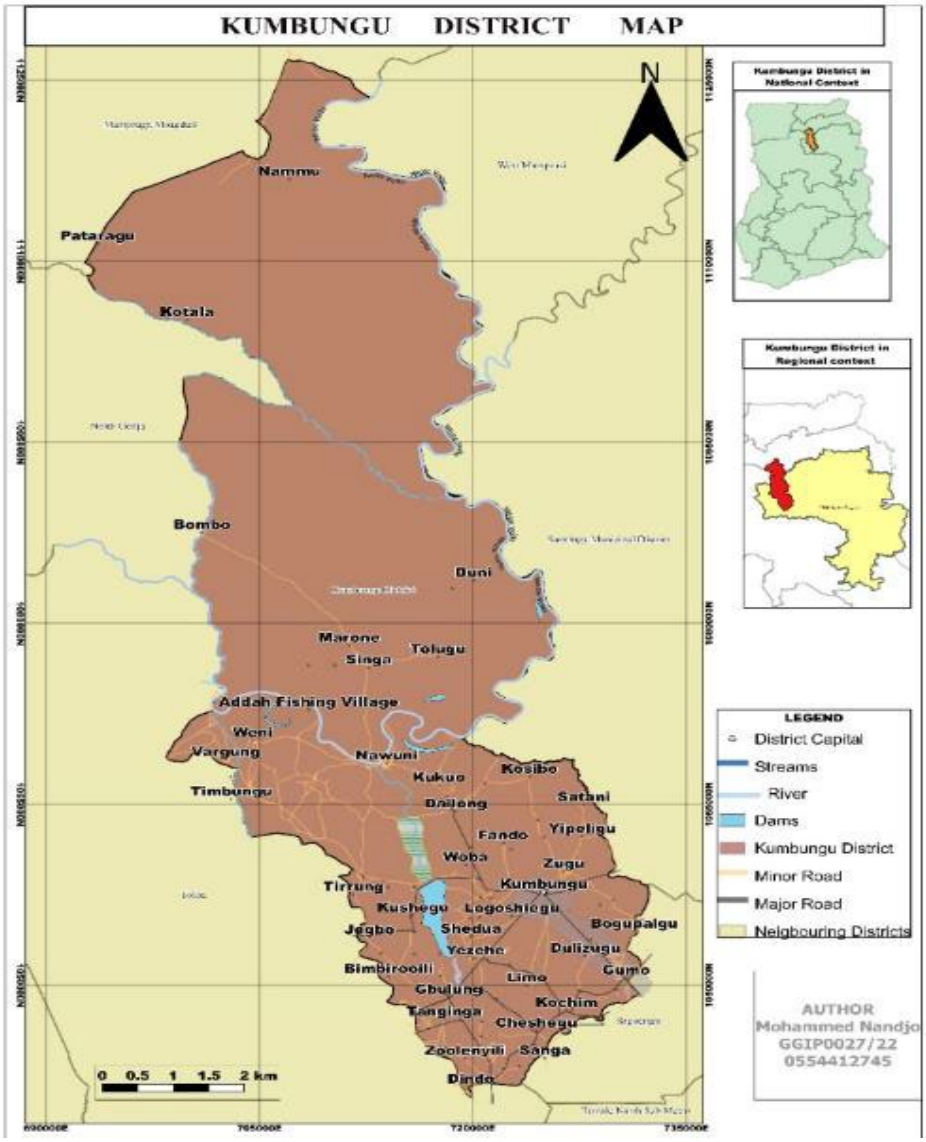
2. Progress Towards Expected Outcomes

2.1 Geography and Climate Related Profiles

2.1.1 Location and Size

The Kumbungu District is located in the Northern Region of Ghana, occupying a land area of approximately 1,599 square kilometers. Geographically, it lies between latitude 9°33′32″ N and longitude -5°65′5″ W. The district is strategically positioned, bordered to the north by the Mamprugu/Moagduri District, to the west by Tolon and North Gonja Districts, to the south by Sagnarigu District, and to the east by Savelugu Municipal (**Figure 2**) (Ghana Statistical Service, 2021). This location places Kumbungu District in a key position within the Northern Region, facilitating administrative oversight and serving as a conduit for regional trade and commerce. Kumbungu, the district capital, acts as the central hub for governance and economic activities, fostering connectivity with neighboring districts and enhancing the district's role as an emerging center for socio-economic development in the region.

Figure 2: Map of Kumbungu District showing the location of major towns and in relation to other districts in the Northern Region



Source: Kumbungu District Planning Office

2.1.2 Topography and Climate

Kumbungu District is predominantly characterized by a flat and gently undulating terrain typical of the Guinea Savannah ecological zone. The district's topography is marked by vast expanses of savannah grasslands interspersed with sparse tree cover, primarily consisting of drought-resistant species (Ghana Statistical Service, 2014). These geographic features create a landscape conducive to both rain-fed agriculture and pastoral activities, which are the primary sources of livelihood for the majority of the district's inhabitants.

The climate of Kumbungu is tropical, with distinct wet and dry seasons influenced by the movement of the Inter-Tropical Convergence Zone (ITCZ). The rainy season, which extends from May to October, is essential for agricultural activities, providing the necessary water for crop cultivation. During this period, the district receives an average annual rainfall ranging from 950mm to 1,200mm, with rainfall intensity peaking between July and September. The dry season, from November to April, is dominated by the Harmattan winds, which bring dry, dusty, and sometimes cold conditions, significantly reducing humidity and leading to water scarcity issues.

In the Kumbungu District, the rain begins in May and ends in the latter part of October. July to September is the peak period for rainfall, and the district experiences flooding during this time, especially due to the White Volta River. The remainder of the year is dry. The average annual rainfall is around 1,000mm. Temperatures are generally warm, dry, and hazy around February to April, while the climate is cool, moist, and rainy from May to September. Harmattan, characterized by dry winds and dust, is experienced from November to February Ghana Statistical Service, 2021).

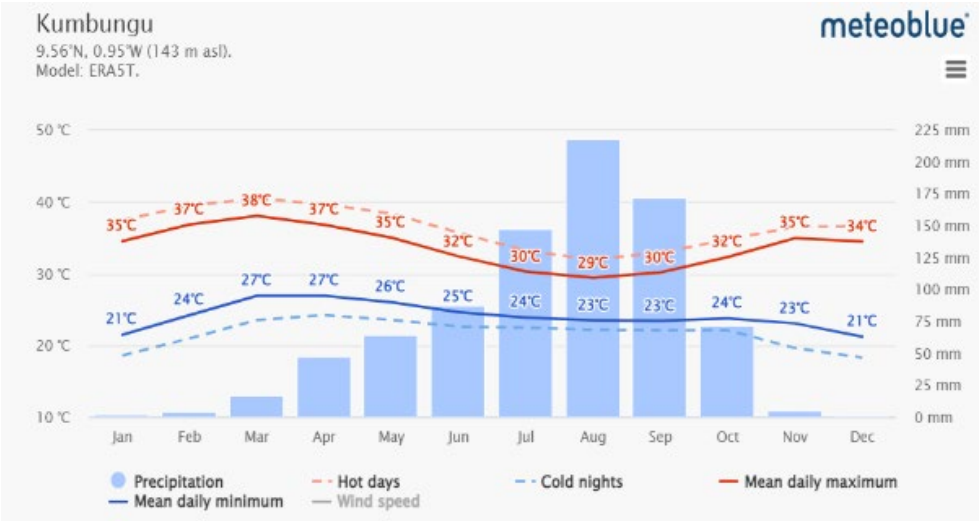
Temperatures in the district vary considerably throughout the year, with average daily temperatures ranging from a minimum of about 20°C during the cooler months to a maximum of 39°C in the hottest months of March and April. This wide temperature range, combined with variable rainfall patterns, influences agricultural productivity and water resource management in the district.

2.1.3 Average Temperatures and Precipitation

The district's yearly temperature is 30.22ºC and it is 1.36% higher than Ghana's averages. Kumbungu typically receives about 48.53 millimeters (1.91 inches) of precipitation and has 88.9 rainy days (24.36% of the time) annually. (**Figure 3**)

The "mean daily maximum" (solid red line) shows the maximum temperature of an average day for every month for Kumbungu. Likewise, "mean daily minimum" (solid blue line) shows the average minimum temperature. Hot days and cold nights (dashed red and blue lines) show the average of the hottest day and coldest night of each month of the last 30 years.

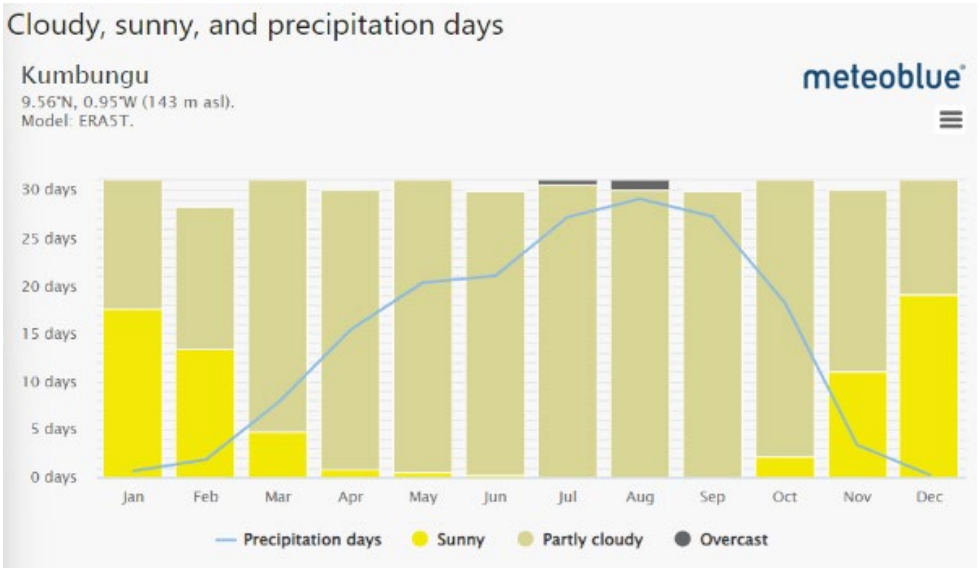
Figure 3: Annual rainfall regime in Kumbungu District



Source: www.meteoblue.com (2024)

Figure 4 illustrates the weather patterns in Kumbungu, highlighting a distinct dry season from November to February characterized by predominantly sunny days, while the rainy season spans from May to October with increased precipitation and overcast conditions peaking between July and September. Partly cloudy days are more frequent during the transition periods, and the sharp decline in precipitation after October signals the return to drier conditions typical of the savanna climate. The graph shows the monthly number of sunny, partly cloudy, overcast and precipitation days. Days with less than 20% cloud cover are considered as sunny, with 20-80% cloud cover as partly cloudy and with more than 80% as overcast.

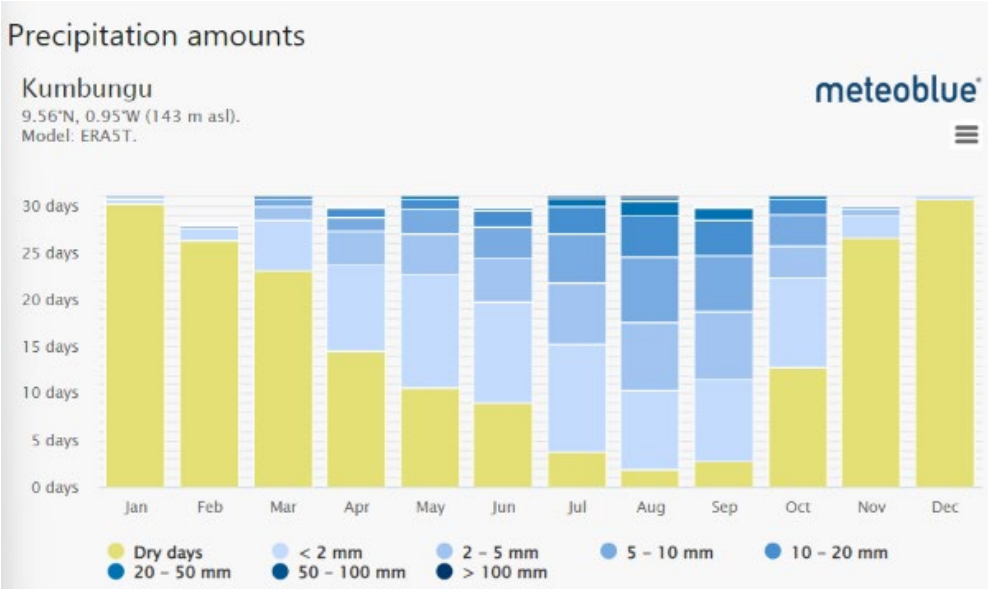
Figure 4: Distribution of cloudy, sunny, and precipitation days in Kumbungu



Source: www.meteoblue.com (2024)

Figure 5 shows the monthly precipitation amounts in the Kumbungu District, indicating a clear dry season from November to February, with almost no rainfall. The rainy season begins in March, intensifies from May, and peaks between July and September with significant rainfall above 20 mm on multiple days. Precipitation decreases sharply in October, signaling the transition back to the dry season. This pattern reflects the typical savanna climate, characterized by distinct wet and dry periods.

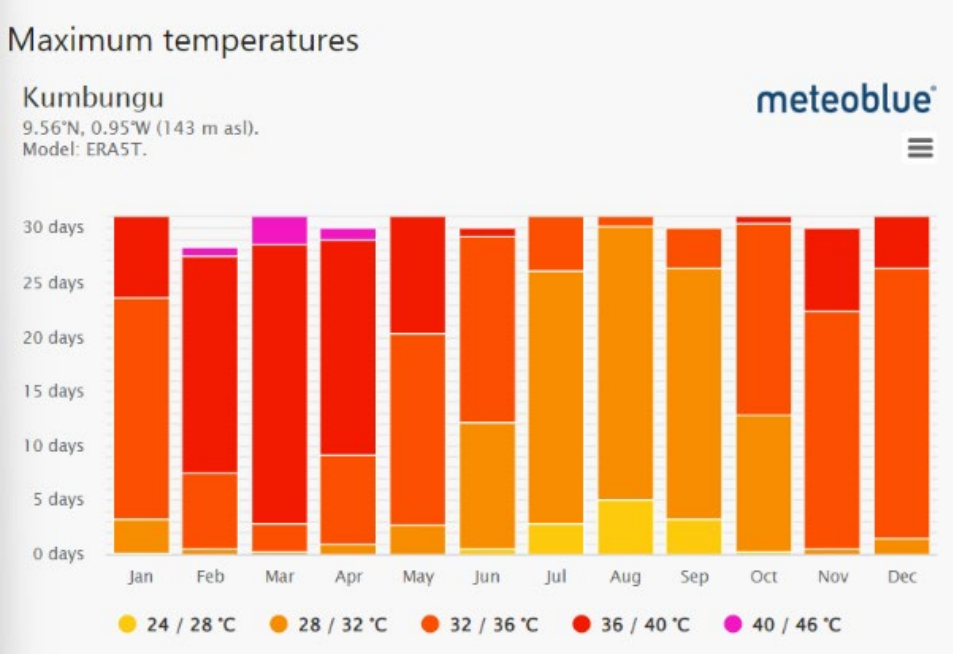
Figure 5: Monthly precipitation amounts in the Kumbungu District



Source: www.meteoblue.com (2024)

Figure 6 illustrates maximum temperature patterns in Kumbungu, with consistently high temperatures throughout the year. The hottest months are February to April, where temperatures frequently exceed 36°C, peaking above 40°C in some cases. The rainy season (June to September) sees slightly cooler maximum temperatures, ranging mostly between 28°C and 36°C. Temperatures begin to rise again in October and remain high until December, reflecting the region's hot savanna climate.

Figure 6: Maximum temperature patterns in Kumbungu District



Source: www.meteoblue.com (2024)

2.1.4 Relief and Vegetation

The land in the Kumbungu District is generally undulating, with scattered depressions and no marked high elevations throughout the district. The landscape in the district shows a mixture of flat and slightly elevated areas, which is typical of the Guinea Savanna zone (Ghana Statistical Service, 2021). Such undulations influence water drainage patterns, often resulting in localized water retention during the rainy season.

The district has several rivers and streams, with the White Volta being the most prominent. The major rivers and their tributaries exhibit dendritic drainage patterns. Most of these tributaries dry up during the dry season. Flooding, particularly from the White Volta, is a frequent occurrence during the peak rainfall period (July–September) (Ayereka & Jaman, 2023).

The vegetation of the district is typical of Guinea Savanna, interspersed with short drought-resistant trees and grasslands. Notable tree species include sheanut (*Vitellaria paradoxa),* dawadawa (*Parkia biglobosa*), neem tree (*Azadirachta indica*) and mango (*Mangifera indica*). These trees, integral to the region's ecology and economy, provide shade, medicinal properties, reduce soil erosion, and play a critical role in the livelihoods of locals through shea butter production (Shu-aib et al., 2023).

The soil in Kumbungu District is mostly sandy loam, with alluvial deposits found in the lowlands (Avornyo et al., 2014). The soils are highly vulnerable to sheet erosion, and some areas also experience gully erosion, primarily due to the perennial burning of natural vegetation, which leaves the soils exposed to intense sunlight. Continuous erosion over many years has depleted the topsoil and organic matter content, hindering soil fertility (Jamaldeen, 2023; **Photo 1**).

Photo 1: A landscape typical of Kumbungu District, featuring shea trees scattered across farmland

Source: Boafo, YA (2024)

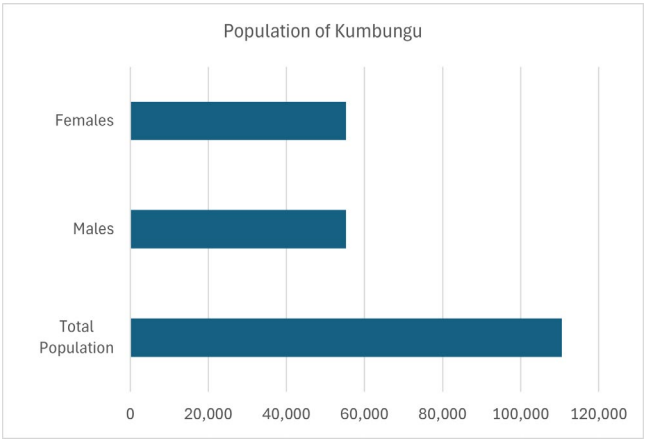
This condition also impacts the soil fauna, which is vital for maintaining healthy plant root development. As a result, soil compaction occurs, significantly reducing rainfall infiltration rates. However, despite soil degradation, the land still holds potential for agriculture if nutrient management strategies, such as soil supplementation, are employed to restore water infiltration rates and improve fertility.

2.2 Demographics and Gender Characteristics

2.2.1 Key Demographic Characteristics

According to the 2021 Population and Housing Census (PHC) report, the Kumbungu District has a total population of 110,586, with 55,291 males and 55,295 females. The district has an estimated annual growth rate of approximately 3%, and a population density of around 50 inhabitants per square kilometer. The population is nearly evenly split, with females constituting about 50.1% and males 49.9%. (**Figure 7**)

Figure 7: Population of Kumbungu District, stratified by gender

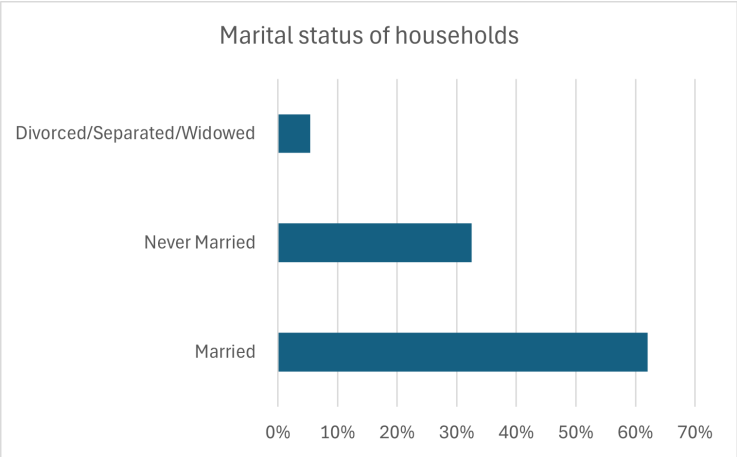


Source: Ghana Statistical Service, 2021

The indigenous people of Kumbungu are primarily *Dagombas,* who make up about 95% of the population (Nchor, 2011; Apungu, 2023). Other ethnic groups such as *Gonjas, Ewes, Fulanis, Frafras, and Moshies* are also present, especially along the White Volta River, where fishing activities are common. The extended family system is widely practiced, with only 14.6% of households following the nuclear family model. As a result, the district is predominantly rural, with most communities following traditional family structures (Ghana Statistical Service, 2021).

Marriage is common in Kumbungu, with approximately 62% of individuals aged 12 years and above being married. Around 32.5% have never married, while 5.4% are either divorced, separated, or widowed. There is a clear relationship between age and marital status, as the likelihood of being married increases with age. (**Figure 8**)

Figure 8: Marital status of households in the Kumbungu District



Source: Ghana Statistical Service, 2021

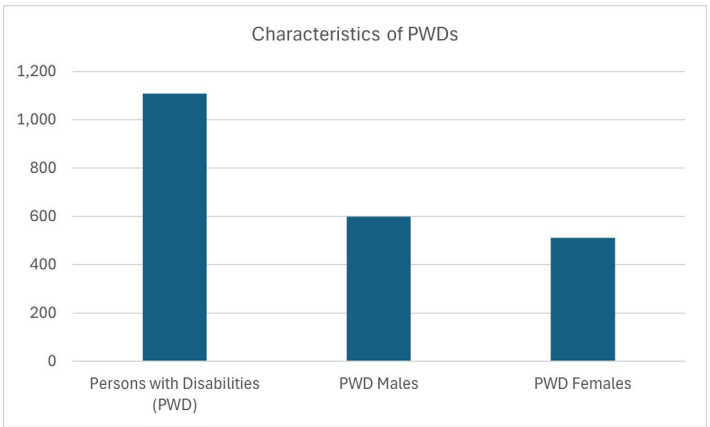
Educationally, Kumbungu faces significant challenges. Among the 23,874 people aged 12 and above, 74.6% have no formal education, while only 0.8% have completed secondary education or earned a post-middle school certificate or diploma. Despite these challenges, about 85.4% of married individuals aged 12 and above are employed, with 1.3% unemployed, and 13.3% are economically inactive.

The district is predominantly Muslim, with a significant proportion of the population practicing traditional religions. Christianity is present but mainly concentrated in urban settlements. The total fertility rate in the district is 3.6, with a general fertility rate of 103.9 and a crude birth rate of 23.4, which is slightly lower than the regional average of 24.0. However, 81.3% of children born to women aged 12 years and above are surviving, which is below the regional rate of 83.7%.

The location of the district makes the people naturally vulnerable to rainstorms and floods, particularly due to the proximity of the White Volta River. Cases of "*Kaayaaye"* (street hawking) are alarmingly high, with many children of school-going age involved. High school dropout rates due to poverty and hunger, combined with a high risk of rainstorm damage, disease outbreaks, and maternal deaths due to early marriages, are the district's key vulnerabilities. The lack of alternative social safety nets for the most vulnerable populations exacerbates these issues. The National Disaster Management Organization (NADMO) is present in the district but faces resource challenges.

In terms of disability, there are 1,109 people with disabilities in Kumbungu, representing 1.5% of the total population. Of these, 598 are males and 511 are females (**Figure 9**). The most common disabilities reported are sight and physical disabilities. Among people aged 15 and above, 61.8% of those with disabilities are employed, while 37.8% are economically inactive. Females with sight disabilities are particularly represented among the employed population.

Figure 9: Characteristics of persons with disabilities in Kumbungu District



Source: Ghana Statistical Service, 2021

The Kumbungu District is also characterized by a patriarchal society, where males are typically regarded as the breadwinners, and women are considered dependents (Ibrahim, 2019). However, women are consulted on important decisions in the family. Gender stereotypes are evident, as male children are often prioritized for education over female children when resources are limited, resulting in fewer girls attending school (Enahoro et al., 2021). Despite these cultural practices, programs like the Ghana School Feeding Programme and CAMFED are making strides to ensure that more girls are educated, and attitudes towards the value of educating girls are gradually changing (KDA, 2022).

2.2.2 Key Economic Activities

Agriculture is the dominant economic activity in Kumbungu District, engaging approximately 90% of the district's labour force. Most of the agricultural activities are carried out on a seasonal and subsistence level, with only a few individuals participating in irrigation farming around the Botanga Dam.

Photo 2: View of the Botanga irrigation scheme

Source: Boafo YA (2024)

Photo 3: View of canal and irrigable areas around the Botanga dam

Source: Boafo YA (2024)

The Botanga Irrigation Scheme in particular supports the cultivation. **(Photos 3 and 4)**

n of a wide range of crops, including vegetables and cereals. This gives Kumbungu a comparative advantage over other districts in the Northern Region, as its produce contributes to the year-round supply of fresh vegetables to Tamale, the regional capital and other cities like Kumasi and Accra.

Shea and groundnut processing are significant economic activities in the Kumbungu District, particularly among women who rely on these industries for their livelihoods. **Photo 4** shows women actively engaged in sorting and cleaning shea nuts, a critical step in the production of shea butter, which is widely used locally and internationally. These activities not only provide income for women but also foster community development and economic sustainability. Groundnut processing, similarly, contributes to food security and trade, making these activities vital to the socio-economic fabric of the district.

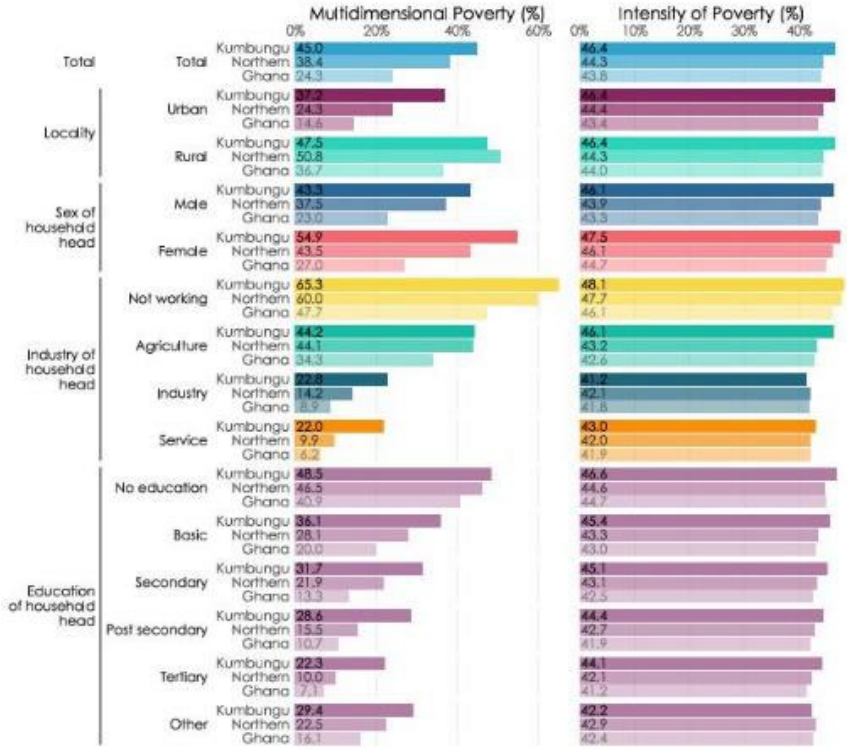
Photo 4: Women sorting and cleaning shea nuts in Kumbungu District

Source: Boafo, YA (2024)

The district' is also known for the production and marketing of maize, rice, ground nuts, yams and pepper, which are grown in both rural and urban areas. The Kumbungu District is also famous for its pepper market located at the UDS Nyankpala Junction (Shiraz et al., 2024). The strategic location of Nyankpala Junction, a hub within the district, facilitates the efficient aggregation and distribution of pepper, ensuring that the produce reaches larger cities where demand is high. (**Photo 4**)

The district's standard of living is relatively low compared to the national average, as indicated by the district's poverty mapping (Ghana Statistical Service, 2021). Drawing on multidimensional poverty and its intensity in Kumbungu, Northern Region, and Ghana, the Kumbungu has a higher multidimensional poverty rate (45.0%) than the national average (24.3%) but slightly lower than the Northern Region (48.4%). (**Figure 10**)

Figure 10: Multidimensional poverty and its intensity in Kumbungu, Northern Region, and Ghana

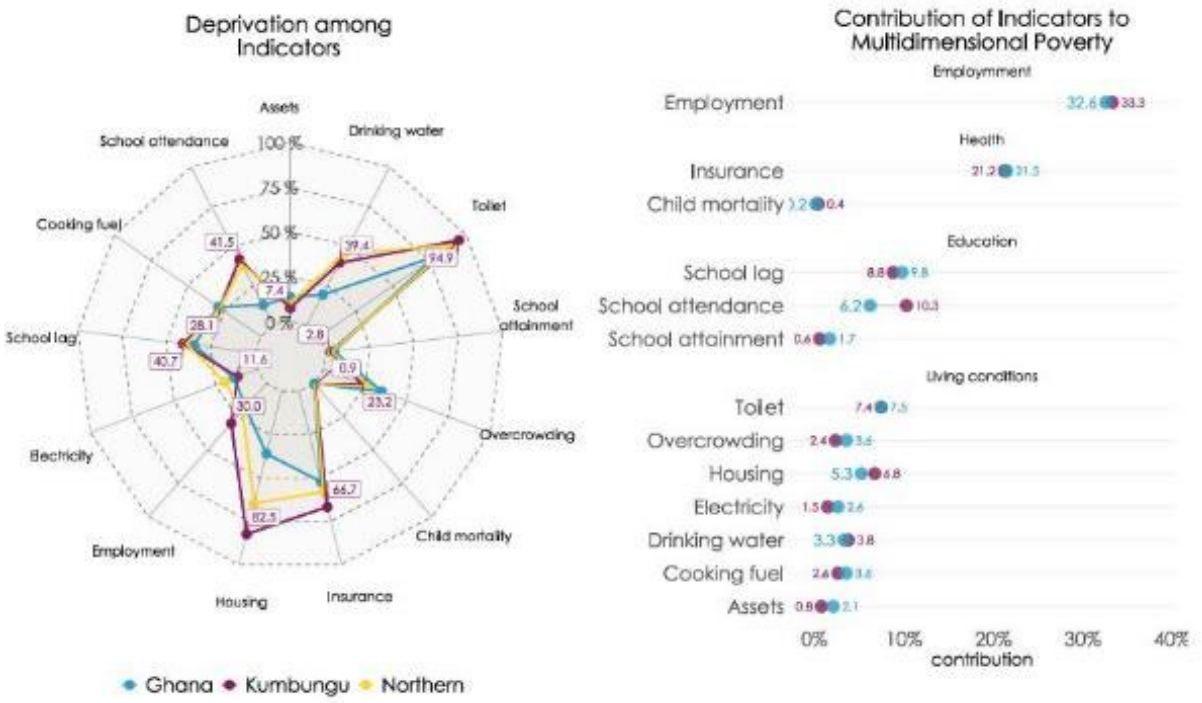


Source: Ghana Statistical Service, 2023

Rural areas, female-headed households, and non-working households exhibit the highest poverty levels. The intensity of poverty is also pronounced, with Kumbungu at 46.4%, reflecting the depth of deprivation.

Figure 11 illustrates the average levels of deprivation (ranging from 0% to 100%) across 13 indicators in Kumbungu, compared to the regional and national averages. The chart on the right highlights the contribution of each indicator to multidimensional poverty, with the total contributions summing up to 100%.

Figure 11: Deprivation and its contribution to multidimensional poverty in Kumbungu District compared to Northern Region and Ghana

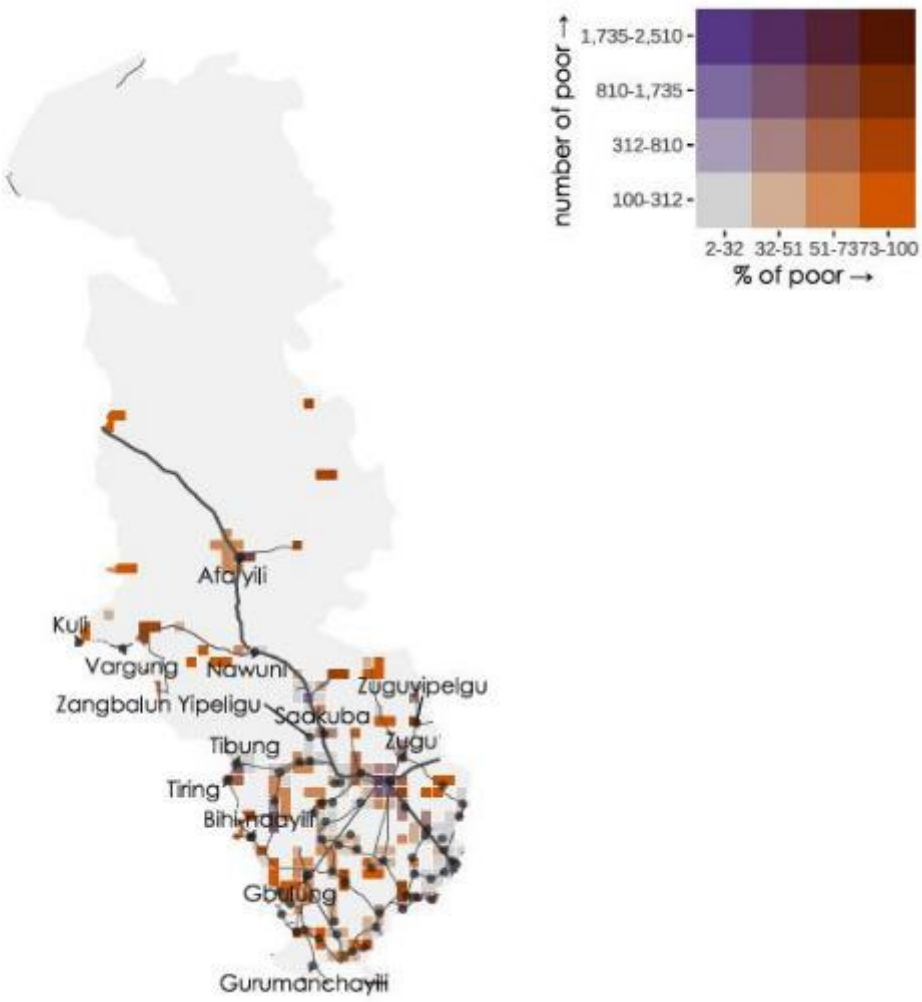


Source: Ghana Statistical Service, 2023

The results reveal significant deprivations and their contributions to multidimensional poverty in Kumbungu District, particularly in access to toilet facilities (94.9%), housing quality (82.5%), and insurance coverage (66.7%), which are higher than both regional and national averages. Employment emerges as the most significant driver of multidimensional poverty in Kumbungu District, contributing **33.3%** to total deprivation. This reflects widespread job insecurity, underemployment, and limited access to stable, well-paying jobs, especially among youth and women. Many residents rely on informal, seasonal, or low-productivity work, which offers little financial stability or social protection. Health-related deprivations follow at **21.2%**, while education challenges—particularly delays in school progression and irregular attendance—further compound household poverty. Poor living conditions, including inadequate housing, lack of electricity, and limited access to clean cooking fuel, also intensify the district's poverty profile.

The map (**Figure 12**) highlights multidimensional poverty hotspots across Kumbungu District, with variations in the density and proportion of poor individuals. Areas such as Afayili and nearby communities show higher concentrations of poverty, as indicated by darker shades on the map. The distribution reflects significant disparities in poverty levels within the district, with some locations experiencing extreme deprivation

Figure 12: Multidimensional poverty hotspots across Kumbungu District



Source: Ghana Statistical Service, 2023

Fishing is a key livelihood for some communities in the Kumbungu District, particularly in Nawuni, located along the Black Volta (**Photo 5**). This community, with its noticeable Ewe population who migrated there years ago, has a strong fishing tradition. However, while many other communities are turning to fishing as an alternative to farming due to agricultural challenges, the increased pressure on the Black Volta is threatening fish stocks. This over-reliance on fishing has led to dwindling fish populations and reduced catches.

Photo 5: Fishing and transportation canoes on the Black Volta at Nawuni Community

Source: Boafo YA (2024)

Sand winning and gravel digging are vital economic activities in Kumbungu District, playing a dual role in generating income for both local communities and the district administration. (Kumbungu District Assembly, 2021)

Photo 6: Heaps of sand gathered in the Nawuni Community for transportation

Source: Boafo YA (2024)

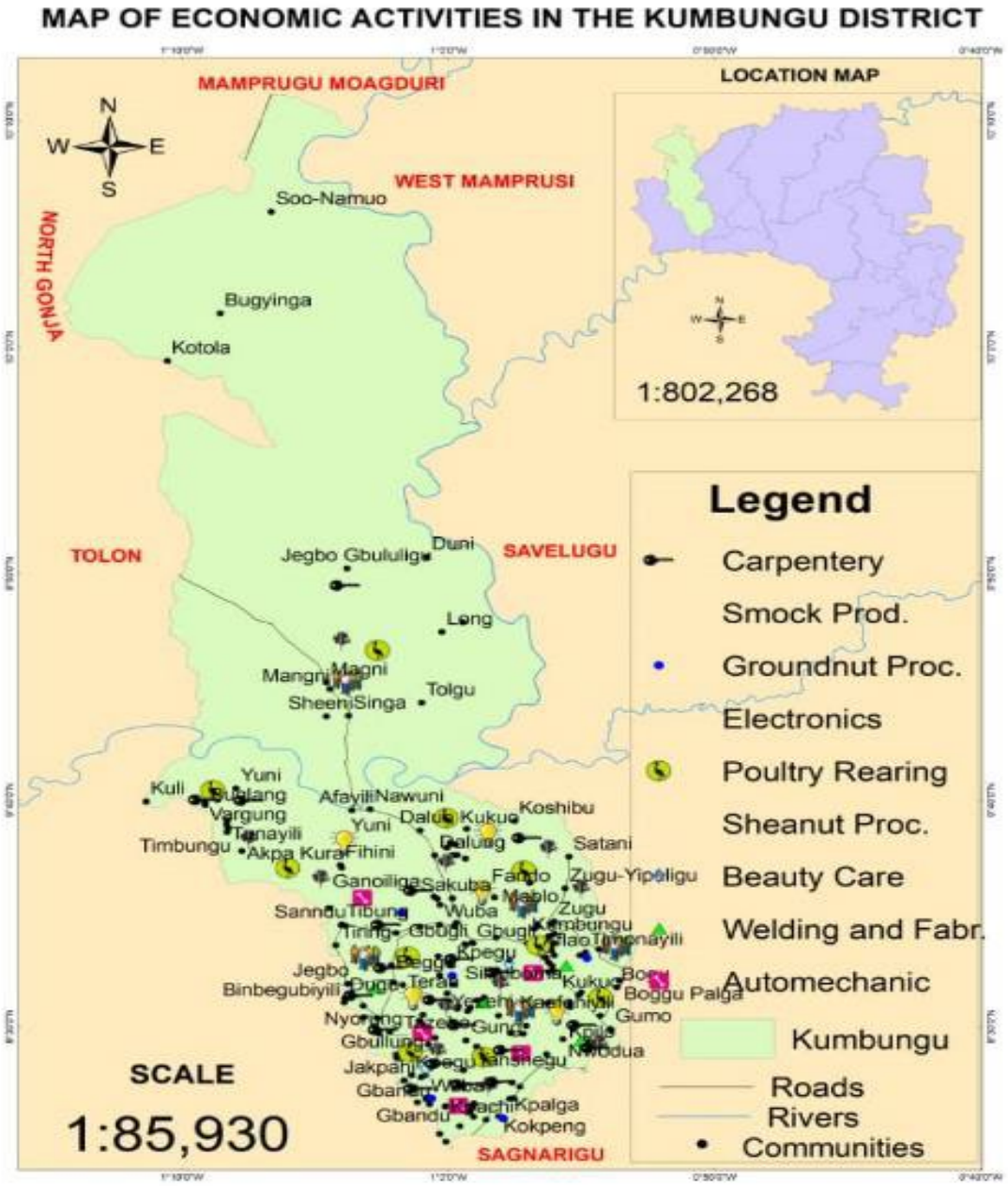
In particular, sand winning is prevalent in the Nawuni community, situated along the Black Volta. For many residents, especially men, sand mining provides a vital source of livelihood. The readily available sand deposits along the riverbank offer an opportunity for employment and income generation. At the same time, the district benefits from the revenue generated through tolls levied on sand mining operations, further emphasizing the importance of this activity to the local economy.

Sand mining, while essential for meeting construction and infrastructure demands, poses significant environmental challenges, particularly concerning soil quality and natural ecosystems. The continuous excavation of sand from riverbanks and surrounding areas accelerates soil erosion, destabilizes landscapes, and diminishes the fertility of adjacent farmlands, which adversely affects agricultural productivity — a critical livelihood activity for many households in the district. Additionally, the removal of vegetation cover associated with sand mining increases the vulnerability of communities engaged in sand mining to wind and water erosion, compounding the environmental degradation.

These practices also exert considerable pressure on natural ecosystems, including the Black Volta River, a vital water source for agriculture and domestic use. During the field survey, the Assessment team observed and were told that unregulated sand mining is disrupting aquatic habitats, altering river flow patterns, and escalating sedimentation levels, thus threatening biodiversity and the overall ecological balance.

It is important to acknowledge that the dual role of sand mining as both a livelihood activity and a driver of environmental degradation highlights the urgent need for effective management strategies. The implementation of regulatory frameworks, enforcement of sustainable extraction practices, and promotion of community awareness are essential to mitigate these adverse impacts while safeguarding the livelihoods that depend on sand mining.

Figure 13: Map showing the main economic activities and their areas of concentration in the Kumbungu District



Source: Kumbungu District Assembly, Planning Office, 2024

Other activities including smock production, reflecting the district's rich cultural heritage, is concentrated in specific communities. Poultry rearing and carpentry are prominent across many areas, supporting both household income and community development. Other trades, such as electronics repair, beauty care, welding, and auto mechanics, are more localized, likely centered in larger settlements with higher demand for such services (**Figure 13**) (Kumbungu District Assembly, 2021).

2.2.3 Observed Gender Gaps in the District

The district faces significant gender disparities across social, economic, and political aspects of life. These inequalities are evident in education, healthcare, agriculture, and participation in community-based organizations (CBOs), highlighting deep-rooted societal and structural barriers that limit opportunities for women and other marginalized groups.

Education

- **Enrollment and Retention:** Despite efforts like the Ghana School Feeding Programme and CAMFED, the district struggles with gender parity in education. Boys are often prioritized for education due to limited resources, leaving girls with reduced access to formal education (Kumbungu District Assembly, 2021).
- **Cultural Practices:** Societal norms often confine girls to domestic roles, discouraging them from pursuing higher education. This limits their future opportunities and perpetuates cycles of poverty and dependence (Kumbungu District Assembly, 2021).

Health

- **Maternal and Reproductive Health:** Early marriages and high fertility rates contribute to health vulnerabilities among women. Limited access to health facilities exacerbates these challenges, especially in rural communities (Kumbungu District Assembly, 2021).
- **Disabilities:** Women and other people with disabilities in the district face heightened vulnerabilities, with fewer opportunities for employment and social integration compared to men (Kumbungu District Assembly, 2021).

Agriculture and Economic Participation

- **Access to Resources:** Although women form the backbone of agricultural labor, they have limited access to land, credit, and agricultural inputs. For instance, only 0.75% of women farmers accessed credit in 2013, according to district agricultural reports (Kumbungu District Assembly, 2021).
- **Economic Marginalization:** Women are predominantly engaged in lower-income activities such as food processing and petty trading, further widening the income gap (Kumbungu District Assembly, 2021).

Community Participation and Decision-Making

- **Barriers in CBOs:** Women face significant barriers to participation in community-based organizations. Socio-economic, cultural, political, and religious biases often exclude them from leadership roles and decision-making processes. They are mostly involved in activity-specific tasks assigned by male leaders—such as preparing food for meetings, organizing other women for communal labor (*e.g.*, weeding, sweeping, or cleaning public spaces), and managing logistics like arranging seating and refreshments for events—which limits their influence and contributions to strategic discussions and leadership roles (Yussif, 2021).
- **Advocacy and Capacity Building:** Efforts like sensitization and training programs have been suggested to enhance women's participation and empowerment in CBOs (Yussif, 2021).

Sociocultural Norms

- **Patriarchal Structures:** The district's patriarchal culture reinforces gender roles that marginalize women. Men dominate decision-making at household and community levels, leaving women with minimal agency (Kumbungu District Assembly, 2021).
- **Migration:** Economic pressures drive many young women to migrate to urban areas for work, often exposing them to exploitation and health risk (Kumbungu District Assembly, 2021).

2.3 Critical Climate Related Hazards in Kumbungu District

This assessment highlights flooding, pests and diseases, bushfires, drought, and water scarcity as the major climate-related hazards affecting Kumbungu District. These challenges are closely linked to the district's socio-economic conditions, worsening vulnerabilities—especially for marginalized groups like women, youth, and smallholder farmers.

2.3.1 Drought

Prolonged dry spells are a recurring climate hazard in the Kumbungu District, significantly reducing crop yields and straining water resources. Rain-fed agriculture is the primary source of livelihood for most households in the district, making them highly vulnerable to changes in rainfall patterns. According to Ghana's Fourth National Communication to the UNFCCC (EPA, 2020), the Northern Region, including the Kumbungu District, has experienced increasing drought frequency, with dry spells now lasting longer and starting earlier than in previous decades (GMet, 2022).

- **Impacts on Agriculture:** Droughts directly impact crop yields, particularly for staple crops like maize *(Zea mays*), millet (*Pennisetum glaucum*), and groundnuts (*Arachis hypogaea*). For instance, during the 2016 drought, many smallholder farmers in the district reported a 40-60% reduction in yields, forcing some households to sell livestock to cope with food shortages.
- **Gendered Effects:** Women, who are primarily responsible for subsistence farming, bear the brunt of these impacts. With fewer financial resources and limited access to irrigation technology, they are often unable to invest in drought-resistant crops. A study by Adzawla et al. (2019) found that women in Northern Ghana spent up to 20% more time managing food shortages during droughts, reducing their capacity for other income-generating activities. For example, in Sang, a community in Kumbungu District, women farmers have had to rely on traditional methods of water conservation, such as digging shallow wells near dried riverbeds, to sustain their crops during dry periods. However, these efforts are often insufficient to meet agricultural and household water needs.

2.3.2 Flooding

Seasonal flooding is another major climate hazard in the district, often caused by intense, short-duration rainfall events during the rainy season. Poor drainage infrastructure and the district's flat terrain exacerbate the severity of floods, which disrupt livelihoods, displace families, and damage property.

- **Damage to Infrastructure:** Floods frequently damage roads, bridges, and homes, isolating communities and hindering access to markets and services. For example, during the heavy rains of August 2021, parts of the Tamale-Kumbungu Road became impassable, cutting off key agricultural trade routes and delaying the transport of perishable goods.
- **Impact on Farmlands:** Floodwaters often wash away topsoil, leaving farmland infertile and reducing productivity in subsequent planting seasons. In flood-prone areas like Dalun, Nawuni and Zangbalun, farmers reported losing up to 70% of their harvests during the 2020 rainy season.
- **Gendered Implications:** Women in Kumbungu are disproportionately affected, as they are often tasked with managing household recovery efforts. This includes rebuilding homes, securing food for their families, and caring for children displaced by floods. Many women in flood-affected areas have had to abandon farming temporarily, further reducing household income. In Dalun, during the 2019 floods, women-led households were among the hardest hit. With limited access to financial support or disaster relief, many resorted to selling livestock or relying on informal borrowing networks to rebuild their homes and farms.

2.3.3 Water Scarcity

Erratic rainfall patterns and prolonged dry seasons have significantly reduced water availability in Kumbungu District, creating a persistent issue of water scarcity. This hazard affects both agricultural productivity and household water access, disproportionately impacting women and girls.

- **Household Water Collection:** Women in several communities in the district often travel long distances to fetch water, particularly during dry periods when local wells and rivers dry up. A study by UNICEF (2020) found that women in the district spent an average of 3-4 hours daily collecting water during the dry season, time that could otherwise be spent on education or income-generating activities.
- **Agricultural Productivity:** Water scarcity limits farmers' ability to irrigate their crops, reducing yields and increasing food insecurity. For example, during the 2018 dry season, several

communities reported crop failures due to insufficient water for irrigation, leading to a 30% rise in local food prices.

- **Health Implications:** Limited access to clean water exacerbates health risks, such as waterborne diseases. In Gupanarigu, women reported an increase in diarrheal diseases among children during periods of severe water scarcity. A women-led cooperative in some communities in the district initiated a rainwater harvesting project in 2021 to mitigate water scarcity during dry spells. However, the initiative has struggled to scale up due to limited funding and technical support.

The intersection of climate-related hazards and socio-economic vulnerabilities in Kumbungu District significantly amplifies the risks faced by communities, particularly marginalized groups such as women, youth, elderly and smallholder farmers. Limited access to land and financial resources reduces women's ability to invest in adaptive measures such as drought-resistant crops or flood-proof homes, leaving them disproportionately exposed to the impacts of both drought and flooding.

Additionally, the district's heavy dependence on ecosystem services, including rain-fed agriculture and groundwater, exacerbates its vulnerability, as these resources are highly sensitive to climate variability (Cobbina et al., 2012; Nkrumah, 2000). For instance, in Nawuni village, a combination of prolonged drought and severe flooding in 2020 caused widespread food shortages. During the Assessment team's visit to Nawuni, it was noted that women in the community, who are often responsible for managing both household food supplies and farming activities, reported losing crops in both the dry and rainy seasons, leaving many households reliant on external food aid.

2.3.4 Bushfires

Bushfires are a growing climate hazard in Kumbungu District, particularly during the dry season, when high temperatures and strong winds create conditions for rapid fire spread. These fires pose serious threats to farmland, grazing areas, and rural livelihoods, exacerbating the challenges faced by smallholder farmers and pastoralists. The frequency and intensity of bushfires in the Northern Region, including Kumbungu District, have increased due to rising temperatures, prolonged droughts, and land-use changes.

- **Impacts on Agriculture:** Bushfires destroy crops, farmlands, and stored food supplies, threatening food security in affected communities. Staple crops like maize (*Zea mays*), groundnuts (*Arachis hypogaea*), and yam (*Dioscorea spp*.) are highly vulnerable, particularly when fires occur just before harvest. For example, in 2019, bushfires in the Voggu and Nawuni areas led to a 30-50% loss in farm yields, forcing many farmers to borrow money or sell livestock to recover. Additionally, fire outbreaks destroy pastureland, reducing available fodder for livestock and affecting the livelihoods of herders and agro-pastoralists.
- **Gendered Effects:** Women, who play key roles in subsistence farming, shea processing, and household food security, are disproportionately affected by bushfires. The destruction of farmland reduces their income from small-scale farming and trading, while the loss of tree crops, such as shea (*Vitellaria paradoxa*) and baobab (Adansonia digitata), threatens their access to key economic resources. According to Adzawla et al. (2019), women in Northern Ghana rely heavily on firewood collection and shea nut processing, both of which are disrupted by frequent bushfires. In Kpaloguam and Zangbalung, for instance, women have reported traveling longer distances to collect firewood due to recurring bushfires that deplete vegetation. Similarly, youth and migrant workers, who often engage in land clearing and farm labor, face increased safety risks and economic instability as fire outbreaks make agricultural work more unpredictable.

As bushfires become more frequent, there is an urgent need for community-based fire management strategies, improved early warning systems, and alternative land-clearing techniques to reduce fire risks while maintaining soil fertility and forest cover.

2.3.5 Pests and Diseases

Pests and crop diseases are becoming an increasing challenge for farmers in Kumbungu District, threatening crop yields, livestock health, and food security. Changing climate patterns—such as erratic rainfall, rising temperatures, and prolonged dry spells—create favorable conditions for pest outbreaks

and the spread of plant and animal the Northern Region, including Kumbungu District, has seen a rise in pest infestations and crop diseases, exacerbated by land degradation and shifting weather patterns.

- **Impacts on Agriculture:** Pests and diseases significantly reduce crop productivity, particularly staple crops like maize (*Zea mays*), sorghum (*Sorghum bicolor*), and cowpea (*Vigna unguiculata*). The fall armyworm (*Spodoptera frugiperda*) has been a persistent threat, destroying maize farms and forcing many farmers to increase pesticide use, which adds to production costs. In 2021, farmers in Dalun and Kumbungu reported up to 45% maize crop losses due to fall armyworm infestations. Additionally, livestock diseases such as foot-and-mouth disease and Newcastle disease are affecting cattle, poultry, and small ruminants, further destabilizing livelihoods.
- **Gendered Effects:** Women farmers, who are heavily engaged in subsistence farming and small-scale trade, face major economic losses when pests and diseases destroy their crops. Unlike larger-scale commercial farmers, they often lack access to pesticides, veterinary services, and improved seeds that could help mitigate these impacts. In Zugu and Nawuni, women have reported increased post-harvest losses due to mold infestations in stored grains, making food security more precarious. Youth farmers, who rely on casual labor in agriculture, also experience reduced income opportunities when pests and diseases decrease labor demand. Meanwhile, migrant farmers are often excluded from agricultural extension services, leaving them with limited knowledge on pest and disease control strategies.

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3. Methodological Framework

3.1 Introduction

This chapter outlines the methodological framework adopted for the climate vulnerability assessment in Kumbungu District, integrating both qualitative and quantitative approaches to capture the district's climate risks, vulnerabilities, and adaptive capacities. The process was structured into four key phases: Desktop Review, Information Synthesis, Stakeholder Consultation, and Revision and Final Validation. The methodology was designed to be inclusive and gender-responsive, ensuring the active participation of diverse stakeholders, including women, youth, and marginalized groups. In addition to these phases, the chapter discusses the primary data collection and analysis approaches, including household surveys, focus group discussions, and key informant interviews, which were employed to gather localized and gender-specific insights.

3.2 Phases of the Assessment Process

This climate risk and vulnerability assessment for the Kumbungu District was guided by a gender-sensitive, mixed-methods approach, combining both qualitative and quantitative techniques to capture the complex dynamics of climate vulnerability and adaptive capacity across diverse population groups (**Figure 14**). The approach was grounded in the gender-responsive climate risk assessment framework proposed by Norman et al. (2014) and aligned with the AR5 conceptual model developed by the Intergovernmental Panel on Climate Change (IPCC), which conceptualizes climate risk as a function of hazard, exposure, and vulnerability (**Figure 15**). This dual framework ensured that the assessment was both scientifically rigorous and socially inclusive.

The methodology was implemented through a three-stage process: (1) Risk Identification, (2) Risk Assessment, and (3) Adaptation Planning and Validation. These stages integrated the key operational components originally outlined as discrete phases—desktop review, information synthesis, stakeholder consultation, and final validation—into a seamless and coherent methodology. The approach also placed strong emphasis on gender inclusion, recognizing that women, youth, persons with disabilities (PWDs), and migrants experience differentiated climate risks and possess varying capacities to adapt.

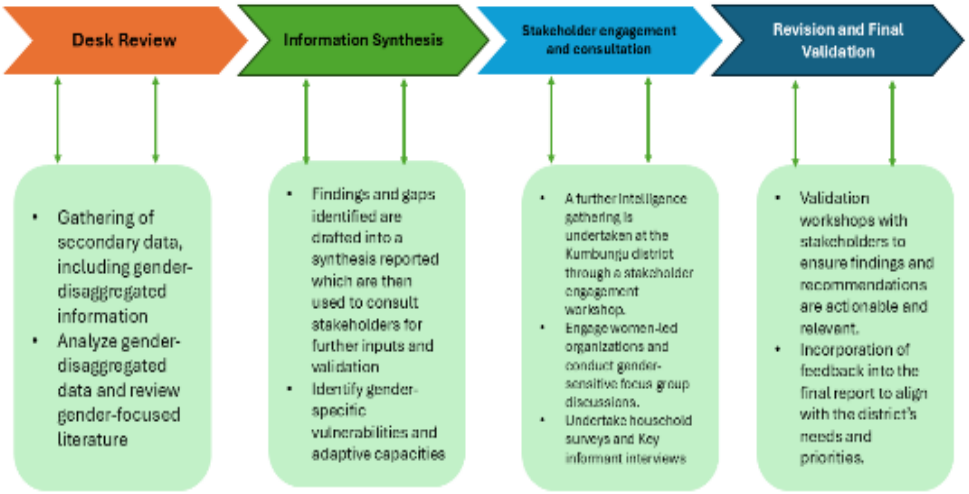
3.2.1 Stage 1: Risk Identification

This stage aimed to develop a comprehensive understanding of the climate context, vulnerabilities, and gender-specific challenges within the Kumbungu District. It laid the foundation for all subsequent field engagements and assessments.

- **Desktop Review and Data Gathering:** A comprehensive review of existing literature, policy documents, district development plans, and secondary climate data was undertaken. This included reports from national agencies, research institutions, and development partners. Particular attention was paid to identifying historical and current trends in rainfall variability, temperature changes, drought frequency, and other key hazards. The review emphasized **gender-disaggregated impacts** and the structural inequalities that shape vulnerability.
- **Identification of Climate Hazards and Vulnerable Groups:** The desktop review highlighted major climate hazards in the district—droughts, floods, water scarcity, heatwaves, bushfires, and pest outbreaks—and how these interact with local socio-economic and environmental conditions. It also revealed that women, youth, the elderly, and people with disabilities face disproportionate risks due to unequal access to land, financial resources, extension services, and decision-making spaces.
- **Gender and Socio-Economic Contextualization:** The team systematically examined how traditional norms, cultural practices, and institutional barriers contribute to gender disparities in climate vulnerability. For example, women's unpaid caregiving roles and limited mobility during climate shocks were highlighted as significant sources of vulnerability.
- **Defining Data Gaps:** While national and regional datasets provided useful background, the review revealed significant gaps in localized, community-level, and gender-specific data,

particularly on how communities perceive and respond to climate risks. These gaps informed the design of the primary data collection tools.

Figure 14: Phases for the assessment process



3.2.2 Stage 2: Risk Assessment

In this stage, risks identified during the desktop review were evaluated through participatory, field-based engagements to understand their real-world implications and validate findings with local communities.

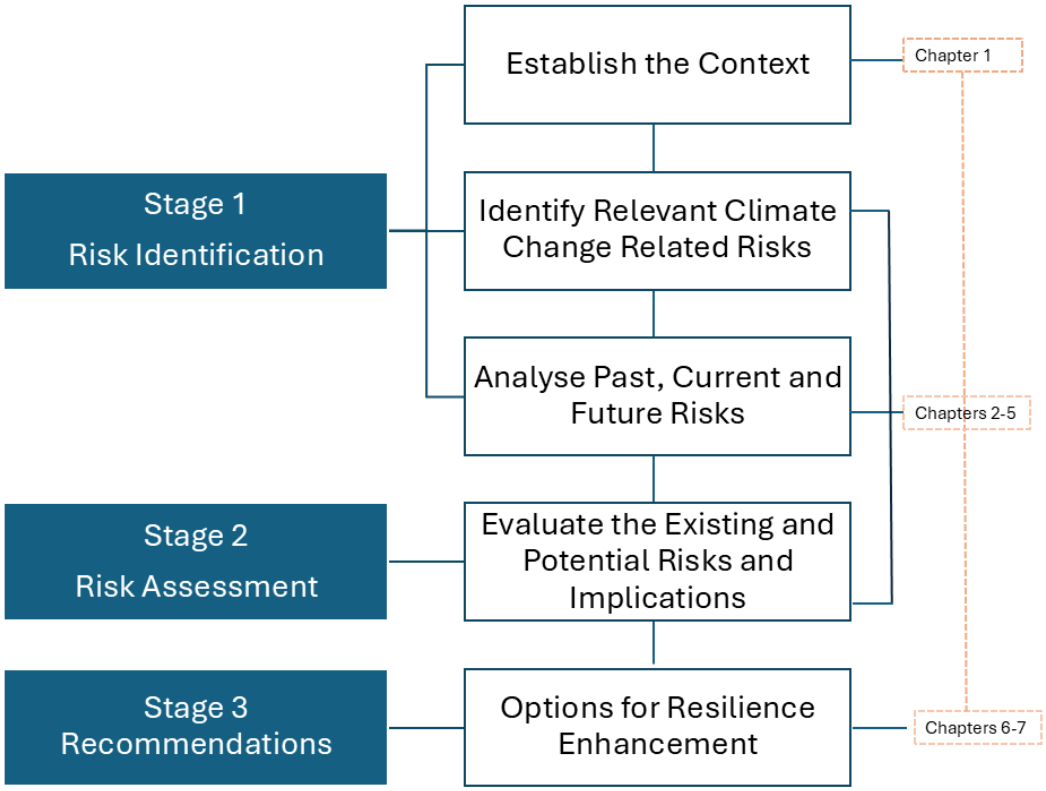
- **Information Synthesis and Fieldwork Planning:** Insights from the literature review were integrated with national climate projections and vulnerability mapping to design a robust fieldwork strategy. A multi-tool approach was adopted to ensure that both quantitative data (*e.g.,* household surveys) and qualitative insights (*e.g.*, focus group discussions and key informant interviews) could be triangulated for a holistic view.
- **Stakeholder Consultations and Participatory Exercises:** The assessment team conducted extensive community engagement activities, beginning with a district inception workshop involving MMDA officials, traditional leaders, women-led CSOs, and civil society stakeholders. This was followed by participatory tools such as:
    - Hazard mapping
    - Resource mapping
    - Seasonal calendars
    - Historical timelines

These tools facilitated discussions around local climate hazards, shifts in rainfall patterns, resource use, and institutional memory of past shocks.

- **Focus Group Discussions (FGDs):** Gender-segregated FGDs were held in 12 communities to capture the differentiated experiences of women, youth, men, migrants, and PWDs. These discussions revealed nuanced insights, such as how women's access to irrigation and extension services remains severely constrained, or how migration pressures affect youth adaptive strategies.
- **Household Surveys:** Quantitative data were collected through structured questionnaires administered to a stratified sample of households across the selected communities. The surveys gathered information on income sources, climate impacts, coping strategies, access to services, and decision-making roles—disaggregated by gender and other social markers.
- **Key Informant Interviews (KIIs):** Interviews were conducted with district planning officers, agricultural extension agents, health workers, traditional authorities, and representatives of NGOs and CSOs. These interviews provided expert perspectives on institutional challenges, ongoing interventions, and capacity needs for gender-responsive adaptation.

- **Gender-Sensitive Risk Evaluation and Prioritization:** The assessment evaluated climate risks based on their likelihood, severity of impact, and the adaptive capacity of different population groups. For example, droughts were found to have a higher impact on women due to their reliance on rain-fed farming and limited access to coping mechanisms. A prioritization matrix was developed to guide the identification of the most pressing vulnerabilities.

Figure 15: Three-stage process for gender-responsive approach to climate vulnerabilities assessment



3.2.3 Stage 3: Adaptation Action Plan

The final stage of the assessment process focused on translating diagnostic findings into a comprehensive, gender-responsive Adaptation Action Plan for Kumbungu District, while ensuring stakeholder validation and contextual relevance. This stage consolidated insights from the risk identification and assessment phases to develop actionable strategies aimed at reducing climate vulnerability, enhancing adaptive capacity, and addressing systemic gender inequalities.

3.2.3.1 Draft Report Compilation and Synthesis of Findings

A synthesis of quantitative and qualitative data gathered through household surveys, focus group discussions, key informant interviews, and participatory exercises formed the analytical basis of the draft report. The report outlined the district's climate risk profile—detailing key hazards, exposure patterns, and gendered vulnerabilities across critical sectors such as agriculture, health, water, and infrastructure. It also captured inter-community variations in sensitivity and adaptive capacity, offering a spatially differentiated understanding of risk.

3.2.3.2 Strategic Adaptation Measures

Building on these findings, the Adaptation Action Plan will propose a suite of targeted, evidence-based interventions to address the multifaceted dimensions of vulnerability in the district. These included:

- Development of gender-sensitive water infrastructure (*e.g.,* boreholes, rainwater harvesting systems) to address both climatic and gendered water access constraints.

- Promotion of climate-resilient agriculture, including the adoption of drought-tolerant crops, soil conservation techniques, and agroforestry systems.
- Implementation of capacity-strengthening initiatives focused on women and youth, covering topics such as climate-smart farming, financial literacy, and livelihood diversification.

Each intervention was designed to be context-specific, equitable, and aligned with local development priorities.

3.2.3.3 Participatory Validation and Stakeholder Engagement

To ensure that the proposed measures were socially legitimate and locally grounded, a multi-stakeholder validation workshop was held on March 5, 2025. The session convened representatives from the Kumbungu District Assembly, traditional authorities, women-led civil society organizations, development partners, and other key actors. The workshop provided a platform to present key findings, deliberate on strategic options, and collect feedback on the proposed adaptation pathways.

Participants provided critical reflections on both the process and outputs, particularly concerning the feasibility of interventions, institutional readiness, and barriers to implementation. These deliberations helped to ground the action plan in local knowledge systems and operational realities.

3.2.3.4 Incorporation of Feedback and Finalization of Recommendations

Feedback from the validation session informed revisions to the adaptation strategies, including refinements to gender-targeted actions, clarification of sectoral priorities, and identification of institutional roles and responsibilities. Emphasis was placed on ensuring that adaptation options:

- Advance gender equity, particularly by enhancing women's access to climate finance, land, and extension services;
- Strengthen inclusive decision-making mechanisms, with representation of marginalized groups in local adaptation governance;
- Support the operational capacity of women-led organizations to drive community-based resilience efforts.

The finalized plan includes short- and medium-term actions that address social, economic, physical, and institutional dimensions of climate risk. It also outlines mechanisms for financing, coordination, and monitoring—serving as a practical tool for implementation by district authorities.

3.2.3.5 Alignment with Policy and Development Frameworks

The Adaptation Action Plan is fully aligned with Ghana’s National Adaptation Plan (NAP), Nationally Determined Contributions (NDCs), and global frameworks such as the Sustainable Development Goals (SDGs)—notably SDG 5 (Gender Equality) and SDG 13 (Climate Action). By embedding equity and inclusion at its core, the plan contributes to both local resilience building and national climate policy coherence.

3.3 Field Data Collection Approaches

3.3.1 Workshop and Participatory Exercises

As part of the climate change vulnerability assessment in Kumbungu District, a comprehensive stakeholder engagement workshop was held on 28 August 2024 at the Kumbungu District Assembly. This workshop aimed to raise climate change awareness and enhance the adaptation capacities of local stakeholders. The event brought together district officials, community leaders, and representatives from key sectors, including agriculture, water resources, health, infrastructure, and gender groups. The objectives were to introduce stakeholders to climate change concepts, assess local vulnerabilities, and collaboratively identify adaptive strategies aligned with Ghana’s National Adaptation Plan (NAP) project.

Key Objectives and Focus Areas of the Workshop

The workshop was structured to provide a platform for collaborative learning, gathering stakeholder input, and conducting participatory risk assessments. The agenda focused on the following areas:

- **Capacity Building on Climate Science and Adaptation Planning:** The workshop commenced with presentations by Dr. Yaw Agyeman Boafo and the assessment team, covering climate science fundamentals and the observed impacts at global, national, and district levels. These presentations contextualized specific vulnerabilities within Kumbungu District. An introduction to the NAP process provided participants with an understanding of Ghana's national strategies for climate adaptation and resilience. A dedicated session on Gender-Responsive Adaptation highlighted the differential impacts of climate change on men and women, emphasizing the importance of gender considerations in effective adaptation planning.

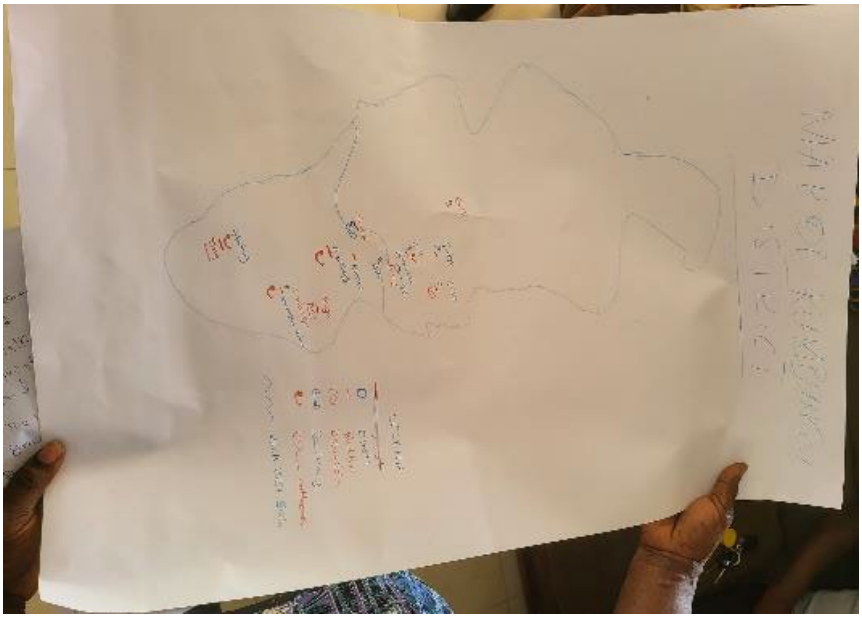
Photo 7: Photocall of participations in the first stakeholder engagement workshop at the Kumbungu District Assembly building

Participatory Exercises and Sector-Specific Mapping

To foster interactive learning and active stakeholder engagement, the workshop integrated several participatory activities. These exercises were designed to allow participants to explore vulnerabilities, assess climate risks, and visualize potential impacts collectively. Key activities included:

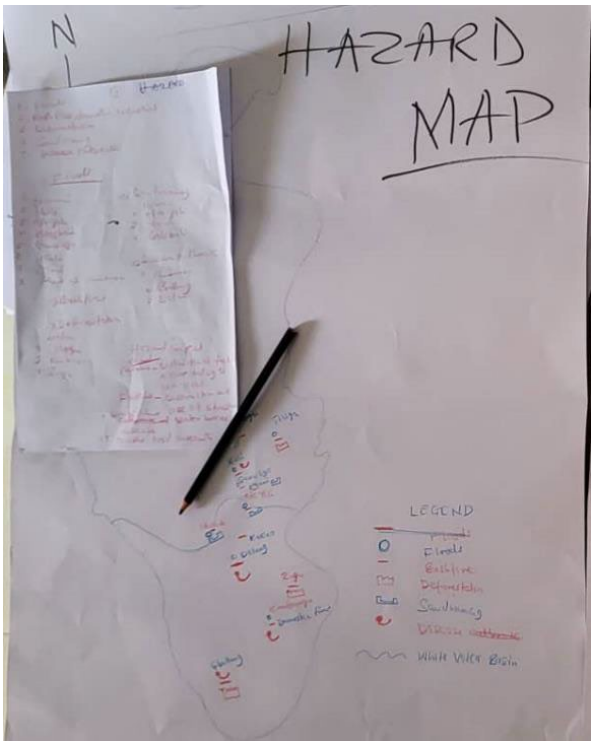
- **District-Level Resource Mapping:** This participatory exercise was led by the District Planning Officer and involved participants mapping essential resources across Kumbungu District. The goal was to identify valuable assets and resources, such as agricultural lands, water bodies, health facilities, and infrastructure, at risk from climate change. Workshop participants collaborated to outline the district's geographical boundaries and identify key resources, environmental challenges, and landmarks. Using simple tools such as markers and paper, participants represented elements like floods, bushfires, deforestation, sawmilling, and disease outbreak locations. A legend was included to explain the symbols used, while specific areas like rivers, villages, and hazard zones were highlighted. This participatory approach ensures the map reflects local knowledge and priorities, fostering community engagement and ownership.

Photo 8: Participatory resource map of Kumbungu District



- **Hazard Mapping:** The hazard map was created during a participatory session facilitated by the local NADMO (National Disaster Management Organization) officer. The exercise aimed to identify and visualize areas within the Kumbungu District that are particularly vulnerable to climate hazards such as floods, droughts, and soil erosion. Workshop participants, including local stakeholders and community members, contributed their knowledge and experiences of past climate events that had significantly impacted the district. Using simple tools, they marked and labeled areas prone to specific hazards, such as flood-prone zones, drought-affected regions, and erosion hotspots. A legend was included to explain the various symbols and features depicted on the map, ensuring clarity and usability for future reference. The process not only highlighted geographic areas of concern but also fostered discussion on the district's vulnerabilities and opportunities for disaster risk reduction.

Photo 9: Participatory hazard mapping of Kumbungu District



- **Seasonal Calendar and Historical Timelines:** The seasonal calendar was developed during the workshop and was facilitated by the District Agriculture Officer. The activity engaged participants in mapping out the timing, frequency, and intensity of key seasonal activities and climate hazards experienced within the district. This participatory exercise served two purposes: documenting historical trends and patterns of climate hazards, and planning for future occurrences. Through group discussions, participants outlined major agricultural activities (*e.g.,* planting, harvesting, fertilizer application), social events (*e.g.,* weddings, festivals), and environmental challenges (*e.g.,* droughts, floods). The calendar captures month-by-month variations in activities and hazards, providing a visual representation of the district's climate rhythm. It also highlights critical periods when communities are most vulnerable, enabling better preparedness and resource allocation.

Photo 10: Kumbungu District seasonal calendar

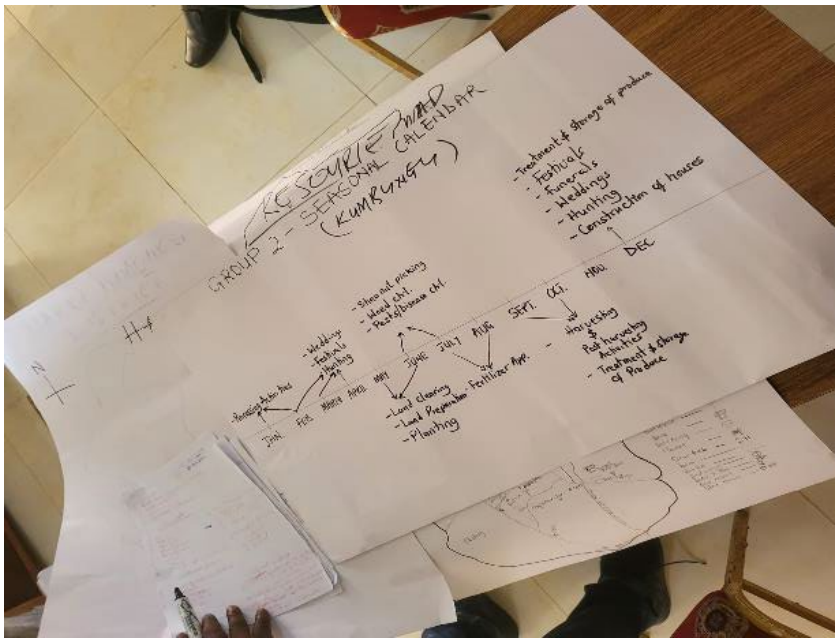


Photo 11: Participants working on seasonal calendar

Identification of Vulnerable Sectors and Geographic Hotspots

(a) Selection of Case Communities for Qualitative and Quantitative Survey

Following consultations with District Planning Officials, the Agriculture Directorate, and Disaster Management Officials, a sample of **12 communities** was selected for further qualitative and quantitative assessments. To capture a diverse range of development levels, two communities were chosen from each of the six area councils. For each area council, a community with relatively well-developed infrastructure and resources (Site 1) was paired with a community exhibiting lower levels of development (Site 2).

Photo 12: Assessment team engaging with planning officer at Kumbungu to identify and select communities

This selection process ensured that the communities chosen had not been previously included in any of SIGRA's team activities, allowing for fresh data collection. The selected communities are outlined in **Table 1** below.

Table 1: Selected communities for quantitative and qualitative data collection

No.	Town/Area Councils	Selected Community (Site 1)	Selected Community (Site 2)
1	Kumbungu	Kumbungu	Zugu
2	Dalun	Dalun	Nawuni
3	Zangballung	Zangballung	Sakuba
4	Voggu	Voggu	Kpalsogun
5	Guppanarigu	Guppanarigu	Bognaayili
6	Gbullung	Gbullung	Bagon

The sampled communities were used to collect both qualitative and quantitative data collection. Qualitative data, obtained through participatory discussions and interviews provided in-depth insights into community perceptions and experiences of climate risks. Quantitative data, including statistical records on climate patterns, hazard frequencies, and resource conditions, will support a data-driven approach to assessing vulnerabilities and planning adaptive measures.

(b) Outcomes and Key Takeaways

The workshop successfully engaged stakeholders in a structured, collaborative process that fostered a shared understanding of climate risks specific to Kumbungu District. Major outcomes included:

- ***Identification of Key Climate Hazards:*** Flooding, drought, water shortage and temperature variability emerged as primary climate hazards affecting the district. Seasonal calendars and historical timelines highlighted the recurrence and intensification of these events.

- ***Mapping of Vulnerable Areas and Resources:*** Resource and hazard mapping exercises identified critical resources and vulnerable locations, such as agricultural lands, water sources, and essential infrastructure, strengthening the district's foundation for targeted adaptation strategies.

3.3.2 Focus Group Discussions

Focus Group Discussions (FGDs) were conducted in each of the 12 selected communities to gather in-depth qualitative insights on gendered vulnerabilities to climate change. Separate discussions were held for men and women to ensure that participants could freely express their perspectives and experiences without the influence of gender dynamics. Participants were randomly selected based on their availability and willingness to participate. Each focus group comprised 8-12 individuals, allowing for diverse viewpoints while maintaining manageability in discussion. Trained facilitators guided the discussions using a semi-structured interview guide to explore key themes such as livelihood strategies, access to resources, decision-making processes, and barriers to climate adaptation.

3.3.3 Household Questionnaire Surveys

Household questionnaire surveys were conducted to quantitatively assess the socio-economic, environmental, and adaptive capacities of households across 12 selected communities in the Kumbungu District. The survey captured data on variables such as income sources and levels, asset ownership, agricultural practices, barriers to resource access, and adaptive strategies. A total of 348 households were surveyed, representing a structured approach to data collection across the district.

The sample size was determined based on the number of households in the district, rather than the total population, to ensure a focus on household-level dynamics. The District Planning Officer of Kumbungu assisted in sampling the households to ensure representativeness across the communities. Stratified random sampling was employed to capture a diverse range of household characteristics, including gender representation. **Table 2** shows the distribution of surveyed households across 12 communities in the Kumbungu District, comprising a total of 348 respondents (263 males and 85 females). The community of Kumbungu had the highest representation (39 respondents), followed by Zangballung (33 respondents) and Dalun and Nawuni (31 respondents each). Male respondents outnumbered female respondents across all communities, particularly in Zangballung and Voggu, highlighting potential gender imbalances in household leadership or willingness to participate. However, communities like Bognaayili and Zugu had relatively higher proportions of female respondents, suggesting greater female household leadership or participation in these areas. The relatively low percentage of female-headed households (6.9%) is consistent with broader trends observed in the Northern Region of Ghana, where cultural norms and traditional inheritance practices largely favor male household leadership.

Table 2: Frequency distribution of surveyed households across the 12 communities

S/n	Community	Gender of respondent		Total
		Male	Female	
1	Kumbungu	26 (67%)	13 (33%)	39 (11.2%)
2	Dalun	24 (77%)	7 (23%)	31 (8.9%)
3	Zangballung	29 (88%)	4 (12%)	33 (9.5%)
4	Voggu	27 (90%)	3 (10%)	30 (8.6%)
5	Gupanarigu	25 (86%)	4 (14%)	29 (8.3%)
6	Gbullung	25 (83%)	5 (17%)	30 (8.6%)
7	Zugu	15 (63%)	9 (37%)	24 (6.9%)
8	Nawuni	22 (71%)	9 (29%)	31 (8.9%)
9	Saakuba	18 (72%)	7 (28%)	25 (7.2%)
10	Kpalsogu	20 (77%)	6 (23%)	26 (7.5%)
11	Bognaayili	15 (58%)	11 (42%)	26 (7.5%)
12	Bagon	17 (70%)	7 (30%)	24 (6.9%)
Grand Total		**263 (76%)**	**85 (24%)**	**348 (100%)**

Trained enumerators (recruited from the Kumbungu District Assembly and University for Development Studies, Nyankpala campus) administered the questionnaires through face-to-face interviews, ensuring the inclusion of respondents who might face literacy challenges. This approach facilitated the accurate collection of data on household-level vulnerabilities, resources, and adaptive capacities. The distribution of surveys across the communities ensured comprehensive geographic representation and captured localized climate change impacts and responses.

3.3.4 Key Informant Interviews

Key Informant Interviews (KIIs) were conducted to gather in-depth insights into community-level vulnerabilities, adaptation strategies, and barriers to resource access. This qualitative approach targeted individuals with extensive knowledge and experience in their respective communities, institutions, and sectors related to climate change, livelihoods, and resource management. The selection of key informants was purposive, focusing on their roles, expertise, and capacity to provide detailed and context-specific information. Participants included community leaders such as chiefs and elders, agricultural extension officers, the District Planning Officer, representatives of local women's and youth groups, environmental and disaster management personnel, and representatives from local NGOs involved in climate adaptation projects.

The interviews were guided by a semi-structured interview format, ensuring consistency across sessions while allowing flexibility for informants to elaborate on critical issues. The interview guide covered topics such as community-specific climate change impacts (*e.g.,* floods, droughts, extreme heat), livelihoods and resource access (*e.g.,* land, water, and financial support), institutional and community-based adaptation mechanisms, gender-specific barriers and opportunities in climate change adaptation, and the role of local organizations and support networks in enhancing adaptive capacity.

The interviews were conducted in person at locations convenient for the informants to ensure comfort and openness. Each session lasted between 45 minutes and an hour, focusing on creating a dialogic and engaging environment. Notes were taken during the interviews, and sessions were audio-recorded with prior consent to ensure accuracy and comprehensiveness during data analysis. Ethical considerations were paramount throughout the process, with participants informed about the study's purpose, assured of confidentiality, and granted the right to withdraw at any time. Cultural sensitivity was also prioritized, particularly when discussing gender-specific topics and issues related to resource access.

3.4 Climate Projections Approach

The methodology for assessing historical and projected climate changes in the Kumbungu District integrates robust data sources, analytical techniques, and stakeholder insights to provide actionable findings. Three key datasets were employed. The CHIRPS dataset offers daily precipitation data at a spatial resolution of 0.05°, ideal for capturing historical rainfall variability in the district. ERA5 Reanalysis provides hourly temperature data at a spatial resolution of 0.25°, which is suitable for analyzing temperature extremes over time. Additionally, the CMIP6 multi-model ensemble projections are utilized to assess future climate scenarios under various Shared Socio-Economic Pathways (SSPs), such as SSP1-2.6, SSP2-4.5, and SSP5-8.5.

These SSP scenarios represent alternative global development trajectories, each associated with specific greenhouse gas concentration pathways and levels of socio-economic change. SSP1-2.6 models a sustainability-focused world with strong mitigation efforts and low emissions, while SSP2-4.5 assumes a “middle-of-the-road” path characterized by moderate emissions and adaptation efforts. In contrast, SSP5-8.5 reflects a fossil-fueled development scenario with high emissions and limited climate policy action. Employing this range of scenarios enables the assessment to explore a spectrum of possible climate futures—from optimistic to high-risk—thereby informing adaptive planning that is both robust and forward-looking.

The Assessment focused on two timeframes. The historical analysis covered the period 1991–2020, aligning with the IPCC’s recommended framework for climate assessments. Future climate projections were evaluated for three periods: near-term (2021–2040), mid-century (2041–2060), and end-century (2081–2100). This temporal division ensured a detailed understanding of both past trends and future changes. The methodological framework consists of six key steps.

- First, historical precipitation and temperature data were collected from CHIRPS and ERA5, while CMIP6 projections provide future data.
- Second, the data underwent quality control to address missing or inconsistent entries, and daily data is aggregated into seasonal and annual summaries for the computation of climate indices.
- Third, ETCCDI indices were calculated using tools such as ClimPACT2 to quantify climate extremes.
- Fourth, trend analysis was performed using statistical tests like the Mann-Kendall test and Sen's slope estimator to identify significant changes in precipitation and temperature over time.
- Fifth, future projections were analyzed using CMIP6 to evaluate potential shifts in climate indices under different SSP scenarios.
- Lastly, the results were integrated with stakeholder knowledge, including inputs from participatory hazard maps and seasonal calendars, to enhance local relevance and applicability.

The analysis generated three main outputs. Visual representations, such as time-series plots and maps, illustrated trends and spatial patterns in climate indices. Statistical summaries provided quantitative descriptions of changes in precipitation and temperature extremes (**Table 3**).

Table 3: ETCCDI climate indices

Category	Metric	Description	Interpretation	Units
Precipitation	Rx1day	Maximum 1-day precipitation: The highest amount of precipitation recorded in a single day during a given year or season.	Indicates the intensity of the most extreme daily rainfall event, highlighting potential for flash floods and extreme weather.	mm
	Rx5day	Maximum 5-day precipitation: The highest accumulated precipitation over any consecutive 5-day period within a given year or season.	Captures the intensity of extended heavy rainfall periods, which could lead to river flooding or waterlogging issues.	mm
	CDD	Consecutive dry days: The maximum number of consecutive days with less than 1 mm of rainfall.	Reflects drought conditions by showing prolonged periods without significant rainfall.	days
	CWD	Consecutive wet days: The maximum number of consecutive days with at least 1 mm of rainfall.	Represents extended wet spells, which may increase the risk of flooding, landslides, or crop saturation.	days
	R95p	Very wet days: Total precipitation from days when rainfall exceeded the 95th percentile of daily precipitation during a reference period.	Indicates the frequency and volume of extremely wet days, showing potential for extreme weather events driven by climate variability or change.	mm
	R95pTOT	Total precipitation from very wet days: The total amount of precipitation occurring on days with rainfall above the 95th percentile.	Indicates the contribution of extreme rainfall events to the total annual precipitation.	mm
	SDII	Simple daily intensity index: The ratio of total precipitation to the number of wet days (days with 1 mm precipitation or more).	Measures the average precipitation intensity on wet days, reflecting the nature of rainfall events.	mm/day

Category	Metric	Description	Interpretation	Units
Temperature	TXx	Maximum daily maximum temperature: The highest daytime temperature observed in a given year or season.	Reflects the intensity of heatwaves and extreme hot days, which can impact health, agriculture, and energy demand.	°C
	TNx	Maximum daily minimum temperature: The highest nighttime temperature observed in a given year or season.	Tracks warm nighttime temperatures, which can influence heat stress, particularly in urban areas, and impact human health and agricultural productivity.	°C
	TXn	Minimum daily maximum temperature: The lowest daytime high temperature recorded in a given year or season.	Highlights cooler days, potentially beneficial during extreme heat periods but also indicative of cold snaps or unseasonal weather.	°C
	TNn	Minimum daily minimum temperature: The lowest nighttime temperature observed in a given year or season.	Reflects the occurrence of cold nights, important for assessing frost risks, agricultural impacts, and extreme cold weather events.	°C

4. Findings and Implications

4.1 Households Vulnerabilities

4.1.1 Economic Vulnerabilities

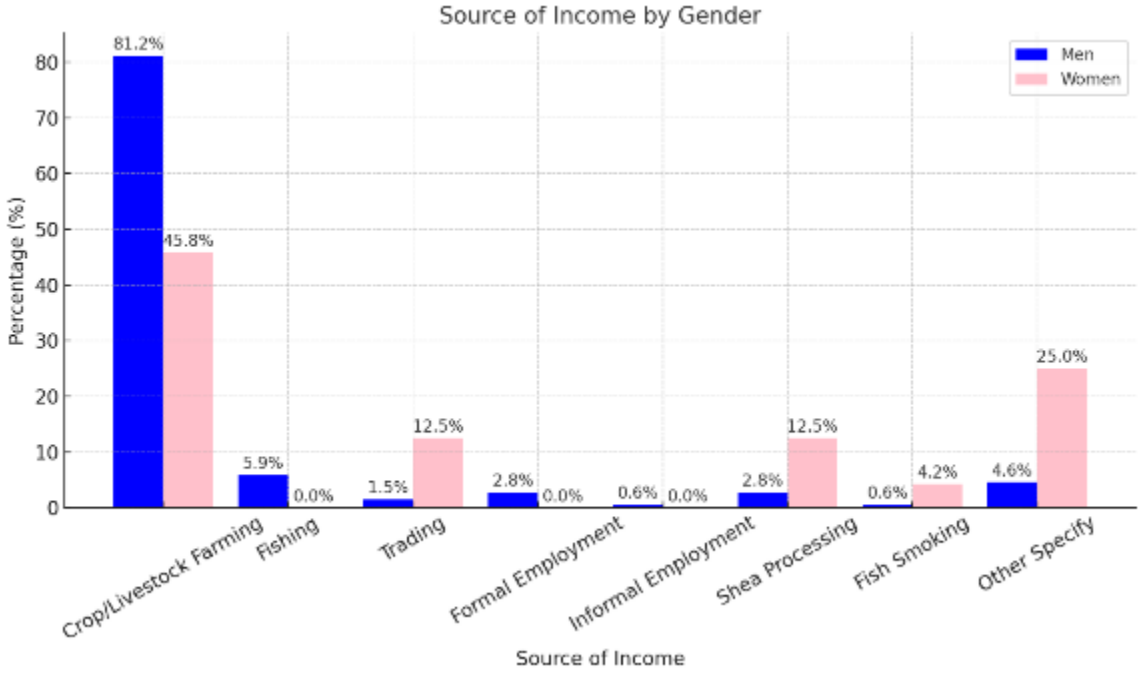
This section explores the economic vulnerabilities present within the Kumbungu District. It pays particular attention to how these vulnerabilities manifest differently along gender lines. Recognizing that men and women often experience and navigate economic challenges in distinct ways, this analysis will explore the specific factors contributing to economic insecurity for both men and women in the district.

Main Sources of Income

Men and women derive their income from different sources, reflecting gendered roles and access to resources. The majority of men (**81.2%**) reported crop and livestock farming as their main source of income, compared to **45.8%** of women. Women, on the other hand, reported a more diverse range of income sources, with **25.0%** deriving their income from unspecified "Other" activities such as seasonal petty trading, soap making, informal food vending, local beverage production, weaving, and handicrafts — all typically informal and often underreported in standard economic classifications. Additionally,**12.5%** each from trading and shea processing. Men reported higher participation in fishing (**5.9%**) compared to no women, while both groups showed minimal engagement in formal or informal employment (**Figure 16**).

These differences reflect systemic gender disparities in resource access and livelihood opportunities. Men's dominance in farming is tied to their greater access to land, inputs, and agricultural tools, as well as societal expectations of men as primary farmers. Women's higher participation in trading and shea processing highlights their reliance on activities that require lower capital and are often carried out alongside household responsibilities. Their engagement in "Other" activities suggests flexibility in exploring diverse, often informal income sources to meet household needs.

Figure 16: Households source of income by gender



Source: Field Survey, 2024

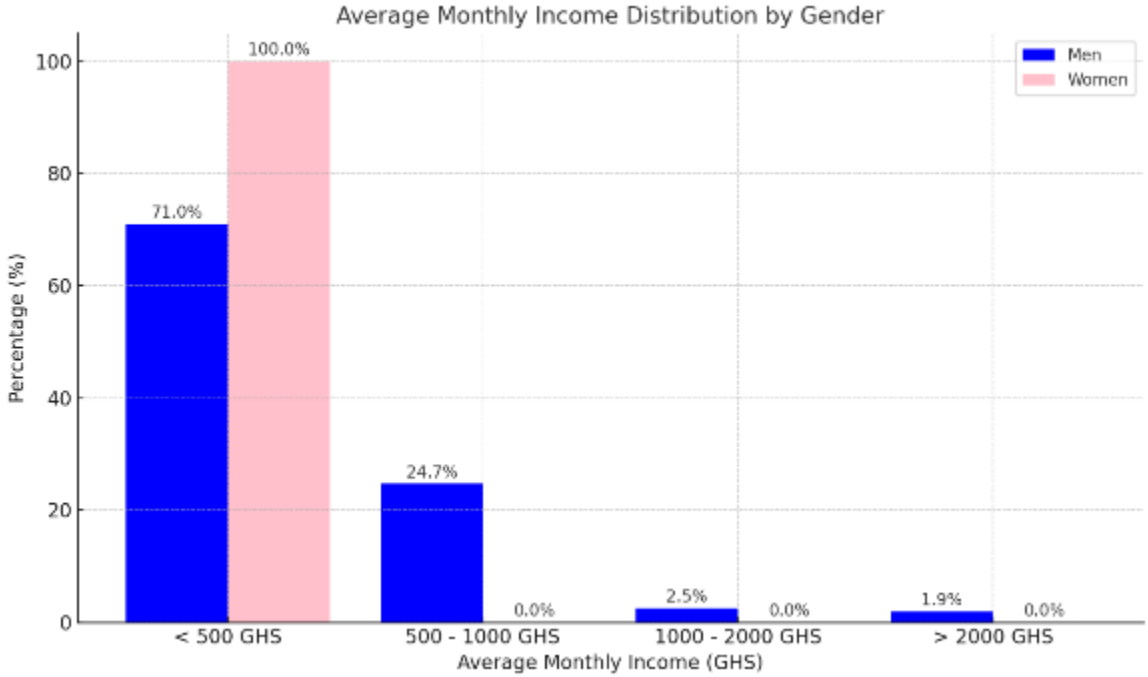
Average Monthly Income

The distribution of monthly income highlights significant gender disparities, with women overwhelmingly concentrated in the lowest income bracket. All women (**100%**) reported earning less than 500 GHS per month, compared to **71.0%** of men. Men demonstrated a more diverse income distribution, with **24.7%** earning 500–1000 GHS, **2.5%** earning 1000–2000 GHS, and **1.9%** earning above 2000 GHS. These findings reflect the structural barriers that limit women's economic opportunities and income potential (**Figure 17**).

The predominance of women in the lowest income bracket can be attributed to their concentration in low-paying activities such as petty trading, subsistence farming, and informal labor. These activities often lack scalability or access to profitable markets. Additionally, women's limited access to capital, skills, and high-value economic opportunities constrain their ability to generate higher incomes. Social norms and unpaid caregiving responsibilities also restrict women's ability to participate in higher-paying jobs or entrepreneurial ventures.

Men's broader income range reflects their engagement in activities with higher earning potential, such as larger-scale farming, livestock rearing, and access to off-farm employment opportunities. Their greater control over resources such as land, equipment, and financial services further enables them to participate in more profitable ventures.

Figure 17: Average monthly income by gender

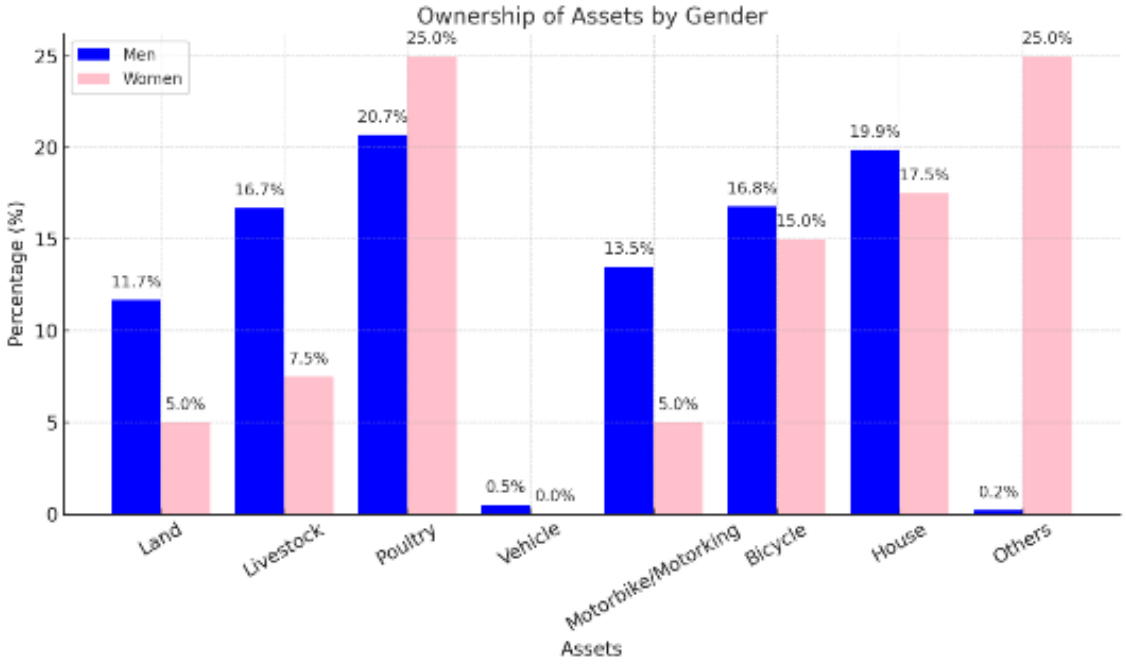


Source: Field Survey, 2024

Households Ownership of Assets

Asset ownership reflects systemic gender disparities, with men reporting higher ownership of land (11.7%) and livestock (16.7%) compared to women (5.0% and 7.5%, respectively) (**Figure 18**). Women, however, own more poultry (25.0%) and assets in the "Other" category (25.0%), which may include tools for small-scale trading or processing. Men dominate in motorbike/motor king ownership (13.5%) and bicycles (16.8%), which are critical for mobility in rural areas. These disparities arise from cultural norms and inheritance systems that favour men, limiting women's access to land and productive assets. Women's higher poultry ownership reflects their involvement in low-cost, household-based income generation.

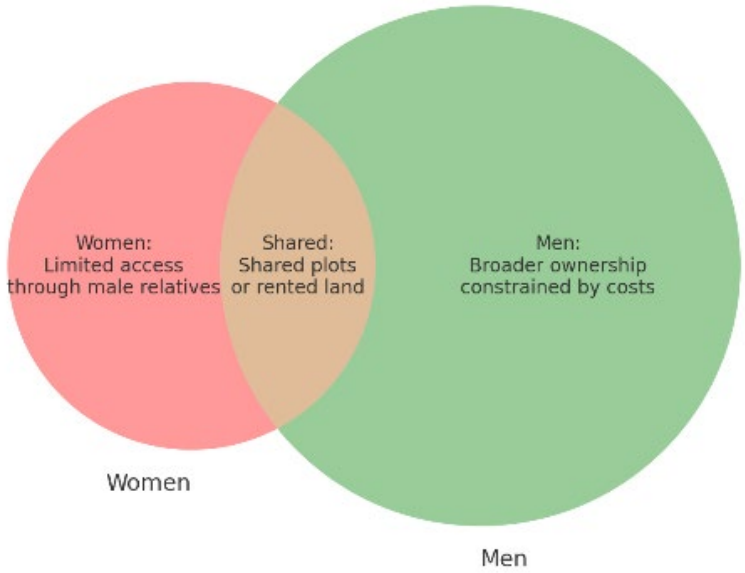
Figure 18: Asset ownership by households stratified by gender



Source: Field Survey, 2024

The Venn diagram highlights disparities in land ownership based on focus group discussions across the Kumbungu District. Women's access to land is largely mediated through male relatives, limiting their autonomy in agricultural decision-making. Men, while having broader ownership, face challenges due to high input costs. Shared plots or rented land represent a small overlap, often reflecting cooperative arrangements within families (**Figure 19**).

Figure 19: Venn diagram highlights disparities in land ownership based on focus group discussions

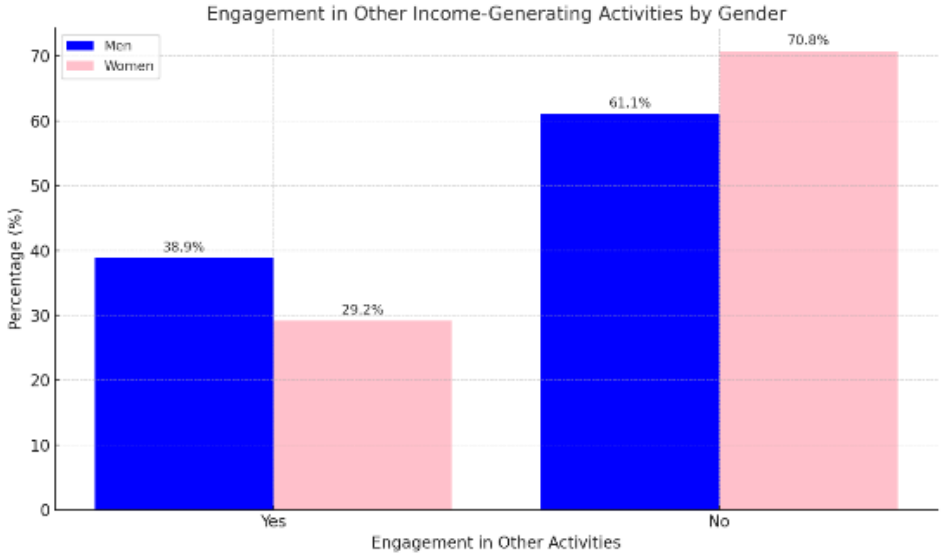


Source: Field Survey, 2024

Are you engaged in other income-generating activities?

Fewer women (29.2%) than men (38.9%) report engagement in additional income-generating activities, with 70.8% of women and 61.1% of men reporting no involvement (**Figure 20**). Women's lower participation reflects time constraints due to unpaid labor and caregiving roles, which limit their ability to diversify income sources. Men's broader engagement in seasonal labor and resource-intensive activities such as livestock trading reflects their greater access to opportunities and networks.

Figure 20: Households' engagement in alternative income-generating livelihood activities

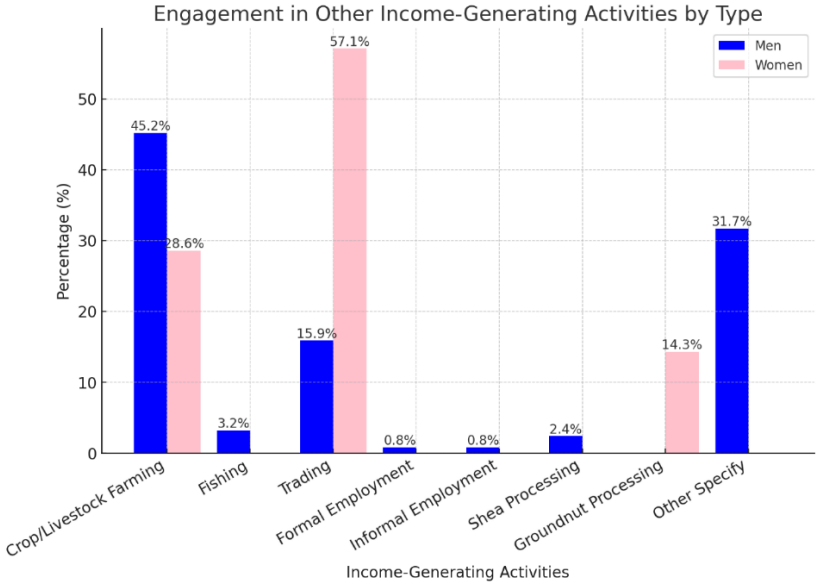


Source: Field Survey, 2024

Engagement in Other Income Generating Activities by Type

Men and women engage in different types of income-generating activities, reflecting traditional roles and resource access (**Figure 21**). Men predominantly participate in crop/livestock farming (45.2%), while women focus heavily on trading (57.1%). Men also report involvement in diverse unspecified activities (31.7%), shea processing (machinery support) and trading (15.9%), whereas women participate in groundnut processing (14.3%) These differences highlight cultural norms and resource disparities. Men's dominance in farming is linked to their access to land and farming inputs, while women's concentration in trading stems from its flexibility and low capital requirements.

Figure 21: Specific other income-generating activities

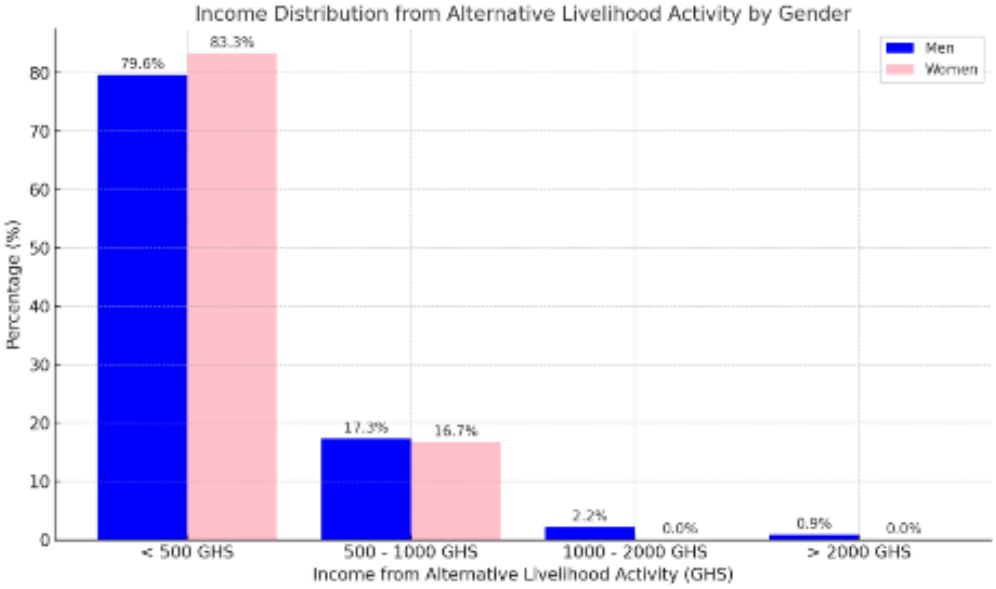


Source: Field Survey, 2024

Income distribution from alternative livelihood activities

Alternative livelihood activities generate low earnings for most households, with 79.6% of men and 83.3% of women earning less than 500 GHS (**Figure 22**). Men are slightly more represented in higher income brackets, with 2.2% earning 1000–2000 GHS and 0.9% earning above 2000 GHS, while no women reported earnings in these ranges. These disparities reflect systemic barriers limiting women's access to profitable ventures, such as capital, skills, and market opportunities. Women's engagement in low-paying activities like petty trading and subsistence farming contrasts with men's involvement in higher-value sectors like livestock rearing.

Figure 22: Income distribution from alternative income generating activities

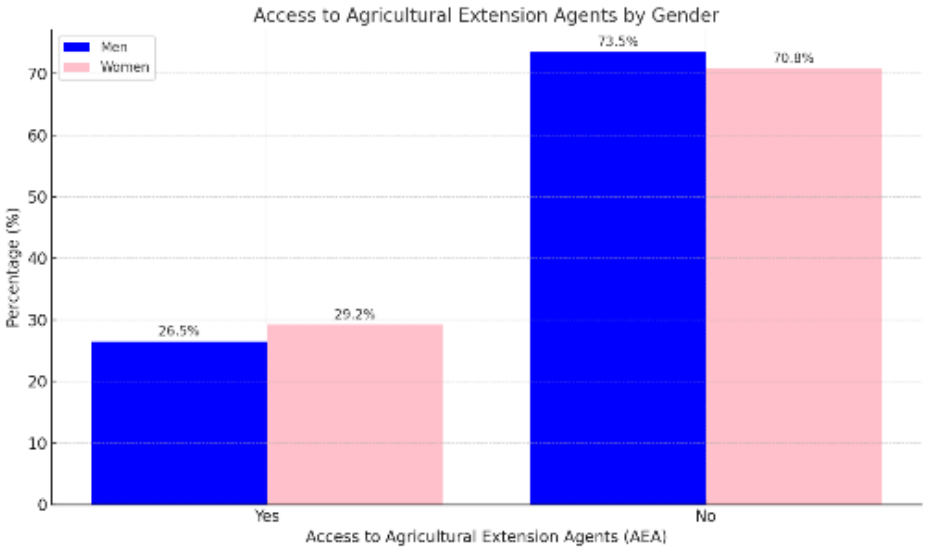


Source: Field Survey, 2024

Access to agriculture extension services

Access to agricultural extension agents is limited for both men and women, with only 26.5% of men and 29.2% of women reporting contact. The majority of both groups (73.5% of men and 70.8% of women) lack access to extension services (**Figure 23**). This limited outreach reflects challenges such as insufficient extension coverage in rural areas and logistical barriers.

Figure 23: Access to agricultural extension agents

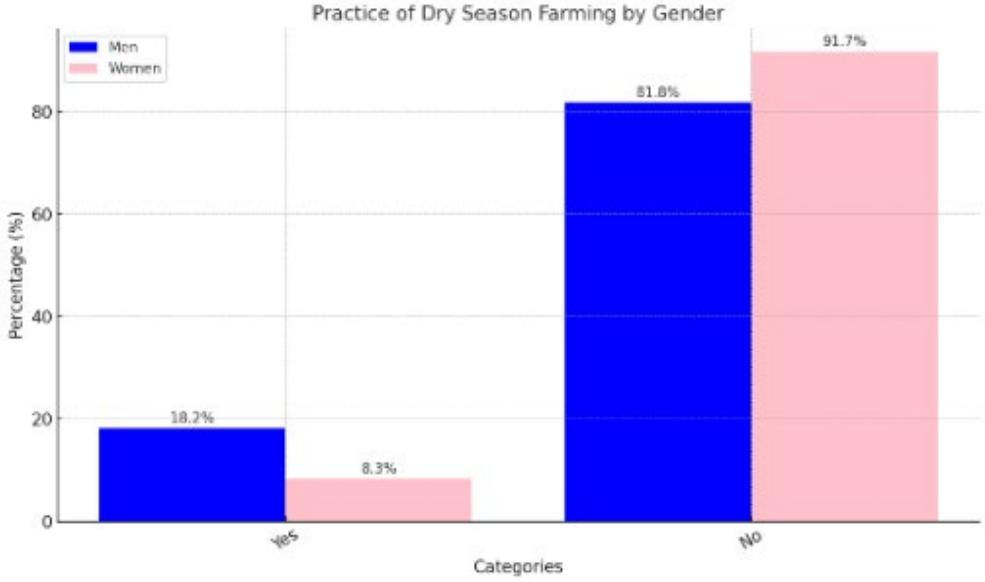


Source: Field Survey, 2024

Engagement in dry season farming

The practice of dry season farming is markedly lower among women, with only 8.3% engaging in it, compared to 18.2% of men (**Figure 24**). This disparity reflects significant barriers faced by women, such as limited access to water resources, capital, and equipment needed for irrigation. Additionally, cultural norms and household responsibilities may further restrict women's capacity to participate in labor-intensive activities like dry season farming. Men's higher engagement can be linked to their ability to secure resources and labor, enabling them to take advantage of opportunities provided by dry season farming.

Figure 24: Households' practice of dry season farming

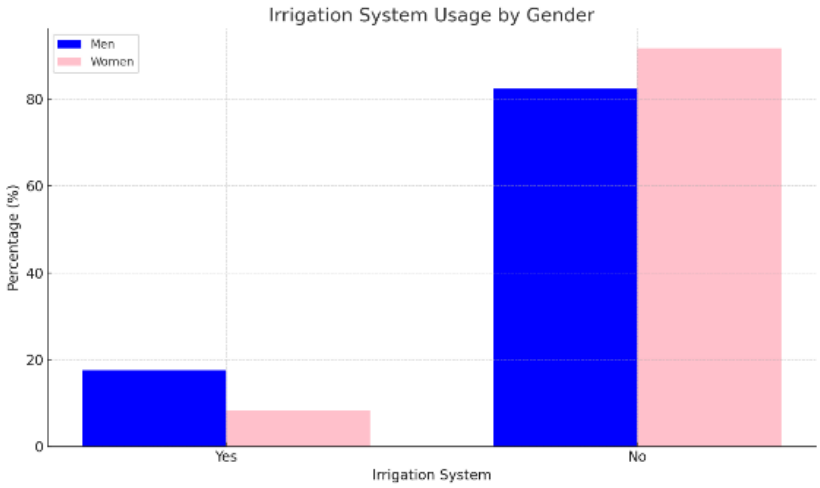


Source: Field Survey, 2024

Access to irrigation system on your farm?

Access to irrigation systems is limited for both genders, but women's access is particularly low, with only 8.3% reporting access compared to 17.6% of men (**Figure 25**). The overwhelming majority of women (91.7%) and men (82.4%) lack irrigation systems, underscoring widespread infrastructural deficits in rural agricultural systems. Women's lower access reflects systemic inequalities in land ownership and decision-making power, as well as financial constraints that hinder investment in irrigation technologies (Akurugu et al., 2021). Men's relatively higher access may result from their greater ability to mobilize resources or benefit from extension services.

Figure 25: Households' access to irrigation system on their farm



Source: Field Survey, 2024

Overall economic vulnerabilities among marginalized groups

From the aggregation of results from household surveys, focus group discussions, participatory workshops, community observations, and key informant interviews other marginalized groups in the Kumbungu District, including youth, people with disabilities (PWDs), migrant households, and the elderly, face distinct economic vulnerabilities that hinder their resilience to climate change and economic instability (**Figure 26**). These vulnerabilities stem from disparities in income sources, asset ownership, access to financial resources, and engagement in agriculture and alternative livelihoods (**Table 4**).

Young people in communities like Kumbungu and Guppanarigu primarily engage in informal labor and sand mining, which offer unstable incomes and expose them to environmental risks. People with disabilities in Zugu and Bagon struggle to access economic opportunities and rely on small-scale trading, which generates limited income. Migrant households, particularly in Nawuni and Sakuba, lack land ownership and rely on precarious wage labor, leaving them vulnerable to seasonal income fluctuations. Meanwhile, elderly individuals in communities like Kpalsogun and Bagon, who no longer actively farm, depend on family support or small-scale trading, making them susceptible to financial shocks.

Figure 26: Marginalized groups economic vulnerabilities in the Kumbungu District

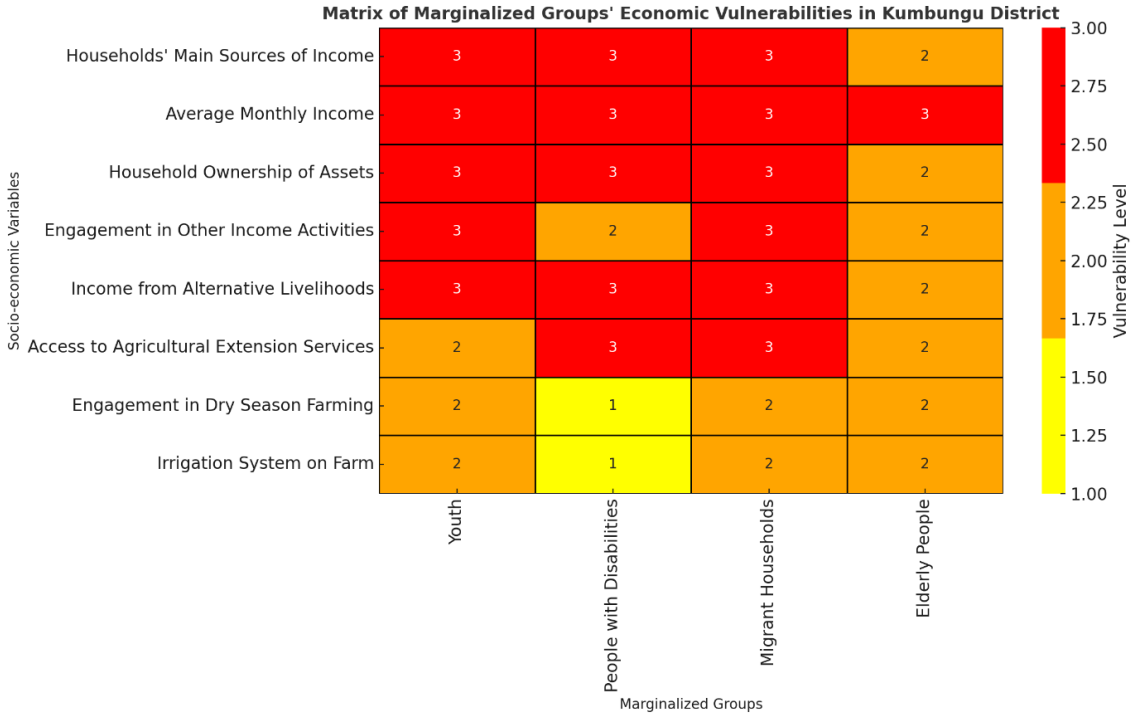


Table 4: Matrix of marginalized groups economic vulnerabilities in the Kumbungu District

Socio-Economic Variables	Youth	People with Disabilities	Migrant Households	Elderly People
Households' Main Sources of Income	Informal labor, trading, sand mining (*Nawuni, Kumbungu)*	Petty trading, craftsmanship (*Zugu, Bagon)*	Fishing, farm labor, sand mining *(Nawuni, Sakuba)*	Traditional farming, small-scale trade (*Dalun, Voggu)*
Average Monthly Income	Mostly below 500 GHS, reliant on remittances *(Dalun, Zangballung)*	Below 500 GHS, limited access to financial opportunities	Seasonal fluctuations, mostly below 500 GHS (Voggu, Nawuni)	Primarily below 500 GHS, highly dependent on family support

Socio-Economic Variables	Youth	People with Disabilities	Migrant Households	Elderly People
Household Ownership of Assets	Limited land ownership, dependence on family land	Rarely own land or equipment, rely on others	No land ownership, short-term leasing (Sakuba, Nawuni)	Own farmland but struggle with tenure security *(Kumbungu, Zangballung)*
Engagement in Other Income Activities	Motorcycle transport, construction work (Dalun, Kumbungu)	Small-scale trade, weaving (Bagon, Kumbungu)	Seasonal farm work, sand mining (Nawuni, Voggu)	Selling local beverages, handicrafts, poultry (Dalun, Bagon)
Income from Alternative Livelihoods	Unstable, low returns from Okada, labor work	Irregular earnings from trading, no formal support	Highly variable due to climate impacts on farming	Small profits from trading and traditional crafts
Access to Agricultural Extension Services	Limited access, lack of technical support (Bognaayili)	Excluded from extension programs (Dalun, Zangballung)	Poor access, no training on climate adaptation (Sakuba)	Minimal support, reliance on traditional practices (Guppanarigu)
Engagement in Dry Season Farming	Limited due to lack of irrigation (Dalun, Guppanarigu)	Rare participation due to mobility constraints	Limited access to land and water (Nawuni, Voggu)	Few engage, traditional farming methods dominate
Irrigation System on Farm	Largely unavailable, reliance on rain-fed agriculture	No access to irrigation systems	No irrigation access, restricted farming opportunities	Limited ability to invest in irrigation (Voggu, Nawuni)

What did some community members say about their economic vulnerabilities?

From the focus group discussions, community members shared their lived experiences regarding economic challenges, livelihood strategies, and barriers to resource access. Their testimonies reveal gendered disparities in income sources, asset ownership, and access to agricultural support.

(a) Main Income Sources and Livelihood Activities

As has been found in the Assessment, economic opportunities in the Kumbungu District are largely shaped by gender and social status. While men dominate crop farming and seasonal migration, women depend on small-scale trading, shea butter processing, and vegetable farming. The youth, facing limited employment options, often resort to casual labor and small-scale trading.

"We sell what we process ourselves because our husbands control large-scale crops. The shea butter business is unpredictable, and sometimes we cannot sell enough to cover basic household needs. The men sell the cash crops like maize and groundnuts, while we have to depend on whatever we can make from processing. If the harvest is poor, we struggle even more." – Woman, Guppanarigu

"Farming is all we know, but the cost of fertilizers and pesticides keeps increasing, making it unsustainable for us. Many men here have started traveling to Accra and Kumasi for construction work, but it's not easy leaving our families behind. Those of us who stay behind have no choice but to take loans just to keep our farms running". – Man, Zugu

"There are no jobs here for young people. If we don't work on our family's farms, we have to go and look for casual labor, but those jobs are seasonal. I sometimes carry sacks of maize for traders at the market or work on someone's farm for daily pay, but it is never enough to survive." – Youth, Gbullung

Women's economic activities are further constrained by social norms that limit their access to land and major income-generating opportunities. Men, though dominant in farming, are also experiencing economic strain due to rising input costs, while youth struggle with unemployment and instability.

(b) Earnings from Alternative Livelihoods

In response to economic hardships, many community members engage in alternative livelihood activities such as livestock rearing, casual labor, and small-scale trading. However, these income sources are often insufficient and unpredictable.

"I rear goats and chickens to support my household but feeding them is becoming more difficult. When the dry season comes, there is little fodder, and we sometimes have to buy expensive feed from the market. I know many women who sell their livestock in emergencies because they cannot afford to sustain them." – Woman, Nawuni

"When farming does not go well, I turn to charcoal burning. It is hard work, and we know it is not good for the land, but what else can we do? It is risky because sometimes the authorities come and seize our charcoal, leaving us with nothing". – Man, Saakuba

"During the rainy season, I try selling vegetables like onions and tomatoes, but once the season ends, business slows down. There is no irrigation, and once the dry season comes, everything becomes expensive. The little I make is not enough to save for the next planting season." – Youth, Zangballung

For many, alternative livelihood activities serve as coping mechanisms rather than sustainable income sources. Women's ventures into livestock rearing are constrained by resource limitations, while men's fallback options, such as charcoal burning, contribute to environmental degradation. Youth, meanwhile, remain caught in a cycle of low-income seasonal work.

(c) Participation in Dry Season Farming

Dry season farming presents an opportunity for income diversification, but it remains largely inaccessible due to the high cost of irrigation, lack of water access, and the burden of domestic responsibilities for women.

"Without irrigation, we cannot farm in the dry season. The rivers dry up, and even if we want to dig wells, it is expensive. We also have to take care of the home, so we cannot travel long distances to fetch water for irrigation. The men can leave and find work elsewhere, but we are stuck here waiting for the rains." – Woman, Dalun

"We grow tomatoes and onions in the dry season, but it is becoming too expensive. We pay high fees to access irrigation water, and if we do not get enough yield, we make losses. Farming used to be reliable, but now, we are at the mercy of the weather and market prices." – Man, Zugu

"I help my family grow onions during the dry season, but it's hard work. We spend hours carrying water to the farm because we do not have a proper irrigation system. If we had irrigation pumps, we could produce more, but right now, it is just survival farming." – Youth, Bognaayili

Despite the potential benefits of dry season farming, the lack of irrigation infrastructure remains a major challenge. Women's engagement is further limited by domestic labor responsibilities, while men and youth struggle with the high costs of sustaining off-season agricultural activities.

(d) Land and Asset Ownership

Access to land and agricultural assets is critical for economic security, yet women, youth, and migrants face significant barriers.

"I farm on my husband's land, but I cannot decide what to plant. If I want to grow vegetables for my business, I have to ask for permission, and sometimes, my husband refuses because he prioritizes other crops. Even if I make money from my farm, I do not have control over the land." – Woman, Kpalsogun

"I own my farm, but fertilizer prices are killing us. I cannot expand my farm because I do not have the money to buy enough inputs. Many of us are selling parts of our land to survive, but in the long run, we will have nothing left." – Man, Kumbungu

"Most of us youth do not own land. We work on family farms or rent land from older men, but the cost of renting is high. We cannot invest in good seeds or fertilizers because the land is not ours." – Youth, Voggu

Land tenure insecurity prevents women from making independent economic decisions, while young farmers struggle with limited ownership and costly rental arrangements. Even male landowners face financial constraints that hinder agricultural productivity.

(e) Agricultural Practices and Barriers to Resource Access

Limited access to agricultural inputs, training, and markets further exacerbates economic vulnerabilities. Women rely on traditional farming techniques, men struggle with rising costs, and youth lack the resources to adopt modern farming methods.

"We lack training, so we use traditional methods that fail during droughts. I have never received any advice from an agricultural officer, and we do not know where to get improved seeds. When the crops fail, we suffer the most." – Woman, Saakuba

"We need modern tools, but they are too expensive. Farming has changed, but we are still using the same old tools that our fathers used. If we had better equipment, we could produce more, but we cannot afford them." – Man, Bagon

"Even as a family, pooling money to buy seeds is a struggle. The prices of farm inputs keep going up, and every year, we have to cut back on how much we plant because we do not have enough money." – Woman, Bognaayili

Both men and women face economic barriers in agriculture, but women experience additional constraints due to social norms and limited decision-making power. Youth, despite their labor contributions, are unable to access the capital needed for productive farming.

4.1.2 Physical Vulnerability

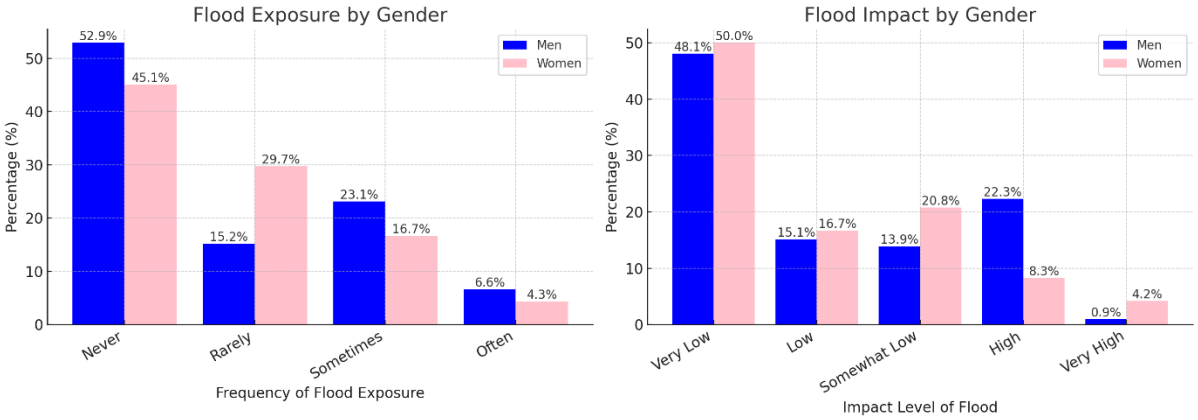
Physical vulnerability assessment is critical for understanding the extent to which communities are exposed to and impacted by climate-related hazards in the Kumbungu District. From the assessment activities, it emerged that climate-related hazards like droughts, floods, and windstorms pose direct threats to agricultural systems, livelihoods, and food security, with impacts varying widely across gender lines. Men and women experience these hazards differently due to disparities in their roles, resource access, and coping mechanisms.

Exposure and Impacts to Climate-Related Hazards in past 5 years

(a) Exposure to Floods and Impacts

Figure 27 reveals a gender disparity in both flood exposure and impact. Men report lower direct exposure to floods, with a majority (51.9%) stating they've never experienced one, compared to 45.8% of women. Women, however, experience more frequent, less severe floods (29.2% rarely) than men (15.4%). While both genders mostly report very low impacts from flooding, women experience a higher proportion of "Somewhat Low" impacts, suggesting a greater burden despite less frequent severe events. Conversely, men report more "High" impacts, but women are disproportionately affected by the most severe "Very High" impacts (4.2% vs. 0.9% for men).

Figure 27: Exposure to floods and impacts in past 5 years stratified by gender



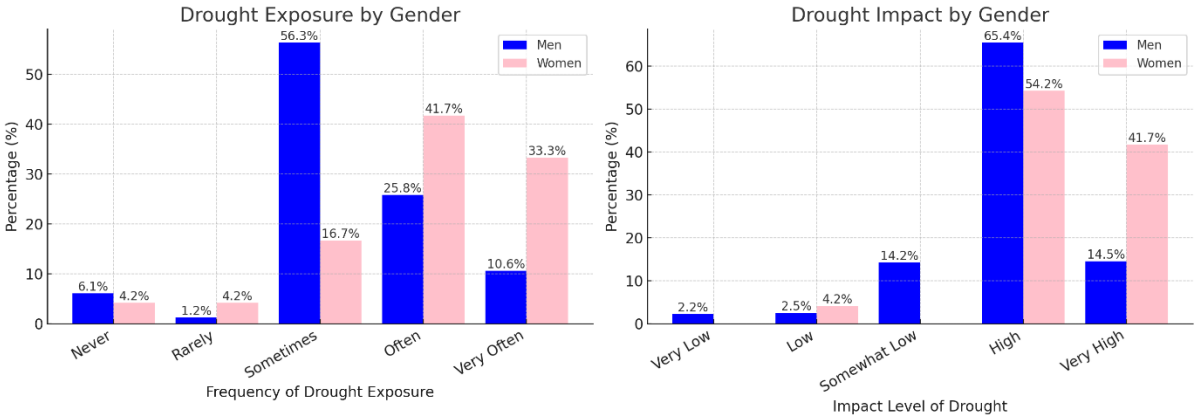
Source: Field Survey, 2024

Women's higher exposure to floods can be attributed to their engagement in low-lying agricultural areas near riverbanks, where small-scale farming and water collection activities are common. Flood-prone areas are often inhabited by female-headed households due to socio-economic constraints that limit access to safer, elevated locations. Women's reliance on traditional farming practices and inadequate infrastructure, such as poorly constructed drainage systems or homes, increases their vulnerability. The severe impacts on women, such as damage to homes, stored food, and agricultural crops, arise from their dependence on these resources for subsistence and income. In contrast, men may have greater access to financial resources, enabling them to construct flood-resistant housing and recover more quickly from flood events, which explains their reports of "High" but fewer "Very High" impacts.

(b) Exposure to Droughts and Impacts

Men reported experiencing droughts "Sometimes" most frequently (56.5%), whereas women experienced higher frequencies of drought, with 41.7% reporting "Often" and 33.3% reporting "Very Often." Few men (6.5%) and women (4.2%) reported "Never" experiencing droughts (**Figure 28**). Regarding the impact of droughts, men most commonly reported "High" impacts (66.4%), while women frequently reported "Very High" impacts (41.7%) compared to men (14.8%). Lower levels of impact, such as "Very Low" and "Somewhat Low," were reported more often by men, with 14.2% of men describing the impact as "Somewhat Low," compared to 0.0% of women.

Figure 28: Exposure to drought and impacts in past 5 years



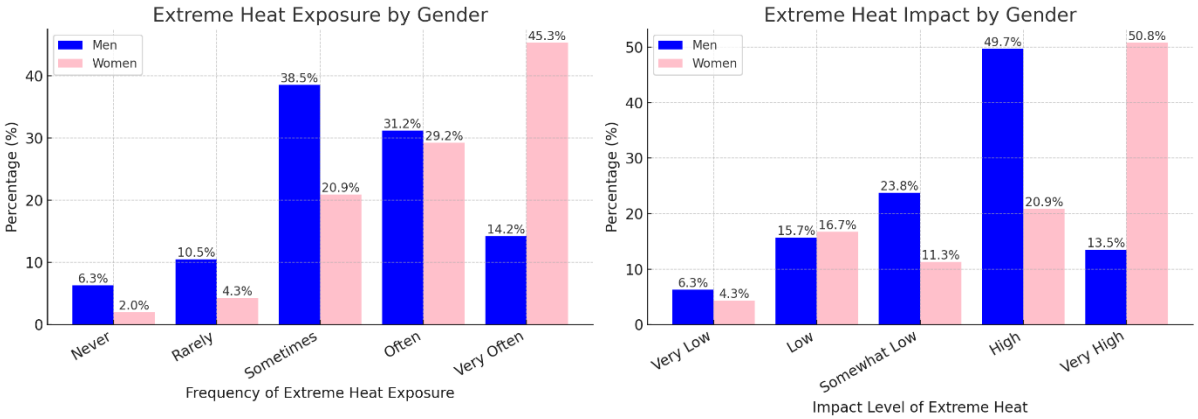
Source: Field Survey, 2024

(c) Exposure to Extreme Heat and Impacts

Women reported significantly higher exposure to extreme heat, with 45.8% experiencing it "Very Often" compared to 14.2% of men (**Figure 29**). Men most frequently reported experiencing extreme heat "Sometimes" (38.9%), while exposure to "Often" was similar across both groups (men: 30.2%, women:

29.2%). Regarding impact, women described the effect of extreme heat as "Very High" (50.0%) far more frequently than men (13.0%), who reported "High" impacts more commonly (49.7%).

Figure 29: Exposure to extreme heat and impacts in the past 5 years

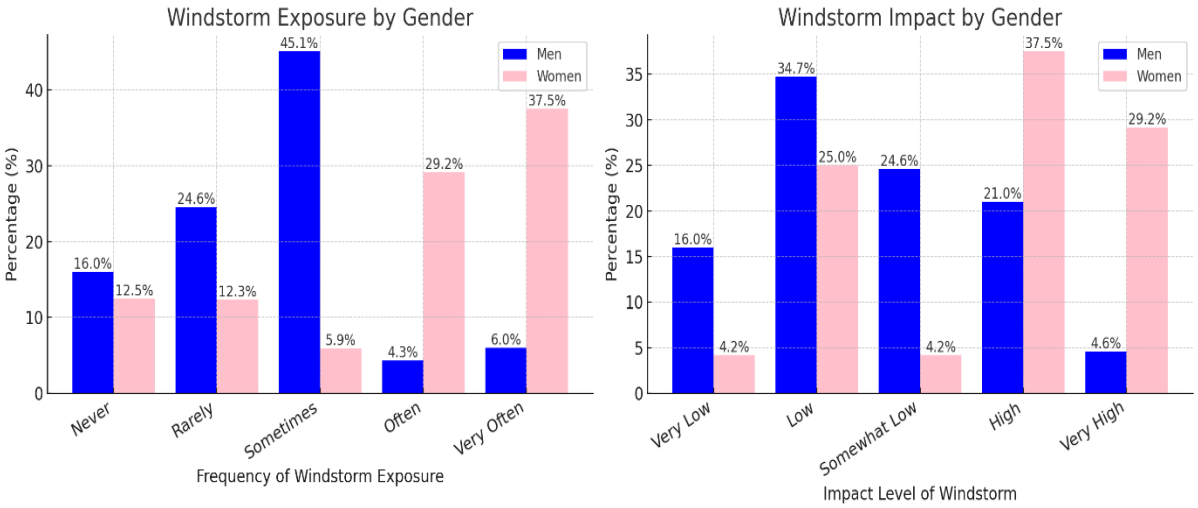


Source: Field Survey, 2024

(d) Exposure to Windstorms and Impact

Men reported experiencing windstorms "Sometimes" most frequently (45.1%), whereas women reported higher frequencies of "Often" (29.2%) and "Very Often" (37.5%) (**Figure 30**). A greater proportion of men reported "Never" (16.0%) or "Rarely" (29.6%) experiencing windstorms compared to women, where these categories were both at 12.5%. Regarding impact, men more frequently reported "Low" (34.0%) and "Somewhat Low" (24.4%) impacts, while women reported more severe impacts, with 37.5% describing the impact as "High" and 29.2% as "Very High."

Figure 30: Exposure to windstorms and impacts in past 5 years



Source: Field Survey, 2024

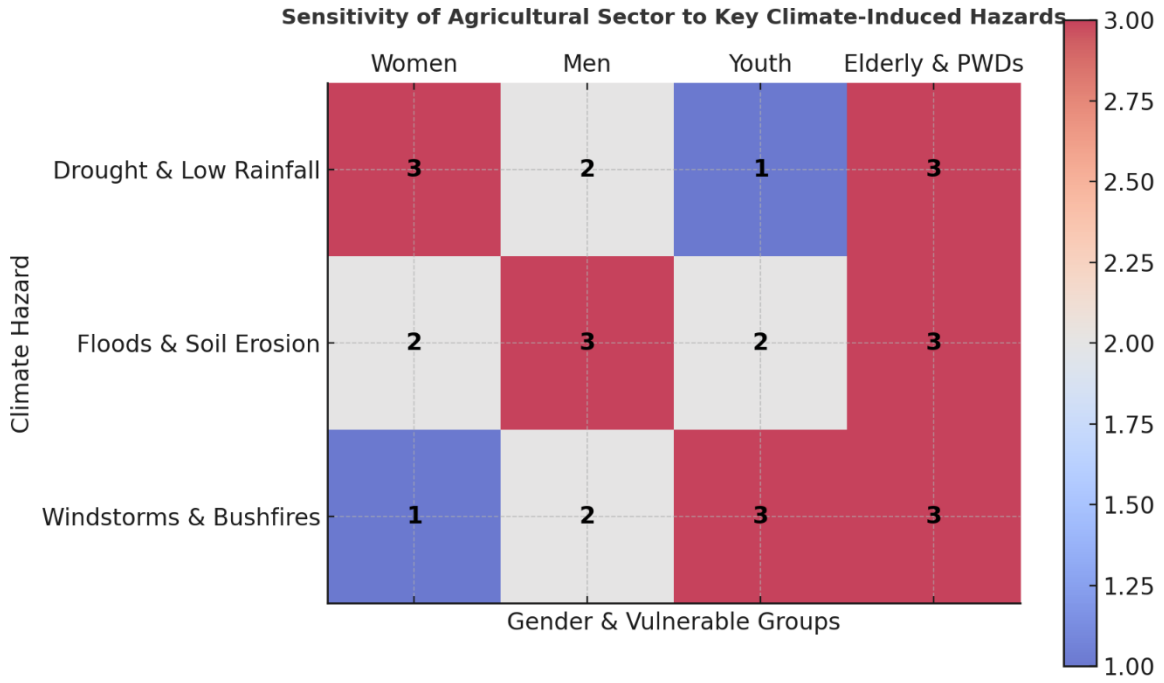
Sensitivity of Critical Sectors to Climate-Related Hazards

The assessment highlights the varying degrees of sensitivity to climate hazards across key sectors in Kumbungu District, revealing critical vulnerabilities in agriculture, infrastructure, health, and water resources. While all sectors experience some level of impact, floods and droughts emerge as the most disruptive hazards, severely affecting livelihoods, infrastructure, and public health. The detailed sectoral analyses, along with supporting data and graphical representations, are presented in the appendix, while the key findings are summarized.

(a) Agricultural Sector Sensitivity

Agriculture emerges as one of the most highly climate-sensitive sectors, particularly in relation to floods, droughts, and windstorms. The color-coded matrix visually represents how different climate hazards impact agriculture and vary across gender groups. The scale ranges from **1 (low impact, blue) to 3 (high impact, red)**, highlighting the severity of effects for women, men, and youth (**Figure 31**).

Figure 31: Sensitivity of agriculture sector to key climate-induced hazards

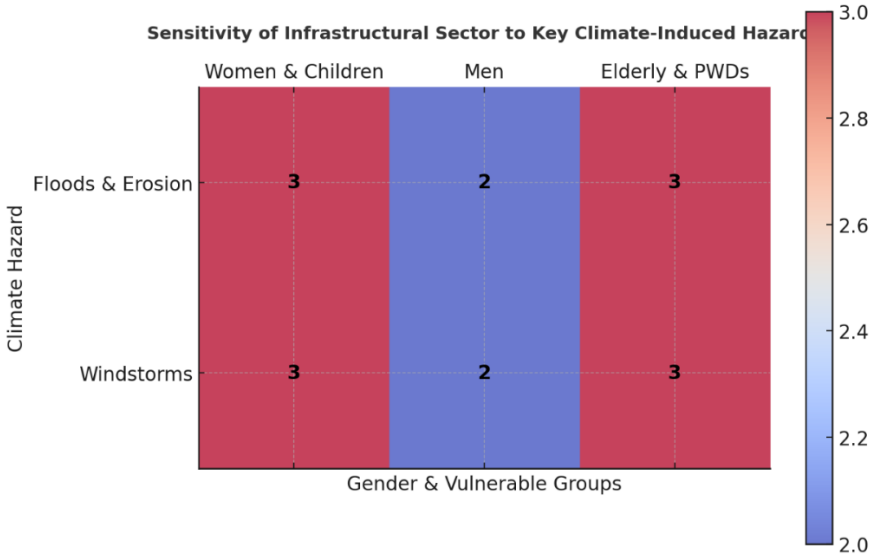


- **Drought and Low Rainfall:** Women (3) and the Elderly & PWDs (3) are highly affected due to reliance on small-scale farming and water constraints. Men (2) struggle with high input costs (*e.g.,* irrigation, fertilizers). Youth (1) face reduced farm labor opportunities but are relatively less affected**.**
- **Floods and Soil Erosion:** Men (3) suffer the most due to financial losses on large farms. Women (2) face challenges with insecure land tenure on erosion-prone land. Youth (2) experience job instability. Elderly & PWDs (3) are severely impacted due to mobility and recovery challenges.
- **Windstorms & Bushfires:** Youth (3) and the Elderly & PWDs (3) experience job losses and increased vulnerability. Men (2) face infrastructure damage (*e.g.,* storage sheds), while women (1) are less affected but lose access to tree-based resources.

(b) Infrastructural Sector Sensitivity

From the Assessment, infrastructure in the Kumbungu District faces high sensitivity to floods and erosion, as poor drainage systems and weak road networks result in frequent disruptions during heavy rains. Flooding damages roads, bridges, and homes, limiting access to markets, schools, and healthcare facilities. In communities with poorly constructed buildings, windstorms also pose a moderate risk, causing structural damage and displacement. While drought and extreme heat have relatively lower direct impacts on infrastructure, prolonged heatwaves increase maintenance costs and contribute to the deterioration of building materials (**Figure 32**).

Figure 32: Sensitivity of the infrastructural sector to key climate-induced hazards

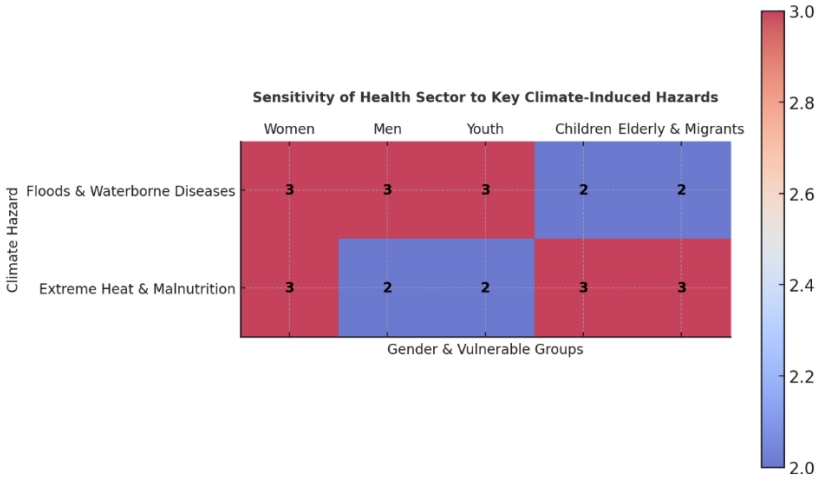


- **Floods and Erosion:** Women and children (3) face limited access to markets and health services due to damaged roads and bridges. Men (2) experience higher transport costs for agricultural goods. The Elderly & PWDs (3) are highly vulnerable due to restricted mobility and accessibility issues**.**
- **Windstorms:** Women and children (3) are at high risk of displacement from damaged homes and community structures. Men (2) often migrate for work post-disaster. The Elderly & PWDs (3) struggle with housing recovery due to financial and physical constraints.

(c) Health Sector Sensitivity

Health is significantly affected by floods, extreme heat, and droughts, with direct implications for waterborne diseases, malnutrition, and heat-related illnesses. Flooding contaminates water sources, increasing cases of cholera, typhoid, and diarrhea, while droughts reduce access to clean water, worsening hygiene and sanitation conditions. Extreme heat poses serious health risks, particularly for elderly individuals, pregnant women, and those engaged in outdoor labor, increasing incidents of heat exhaustion, dehydration, and respiratory illnesses. In contrast, windstorms and erosion have a relatively lower impact on health, though poor air quality from dust and debris can contribute to respiratory complications (**Figure 33**).

Figure 33: Sensitivity of health sector to key climate-induced hazards

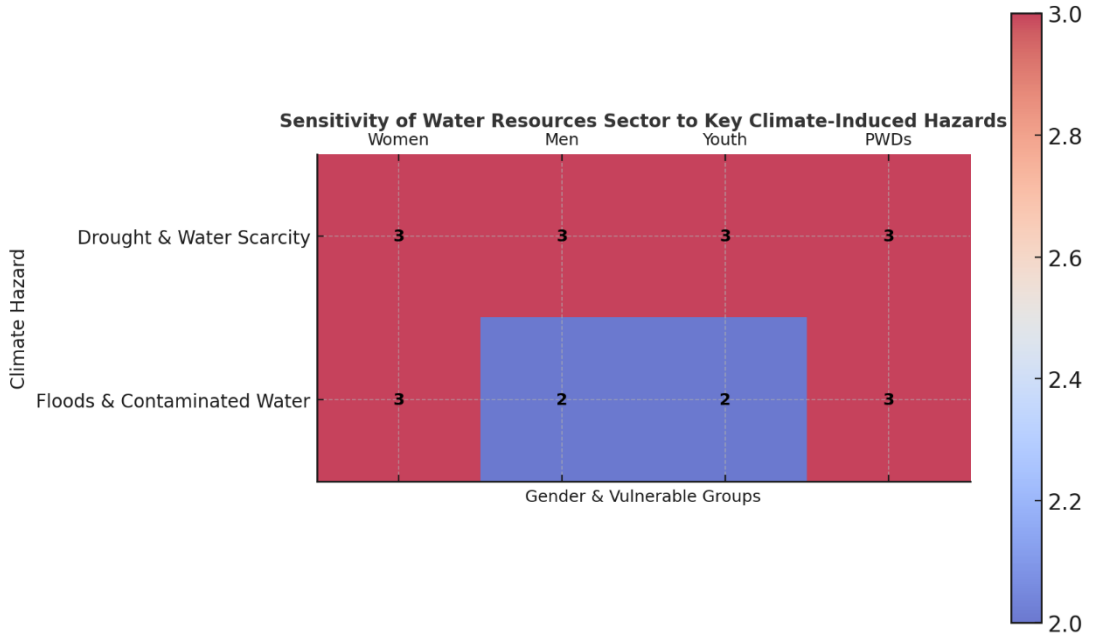


- **Floods and Waterborne Diseases:** Women (3) bear the greatest burden as caregivers, managing increased cases of cholera, typhoid, and diarrhea. Men (3) and youth (3) are also highly affected, especially those exposed to contaminated water sources. Children, the elderly, and migrant communities (2) face moderate risks due to weaker immune systems and limited access to healthcare.
- **Extreme Heat & Malnutrition:** Women (3) suffer severe impact due to prolonged exposure to heat in poorly ventilated kitchens. Men (2) and youth (2) experience moderate risks of heat stress from outdoor labor. Children, the elderly, and migrants (3) are highly vulnerable to dehydration, respiratory illnesses, and food insecurity caused by declining agricultural productivity.

(d) Water Resources Sector Sensitivity

Water resources are highly vulnerable to both floods and droughts, with severe consequences for agriculture, domestic water use, and livestock production. Floods often lead to river overflows and water contamination, limiting the availability of clean drinking water, while droughts create chronic water shortages, disproportionately affecting women and girls, who are primarily responsible for water collection in many communities. Extreme heat and windstorms, while less directly impactful, contribute to increased evaporation rates, further reducing water availability (**Figure 34**).

Figure 34: Sensitivity of water resources sector to key climate-induced hazards



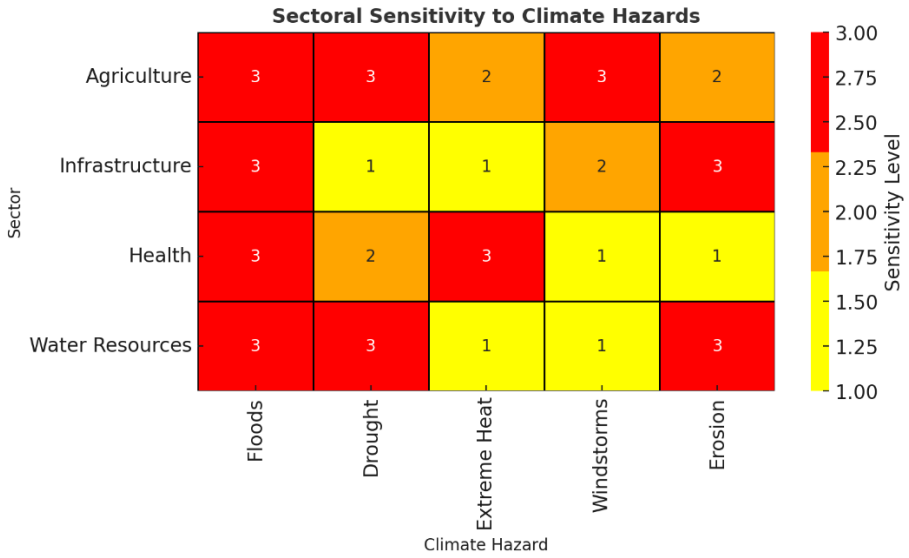
- **Drought & Water Scarcity:** Women (3) face increased time fetching water, worsening their domestic workload. Men (3) and youth (3) struggle with water shortages for irrigation, reducing agricultural productivity. PWDs (3) experience severe difficulties accessing water sources due to mobility constraints.
- **Floods & Contaminated Water:** Women (3) are highly exposed to waterborne diseases due to caregiving roles. Men (2) and youth (2) face moderate impacts, mainly through reduced water quality and sanitation challenges. PWDs (3) are among the most affected, as mobility issues limit their ability to access clean water.

(e) Overall Sectoral Sensitivity in Kumbungu

The sensitivity analysis highlights the uneven distribution of climate risks across key sectors in Kumbungu District, with floods and droughts posing the most significant threats (**Figure 35)**. Agriculture is particularly vulnerable, experiencing high sensitivity to floods, droughts, and windstorms, which

disrupt farming activities, degrade soil quality, and reduce crop yields. Infrastructure is most affected by flooding and erosion, leading to damage to roads, bridges, and housing, while windstorms present a moderate risk to poorly constructed structures. In the health sector, floods and extreme heat are major concerns, increasing cases of waterborne diseases, heat-related illnesses, and respiratory complications, while windstorms and erosion have minimal direct impacts. Water resources face high sensitivity to both floods and droughts, resulting in contaminated water supplies, scarcity of drinking water, and reduced irrigation potential.

Figure 35: Overall sectoral sensitivity to climate hazards in Kumbungu District



- Floods pose the highest risk across all sectors, particularly for agriculture, infrastructure, health, and water resources (3).
- Drought significantly impacts agriculture and water resources (3) but has a moderate impact on health (2) and a low impact on infrastructure (1).
- Extreme heat is most critical for health (3) and has a moderate effect on agriculture (2), while its impact on infrastructure and water resources remains low (1).
- Windstorms severely impact agriculture (3), moderately affect infrastructure (2), and have a lower impact on health and water resources (1).
- Erosion is a major threat to infrastructure and water resources (3), with moderate effects on agriculture (2) and low impact on health (1).

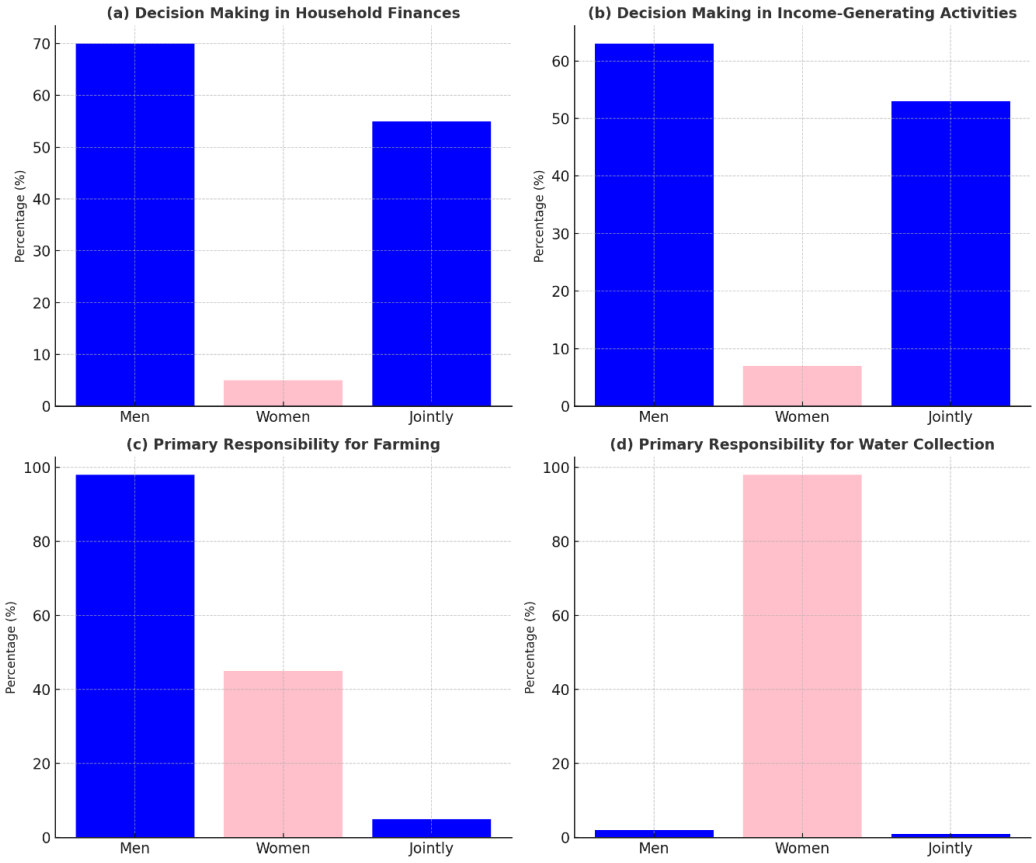
4.1.3 Social Vulnerability

Social vulnerability highlights how social factors like gender roles, resource access, and community support shape responses to climate change. In the Kumbungu District, gender dynamics significantly influence household decision-making, resource distribution, and adaptive capacity. Women often face increased workloads, limited participation in adaptation decisions, and inequitable access to resources, which exacerbate their vulnerability. This section examines key aspects of social vulnerability, including gender roles, women's impacts, resource barriers, adaptive capacity, and social support, to uncover the challenges and opportunities for building equitable resilience to climate change.

4.1.3.1 Gender Roles and Decision-Making

Gender roles and decision-making dynamics significantly shape household and community responses to climate change. In the Kumbungu District, traditional norms often assign men authority over finances, farming, and income-generating decisions, while women shoulder domestic responsibilities, including water collection and caregiving. This section explores how decision-making, and task distribution are divided along gender lines, shedding light on inequalities that may hinder equitable resilience to climate change (**Figure 36 a, b, c and d**).

Figure 36: Gender roles in household decision-making and resource management

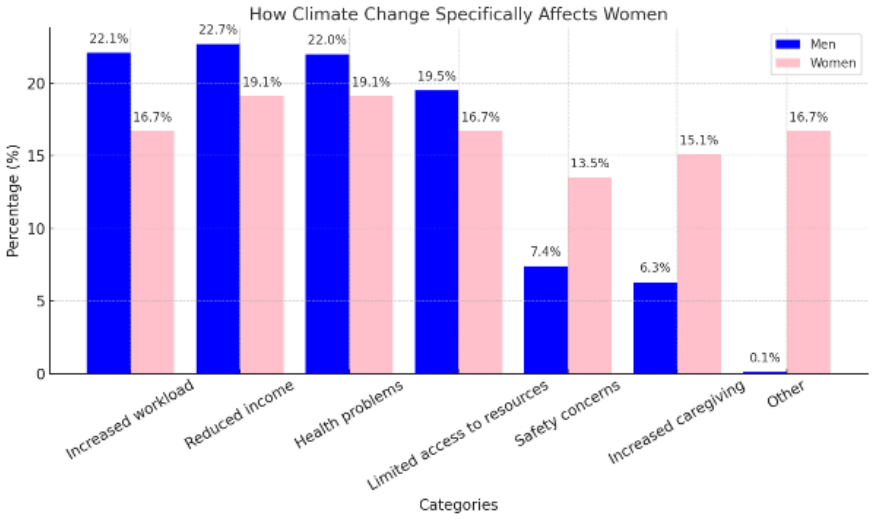


- **Decision-Making in Household Finances:** Men dominate financial decision-making (70%), while joint decision-making (55%) is also common. Women play a limited role (5%), reflecting gendered financial control structures in households.
- **Decision-Making in Income-Generating Activities:** Men largely control income-related decisions (63%), while joint decision-making is substantial (53%). Women have minimal influence (7%), indicating limited autonomy over earnings and economic choices.
- **Primary Responsibility for Farming:** Farming is heavily male-dominated (98%), with women playing a supportive role (45%) but rarely having full responsibility. Joint responsibility is negligible (5%), reinforcing gendered labor divisions in agriculture.
- **Primary Responsibility for Water Collection:** Water collection is overwhelmingly a female responsibility (98%), with men playing almost no role (2%). This highlights gendered burdens on women, impacting time availability for education, work, and economic participation.

4.1.3.2 Gendered impacts of climate change on women

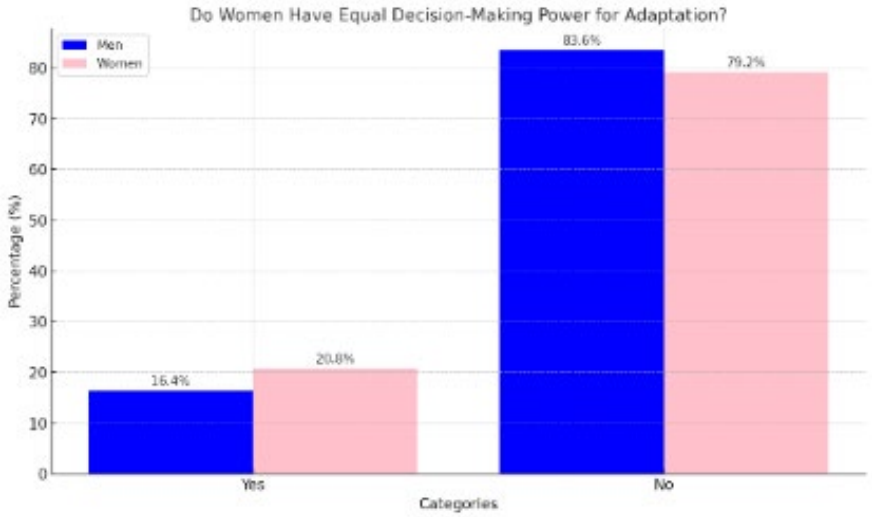
Figure 37 highlights the gendered impacts of climate change on women in households and their decision-making power in climate adaptation. Both men and women identified increased workload, reduced income, and health problems as primary effects of climate change on women. Men perceived these impacts slightly more acutely, likely reflecting their awareness of the visible effects of climate change on women's labor and well-being. Women, however, reported higher concerns about safety (**13.5%**) and increased caregiving responsibilities (**15.1%**). These findings show the compounded responsibilities women face during climate crises, such as caring for children, the sick, and the elderly, as well as ensuring household safety during disasters. Additionally, **16.7%** of women cited "other" impacts. These impacts were mentioned to include emotional stress, social isolation, reduced mobility, food insecurity, displacement-related vulnerabilities, and restricted access to climate adaptation resources such as agricultural inputs, all of which exacerbate the disproportionate burdens women bear during climate stress.

Figure 37: How climate change affects women



On decision-making power, an overwhelming majority of men (**83.6%**) and women (**79.2%**) agreed that women lack equal decision-making authority in climate adaptation (**Figure 38**). The slightly higher percentage of women (**20.8%**) who believe they have equal decision-making power may reflect localized efforts in some households or communities to include women in decision-making. However, the responses also reveal systemic barriers, such as traditional gender norms, limited access to resources, and a lack of formal representation, that restrict women's influence in adaptation strategies.

Figure 38: Do women have equal decision-making power for climate change adaptation



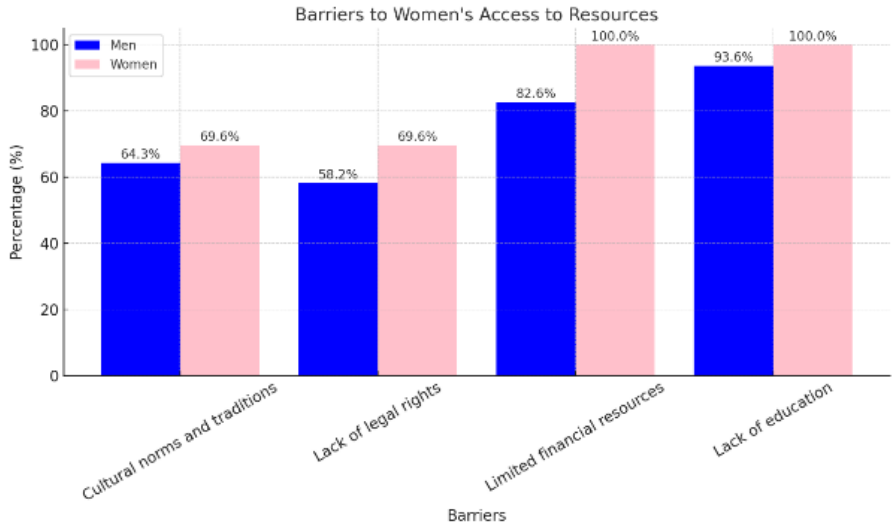
Source: Field Survey, 2024

4.1.3.3 Barriers to Access Resources

In the Kumbungu District, cultural norms and traditions were identified as significant barriers to women's access to resources, with **64.3%** of men and **69.6%** of women affirming this (**Figure 39**). Patriarchal traditions often prioritize men in land ownership and decision-making, leaving women dependent and excluded from resource control. For example, customary land tenure practices in Kumbungu frequently prevent women from inheriting land, limiting their agricultural and economic opportunities.

Lack of legal rights was highlighted by **58.2%** of men and **69.6%** of women, reflecting the limited enforcement of gender-equity laws. While Ghana's constitution supports equality, women in Kumbungu face challenges asserting their rights in land disputes or accessing formal systems of justice. This is compounded by a lack of awareness about legal protections among rural women.

Figure 39: Barriers to women's access to resources for climate change adaptation



Source: Field Survey, 2024

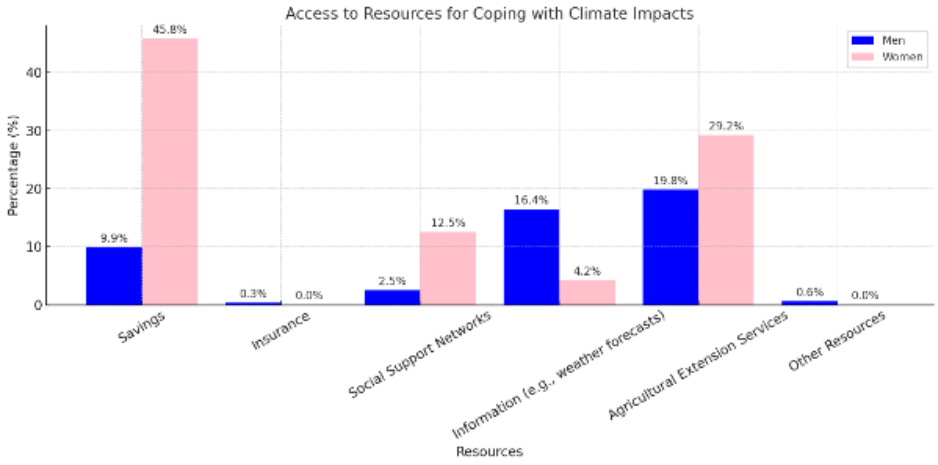
Financial constraints were nearly universal, with **82.6%** of men and **100.0%** of women citing limited financial resources as a major barrier. Women in Kumbungu often rely on small-scale farming or shea butter processing, which generate low incomes, leaving them unable to invest in adaptive measures like irrigation or drought-resistant seeds during climate crises.

Lack of education was the most significant barrier, with **93.6%** of men and **100.0%** of women recognizing it. Limited educational opportunities for girls in the district contribute to high illiteracy rates, preventing women from accessing information about climate adaptation programs or financial assistance. This lack of education restricts women's participation in decision-making and adaptive planning.

4.1.3.4. Adaptive Capacity

Figure 40 highlights significant gaps in adaptive capacity among households in Kumbungu District due to limited access to critical resources for coping with climate impacts. Women reported higher access to savings (**45.8%**) and social support networks (**12.5%**) than men, reflecting their reliance on informal coping mechanisms such as savings groups and community-based support. Men, however, had greater access to information (**16.4%**) and agricultural extension services (**19.8%**) compared to women, suggesting their stronger involvement in formal networks and agricultural activities. Access to insurance and other resources was negligible for both genders, indicating a critical gap in formalized risk management systems.

Figure 40: Access to resources for coping with climate change impacts

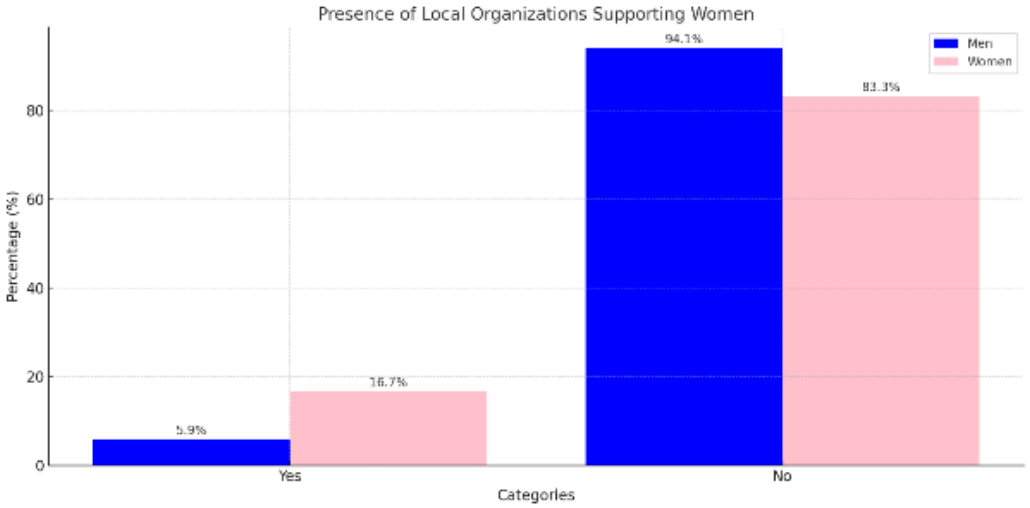


Source: Field Survey, 2024

4.1.3.5 Social Support

Figure 41 reveals a significant lack of local organizations or groups supporting women in adapting to climate change in Kumbungu District. Only **16.7%** of women and **5.9%** of men reported the presence of such organizations. This low percentage reflects the limited presence or visibility of gender-focused adaptation initiatives in rural areas. The disparity between men and women could stem from women being more likely to engage with informal networks or grassroots-level organizations. However, the overall absence of structured support highlights systemic gaps in institutional efforts to address women's specific vulnerabilities and promote equitable resilience.

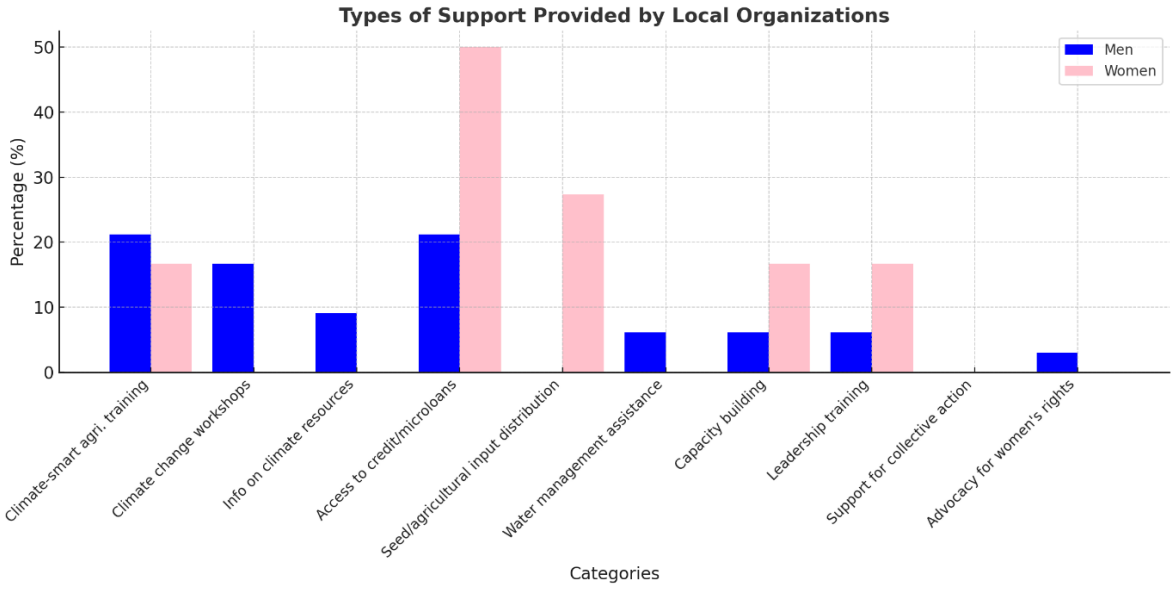
Figure 41: Presence of local organizations supporting women



Source: Field Survey, 2024

Figure 42 shows notable differences in the types of support reported by men and women. Women predominantly reported the presence of local organizations offering access to credit or microloans (**50%**) and leadership training (**16.7%**), reflecting targeted empowerment programs. Conversely, men reported greater access to climate-smart agricultural training, information on climate change and climate change workshops.

Figure 42: Type of support provided by local organizations



Source: Field Survey, 2024

4.2 Community-Level Variations

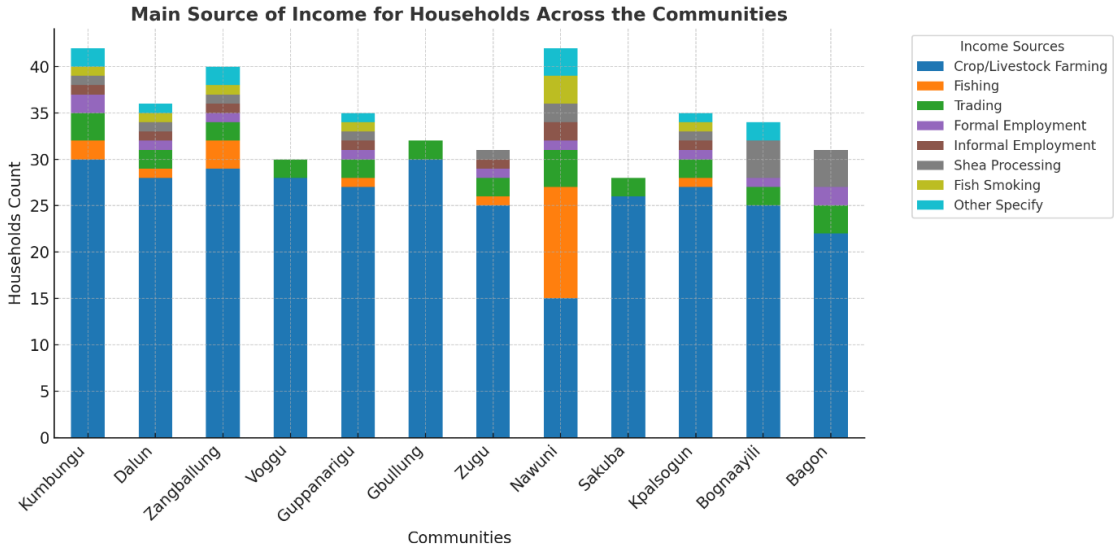
4.2.1 Economic Vulnerabilities

4.2.1.1 Income Sources, Distribution and Assets Ownership

The analysis of income sources across the 12 towns in Kumbungu District reveals significant inter-community variations (**Figure 43**). Crop and livestock farming dominate as the primary livelihood in most towns, with Gbullung (100%), Zangballung (87.9%), and Voggu (96.7%) showing almost exclusive reliance on agriculture. These communities, with limited diversification, are particularly vulnerable to climate-related hazards like droughts and floods that directly threaten their primary source of income.

Nawuni stands out as a fishing-dependent community, where 58.1% of households rely on fishing, supplemented by fish smoking (9.7%) and other related activities (19.4%). This specialization is likely tied to its proximity to water bodies but also increases susceptibility to risks such as overfishing, flooding, and water pollution. Similarly, Bognaayili demonstrates a high engagement in shea processing (34.6%), highlighting the critical role this activity plays in women's livelihoods. However, the lack of complementary income sources like trading or formal employment may limit income stability and growth potential for women in this town.

Figure 43: Main income courses for households across the surveyed communities

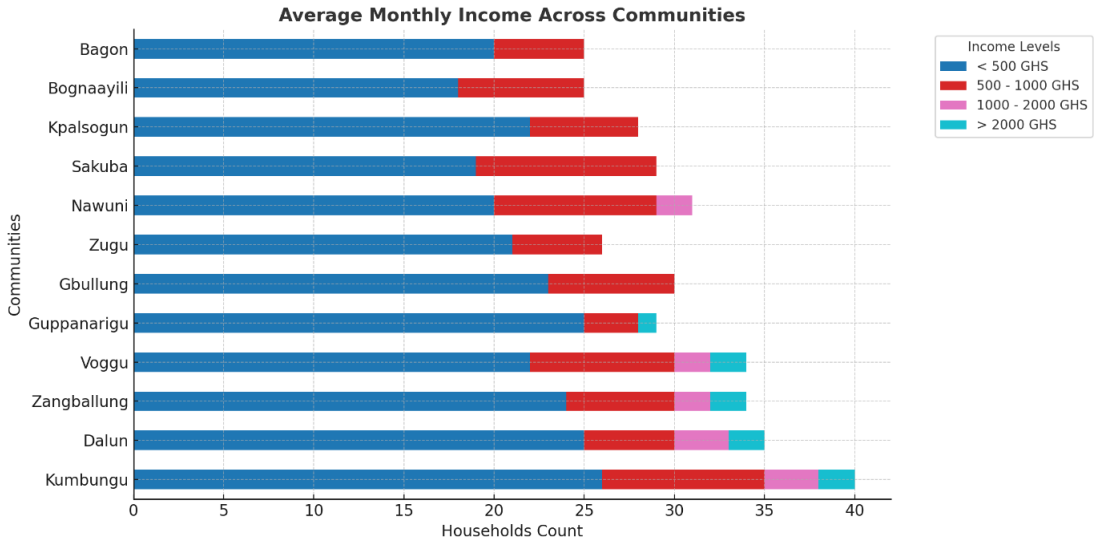


Source: Field Survey, 2024

Kumbungu and Dalun show relatively higher levels of diversification, with modest participation in formal employment (10.3% and 6.5%, respectively) and trading (7.7% and 6.5%). This diversification likely reflects better access to markets and urban opportunities, positioning these towns as potential hubs for small business growth. Conversely, towns such as Gbullung, Zugu, and Kpalsogun exhibit minimal diversification, with most households exclusively engaged in farming, making them highly susceptible to economic disruptions caused by environmental shocks.

The analysis of income brackets across towns in the Kumbungu District reveals significant disparities (**Figure 44**), with the majority of households earning less than 500 GHS per month. Towns like Guppanarigu, Zugu, and Gbullung are heavily concentrated in the lowest income bracket, highlighting their reliance on subsistence farming and limited economic diversification. In contrast, Kumbungu and Nawuni exhibit relatively higher proportions in the 500-1000 GHS range, reflecting better access to moderate income sources such as petty trading and small businesses.

Figure 44: Average monthly income from main livelihood activities

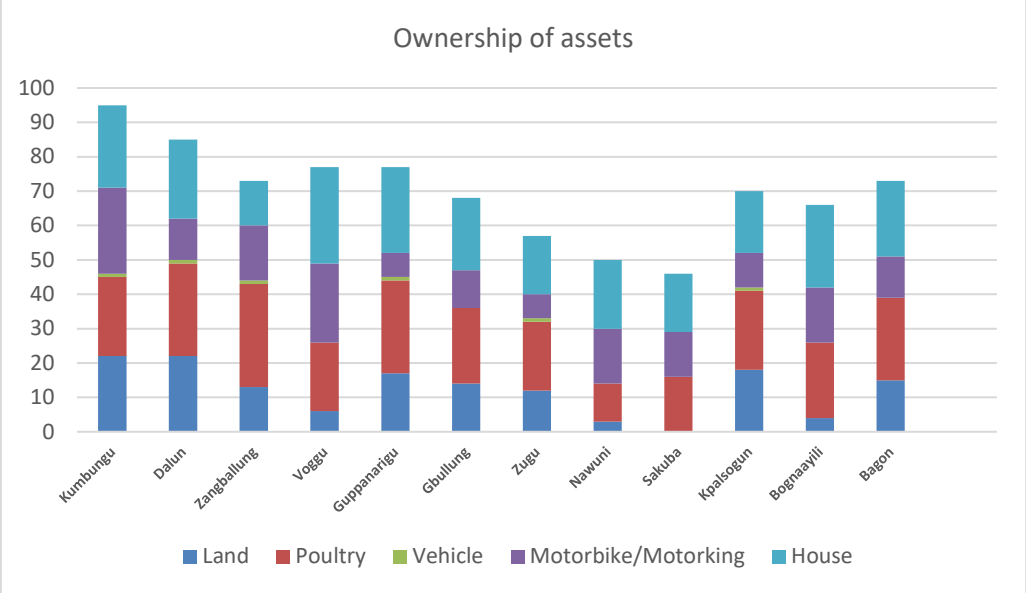


Source: Field Survey, 2024

Higher income brackets (1000-2000 GHS and above) are sparsely represented, with only a few households in towns like Kumbungu, Zangballung, and Dalun reporting earnings in these ranges. This indicates limited access to lucrative economic opportunities or formal employment. The findings suggest that economic vulnerability is widespread, with stark contrasts between towns like Zugu and Guppanarigu, which face acute poverty, and towns like Kumbungu and Nawuni, which show potential for economic growth through diversification and market access.

The analysis of asset ownership across the 12 communities in Kumbungu District reveals significant disparities that reflect differences in economic capacity, livelihood practices, and access to resources (**Figure 45**). Land ownership is highest in Kumbungu and Dalun, where all respondents reported access to land, indicating better opportunities for agricultural livelihoods. In contrast, Nawuni and Bognaayili report the lowest land ownership, likely due to land scarcity or socio-economic barriers that limit access. Similarly, poultry ownership is most prevalent in Zangballung and Dalun, where it serves as an accessible livelihood option, while Nawuni reports the lowest poultry ownership, reflecting constraints such as high costs or limited inputs.

Figure 45: Asset ownership by communities



Source: Field Survey, 2024

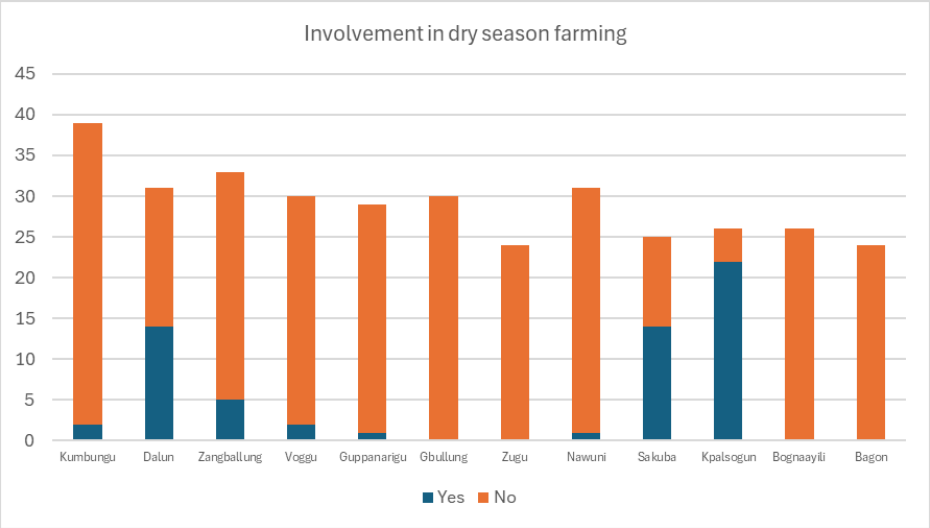
Vehicle ownership across all communities is minimal, with only six towns reporting any vehicles, emphasizing restricted mobility and limited economic resources for transportation. However, motorbike ownership is relatively higher in Kumbungu and Voggu, suggesting better mobility and access to markets, while towns like Guppanarigu and Zugu report the lowest numbers, further limiting economic opportunities. House ownership is most common in Voggu and Guppanarigu, reflecting relative stability and better access to housing, whereas Zangballung and Sakuba show lower ownership, possibly due to economic challenges or reliance on shared housing.

4.2.1.2 Dry Season Farming and Irrigation Systems

The analysis of dry season farming practices across the 12 communities in Kumbungu District reveals stark variations in engagement, with most households not participating in this activity (**Figure 46**). Overall, only 61 households reported practicing dry season farming, compared to 287 households that do not. This indicates a low overall adoption rate of dry season farming, likely due to limited access to irrigation, financial constraints, or a reliance on rain-fed agriculture.

Communities like Kpalsogun (22 households) and Sakuba (14 households) exhibit the highest participation in dry season farming, reflecting better access to resources such as water sources, equipment, or local support systems. Conversely, several communities, including Gbullung, Zugu, Bognaayili, and Bagon, report no participation in dry season farming. This absence likely highlights barriers such as lack of irrigation infrastructure, knowledge gaps, or economic limitations.

Figure 46: Households' involvement in dry season farming



Source: Field Survey, 2024

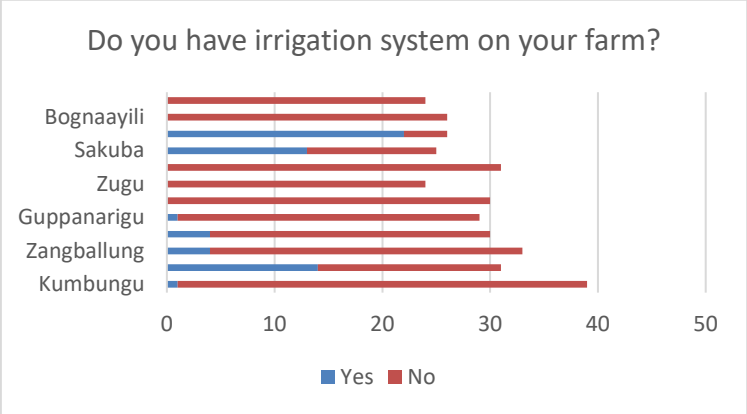
A community like Dalun shows a balanced distribution, with 14 households practicing dry season farming and 17 not participating. This indicates partial engagement, possibly driven by selective access to suitable farming conditions or local initiatives promoting off-season farming. In contrast, towns like Kumbungu, Voggu, and Guppanarigu have minimal engagement, with only one or two households practicing dry season farming, further underscoring their reliance on rain-fed agriculture.

The distribution of irrigation systems across communities reveals significant disparities (**Figure 47**), with Kpalsogun standing out as the community with the highest number of households reporting access to irrigation systems (22 households). This is likely due to its strategic location in the environs of the Botanga Dam, providing residents with access to water resources essential for irrigation. Other communities such as Dalun (14 households) and Sakuba (13 households) also reported notable levels of irrigation access, possibly reflecting efforts to engage in more water-intensive agricultural practices in certain areas.

In contrast, the majority of communities, including Gbullung, Zugu, Nawuni, Bognaayili, and Bagon, reported no access to irrigation systems, which highlights the challenges faced by these communities in enhancing agricultural productivity, particularly during the dry season. Limited infrastructure, financial constraints, or geographic isolation may explain the lack of irrigation in these areas. Similarly, in

Kumbungu, only one household reported access to irrigation, further emphasizing the uneven distribution of irrigation resources across the district.

Figure 47: Farmers access irrigation systems on their farms

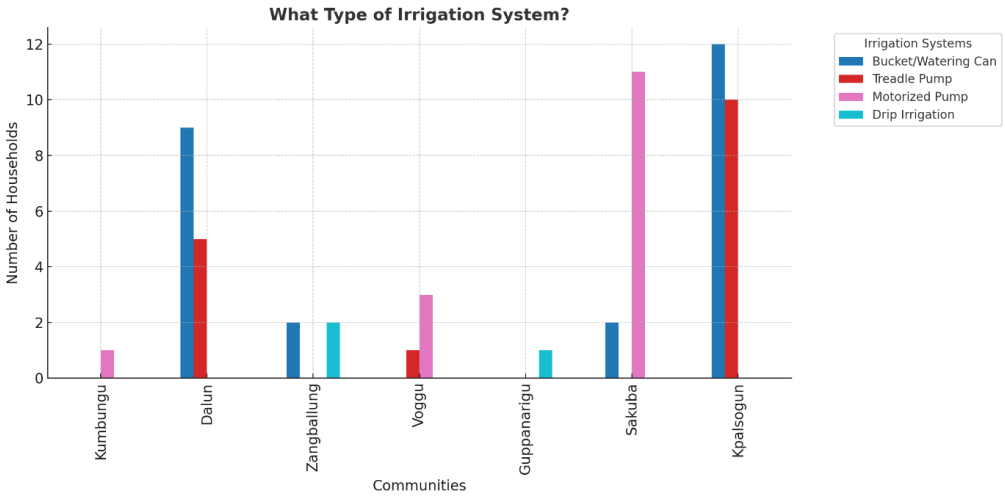


Source: Field Survey, 2024

On the type of irrigation systems used, households across the Kumbungu District reported notable variations influenced by local geographic, socio-economic, and infrastructural factors (**Figure 48**). In Kpalsogun, which is directly in the environs of the Botanga Irrigation Scheme, many households reported reliance on bucket/watering can systems (12 households) and treadle pumps (10 households). The Botanga scheme utilizes a gravity-fed canal system that delivers water to fields without the need for pumps. This accessibility may explain the widespread use of manual methods such as bucket systems in Kpalsogun, as households can easily draw water from the canals to irrigate their crops.

Households in Dalun also reported significant use of bucket/watering cans (9 households) and treadle pumps (5 households), highlighting reliance on manual irrigation systems despite being further from the Botanga scheme. This may reflect moderate availability of water resources combined with financial or technical barriers to adopting more efficient systems. In Sakuba, households predominantly reported using motorized pumps (11 households), suggesting a higher adoption of mechanized systems, likely driven by local farming needs and the absence of gravity-fed irrigation infrastructure like that at Botanga.

Figure 48: Type of irrigation system being employed by farmers in Kumbungu



Source: Field Survey, 2024

In other communities, households reported minimal adoption of advanced irrigation systems. For instance, in Voggu, three households reported using motorized pumps, while in Zangballung and Guppanarigu, a few households adopted drip irrigation systems. Kumbungu and other communities reported very limited use of mechanized or drip irrigation systems, reflecting challenges such as financial constraints, limited technical knowledge, or insufficient access to infrastructure.

Box 1: The importance of dry season farming in Kumbungu District and the need for investment in climate resilience

In the semi-arid regions of Ghana, including Kumbungu District, agriculture is predominantly rain-fed, making it highly vulnerable to climate change impacts such as erratic rainfall, prolonged droughts, and rising temperatures. The Ghana Meteorological Agency (GMet, 2022) reports that rainfall variability has increased over the past two decades, with dry spells becoming more frequent and lasting longer. This poses a severe threat to food security, incomes, and rural economies, especially for smallholder farmers who lack access to irrigation.

Dry season farming, which involves cultivating crops during the dry months using irrigation, has become an essential adaptation strategy for ensuring year-round food production, stabilizing household incomes, and enhancing resilience to climate change. However, as seen in Kumbungu District, participation remains low due to limited access to irrigation systems, financial barriers, and continued dependence on seasonal rainfall (EPA, 2020).

The Role of Dry Season Farming in Rural Livelihoods
Dry season farming extends the agricultural calendar beyond the rainy season, allowing farmers to grow food and cash crops when water availability is typically low. Research by Laube et al. (2012) on irrigation and food security in northern Ghana highlights that communities with access to irrigation experience greater food security and income stability compared to those relying solely on rainfall.

Communities like Kpalsogun and Sakuba, which report higher participation in dry season farming, benefit from diversified food production, improved household nutrition, and increased income from off-season crop sales. Dry season farming supports the cultivation of vegetables, cereals, and legumes, which boost local markets and create employment opportunities for youth and women (Asare-Nuamah & Botchway, 2021).

However, for communities with no or minimal engagement in dry season farming, such as Gbullung, Zugu, Bognaayili, and Bagon, food insecurity and economic dependency on rain-fed farming remain major challenges. According to the World Food Programme (WFP, 2021), households in northern Ghana often face extended lean seasons, during which food availability declines sharply, forcing many families to rely on food aid or migration for survival. The lack of irrigation access limits agricultural productivity, reducing opportunities for both men and women farmers, youth seeking employment, and local economies that depend on consistent food production.

Box 2: The importance of dry season farming in semi-arid Ghana and the need for investment in climate resilience

Investing in Dry Season Farming for Climate Resilience
With climate change increasing rainfall unpredictability and extending dry spells, investing in irrigation infrastructure and dry season farming initiatives is essential for building resilient agricultural communities in semi-arid Ghana. According to the FAO (2020), expanding irrigation coverage can increase crop yields by up to 400% in some dryland areas.

Investments in irrigation technologies, such as solar-powered water pumps, boreholes, and small-scale irrigation schemes, would enable more households to engage in off-season farming and reduce dependency on rain-fed agriculture. Research by Namara et al. (2011) on smallholder irrigation in sub-Saharan Africa suggests that providing smallholder farmers with affordable irrigation technologies can significantly improve agricultural output and household resilience to climate shocks.

Financial support through credit facilities, grants, and training programs would help farmers overcome economic barriers to investing in irrigation equipment, drought-resistant crops, and efficient water management techniques. Additionally, strengthening community-led agricultural cooperatives and extension services would enhance knowledge-sharing on dry season farming practices, ensuring that both smallholder and commercial farmers benefit from improved adaptation strategies (IFPRI, 2022).

Conclusion
Dry season farming is not just an agricultural practice; it is a climate adaptation necessity in semi-arid Ghana. Communities with better irrigation access, such as Kpalsogun and Sakuba, demonstrate the benefits of investment in water infrastructure, while others with limited access continue to face economic and food insecurity risks. As climate change intensifies, targeted investments in irrigation infrastructure, financial support for smallholder farmers, and knowledge-sharing initiatives will be critical to ensuring that rural households can sustainably produce food year-round and build long-term resilience (UNDP, 2023).

4.2.2 Physical Vulnerabilities

This section examines the physical vulnerabilities of communities surveyed in the Kumbungu District, focusing on their exposure and sensitivity to climate-related hazards and their impacts. Key areas discussed include exposure to floods, droughts, extreme heat, and windstorms over the past five years, and the associated impacts on households.

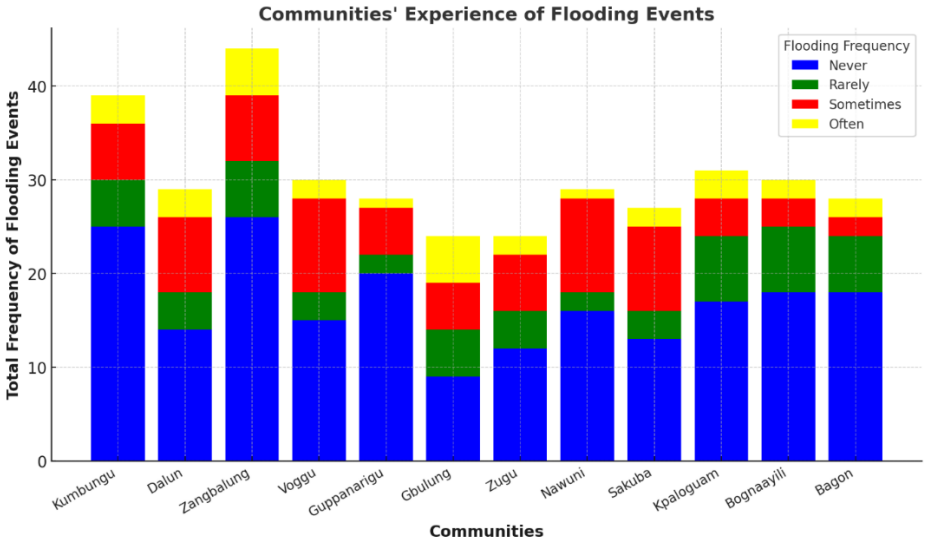
4.2.2.1 Exposure to Climate-Related Hazards and their Impacts

This section explores the exposure of communities in the Kumbungu District to key climate-related hazards, including floods, droughts, extreme heat, and other environmental risks.

(a) Flooding Events

Figure 49 illustrates the varying flooding experiences across different communities, categorized by frequency (Never, Rarely, Sometimes, and Often). Kumbungu, Zangbalung, and Bognaayili report the highest occurrences of "Never" experiencing floods, indicating less flood exposure and greater flood resilience. in these areas. In contrast, Voggu, Nawuni, and Sakuba show higher cases of “Sometimes” and “Often”, suggesting greater flood exposure and recurring risks, likely due to their proximity to water bodies or poor drainage infrastructure. Communities such as Dalun, Kpaloguam, and Bagon experience more cases of "Rarely" and "Sometimes", highlighting intermittent flooding risks that may be influenced by seasonal rainfall patterns or inadequate flood control systems. Meanwhile, Guppanarigu and Gbulung show a more balanced mix of flood experiences, meaning that while some areas remain flood-prone, others face fewer flood-related disruptions.

Figure 49: Communities experience of floods in the Kumbungu District



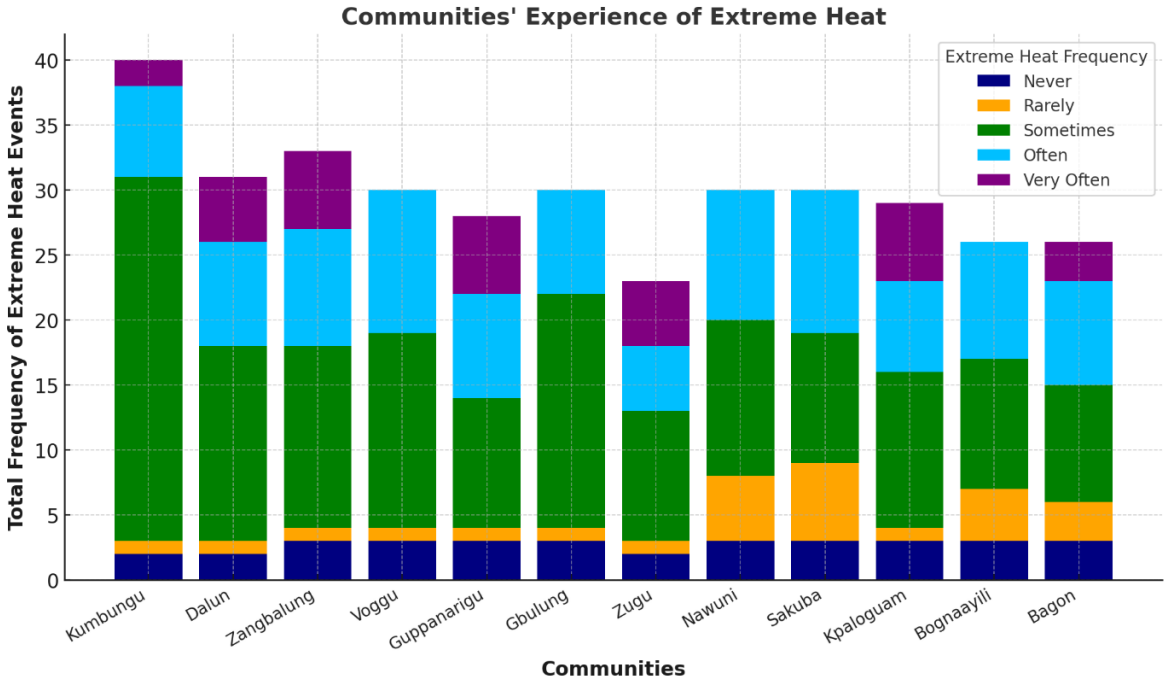
Source: Field Survey, 2024

(b) Extreme Heat

Households across these communities are feeling the intense heat (**Figure 50**). Kumbungu, Voggu, and Nawuni report the highest occurrences of "Often" and "Sometimes" experiencing extreme heat, indicating that these communities are more frequently exposed to high temperatures and prolonged heat waves. This could be due to limited vegetation cover, exposure to direct sunlight, or geographical positioning that makes them more vulnerable to extreme heat conditions.

In contrast, Dalun, Zangbalung, and Kpaloguam show a significant proportion of "Very Often" cases, suggesting that extreme heat events are not only common but also persistent in these areas. Communities like Sakuba, Guppanarigu, and Bognaayili exhibit a more mixed distribution, meaning some areas experience heat frequently, while others have relatively fewer occurrences. Zugu and Bagon, on the other hand, show relatively lower occurrences of extreme heat compared to other communities, although they still experience noticeable heat waves.

Figure 50: Communities experience extreme heat in the Kumbungu District

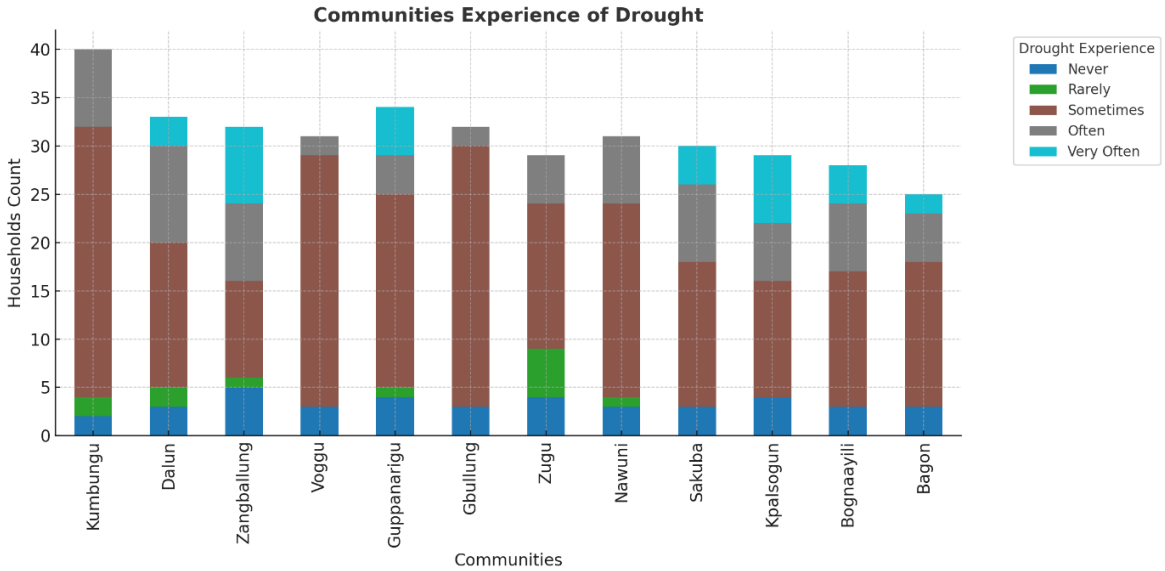


Source: Field Survey, 2024

(c) Droughts

Drought is a pervasive challenge across communities in the Kumbungu District, with households reporting a range of experiences. It's clear that drought affects everyone to some degree, but some areas are more frequently impacted than others (**Figure 51**). Kpalsogun, Sakuba, and Nawuni stand out as particularly vulnerable, with residents reporting “Often” and “Very Often” occurrences of drought. Interestingly, while drought is widespread, some communities like Zangballung, Voggu, and Guppanarigu report a lower frequency of drought events.

Figure 51: Communities experience of drought in the past 5 years



Source: Field Survey, 2024

4.2.3 Social Vulnerabilities

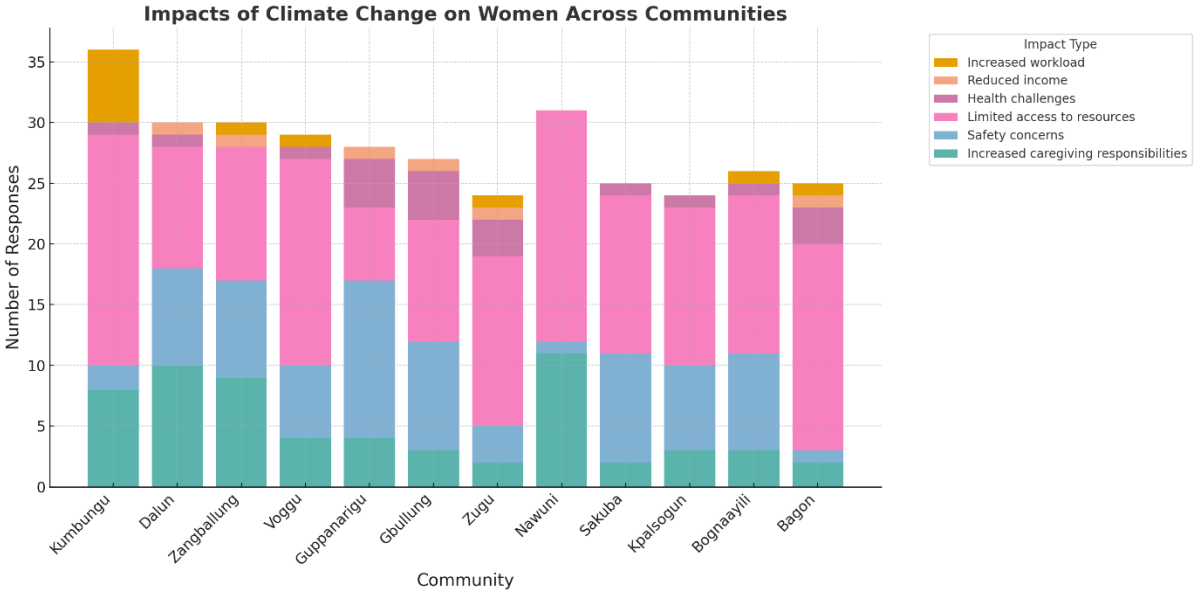
Social vulnerabilities in communities in the Kumbungu District significantly shape the impacts of climate change and the capacity to respond effectively. This section explores key aspects of social vulnerabilities, including the role of gender in decision-making, the specific impacts of climate change on women, barriers to accessing essential resources, and the adaptive capacity of communities supported by social networks.

4.2.3.1 Impact of Climate Change on Women

Figure 52 highlights the diverse impacts of climate change on women across communities in the Kumbungu District. Increased workload, reduced income, and health problems emerge as the most prevalent impacts, with consistently high responses across all communities. For example, Kumbungu, Dalun, and Nawuni report the highest levels of increased workload, reduced income, and health issues, reflecting the compounded vulnerabilities faced by women in these areas. Limited access to resources is another significant challenge, particularly in communities like Nawuni, Kumbungu, and Gbullung, where women reported struggling to access critical resources necessary for daily livelihoods.

Safety concerns are less frequently reported but are notably higher in Nawuni, Dalun, and Kpalsogun compared to other communities, indicating localized threats to women's well-being and security. Increased caregiving responsibilities, while less reported overall, are most pronounced in Guppanarigu, Dalun, and Zugu, suggesting that women in these communities are disproportionately burdened with additional household and caregiving duties due to climate-related stressors.

Figure 52: Climate change impact on women in Kumbungu District



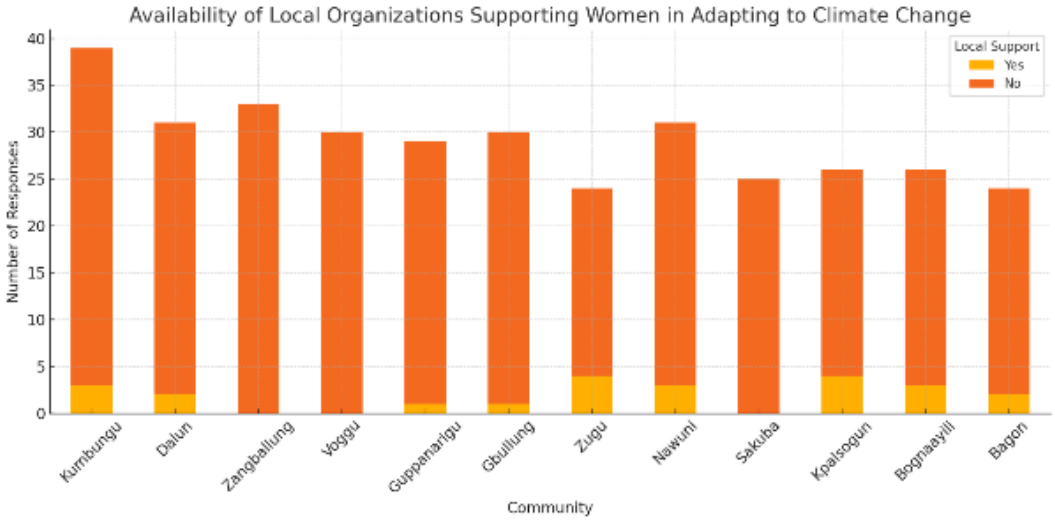
Source: Field Survey, 2024

4.2.3.2 Availability of Local Organizations or Groups that Support Women in Adapting to Climate Change

Figure 53 reveals the limited presence of local organizations or groups supporting women in adapting to climate change across the communities in Kumbungu District. The majority of respondents across all communities reported the absence of such organizations, with "No" responses overwhelmingly dominating in most areas. Communities like Zangballung, Voggu, Guppanarigu, and Sakuba reported no significant presence of local support groups, with nearly all respondents indicating "No." Similarly, Kumbungu, Dalun, and Gbullung also show a lack of support, though a small proportion of respondents acknowledged the presence of some local organizations.

On the other hand, Zugu and Kpalsogun stand out slightly, with relatively higher "Yes" responses, indicating better access to local support organizations. However, even in these communities, the majority of respondents still indicated a lack of support.

Figure 53: Availability of local organizations supporting women in adapting to climate change



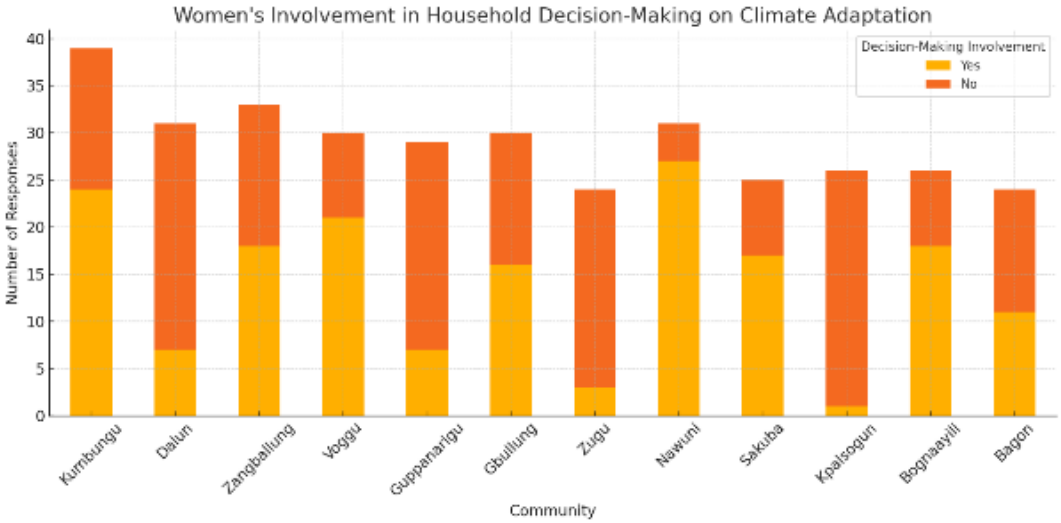
Source: Field Survey, 2024

4.2.3.3 Women's Involvement in Household Decision-Making on Climate Adaptation

Figure 54 reveals varying levels of women's involvement in household decision-making on climate adaptation across different communities in the Kumbungu District. Communities such as Nawuni, Voggu, and Kumbungu report the highest levels of involvement, with a majority of households indicating that women are engaged in decision-making. For instance, Nawuni stands out, where 27 households reported women's, participation compared to only 4 indicating otherwise.

Conversely, communities such as Dalun, Guppanarigu, and Zugu report notably low involvement, with the majority of households indicating that women are not part of decision-making processes. For example, in Dalun, only 7 households involve women in climate-related decisions, while 24 do not. Similarly, in Kpalsogun, there is an even starker disparity, with only 1 household indicating women's involvement against 25 reporting no involvement.

Figure 54: Women's involvement in household decision-making on climate adaptation



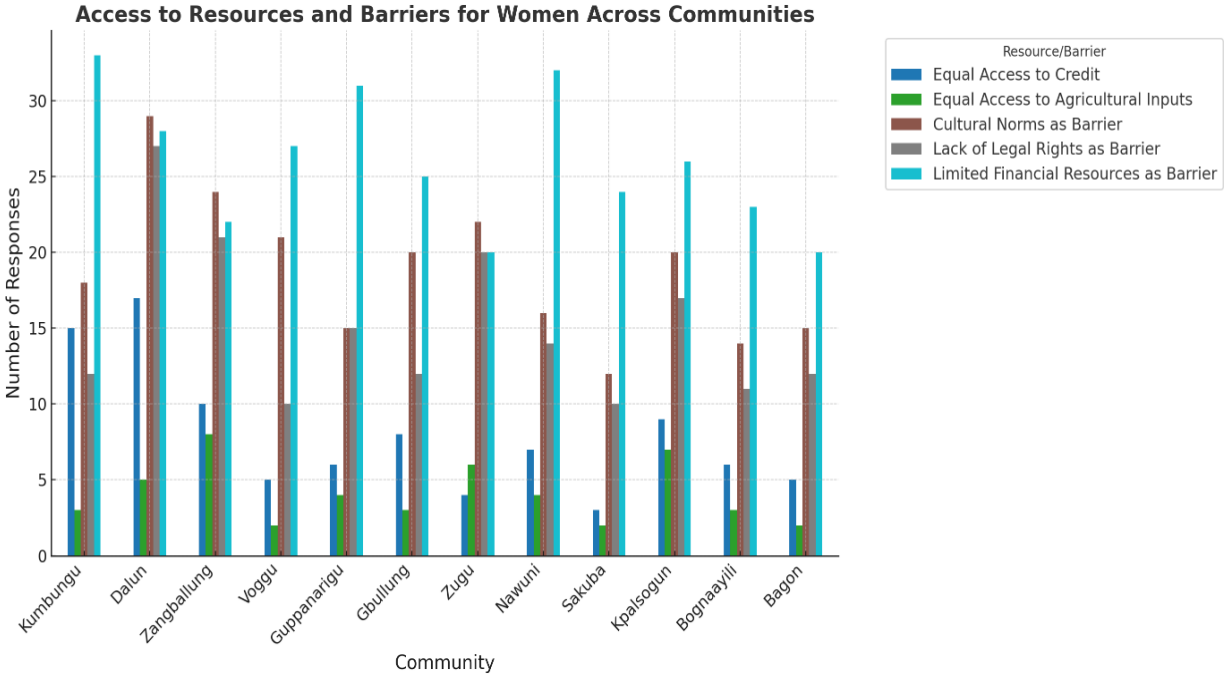
Source: Field Survey, 2024

4.2.3.4 Women's Access to Resources and Barriers for Women Across Various Communities

Figure 55 highlights significant disparities in women's access to resources and barriers across communities in the Kumbungu District.

- **Limited financial resources** emerge as the most prominent barrier, with an overwhelming majority of respondents across communities citing it as a key obstacle to resource access. Communities such as Nawuni, Kumbungu, Voggu, and Sakuba report particularly high levels of financial constraints, underscoring the need for targeted financial support and empowerment programs.
- **Cultural norms and traditions** are another significant barrier, especially in communities like Dalun, Guppanarigu, Zangballung, and Kpalsogun, where the majority of respondents acknowledge that social traditions limit women's access to critical resources. This highlights the role of entrenched societal structures in perpetuating gender disparities.
- **Lack of legal rights** also poses a substantial challenge, with Dalun, Zangballung, and Kpalsogun reporting the highest responses for this barrier. These findings suggest the need for legal reforms and awareness campaigns to promote equitable access to resources for women.
- In terms of access to specific resources, despite women reporting the presence of local organizations offering access to credit and agricultural inputs, the chart reveals that women still have limited **access to credit** and **agricultural inputs** across most communities. Communities like Voggu, Nawuni, Guppanarigu, and Sakuba report particularly low access to credit, which directly hampers their ability to adapt to climate change. Similarly, Nawuni, Voggu, and Guppanarigu show very low levels of access to agricultural inputs such as seeds and fertilizers, further exacerbating their vulnerability.

Figure 55: Access to resources and barriers for women



Source: Field Survey, 2024

4.2.4 Summary of Vulnerabilities

Communities in the Kumbungu District area face multi-dimensional vulnerabilities that impact their economic stability, physical environment, and social well-being. These vulnerabilities are shaped by climate-induced hazards, resource constraints, and socio-cultural factors, creating complex challenges for different populations.

- **Economically**, most communities rely on rain-fed agriculture and informal trade, leaving them highly susceptible to climate variability. Limited access to credit, farming tools, and alternative income sources exacerbates financial instability, particularly for women, youth, and smallholder farmers. Seasonal migration is common in most areas as a coping mechanism, but it often disrupts local labor markets.
- **Physically**, communities experience flooding, windstorms, soil erosion, and prolonged dry spells, leading to crop failures, infrastructure damage, and water shortages. Poor drainage systems in flood-prone areas, reliance on local materials for housing, and land degradation further increase exposure to environmental shocks.
- **Socially**, gender disparities and cultural norms limit access to land, financial services, and decision-making power for marginalized groups, especially women and youth. Many communities struggle with education gaps, skill shortages, and inadequate institutional support, which hinder adaptive capacity and long-term resilience.

Table 5 provides a community-specific breakdown of these vulnerabilities, highlighting the unique challenges each locality faces and the intersection of economic, physical, and social risks across the district.

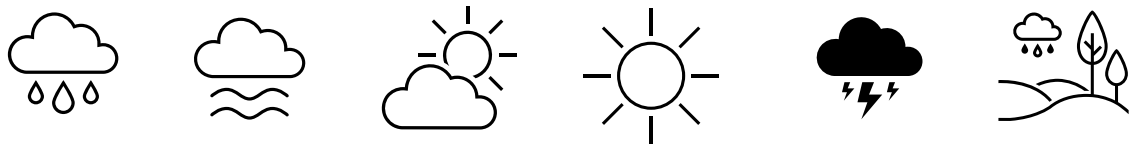
Table 5: Summary of community vulnerability findings from focus group discussions and key informant interviews

Community	Key Vulnerability Issues Observed Across Communities		
	Economic Issues	**Physical Issues**	**Social Issues**
Dalun	• Dependency on rain-fed agriculture. • Lack of credit for women's trade.	• Frequent flooding. • Poor drainage exacerbates impacts.	Exclusion of women from land and farming decisions.
Zugu	• Soil fertility decline; limited financial resources.	• Flooding disrupts farming and damages infrastructure.	• Dual caregiving and farming burden limits women's participation.
Nawuni	• Drought-driven migration. • Women manage small-scale farming.	• Soil erosion damages fertile lands; prolonged dry spells. • Flooding destroys infrastructure.	• Caregiving and farming burden on women. • Male-dominated decisions. • Migrant alienation.
Bagon	• High farming input costs. • Reliance on seasonal migration.	• Windstorms damage homes and farms • Reliance on local materials.	• Lack of education affects women's participation and youth opportunities.
Saakuba	• Reliance on VSLAs. • Barriers to training and tools.	• Prolonged dry spells deplete water resources.	• Caregiving responsibilities limit adaptation. • Poor access to financial tools.
Gbullung	• Reliance on VSLAs. • Poor access to farming tools and training.	• Water scarcity • Reliance on shallow wells.	• Water collection burden affects economic participation of women.
Zangballung	• Declining shea productivity. • Water scarcity for processing.	• Water scarcity for processing • Windstorm damage to structures.	• Limited control over resources hinders adaptation for women.
Bognaayili	• High costs and degraded farmland. • Disruption from seasonal labor migration.	• Windstorms frequently damage local homes. • Limited repair options.	• Lack of education and skill training programs for women and youth.
Guppanarigu	• Land access constraints • Limited income diversification.	• Recurrent erosion and windstorms disrupt farming activities.	• Cultural norms restrict resource access. • Limited formal support for women.

Source: Household Survey, Focus Group Discussions, KII interviews

4.3 Projected Climate Trends and Implications on Vulnerability

This section examines projected climate trends in the Kumbungu District and their implications for gendered vulnerabilities and community resilience. Changes in rainfall patterns, precipitation variability, and rising temperatures under different emission scenarios are analyzed to understand their impact on households and communities. This understanding is essential for developing gender-sensitive and inclusive adaptation strategies that address the unique challenges faced by women and marginalized groups while strengthening overall community resilience to climate change.



4.3.1 Projected Climate Trends

To evaluate climate extremes, the methodology employed ETCCDI metrics for precipitation and temperature. For precipitation, the study calculated indices such as the maximum 1-day precipitation (Rx1day), maximum 5-day precipitation (Rx5day), consecutive dry days (CDD), consecutive wet days (CWD), and total rainfall above the 95th percentile (R95p). For temperature, indices include the maximum daily maximum temperature (TXx), maximum daily minimum temperature (TNx), minimum daily maximum temperature (TXn), and minimum daily minimum temperature (TNn). These indices provide insights into rainfall intensity, drought duration, and temperature variability.

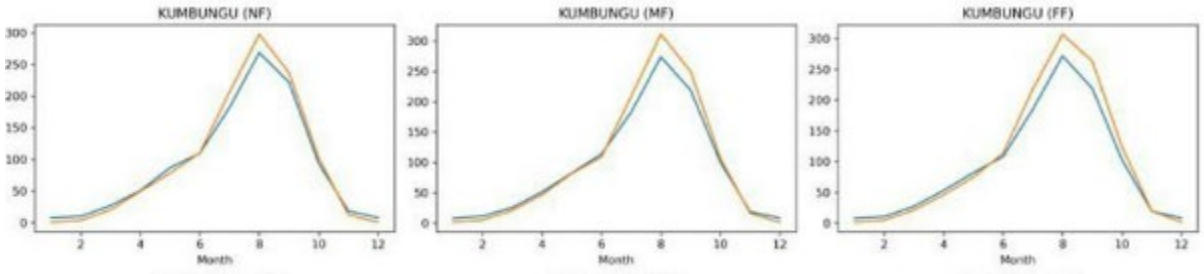
4.3.1.1 Precipitation

Projected Rainfall Patterns and Climate Scenarios

Figure 56 illustrates the projected monthly rainfall climatology for Kumbungu District across three future timeframes: Near-Future (NF), Mid-Future (MF), and Far-Future (FF). Each graph compares two emission scenarios: SSP2-4.5 (moderate emissions, blue lines) and SSP5-8.5 (high emissions, orange lines).

Across all three timeframes, the graphs **maintain a unimodal rainfall pattern**, characteristic of the Northern Region of Ghana. Rainfall peaks between June and August, coinciding with the region's traditional rainy season. This consistency in seasonal timing suggests that agricultural planning and water resource management can still align with historical cycles. However, the intensity of rainfall during the peak months varies significantly between the scenarios, particularly in the mid- and far-future periods.

Figure 56: Projected monthly rainfall climatology for Kumbungu District under SSP2-4.5 and SSP5-8.5 scenarios: near-future, mid-future, and far-future



In the Near-Future (NF), rainfall patterns under SSP2-4.5 and SSP5-8.5 are relatively similar, with peak rainfall occurring in July and August. However, as the projections advance to the **Mid-Future (MF) and Far-Future** (FF), the SSP5-8.5 scenario shows increasingly higher rainfall intensities during the rainy season compared to SSP2-4.5. This trend highlights the impact of higher greenhouse gas emissions on rainfall variability.

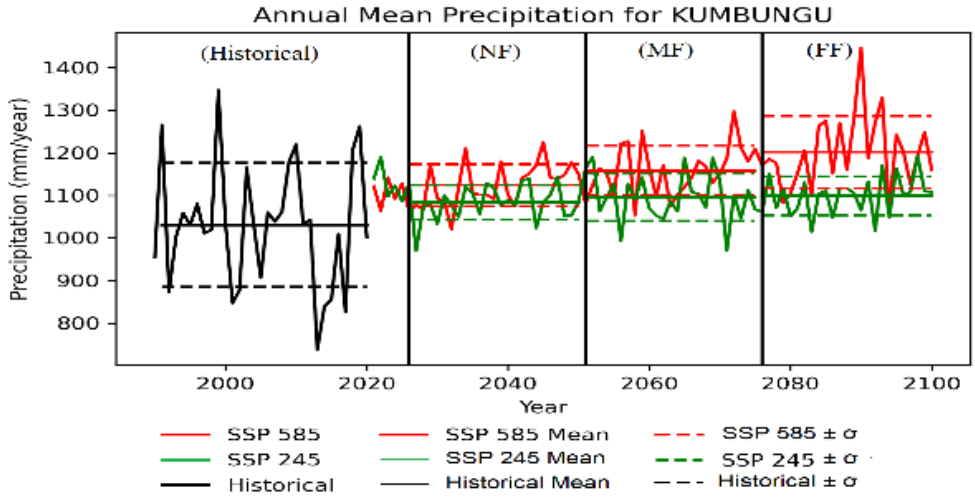
By the Far-Future (FF), SSP5-8.5 predicts substantially higher peak rainfall totals, potentially indicating an increased risk of flooding and associated challenges for infrastructure, agriculture, and water management.

Long-Term Trends and Variability in Annual Mean Precipitation

The analysis of annual total precipitation in the Kumbungu District shows historical patterns with significant interannual variability (750 mm - 1350 mm). The projection period shows an increasing pattern in precipitation amount, especially under SSP 5-8.5. Within the near future (NF: ~2020–2040), the SSP 5-8.5 scenario (red) projects marginally higher precipitation climatology compared to SSP 2-4.5 (green), which slightly widens towards the end of the century (**Figure 57**), highlighting more wetness towards the end-of-the-century.

Under SSP 2-4.5, precipitation remains relatively stable across the projection periods, with lower variability and only marginal increase in the rainfall climatology from the near-future to mid-future period.

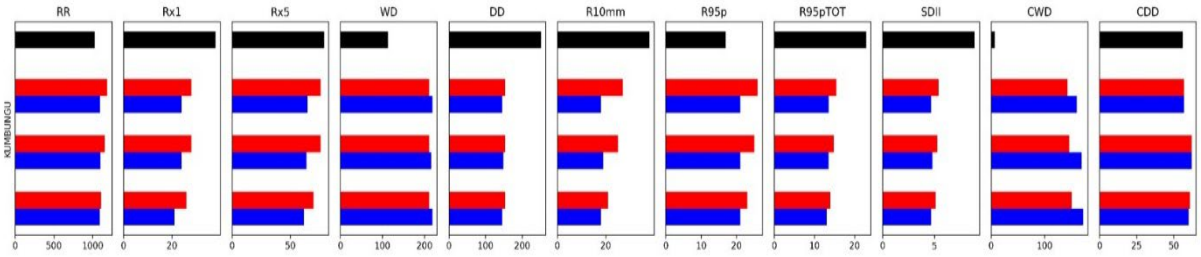
Figure 57: Historical and projected mean precipitation patterns under SSP 5-8.5 and SSP 2-4.5 scenarios for Kumbungu



The climate indices for Kumbungu District (**Figure 58**) project an increase in RR and decline in Rx1 and Rx5 events, the frequency of dry days, moderate rainfall days (R10mm), very wet days' contribution to total precipitation (R95pTOT), and the Simple daily intensity index (SDII).

The indices from Kumbungu show that despite fewer increases in very heavy precipitation events within the district, the respective increments are appreciable. The Kumbungu District is projected to be wetter than its historical phase, however, the wetter conditions are intensified under the moderate scenario (SSP 2-4.5). On the contrary, consecutive wet days are higher under SSP 5-8.5, potentially indicating risks of flooding and waterlogging. These trends indicate a potential increase in the intensity and frequency of extreme and moderate rainfall events and marginally prolonged dry periods.

Figure 58: Climate indices for Kumbungu District



4.3.1.2 Projected Mean Temperature Trends

Figure 59 the historical and projected mean temperature patterns for the Kumbungu District under two emission scenarios: SSP5-8.5 (high emissions) and SSP2-4.5 (moderate emissions), covering three time periods—Near-Future (NF: 2020–2040), Mid-Future (MF: 2041–2060), and Far-Future (FF: 2081–2100). Historically, the district's mean temperature remained relatively stable at approximately 29°C, with moderate interannual variability, as indicated by the standard deviation bands.

In the Near-Future, **both scenarios show an initial increase in mean temperatures compared to historical levels**. Under SSP5-8.5, temperatures rise to around 30.5°C by the end of this period, while SSP2-4.5 projects a more moderate increase to about 30°C. **By the Mid-Future, the differences between the two scenarios become more pronounced.** The SSP5-8.5 scenario projects a steep rise in temperatures, reaching approximately 32°C, while SSP2-4.5 shows a more gradual increase to around 31°C**. In the Far-Future, the SSP5-8.5 scenario exhibits significant warming, with mean temperatures peaking at approximately 34°C by 2100**, accompanied by increased variability, indicating a heightened risk of extreme heat events. Conversely, under SSP2-4.5, the temperature stabilizes at around 32°C, with less variability, reflecting the potential benefits of emission mitigation efforts.

Figure 59: Projected mean temperature trends for Kumbungu District under SSP5-8.5 and SSP2-4.5 scenarios

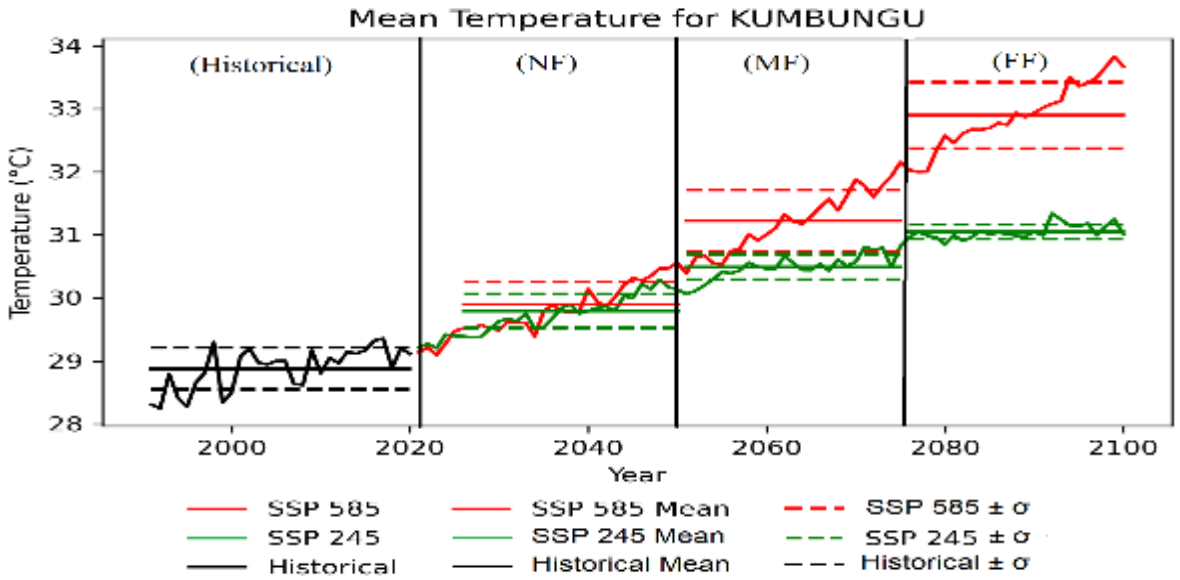


Table 6: Summary of projected climate trends in Kumbungu District

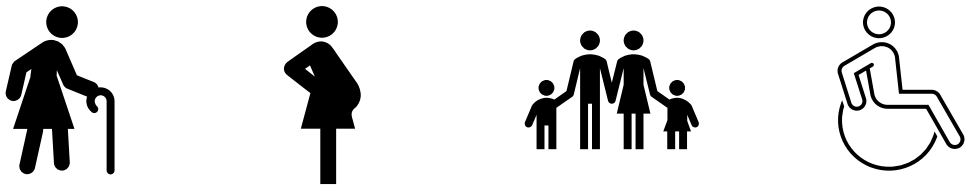
Climate Variable	Key Findings	Implications
Rainfall Patterns	• Unimodal pattern with rainfall peaking in June-August. • Increased intensity under SSP5-8.5, particularly in Mid- and Far-Future.	• Increased risk of flooding and infrastructure damage. • Potential disruptions to agricultural and water management practices.
Annual Precipitation	• Annual precipitation increases under SSP5-8.5 with higher variability. • SSP2-4.5 shows stable trends with marginal increases.	• Greater rainfall variability demands enhanced water storage, flood management, and soil conservation strategies.

Climate Variable	Key Findings	Implications
Rainfall Extremes	• Moderate rainfall days (R10mm) and very wet days (R95pTOT) increase. • Fewer extreme events (Rx1, Rx5). • Consecutive wet days higher under SSP5-8.5, raising flooding risks.	• Increased risk of waterlogging and flooding. • Potential challenges for agriculture and infrastructure resilience.
Mean Temperature	• Temperatures rise steadily under both scenarios, with SSP5-8.5 reaching ~34Â°C by 2100, while SSP2-4.5 stabilizes at ~32Â°C.	• Intensified heat stress under SSP5-8.5 impacts agriculture, water resources, and human health. • Underscores the need for emission reductions.

4.3.2 Projected Climate Change Trends, Gender and Vulnerable Group Vulnerability

This section examines the implications of projected climate trends on existing gender and other vulnerabilities within Kumbungu District. The aim is to understand how the anticipated changes in temperature, rainfall patterns, and extreme weather events will disproportionately affect men, women, youth, and migrants.

The findings presented in this section are based on current vulnerabilities identified through focus group discussions, field observations, and household surveys. These existing challenges have been analyzed and envisioned in the context of projected climate scenarios to assess how they may evolve in the future. This approach allows for a deeper understanding of how climate change will intensify inequalities and further marginalize vulnerable groups in the district.



4.3.2.1 Livelihoods and Economic Changes

The livelihoods of communities in Kumbungu District are predominantly reliant on rain-fed agriculture, small-scale trading, and natural resource-based activities such as shea processing. Projected climate changes, including erratic rainfall, prolonged droughts, and rising temperatures, pose significant threats to these economic activities. Women, men, youth, and migrants experience these impacts differently due to their distinct roles in livelihood activities, with women and migrants often facing greater challenges due to systemic barriers. **Table 7** summarizes these gendered and group-specific impacts across the communities, linking them to specific climate stressors.

Table 7: Projected impacts of changing climate on livelihoods and economic activities stratified by gender and vulnerable groups

Community	Climate Change	Gender and Vulnerable Groups						
		Women	**Men**	**Youth**	**Migrants**	**Elderly**	**Pregnant Women**	**PWDs**
Dalun	Erratic rainfall, floods	Reduced shea processing income as flooding damages nuts and market access.	Crop yield loss due to waterlogging.	Migration due to limited agricultural jobs.	Displacement during floods reduces income opportunities.	Increased difficulty accessing markets and essential services due to poor infrastructure.	Higher risk of malnutrition and waterborne diseases from flooding.	Mobility challenges increase reliance on caregivers during floods.
Zugu	Prolonged droughts, water scarcity	Declining income from shea and rice processing due to water shortages.	Lower productivity in livestock farming.	School dropouts as youth take on farming and caregiving roles.	Excluded from community recovery resources.	Water shortages limit household resilience and food security.	Increased health risks due to heat stress and water scarcity.	Difficulty accessing clean water and adaptive farming programs.
Nawuni	Intense floods, soil erosion	Crop failures increase debt for small-scale female farmers.	Disruption of fishing activities and farming.	Increased malnutrition risk from declining yields.	Severe disruptions in fishing livelihoods.	Loss of traditional farming knowledge as older farmers struggle to cope with soil erosion.	Higher risk of pregnancy complications due to poor healthcare access in flood-affected areas.	Lack of inclusion in disaster response plans worsens livelihood security.
Saakuba	Rising temperatures, prolonged droughts	Reduced shea processing due to heat stress and vegetation loss.	Challenges in livestock farming due to reduced pasture.	Limited off-farm livelihood opportunities.	Seasonal labor opportunities disrupted.	Heat stress makes traditional farming harder, increasing dependency on family support.	Extreme heat increases pregnancy complications and dehydration risks.	Limited employment and accessibility to alternative economic activities.

Community	Climate Change	Gender and Vulnerable Groups						
		Women	Men	Youth	Migrants	Elderly	Pregnant Women	PWDs
Zangballung	Erratic rainfall, soil erosion	Shea income declines as rains fail during flowering periods.	Crop failures due to poor water retention in degraded soils.	Migration to urban areas for work.	Exclusion from adaptive land management practices.	Traditional farming techniques become unsustainable, leading to food insecurity.	Increased burden on pregnant women for water and fuelwood collection.	Difficulty in engaging with climate adaptation training due to physical challenges.
Bognaayili	Erratic rainfall, heatwaves	Shea processing and trade decline due to poor yields and heat stress.	Crop productivity falls due to water shortages.	Migration as agriculture becomes less viable.	Limited inclusion in economic recovery plans.	Elderly struggle with increasing dependency due to economic strain.	Greater vulnerability to malnutrition and pregnancy-related health issues.	Exclusion from skill training programs worsens economic marginalization.
Gbullung	Flooding, rising temperatures	Reduced trade income due to damaged roads.	Economic strain from reduced crop yields.	Increased dropout rates to contribute to household incomes.	Exclusion from climate adaptation programs.	Increased isolation as floods limit access to medical and social services.	Higher exposure to infectious diseases from stagnant floodwaters.	Difficulty accessing disaster relief centers and agricultural extension support.
Voggu	Prolonged droughts, deforestation	Firewood trade affected by deforestation; water shortages disrupt farming.	Lower crop and livestock yields from heat stress.	Loss of educational opportunities due to migration.	Higher exposure to economic shocks.	Increased difficulty in securing water and food as drought intensifies.	Heat stress and water scarcity increase pregnancy-related risks.	Lack of mobility limits adaptation options and livelihood opportunities.
Kumbungu	Intense rainfall, prolonged dry spells	Trade and farming constrained by market disruptions from flooding.	Limited adaptive capacity due to resource strain.	Outmigration due to declining farming opportunities.	Exclusion from formal recovery programs.	Increased dependency on family members for food and shelter during extreme weather events.	Flooding limits access to maternal healthcare and essential services.	Poor infrastructure makes it harder for PWDs to access economic activities.

Community	Climate Change	Gender and Vulnerable Groups						
		Women	**Men**	**Youth**	**Migrants**	**Elderly**	**Pregnant Women**	**PWDs**
Guppanarigu	Soil erosion, water scarcity	Decline in shea processing income from reduced nut availability.	Crop losses due to lack of irrigation systems.	Limited skills training to diversify livelihoods.	Excluded from adaptive resource planning.	Elderly farmers struggle with soil degradation and lack of irrigation.	Increased burden of fetching water and food preparation due to shortages.	Poor road conditions limit access to support programs.
Kpalsogun	Erratic rainfall, heatwaves	Reduced market access for processed goods.	Yield losses from pest outbreaks linked to climate changes.	Youth disengagement from farming due to low returns.	Excluded from resilience-building initiatives.	Heat stress increases health complications for the elderly.	Greater risk of pregnancy complications from dehydration and extreme heat.	Limited financial inclusion in village savings programs.
Bagon	Seasonal migration, erratic rainfall	Disruptions in women-led farming initiatives from erratic rainfall.	Reduced profitability in crop and livestock farming.	Migration to cities for alternative livelihoods.	Marginalized in host communities.	Increasing difficulty in adapting to seasonal changes due to physical strain.	Higher risk of food shortages and stress-related health issues.	Displacement during migration further marginalizes PWDs.

Source: Household Survey, Focus Group Discussions, KII interviews, Climate Projections

4.3.2.2 Access to Resources

Table 8 highlights disparities in access to critical resources such as land, credit, agricultural inputs, and extension services across different groups in Kumbungu District. Climate-induced stressors like erratic rainfall, prolonged droughts, and flooding could further exacerbate exclusion and resource competition, disproportionately affecting marginalized groups.

Women and youth face significant barriers to credit, land tenure security, and irrigation systems, limiting their ability to adapt to changing climate conditions. Migrants are frequently excluded from resource-sharing programs, making it harder for them to recover from climate shocks. Elderly individuals struggle with declining land productivity and reduced mobility, which limits their participation in modern adaptation initiatives. Pregnant women are particularly vulnerable to food and water shortages, increasing health risks during climate crises. PWDs remain largely excluded from agricultural and financial support systems, further deepening their economic marginalization.

Table 8: Projected impacts of changing climate on access to resources stratified by gender and vulnerable groups

Community	Climate Change	Gender and Vulnerable Groups						
		Women	Men	Youth	Migrants	Elderly	Pregnant Women	PWDs
Dalun	Erratic rainfall, soil degradation	Limited credit access for shea and farming inputs.	Limited availability of adaptive tools.	Excluded from key resource-sharing systems.	Marginalized in resource allocation.	Increasing dependency on family for resources.	Limited access to maternal health support in times of drought.	Poor infrastructure prevents access to agricultural inputs.
Zugu	Prolonged droughts	Barriers to credit for expanding trade.	Limited adaptive farming resources.	Excluded from irrigation programs.	Poor inclusion in community resource management.	Increasing reliance on family support due to loss of traditional livelihoods.	Higher exposure to dehydration and food insecurity.	Inaccessible irrigation and adaptation training services.
Nawuni	Intense rainfall, soil erosion	Reliance on informal land arrangements; limited access to credit.	Better access to irrigation and recovery tools.	Limited role in resource distribution decisions.	Excluded from flood recovery programs.	Struggle with accessing productive farmlands due to soil erosion.	High vulnerability to waterborne diseases due to poor access to clean water.	Disaster recovery programs lack provisions for PWDs.
Saakuba	Prolonged droughts, heat stress	Barriers to accessing irrigation systems and agricultural inputs.	Limited capacity to invest in adaptive resources.	Limited access to tools for farming.	Insecure land tenure during adaptation planning.	Water shortages increase difficulty in sustaining small-scale farming.	Increased health risks from heat exposure and water scarcity.	Lack of accessible pathways to water and agricultural sites.
Zangballung	Erratic rainfall, soil erosion	Poor access to irrigation tools for shea and farming activities.	Better access to communal farming tools.	Excluded from access to modern agricultural systems.	Excluded from formal recovery support.	Older farmers struggle to adapt to new water-saving techniques.	Increased workload fetching water and firewood.	Limited consideration in adaptive land-use policies.
Bognaayili	Prolonged droughts, limited rainfall	Limited access to credit for agricultural tools.	Declining communal resource availability.	Excluded from community irrigation systems.	Limited inclusion in communal resources.	Struggle to adapt to water conservation methods.	Higher risk of food insecurity as food production declines.	Inadequate support for PWDs in agricultural training programs.

Community	Climate Change	Gender and Vulnerable Groups						
		Women	Men	Youth	Migrants	Elderly	Pregnant Women	PWDs
Gbullung	Frequent flooding, rising temperatures	Poor access to credit for trade recovery.	Access to flood recovery tools but limited by costs.	Excluded from recovery resources targeting youth.	Excluded from institutional adaptation systems.	Increased isolation as roads become impassable after floods.	High risk of maternal health complications due to displacement.	Limited ability to evacuate during flooding.
Voggu	Prolonged droughts, deforestation	Restricted access to markets and inputs.	Strain from limited irrigation tools.	Excluded from resource-sharing systems.	Poor integration into adaptation planning.	Reliance on unsustainable firewood collection methods.	Increased workload due to household labor strain.	Lack of access to assistive technology for farming.
Kumbungu	Intense flooding, erratic rainfall	Limited financial access for trade expansion.	Better access to resources but competition increases.	Excluded from decision-making on resource allocation.	Marginalized during flood recovery planning.	Difficulty accessing financial services for rebuilding after floods.	High risk of pregnancy-related illnesses due to poor water and sanitation.	Flood recovery programs often fail to accommodate mobility needs.
Guppanarigu	Soil erosion, water shortages	Limited access to land and farming resources.	Access to shared tools but constrained by costs.	Excluded from irrigation and modern inputs.	Excluded from land-sharing agreements.	Elderly farmers struggle with reduced land productivity.	High risk of undernutrition due to food production decline.	No targeted financial or agricultural inclusion programs.
Kpalsogun	Erratic rainfall, prolonged dry spells	Limited access to improved seeds and fertilizers.	Strain from resource competition during droughts.	Excluded from irrigation projects.	Poor inclusion in land recovery initiatives.	Water shortages impact elderly farmers' resilience.	Extreme heat increases health risks for pregnant women.	Poor accessibility in communal farming and irrigation infrastructure.
Bagon	Seasonal migration, erratic rainfall	Poor access to resources due to migration disruptions.	Better access to inputs but constrained by drought stress.	Excluded from agricultural support systems.	Excluded from resource-sharing initiatives.	Older individuals struggle with shifting rainfall patterns and loss of land productivity.	Disruptions in maternal healthcare due to migration-related displacements.	Increased difficulty in participating in agricultural adaptation programs.

4.3.2.3 Responsibilities

Table 9 shows how climate change reshapes household and community responsibilities, deepening existing inequalities and placing additional burdens on vulnerable groups.

Women and youth face increasing caregiving responsibilities, especially during floods, droughts, and disease outbreaks, limiting their ability to pursue education and economic activities. Men are primarily engaged in physical recovery efforts, such as rebuilding homes and restoring farmland, which adds economic strain and physical exhaustion. Migrants struggle with exclusion from community recovery efforts, leaving them dependent on informal aid networks.

Elderly individual experience heightened vulnerability, as mobility limitations restrict their ability to secure resources and adapt to changing conditions. Pregnant women are at severe risk from food and water shortages, increasing health complications and maternal stress. PWDs remain largely excluded from disaster response and rebuilding efforts.

Table 9: Projected impacts of changing climate on responsibilities within households and communities

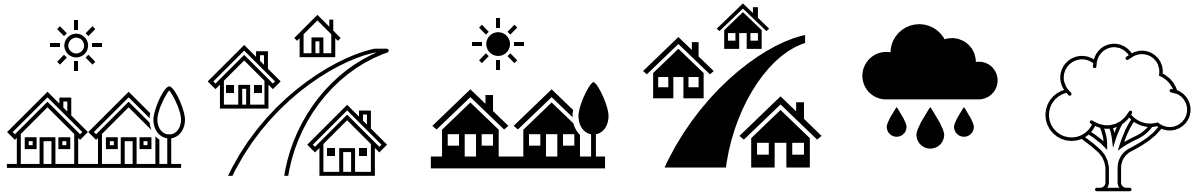
Community	Climate Change	Gender and Vulnerable Groups						
		Women	**Men**	**Youth**	**Migrants**	**Elderly**	**Pregnant Women**	**PWDs**
Dalun	Frequent flooding	Increased caregiving burden during waterborne disease outbreaks.	Physical strain from rebuilding homes.	Increased role in caregiving during crises.	Dependency on host community support.	Limited mobility during recovery efforts.	Higher risk of infections and poor access to maternal care.	Increased reliance on family for survival.
Zugu	Droughts, water scarcity	Time spent on water collection limits income opportunities.	Infrastructure repairs following water shortages.	Increased household responsibilities, reducing education time.	Exclusion from planning during crises.	Difficulty in accessing water sources.	High dehydration risk; increased household labor strain.	Limited ability to contribute to recovery efforts.
Nawuni	Floods, intense rainfall	Water collection during floods disrupts economic roles.	Limited caregiving contributions during crises.	Increased caregiving roles for children.	Reliance on informal social networks.	Vulnerable to displacement; difficulty accessing relief.	Greater risk of pregnancy complications from displacement.	Poor accessibility to emergency aid during flooding.
Saakuba	Prolonged droughts	Increased time spent balancing caregiving and farming.	Rebuilding of damaged farms and irrigation systems.	Disruptions in schooling to assist with farming.	Reduced access to family-based support.	Reduced ability to contribute to farming recovery.	Extreme heat and food shortages worsen pregnancy risks.	Struggle to access community-based support services.
Zangballung	Erratic rainfall	Increased caregiving demands due to limited water and food supplies.	Rebuilding homes and community assets damaged by floods.	Youth assist in caregiving, reducing study time.	Dependency on temporary aid systems.	Strain in accessing resources due to mobility challenges.	Increased food and water insecurity.	Excluded from rebuilding initiatives.
Bognaayili	Prolonged droughts, heat stress	Dual caregiving and economic roles during droughts.	Infrastructure repairs; limited caregiving engagement.	School disruptions to help with household tasks.	Increased marginalization during recovery.	High vulnerability to extreme heat; dependence on family support.	Higher exposure to malnutrition due to food scarcity.	Reduced capacity to contribute to recovery efforts.

Community	Climate Change	Gender and Vulnerable Groups						
		Women	Men	Youth	Migrants	Elderly	Pregnant Women	PWDs
Gbullung	Frequent flooding	Caregiving during disease outbreaks; time burden increases.	Engagement in flood recovery work.	Youth manage household roles while parents focus on recovery.	Exclusion from community recovery resources.	Struggles with mobility during floods.	Greater risk of infections due to poor sanitation.	Lack of inclusion in disaster planning efforts.
Voggu	Prolonged droughts, water scarcity	Longer distances for water collection; caregiving strain.	Recovery of farms from drought stress.	Increased support roles in farming and water collection.	Limited access to family support networks.	Reduced ability to secure drinking water.	High dehydration and exhaustion risks.	Dependency on caregivers for survival.
Kumbungu	Erratic rainfall, intense flooding	Greater caregiving burden during health crises.	Strain from rebuilding and farm recovery.	Reduced educational participation due to caregiving tasks.	Marginalized during post-disaster recovery.	Increased isolation and dependency on family.	Limited mobility restricts healthcare access.	Disaster relief programs rarely consider disability needs.
Guppanarigu	Soil erosion, water shortages	Water collection and caregiving responsibilities increase.	Engagement in repairing damaged infrastructure.	Reduced educational opportunities due to increased responsibilities.	Excluded from communal recovery systems.	High dependence on younger family members.	Poor access to clean water and sanitation.	Barriers to accessing climate recovery programs.
Kpalsogun	Erratic rainfall, prolonged dry spells	Strain from managing caregiving and household tasks during droughts.	Limited involvement in caregiving; focus on recovery.	Youth assist in economic activities, reducing study time.	Reliance on host communities for support.	Reduced ability to farm due to physical strain.	High risk of complications from malnutrition and heat exposure.	Increased exclusion from community recovery efforts.
Bagon	Seasonal migration, intense heatwaves	Strain from caregiving due to reduced family labor.	Greater focus on rebuilding efforts.	Loss of schooling due to migration and caregiving roles.	Excluded from recovery initiatives.	Increased food insecurity due to disrupted livelihoods.	High health risks from stress and malnutrition.	Lack of accessibility to relocation services.

4.3.3 Inter-Community Variations in Projected Climate Change Trends and Vulnerabilities

The projected climate change trends—erratic rainfall, prolonged droughts, intense flooding, rising temperatures, and soil erosion—manifest differently across the 12 communities in Kumbungu District, creating unique vulnerability profiles. These variations are influenced by geographic, economic, and social factors, making community-specific responses essential for effective adaptation.

The inter-community explanations provided in this section are based on present analyses of vulnerabilities, focusing on how existing socio-economic and environmental challenges may be exacerbated by climate change. However, this assessment does not quantitatively analyze actual changes in climatic variables such as rainfall and temperature due to the unavailability of meteorological data for the district.



4.3.3.1 Rainfall Patterns and Flooding

- **Dalun**: Frequent and intense rainfall events are projected to exacerbate flooding due to poor drainage systems, disrupting livelihoods, damaging homes, and making roads impassable. Farming activities will be heavily affected by waterlogging, limiting crop yields.
- **Nawuni**: As a low-lying community, Nawuni faces heightened flood risks, damaging farmlands, fishing equipment, and critical infrastructure such as bridges. Prolonged recovery periods after floods are projected, increasing food and income insecurity.
- **Voggu**: Moderate flooding is projected to cause prolonged wet conditions, leading to waterlogging and reduced productivity for crops such as maize and rice. Access to markets and services may also be disrupted.
- **Kumbungu**: Localized flooding due to erratic rainfall is likely to disrupt agricultural zones and damage rural roads, limiting transportation and market accessibility. Flood-prone areas may also experience displacement of residents.
- **Zugu**: Increased rainfall variability may reduce water availability during critical farming periods, but sudden intense rains could lead to localized flooding, further straining infrastructure and farmlands.
- **Saakuba**: Periodic flooding is expected, but prolonged droughts between rainfall events will likely exacerbate water shortages for crops and households.
- **Zangballung**: Intense rainfall will likely cause localized flooding, leading to soil erosion and waterlogging in farmlands, reducing crop productivity and straining household incomes.
- **Bognaayili**: Flooding events are projected to increase in frequency, disrupting farming activities and damaging homes. Recovery periods will strain financial and labor resources.
- **Gbullung**: Moderate flooding will likely damage infrastructure such as roads and bridges, disrupting access to markets and services while creating food security concerns.
- **Guppanarigu**: Moderate flooding coupled with localized soil erosion is projected to affect farmlands, leading to lower agricultural productivity.
- **Kpalsogun**: Frequent rainfall variability could result in both water shortages and flooding, straining irrigation systems and reducing crop yields.
- **Bagon**: Heavy rainfall and flooding are expected to disrupt agricultural activities and infrastructure, with homes in low-lying areas at higher risk of damage.

4.3.3.2 Prolonged Droughts

- **Dalun**: Prolonged dry spells may strain irrigation systems and increase water scarcity for both agriculture and households, limiting economic activities.

- **Nawuni**: Droughts are projected to exacerbate soil degradation and reduce water availability for farming, particularly for rice and maize cultivation.
- **Voggu**: Water scarcity is likely to intensify during prolonged droughts, reducing crop yields and forcing farmers to rely on costly irrigation options.
- **Kumbungu**: Extended dry periods will likely result in water shortages for both households and farms, increasing reliance on shallow wells and informal water-sharing systems.
- **Zugu**: Severe water shortages are projected, limiting crop and livestock productivity. Droughts will further degrade already declining soil fertility.
- **Saakuba**: Reduced rainfall during the growing season is expected to significantly affect crop outputs, forcing households to depend on alternative livelihoods.
- **Zangballung**: Extended dry spells will likely reduce the productivity of shea trees, a critical source of income, and increase vegetation loss, further reducing livestock grazing options.
- **Bognaayili**: Prolonged droughts are expected to worsen water scarcity, increasing competition for irrigation resources and reducing agricultural outputs.
- **Gbullung**: Moderate drought impacts are projected to strain water supplies and disrupt shallow wells, limiting water availability for crops and households.
- **Guppanarigu**: Prolonged dry spells are projected to impact crop and livestock farming, with water shortages worsening during critical periods.
- **Kpalsogun**: Water scarcity during droughts will likely reduce crop and livestock productivity, increasing reliance on external food and water sources.
- **Bagon**: Extended dry periods are expected to exacerbate soil dryness and reduce crop viability, with significant impacts on farming households.

4.3.3.3 Rising Temperatures

- **Dalun**: Rising temperatures are expected to increase heat stress on crops, particularly maize and vegetables, reducing agricultural productivity.
- **Nawuni**: Heat stress will likely affect fishing activities and crop yields, increasing reliance on alternative livelihoods.
- **Voggu**: Higher temperatures are expected to exacerbate water evaporation rates, limiting the availability of water for irrigation and household use.
- **Kumbungu**: Rising temperatures may intensify pest and disease outbreaks on crops and livestock, straining agricultural outputs and household incomes.
- **Zugu**: Heat stress on crops such as millet and sorghum is expected to lower yields, impacting food security and household earnings.
- **Saakuba**: Higher temperatures will likely reduce pasture availability for livestock and limit crop productivity.
- **Zangballung**: Rising temperatures may affect the growth of shea trees, reducing nut production and incomes for households reliant on this resource.
- **Bognaayili**: Prolonged heat stress is expected to reduce water availability for both households and agriculture, increasing competition for resources.
- **Gbullung**: Heat stress on crops and livestock is expected to lower productivity and reduce household resilience to climate variability.
- **Guppanarigu**: Rising temperatures are projected to increase pest outbreaks and reduce crop viability during critical growing seasons.
- **Kpalsogun**: Heat stress will likely reduce crop and livestock productivity, increasing economic vulnerability for farming households.
- **Bagon**: Higher temperatures are expected to exacerbate evaporation rates, reducing irrigation efficiency and limiting water availability for crops.

4. 3.3.4 Soil Erosion

- **Dalun**: Projected increases in intense rainfall are expected to worsen soil erosion, reducing agricultural productivity in already degraded farmlands.
- **Nawuni**: Intense rainfall events are projected to exacerbate soil erosion, further limiting arable land availability and increasing food insecurity.
- **Voggu**: Soil erosion from prolonged wet conditions is likely to reduce long-term agricultural productivity.

- **Kumbungu**: Flood-induced soil erosion will likely affect agricultural zones, reducing farm yields and increasing recovery costs.
- **Zugu**: Heavy rains are expected to increase topsoil loss, reducing arable land for farming and livestock grazing.
- **Saakuba**: Soil erosion, compounded by vegetation loss, will likely reduce land fertility, forcing shifts to less productive areas.
- **Zangballung**: Intense rainfall is projected to increase erosion rates, reducing the viability of farmlands for crops and shea production.
- **Bognaayili**: Flood-induced erosion is likely to degrade farmland, requiring costly investments in soil rehabilitation.
- **Gbullung**: Moderate soil erosion is projected, particularly in farming zones reliant on informal drainage systems.
- **Guppanarigu**: Topsoil loss from flooding and poor land management practices is projected to reduce crop viability.
- **Kpalsogun**: Soil erosion from prolonged rainfall variability will likely degrade farmlands and increase recovery costs for farmers.
- **Bagon**: Projected heavy rains are expected to worsen erosion, reducing agricultural outputs and increasing food insecurity.

Table 10: Summary of projected community vulnerabilities to climate trends

Community	Projected Climate Trend	Key Vulnerabilities
Dalun	• Flooding • Soil erosion	• Disrupted livelihoods • Damaged infrastructure • Long-term soil degradation
Nawuni	• Flooding • Soil erosion	• Severe damage to farmlands and infrastructure • Displacement • Prolonged recovery needs
Voggu	• Flooding • Waterlogging	• Reduced agricultural productivity due to extended wet conditions
Kumbungu	• Erratic rainfall • Flooding	• Disruption of transportation and market access • Reduced farming efficiency
Zugu	• Droughts • Water scarcity	• Declining soil fertility • Reduced water availability for agriculture and domestic use
Saakuba	• Droughts • Water scarcity	• Drying of seasonal water sources • Increased competition for scarce resources
Zangballung	• Droughts • Soil erosion	• Declining shea production • Vegetation loss • Reduced options for livestock farming
Gbullung	• Droughts • Moderate flooding	• Reduced water table levels • Disruption of shallow well systems for domestic and farm use
Bognaayili	• Rising temperatures	• Reduced crop yields • Increased water evaporation from communal sources
Kpalsogun	• Rising temperatures • Pests	• Heat stress on livestock • Increased pest outbreaks reducing crop yields
Bagon	• Rising temperatures • Droughts	• Water scarcity • Increased competition for irrigation resources
Guppanarigu	• Rising temperatures • Erosion	• Heat stress on crops • Topsoil loss reducing agricultural productivity

5. Implications for Gender Responsive Climate Adaptation Planning and Resilience Building

5.1 Introduction

While the scope of this CRVA was primarily to diagnose the climate-related risks and vulnerabilities in Kumbungu District, the findings strongly signal the urgent need to translate assessment outcomes into practical, gender-responsive adaptation planning. The complexity and depth of vulnerabilities observed across economic, physical, and social domains—particularly among women, youth, and other marginalized populations—call for early guidance to support the conceptualization and development of targeted adaptation strategies.

Kumbungu District, situated within Ghana's Guinea Savannah zone, is characterized by erratic rainfall, prolonged droughts, seasonal flooding, extreme heat, and frequent bushfires. These hazards are further exacerbated by poor access to clean water, low agricultural productivity due to degraded soils, limited access to irrigation, and weak infrastructure. Notably, communities such as Nawuni, Gbullung, Zangballung, and Dalun consistently report compounded vulnerabilities due to climate hazards and limited adaptive resources.

Women in Kumbungu are particularly affected by these stresses. They bear the primary responsibility for water collection, food production, and caregiving—roles that are increasingly threatened by worsening climate impacts. Limited access to land, credit, extension services, and decision-making spaces further restrict their ability to adapt. Similarly, youth in the district face high unemployment and limited livelihood alternatives, resulting in increased rural-urban migration and erosion of the local labor force. Persons with disabilities and migrant groups also experience heightened exposure and reduced coping capacities, reinforcing systemic marginalization.

Therefore, gender-responsive and socially inclusive adaptation planning is not optional—it is a necessity for building equitable resilience in Kumbungu. The recommended adaptation interventions must prioritize social protection, economic empowerment, equitable access to climate resources, and inclusive governance structures. Importantly, such measures should be deeply informed by community-specific needs and realities documented through this CRVA.

The adaptation planning process should also align with Ghana's broader development frameworks, including the Medium-Term Development Plans (MTDPs), National Adaptation Plan (NAP), and Nationally Determined Contributions (NDCs), while contributing meaningfully to international goals. Specifically, these include the Sustainable Development Goals (SDGs)—with direct linkages to SDG 1 (No Poverty), SDG 5 (Gender Equality), SDG 10 (Reduced Inequalities), and SDG 13 (Climate Action).

5.2 Thematic Gender-Responsive Adaptation Strategies

5.2.1 Social Adaptation Strategies

Social vulnerabilities in Kumbungu District, especially among women, youth, and marginalized groups, are significantly exacerbated by climate crises such as flooding, droughts, and rising temperatures. These challenges strain caregiving responsibilities, exclude vulnerable groups from decision-making, and disrupt social cohesion. Addressing these vulnerabilities requires inclusive, gender-responsive approaches to reduce these pressures and empower all members of the community to actively participate in climate adaptation. **Table 11** provides some recommendations which can provide a foundation for addressing social vulnerabilities in across communities in the Kumbungu District.

Table 11: Strategies to address social vulnerabilities in Kumbungu District

Recommendation	Actions	Expected Impact	Potential Partners
Promote Gender-Inclusive Platforms for Decision-Making	Create quotas for women and youth in district and community adaptation committees.	Increased representation of marginalized groups in adaptation planning and equitable decision-making processes.	MoGCSP, ActionAid Ghana, UN Women, District Assemblies
	Facilitate inclusive town hall meetings to discuss climate adaptation plans, ensuring equal participation by women and youth.		
	Introduce mentorship programs pairing experienced leaders with women and youth to build confidence and leadership skills.		
	Develop gender-responsive climate policies with input from local women's groups.		
Support Initiatives to Reduce Caregiving Burdens During Climate Crises	Establish mobile childcare centers during flood seasons to support families.	Women can actively engage in income-generating and adaptation activities during crises, reducing caregiving pressures.	SEND Ghana, GSOP, WFP, World Vision Ghana
	Train local volunteers to provide caregiving support for children, elderly, and PWDs.		
	Create "Care Circles," where community members share caregiving responsibilities during emergencies.		
	Establish community kitchens to provide meals during crises, reducing women's domestic workload.		
	Provide psychosocial support and counselling services for caregivers to address stress during prolonged crises.		
Enhance Social Cohesion by Integrating Marginalized Groups	Launch inclusive community activities like tree-planting drives and environmental clean-up initiatives to engage all demographic groups.	Strengthened social cohesion, reduced marginalization, and increased collaboration between diverse community groups.	NADMO, UNICEF, IOM, Local Traditional Councils
	Conduct disaster preparedness workshops tailored to include PWDs, migrants, and youth.		

Recommendation	Actions	Expected Impact	Potential Partners
	Create youth-led "Climate Action Clubs" to foster intergenerational dialogue and collaboration.		
	Include marginalized groups in cultural and social events, like harvest festivals, reimagined to reflect changing seasonal patterns.		
	Implement PWD-friendly adaptation training, including visual aids and tailored instructions.		

5.2.2 Economic Adaptation Strategies

Economic resilience in Kumbungu is closely tied to climate-sensitive livelihoods such as agriculture, shea processing, and small-scale trade. Climate-induced disruptions to these activities disproportionately impact women and marginalized groups. The proposed economic adaptation strategies focus on building resilience by empowering women, youth, and marginalized groups through improved access to finance, market opportunities, and sustainable farming practices (**Table 12**).

Table 12: Strategies to enhance economic resilience to climate impacts in Kumbungu District

Recommendation	Actions	Expected Impact	Potential Partners
Expand Access to Climate Finance for Women and Marginalized Groups	Introduce low-interest loan products for women-led cooperatives in shea processing and small-scale farming.	Increased financial independence for women and marginalized groups, enabling investment in adaptive livelihoods.	GHAMFIN, CIF, IFAD, Women's World Banking
	Provide grants and microcredit to support start-ups for youth in climate-smart agribusiness.		
	Create community savings and loan groups to enable marginalized groups to access pooled resources for adaptation projects.		
	Develop affordable climate insurance schemes for women-led farms and cooperatives to mitigate risks from floods and droughts.		
	Establish targeted entrepreneurial funds to support youth innovations in renewable energy and value-added agriculture		

Recommendation	Actions	Expected Impact	Potential Partners
Strengthen Market Access and Cooperatives for Women	Develop digital platforms and mobile apps to connect women's cooperatives to regional and international markets.	Improved market opportunities and increased income for women, enhancing economic stability and reducing vulnerability.	GCX, CARE International, MoFA, TradeAid Integrated
	Establish resource hubs for women-led businesses, offering training on packaging, marketing, and product diversification.		
	Facilitate trade fairs to showcase products like shea butter and groundnuts, boosting visibility and sales.		
	Leverage mobile technologies to enable rural e-commerce for smallholder farmers, improving market connectivity during climate disruptions.		
	Support cooperatives in integrating into regional value chains for shea, groundnuts, and other products, with support from trade organizations		
Promote Diversified, Climate-Smart Agricultural Practices	Train farmers on drought-tolerant crops, agroforestry techniques, and integrated pest management systems.	Increased agricultural productivity, food security, and economic resilience under changing climatic conditions.	SARI, MoFA, FAO, USAID Agriculture Programs
	Distribute subsidized tools such as drip irrigation kits, solar dryers, and improved seeds to women-led farms.		
	Organize demonstration farms to showcase the benefits of climate-smart agricultural practices.		
	Implement rainwater harvesting systems and community-managed water reservoirs to support dry-season farming activities.		
	Provide solar-powered equipment for shea nut processing, reducing reliance on woodfuel and improving sustainability.		

5.2.3 Physical Adaptation Strategies

The physical impacts of climate change in Kumbungu District, such as flooding, soil erosion, and water scarcity, pose significant challenges to infrastructure, natural resources, and community livelihoods (**Table 13**). Flooding often disrupts transportation, damages homes, and threatens agricultural

productivity, while soil erosion and land degradation undermine the fertility of farmlands, reducing yields and incomes for already vulnerable households. Prolonged droughts exacerbate water scarcity, affecting both domestic needs and irrigation for farming activities. These challenges demand urgent investments in climate-resilient infrastructure, sustainable land management practices, and water conservation systems.

Table 13: Strategies to mitigate physical climate vulnerabilities

Recommendation	Actions	Expected Impact	Potential Partners
Invest in Climate-Resilient Infrastructure	Construct flood-proof roads and bridges in flood-prone areas.	Reduced infrastructure damage and improved community mobility and safety during extreme weather events.	Department of Urban Roads (DUR), World Bank CRIP, Environmental Protection Agency (EPA)
	Upgrade drainage systems in urban areas to reduce flood risks and waterlogging.		
	Build climate-resilient irrigation systems to support farming during extreme weather events.		
	Develop multi-use emergency shelters in vulnerable areas to provide safety during floods and extreme rainfall.		
	Use eco-friendly materials in construction projects to reduce carbon footprints.		
Address Soil Degradation and Erosion	Implement terracing projects in erosion-prone areas to reduce topsoil loss and improve water retention.	Improved soil fertility, reduced erosion, and increased productivity of farmlands in vulnerable areas.	Forestry Commission, UNDP, MoFA
	Create awareness campaigns on sustainable farming practices to prevent overgrazing and land degradation.		
	Promote agroforestry techniques that combine tree planting with agricultural practices.		
	Establish community-led reforestation programs, focusing on native species to restore degraded lands.		

Recommendation	Actions	Expected Impact	Potential Partners
Develop Water Conservation Systems	Install rainwater harvesting systems to collect and store water for domestic and agricultural use.	Increased water availability and reduced reliance on irregular rainfall for agricultural and domestic needs.	Water Resources Commission (WRC), International Water Management Institute (IWMI), World Bank, MoF
	Construct small-scale reservoirs and check dams to manage seasonal water availability.		
	Promote the use of drip irrigation technologies to minimize water wastage and ensure efficient crop watering.		
	Build community-managed boreholes in areas experiencing prolonged droughts.		

5.3 Community Specific Recommendations

The assessed communities in Kumbungu District exhibit diverse vulnerabilities stemming from unique climate-induced challenges such as flooding, drought, soil erosion, and water scarcity. These challenges are compounded by socio-economic factors such as limited access to resources, infrastructure deficits, and gendered inequalities. The following community-specific recommendations are tailored to address the peculiar vulnerabilities observed in each of the twelve communities. In focusing on localized needs, these strategies ensure that interventions are effective, equitable, and aligned with the specific environmental and socio-economic contexts of each community. This approach underscores the importance of targeted, context-sensitive solutions to build resilience and sustainable development across the district.

5.3.1 Nawuni: Building Resilience Against Flooding

Nawuni faces recurrent flooding and intense rainfall due to its proximity to the White Volta River. These challenges disrupt livelihoods, damage infrastructure, and heighten waterborne health risks (**Table 14**). The recommendations aim to enhance flood resilience and ensure water security.

Table 14: Recommendation for building resilience against flooding in Nawuni

Action	Expected Impact	Potential Collaborators
Construct flood-resilient housing and elevated infrastructure.	Reduced vulnerability of households and infrastructure to frequent flooding.	Department of Urban Roads (DUR), World Bank, Local Contractors
Establish early warning systems using mobile alerts and radio broadcasts.	Improved community preparedness and timely evacuation during flood events.	NADMO, Ghana Meteorological Agency (GMet)
Install rainwater harvesting systems and rehabilitate silted water bodies.	Enhanced water security during both floods and droughts.	Water Resources Commission (WRC), Local NGOs

5.3.2 Dalun: Mitigating Flooding and Erosion

Dalun experiences frequent flooding, soil erosion, and poor drainage systems, which significantly impact agriculture and infrastructure. The proposed strategies focus on mitigating flood risks, restoring degraded soils, and diversifying livelihoods to improve resilience (**Table 15**).

Table 15: Recommendations for mitigating flooding and erosion in Dalun

Action	Expected Impact	Potential Collaborators
Develop comprehensive urban drainage systems to prevent waterlogging.	Reduced flood damage to homes and roads, improving community mobility.	Environmental Protection Agency (EPA), Ministry of Works and Housing
Implement reforestation and terracing projects to control erosion.	Stabilized soils, reduced runoff, and restored farmland productivity.	Forestry Commission
Promote aquaculture as an alternative livelihood.	Reduced economic dependence on flood-prone agriculture and improved household incomes.	Ministry of Fisheries and Aquaculture Development (MoFAD), Local NGOs

5.3.3 Saakuba: Addressing Drought and Water Scarcity

Prolonged droughts and erratic rainfall patterns in Saakuba exacerbate water scarcity and reduce agricultural productivity. The recommendations prioritize water conservation, sustainable farming, and irrigation solutions to mitigate these challenges (**Table 16**).

Table 16: Recommendations for addressing drought and water scarcity in Saakuba

Action	Expected Impact	Potential Collaborators
Train farmers on sustainable farming techniques like crop rotation and intercropping.	Restored soil health and increased crop yields during droughts.	SARI, MoFA, FAO
Build community-managed storage facilities.	Reduced post-harvest losses and improved food security during lean seasons.	WFP, Local Farmer Groups, Kumbungu District Assembly
Promote water recycling and greywater use in irrigation.	Improved water availability for farming during prolonged dry periods.	IWMI, WRC, Local NGOs
Develop small-scale irrigation systems using water-efficient technologies.	Enhanced agricultural productivity and reduced reliance on erratic rainfall.	Ghana Irrigation Development Authority (GIDA), IWMI, MoFA
Distribute subsidized drip irrigation systems and solar-powered pumps.	Improved water efficiency, reduced labor burdens, and enhanced farming capacity.	FAO, Local Farmer Associations, Development Partners
Introduce training on the use and maintenance of irrigation facilities.	Strengthened community capacity to manage irrigation systems sustainably.	Local NGOs, District Assemblies, Farmer

5.3.4 Zugu: Empowering Women and Enhancing Water Security

Zugu community's vulnerabilities include droughts, water scarcity, and deforestation, which impact agriculture and livelihoods. The recommendations aim to empower women through financial inclusion and address environmental degradation to enhance resilience (**Table 17**).

Table 17: Recommendations for empowering women and enhancing water security in Zugu community

Action	Expected Impact	Potential Collaborators
Provide microfinance programs for women in shea and rice processing.	Increased financial independence for women and enhanced economic resilience.	GHAMFIN, Women's World Banking, IFAD
Establish community nurseries for reforestation efforts.	Restored forest cover, improved biodiversity, and sustainable resource use.	Forestry Commission, UNDP, Local CSOs
Install boreholes and small dams.	Reduced reliance on rain-fed water sources and improved water access for farming.	IWMI, WRC, Local Assemblies

5.3.5 Gbullung: Addressing Seasonal Water Shortages

Seasonal water shortages and soil degradation in Gbullung undermine agricultural productivity and community livelihoods. The strategies focus on water storage, soil health restoration, and improving market connectivity to reduce vulnerabilities (**Table 18**).

Table 18: Recommendations for addressing seasonal water shortages in Gbullung community

Action	Expected Impact	Potential Collaborators
Build boreholes and water catchment areas.	Improved water availability for households and farms during dry periods.	WRC, World Vision Ghana, District Assemblies
Promote organic composting and agroforestry practices.	Restored soil fertility and increased agricultural productivity.	MoFA, Local Farmer Associations
Upgrade transportation networks to improve market connectivity.	Reduced post-harvest losses and improved incomes for farmers.	DUR, Local Road Contractors, UNDP

5.3.6 Kpalsogun: Managing Flood Risks and Expanding Financial Access

Frequent flooding and limited financial access in Kpalsogun increase vulnerability to climate-induced income shocks and health risks. The proposed actions emphasize flood mitigation, financial inclusion, and irrigation systems to support agriculture (**Table 19**).

Table 19: Recommendations for managing flood risks and expanding financial access in Kpalsogun community

Action	Expected Impact	Potential Collaborators
Build embankments and improve drainage systems in flood-prone areas.	Reduced flood impacts on homes, farms, and roads, ensuring safety and productivity.	EPA, DUR, NADMO
Develop low-interest credit schemes for women-led cooperatives.	Enhanced economic participation of women, reducing vulnerability to climate-induced income shocks.	GHAMFIN, Women's World Banking, Local NGOs
Strengthen healthcare services to manage waterborne diseases.	Improved community health outcomes during floods.	Ministry of Health, WHO, WFP
Introduce basic irrigation facilities using water from Bontanga Dam.	Year-round farming activities and reduced reliance on erratic rainfall for agriculture.	Ghana Irrigation Development Authority (GIDA), IWMI, MoFA, World Bank

Action	Expected Impact	Potential Collaborators
Distribute subsidized drip irrigation systems for smallholder farmers.	Improved water use efficiency, increased crop yields, and enhanced agricultural resilience.	FAO, District Assemblies, Local Farmer Associations
Train local farmers on irrigation management and maintenance.	Strengthened community ownership and long-term sustainability of irrigation infrastructure.	Local NGOs, Farmer Cooperatives, Development Partners

5.3.7 Voggu: Restoring Water Sources and Forests

Water scarcity and deforestation in Voggu strain resources and livelihoods. The proposed strategies focus on rehabilitating water sources, reforestation, and promoting energy-efficient technologies to address these issues (**Table 20**).

Table 20: Recommendations for restoring water resources and forests in Voggu community

Action	Expected Impact	Potential Collaborators
Rehabilitate wells and standpipes to improve water reliability.	Enhanced water access for households and farms during dry periods.	WRC, District Assemblies, Local Water Boards
Launch afforestation campaigns focusing on multi-use trees.	Restored forest cover and reduced reliance on firewood for energy.	Forestry Commission, UNDP, Local CSOs
Distribute energy-efficient stoves to reduce firewood demand.	Reduced deforestation and improved air quality for households.	GIZ, SNV, Local NGOs

5.3.8 Bagon: Reducing Land Degradation and Supporting Fisheries

Bagon is affected by land degradation and declining fishing livelihoods, which threaten economic stability. The recommendations target sustainable land use, agricultural support, and revitalizing fisheries to build resilience (**Table 21**).

Table 21: Recommendations for reducing land degradation and supporting fisheries in Bagon community

Action	Expected Impact	Potential Collaborators
Provide subsidized tools for land management, including contour ploughs.	Reduced soil erosion and improved agricultural productivity.	SADA, MoFA, Local Farmer Associations
Distribute pest-resistant seeds and fertilizers to farmers.	Increased crop yields and reduced farming costs.	FAO, District Assemblies, Local Farmer Groups
Restore silted dams and fish habitats.	Revitalized fisheries, improved livelihoods, and enhanced biodiversity.	MoFAD, WRC, Local Assemblies

5.3.9 Zangballung: Diversifying Livelihoods

Erratic rainfall and limited livelihood opportunities in Zangballung exacerbate economic vulnerabilities. The recommendations address these through vocational training, cooperative strengthening, and educational support for youth (**Table 22**).

Table 22: Recommendations for diversifying livelihoods in Zangballung community

Action	Expected Impact	Potential Collaborators
Provide vocational training in carpentry, welding, and handicrafts.	Reduced reliance on climate-sensitive agriculture and diversified income sources for youth and women.	National Vocational Training Institute (NVTI), Local NGOs, UNDP
Strengthen cooperatives to stabilize market prices for shea and groundnuts.	Improved income stability and resilience for women engaged in shea processing and groundnut farming.	GCX, MoFA, CARE International
Offer scholarships to support youth education.	Reduced school dropout rates and enhanced future opportunities for youth.	District Education Offices, Ghana Education Service (GES)

5.3.10 Bognaayili: Improving Water and Infrastructure

Bognaayili struggles with water scarcity and inadequate infrastructure, impacting agriculture and daily life. The proposed actions focus on improving water access, constructing resilient infrastructure, and empowering women through financial resources (**Table 23**).

Table 23: Recommendations for improving water and infrastructure in Bognayili community

Action	Expected Impact	Potential Collaborators
Install mechanized boreholes with water treatment facilities.	Increased access to clean water for households and agricultural use.	WRC, Local Water Boards, District Assemblies
Construct durable roads to withstand erosion.	Enhanced mobility and market access during rainy seasons.	DUR, World Bank CRIP, Local Contractors
Facilitate women's access to financial credit for value-added agriculture.	Improved economic opportunities and resilience for women in farming and agro-processing.	GHAMFIN, IFAD, CARE International

5.3.11 Guppanarigu: Combating Erosion and Biodiversity Loss

Soil erosion and biodiversity loss in Guppanarigu threaten livelihoods and agricultural productivity. The recommendations promote erosion control, reforestation, and youth engagement in sustainable practices to address these challenges (**Table 24**).

Table 24: Recommendations for combating erosion and biodiversity loss in Guppanarigu community

Action	Expected Impact	Potential Collaborators
Implement terracing systems and plant cover crops.	Reduced soil erosion, improved soil fertility, and increased agricultural productivity.	SADA, Forestry Commission, MoFA
Reintroduce native tree species like shea and dawadawa.	Restored biodiversity and sustainable livelihoods for women in shea processing.	Forestry Commission, UNDP, Local Farmer Groups
Engage youth in agroforestry and renewable energy programs.	Increased youth participation in sustainable practices, fostering ownership of adaptation strategies.	Local Youth Councils, UNDP, GIZ

5.3.12 Kumbungu: Enhancing Urban Resilience and Resource Access

Kumbungu, the district capital, faces complex vulnerabilities, including urban flooding, poor drainage systems, and limited access to financial resources. The recommendations aim to strengthen urban planning, expand financial inclusion, and enhance infrastructure resilience (**Table 25**).

Table 25: Recommendation for enhancing urban resilience and resource access in Kumbungu community

Action	Expected Impact	Potential Collaborators
Upgrade urban drainage systems to manage waterlogging and flooding.	Reduced flood damage to infrastructure and improved sanitation in urban areas.	DUR, Environmental Protection Authority (EPA), District Assemblies
Introduce community-based waste and water management programs.	Improved environmental sanitation, reducing waterborne diseases during floods.	Ghana Water Company Limited (GWCL), NADMO, Local NGOs
Expand access to microfinance and credit schemes for small-scale traders.	Increased economic opportunities for women and youth engaged in informal urban trades.	GHAMFIN, IFAD, Microfinance Institutions Network
Strengthen urban planning initiatives to include climate-resilient infrastructure.	Improved urban safety, better housing conditions, and reduced vulnerabilities during climate events.	Ministry of Works and Housing, World Bank CRIP, UNDP
Develop solar-powered water pumping systems for public water supply.	Reliable access to clean water during droughts and power outages.	IWMI, GWCL, Development Partners
Conduct community-based climate risk assessments to identify hotspots for intervention.	Improved targeted response to vulnerabilities and better integration of local knowledge in planning.	NADMO, GMet, District Assemblies

6. Institutional Capacity Building and Adaptation Policy Implications

6.1 Introduction

Adaptation governance requires intentional efforts and adequate capacity at all levels both human and institutional. A major lesson that has emerged from all our CRVA experiences, especially at the subnational level, and in the district, is the lack of climate adaptation governance capacity. This remains a national challenge and one that we have tried, as much as it has been possible, to use our current assignments and engagements with the Assemblies to address. In all instances, we have approach our work in the districts as learning and capacity building journeys and in ways that bring a conscious focus on the need to co-produce knowledge and to build the capacity of district/municipal staff, as well as other critical stakeholders in adaptation planning and in areas such as climate risk and vulnerability assessments, and climate-informed decision making.

While we have done our best, there is still a capacity gap at the institutional level which needs to be addressed. We proceeded from the premise that the Kumbungu District Assembly is not an exception even though it remains at the forefront of providing the requisite governance machinery for adaptation planning and resilience building in the district. The Assembly, therefore, is supposed to provide leadership to address the district's unique climate impacts and vulnerabilities, which include flooding, drought, soil erosion, and resource scarcity. Our engagements therefore targeted key personnel from the Assembly and relevant stakeholders within the district and the objective was to use participatory learning processes to develop knowledge and build capacity.

These collaborative efforts, as we have learned, enriched the process by ensuring inclusion, voice, ownership and incorporating diverse perspectives. The collaborative processes, especially using tools such as participatory risk mapping, seasonal calendar analysis, matrix of function (MoF), etc., highlighted the pressing issues faced by communities, particularly women, youth, and other marginalized groups. The different discussions also provided an understanding of the climate change phenomenon, the nature of impact manifestations and how different groups such as women, children the elderly etc. experienced impacts and vulnerabilities in different ways and the need for targeted adaptation interventions.

In this chapter, we underscore the critical importance of the Assembly in providing the requisite climate change governance leadership and how capacity at multi-levels also become a critical imperative for effective and proactive adaptation planning. We also highlight an unavoidable concern: climate finance, as a necessary topic for broader engagement and discussion. In our view, climate finance is at the very core of adaptation planning both at the national and subnational levels. Thus, we as a consultant team, have been conscious and intentional about making the topic a part of our process and as an effort towards institutional strengthening and capacity building. We provided insights and directions on how to identify funding sources and what to do to attract funding.

Additionally, we have also been very intentional about locating this work within the broader Ghana National Adaptation Plan (NAP) process by educating stakeholders on how the implementation of adaptation actions in the district contributed to the NAP process at the national level. We demonstrated the link between national and subnational level processes and how that responds to the vertical integration approach adopted by the Ghana NAP process. In aligning district level planning processes to national level aspirations, we clearly demonstrated what vertical integration means and how such processes could distill and highlight unique needs and particularities at the district level and how they might be prioritized within national policy regimes. A case in point is the issue of gendered vulnerabilities, biophysical challenges and the diversity and extremity of climate constraints and associated adaptation needs in specific local communities. A principal organizing philosophy that underscored this work was awareness creation, knowledge co-production and understanding of the complex linkages between national level climate risk and vulnerabilities and subnational risk and vulnerabilities. More importantly, we highlighted the gendered nature of climate impacts, risks and vulnerabilities and the critical imperative for gender-responsive adaptation interventions.

6.1.1 Strengthening the Enabling Environment for Climate Finance

Accessing climate finance is vital for the Kumbungu District Assembly to implement large-scale adaptation strategies. Participatory workshops conducted during the assessment process brought together community members, District Assembly staff, CSOs, and traditional leaders to highlight the challenges and opportunities of accessing resources such as the Green Climate Fund (GCF) and Adaptation Fund (**Table 26**). These workshops emphasized the need for enhanced technical capacity, streamlined processes, and collaboration among stakeholders to navigate the complexities of climate finance.

Table 26: Key actions, expected outcomes, and collaborators for strengthening the enabling environment for climate finance

Key Actions	Expected Outcomes	Key Collaborators
Train district personnel on writing fundable proposals aligned with climate finance priorities.	Increased capacity to secure and manage funds for gender-responsive adaptation projects.	EPA, Ministry of Finance, Development Partners, Academic Institutions
Simplify internal administrative processes for budgeting and resource allocation.	Faster and more transparent disbursement of funds to priority projects.	Kumbungu District Assembly, CSOs
Foster partnerships with CSOs and international agencies to strengthen funding applications.	Improved technical expertise and resource mobilization for climate adaptation projects.	UNDP, World Bank, Local NGOs

6.1.2 Implementing a Gender-Responsive National Adaptation Plan

Ghana's National Adaptation Plan (NAP) serves as a guiding framework for climate adaptation across all levels. Through participatory workshops, the Kumbungu District Assembly engaged with community members, CSOs, and traditional leaders to co-create locally relevant and gender-responsive adaptation strategies. These efforts emphasized the inclusion of women, youth, and marginalized groups in decision-making processes to ensure equitable outcomes (**Table 27**).

Table 27: Key actions, expected outcomes, and collaborators for implementing a gender-responsive NAP

Key Actions	Expected Outcomes	Key Collaborators
Develop district-level guidelines to integrate gender considerations into adaptation projects.	Projects that address unique vulnerabilities of women, youth, and marginalized groups.	MoGCSP, EPA, CSOs
Establish quotas for women and youth in district adaptation committees.	Increased representation of women and youth in decision-making processes.	Kumbungu District Assembly, Women-Led CSOs
Create gender-responsive monitoring indicators to assess project impact.	Improved accountability and ability to measure progress in reducing gender inequalities.	MoGCSP, Local NGOs, UNDP

6.1.3 Enhancing Planning and Execution of Inclusive Projects

Participatory workshops provided a platform for identifying vulnerabilities and co-creating solutions tailored to the needs of communities in Kumbungu District. In engaging community members, traditional leaders, and CSOs, the Assembly was able to incorporate diverse perspectives into its planning and execution processes (**Table 28**).

Table 28: Key actions, expected outcomes, and collaborators for enhanced planning and execution of inclusive projects

Key Actions	Expected Outcomes	Key Collaborators
Conduct participatory planning workshops to co-design adaptation initiatives with communities.	Locally relevant projects that address specific vulnerabilities, fostering ownership and trust.	District Assemblies, CSOs, Local Leaders
Provide technical training on implementing adaptive practices like climate-smart agriculture.	Improved project outcomes and increased capacity to mitigate climate impacts on food security.	SARI, MoFA, FAO
Establish robust monitoring and evaluation systems to track project impacts.	Enhanced accountability, timely course corrections, and data-driven improvements in project design.	EPA, Development Partners, Local NGOs

6.1.4 Collaboration Between Key Institutions and Stakeholders

The success of climate adaptation efforts in Kumbungu District depends on effective collaboration between the Assembly and various stakeholders. By working closely with government agencies, CSOs, development partners, and research institutions, the Assembly can ensure that its adaptation strategies are well resourced, aligned with national goals, and responsive to community needs (**Table 29**).

Table 29: Key institutions and their roles for collaboration between key institutions and stakeholders

Institution/Agency	Role in Climate Adaptation
Environmental Protection Authority	Provides technical guidance and ensures alignment with Ghana's NAP.
Ministry of Gender, Children, and Social Protection (MoGCSP)	Advocates for gender-responsive adaptation strategies and supports capacity building for women and marginalized groups.
Savanna Agricultural Research Institute (SARI)	Delivers research-based solutions for climate-smart agricultural practices.
Civil Society Organizations (CSOs)	Facilitate community engagement, provide technical assistance, and advocate for inclusive and gender-responsive policies.
Development Partners (UNDP, World Bank, GCF)	Offer funding, technical expertise, and capacity-building support to enhance local adaptation efforts.

6.2 Strengthening Institutional Capacity

6.2.1 Building Capacity of Local Governance Structures

The effective implementation of climate adaptation strategies relies on strengthening the technical and operational capacity of local governance structures like MMDAs as governance institutions should have the requisite capacity to lead tailored and gender-responsive adaptation planning. It also implies that Assemblies should have the capacity to integrate climate adaptation considerations in their Medium-Term Development Plans (MTDP).

Key Strategies

- Targeted Training Programs: Provide comprehensive training for MMDA staff on climate adaptation, with a focus on identifying gender-specific vulnerabilities and designing interventions to address them.

- Knowledge Transfer: Facilitate peer learning and exchange programs where officials from Kumbungu District can learn from successful climate adaptation initiatives in other districts or regions.
- Toolkits and Guidelines: Develop user-friendly toolkits on gender-responsive climate adaptation for district-level officials, covering vulnerability assessments, project design, and community engagement.

Expected Outcomes

- Increased technical capacity to design and implement gender-responsive climate projects.
- Improved engagement with communities to ensure that adaptation plans reflect their specific needs and priorities.

6.2.2 Expanding Gender-Sensitive Budgeting Strategies

Gender-sensitive budgeting is a critical tool for ensuring that resources are allocated equitably and that climate adaptation initiatives address the unique needs of different groups within the community. This approach requires integrating gender analysis into all stages of the budgeting process, from planning to execution and evaluation.

Key Strategies

- Capacity Building for Finance Officials:
  - Conduct workshops to train district finance and planning officers on integrating gender perspectives into budget formulation and execution.
  - Introduce training on tracking and reporting gender-focused expenditures to ensure accountability.
- Development of Budgeting Tools:
  - Create standardized templates and checklists to guide the preparation of gender-sensitive budgets for climate adaptation projects.
  - Include gender impact assessments as a mandatory component of project budget proposals.
- Participatory Budgeting Mechanisms:
  - Involve women, youth, and other marginalized groups in budget planning discussions to ensure their priorities are adequately represented.
  - Establish community budgeting forums where stakeholders can provide input on resource allocation for adaptation projects.

Practical Examples

- Supporting Women's Livelihoods: Allocate a specific percentage of the adaptation budget to initiatives that support women-led cooperatives in climate-resilient trades such as shea processing or agroforestry.
- Youth Inclusion: Design budget lines to fund skill-building programs for youth in adaptive technologies, such as solar irrigation or climate-smart agriculture.
- Health and Safety: Ensure sufficient budgetary provisions for mobile health units and childcare facilities to support women during climate crises.

6.2.3 Fostering Collaboration Between Local and Regional Agencies

Collaboration between local and regional agencies is essential for ensuring that adaptation strategies are coherent, well coordinated, and effectively implemented. The Kumbungu District Assembly can benefit from strengthening ties with regional coordinating councils, CSOs, and development partners.

Key Strategies

- Inter-Agency Coordination:
  - Establish regular coordination meetings and joint task forces between the District Assembly and regional agencies to align adaptation strategies and share resources.

  - Create shared action plans that integrate district-level projects with regional adaptation frameworks.

- Data Sharing Platforms:
  - Develop digital platforms to share real-time data on climate risks, project implementation progress, and funding opportunities.
  - Use these platforms to monitor and evaluate the impact of regional and district-level adaptation initiatives.

- Capacity-Building Partnerships:
  - Collaborate with regional institutions such as the Environmental Protection Authority and Ministry of Gender, Children, and Social Protection (MoGCSP) to provide technical training and advisory services.
  - Engage development partners like UNDP and the World Bank to support project funding and capacity-building initiatives.

Expected Outcomes

- Streamlined implementation of climate adaptation strategies across local and regional levels.
- Increased resource efficiency through coordinated planning and data sharing.
- Mainstreaming of climate-informed budgeting in MTDPs.

6.3 Policy Implications

An effective response to climate vulnerabilities in Kumbungu District necessitates policy reforms that embed gender-responsive strategies and dismantle the systemic barriers confronting women, youth, and marginalized communities. To ensure comprehensive and sustainable solutions, both district and national policies must be harmonized with international frameworks, including Ghana's National Adaptation Plan (NAP) and the Sustainable Development Goals (SDGs). This section will detail actionable recommendations aimed at facilitating policy integration and alignment, illustrated by concrete examples.

6.3.1 Integrating Gender-Responsive Approaches into Adaptation Policies

Gender-responsive policies ensure that adaptation efforts address the unique vulnerabilities of women and marginalized groups while promoting equitable resource allocation and decision-making (**Table 30**).

Table 30: Policy recommendations for integrating gender-responsive approaches into adaptation plans

Recommendation	Action	Expected Outcome	Practical Example
Institutionalize gender mainstreaming in policies.	Include mandatory gender analysis in all district adaptation policies.	Policies address specific vulnerabilities of women and marginalized groups.	Gender analysis incorporated into flood management plans in Nawuni.
Promote gender-equitable resource allocation.	Embed gender-sensitive budgeting requirements into district frameworks.	Increased funding for initiatives supporting women and marginalized groups.	Allocating funds for women-led cooperatives in Saakuba and Zugu.
Ensure women's representation in policymaking.	Introduce quotas for women in district climate committees.	More inclusive and diverse decision-making processes.	Women-led CSOs actively participating in drafting adaptation strategies in Dalun

6.3.2 Addressing Systemic Barriers to Resource Access

Systemic barriers, such as limited land ownership and financial constraints, hinder women and marginalized groups from participating fully in adaptation efforts. Tackling these barriers requires targeted policies that remove restrictions and promote inclusivity (**Table 31**).

Table 31: Policy recommendations for addressing systematic barriers to resource access

Barrier	*Policy Recommendation*	*Action*	*Practical Example*
Women's limited access to land	Facilitate land ownership and inheritance rights for women through district bylaws.	Provide land tenure certificates to women farmers to secure credit.	Pilot land tenure programs in Zugu and Saakuba.
Financial resource constraints	Develop microfinance policies mandating low-interest loans for women-led enterprises.	Partner with financial institutions to establish loan guarantee schemes.	Microfinance support for shea processing groups in Kumbungu.
Cultural norms restricting women's participation	Include public awareness campaigns in district action plans to challenge restrictive norms.	Leverage traditional leaders to advocate for women's participation in adaptation projects.	Traditional leaders supporting women-led reforestation initiatives in Guppanarigu.

6.3.3 Aligning Local Adaptation Efforts with National and International Frameworks

To maximize impact and efficiency, local adaptation efforts must align with Ghana's National Adaptation Plan (NAP), the Sustainable Development Goals (SDGs), and other international frameworks. This alignment ensures that district-level initiatives contribute to broader climate resilience objectives (**Table 32**).

Table 32: Policy recommendation for aligning local adaptation efforts with national and international frameworks

Framework	**Alignment Recommendation**	**Action**	**Practical Example**
Ghana's National Adaptation Plan (NAP)	Integrate district priorities into the NAP.	Reflect district priorities, like flood management in Nawuni and erosion control in Dalun, in national plans.	Community-led adaptation solutions incorporated into NAP submissions.
Sustainable Development Goals (SDGs)	Align district policies with SDGs 5 (Gender Equality) and 13 (Climate Action).	Include gender-responsive water management and climate-smart agriculture projects in district strategies.	Rainwater harvesting systems installed in Saakuba to address SDG 6 (Clean Water and Sanitation).
Regional climate cooperation	Collaborate with neighbouring districts on regional adaptation strategies.	Develop joint flood management systems and water-sharing agreements.	Joint regional flood mitigation projects initiated between Kumbungu and nearby districts.

6.4 Conclusion

Kumbungu District faces complex climate vulnerabilities that demand targeted, inclusive, and sustainable solutions. This report outlines gender-responsive strategies to address social, economic, and physical challenges exacerbated by climate change. Key recommendations include promoting gender-inclusive decision-making, expanding access to climate finance, investing in resilient infrastructure, and integrating gender-sensitive budgeting into governance frameworks. These actions aim to enhance community resilience, reduce inequalities, and align local efforts with Ghana's National Adaptation Plan (NAP) and Sustainable Development Goals (SDGs).

Resilience-building requires collective action and inclusive governance. Collaboration among community members, government agencies, CSOs, and development partners ensures that adaptation strategies reflect the diverse needs of women, men, youth, and marginalized groups. In fostering partnerships and leveraging local knowledge, the district can address immediate vulnerabilities while strengthening its capacity for long-term climate adaptation.

7. Way Forward

7.1 Introduction

The findings and recommendations outlined in this report highlight the pressing need for targeted, inclusive, and gender-responsive climate adaptation strategies in the Kumbungu District. Climate change poses significant challenges to the district's social, economic, and physical systems, with women, youth, and marginalized groups bearing disproportionate burdens. Addressing these vulnerabilities requires a comprehensive approach that integrates observed impacts with projected climate trends, ensuring that solutions are tailored to the district's unique context and challenges.

The integration of localized vulnerabilities—such as increased caregiving responsibilities, reduced agricultural productivity, and infrastructure damage—with climate projections offers a roadmap for resilience-building. These efforts must go beyond short-term mitigation to embrace long-term strategies that empower communities, enhance governance, and promote sustainable development. By focusing on inclusivity and equity, the district can create an enabling environment where all residents, particularly those most affected, can participate in and benefit from adaptation efforts.

The participatory process undertaken during this assessment, involving community members, district assembly staff, traditional leaders, and CSOs, underscores the value of collaboration in designing effective climate solutions. This inclusive approach has provided insights into community priorities, resource gaps, and potential synergies, laying the foundation for actionable strategies that align with national and international climate frameworks.

As Kumbungu District embarks on the implementation of these recommendations, the focus must remain on empowering women, reducing systemic barriers, and fostering collective action to address climate vulnerabilities.

7.2 Strengthening Gender-Responsive Governance

Effective climate adaptation in Kumbungu District hinges on the district’s ability to enhance and sustain governance structures that prioritize gender equity. Climate change disproportionately affects women, youth, and marginalized groups, often due to systemic barriers in resource access, decision-making, and economic opportunities. The integration of gender considerations into governance frameworks is therefore critical for ensuring that adaptation strategies are inclusive, equitable, and effective.

The district's existing Gender Desk provides a strong foundation for coordinating gender-responsive initiatives. This office can play a pivotal role in embedding gender equity into climate adaptation planning and implementation. However, its capacity must be strengthened through adequate resourcing, technical support, and strategic partnerships with civil society organizations (CSOs) and development agencies.

Participatory processes, such as the workshops and community engagements conducted during this assessment, have demonstrated the value of inclusive governance. These initiatives facilitated meaningful contributions from women, youth, and marginalized groups, ensuring their perspectives were considered in the design of adaptation projects. For example, women’s groups highlighted the challenges of balancing caregiving duties with economic activities during climate crises, while youth emphasized the need for skills training in climate-resilient livelihoods.

To further strengthen gender-responsive governance, the district should focus on:

- **Enhancing Capacity at the Gender Desk:** Provide the Gender Desk with additional resources and training to lead climate adaptation efforts effectively. This includes equipping staff with tools for conducting gender analysis and monitoring the impacts of adaptation projects on different demographic groups.

- **Institutionalizing Gender Analysis in Policy Design:** Ensure that all climate adaptation policies and projects undergo a thorough gender analysis to address inequalities and promote inclusivity.
- **Formalizing Participatory Governance Mechanisms:** Build on the success of recent workshops by establishing permanent forums or committees where women, youth, and marginalized groups can engage with district officials regularly on climate issues.

In addition, traditional leaders and CSOs must remain integral to governance processes. Traditional leaders can advocate for cultural shifts that support women's involvement in decision-making, while CSOs can provide technical expertise and amplify the voices of marginalized communities. Partnerships with these stakeholders will ensure that governance systems are both inclusive and effective.

The participatory groundwork laid during this assessment underscores the potential for gender-responsive governance to transform climate adaptation planning in Kumbungu District. The district can create governance frameworks that not only address current climate vulnerabilities but also support long-term, inclusive development by capitalizing on existing structures like the Gender Desk and fostering greater collaboration among stakeholders. This approach ensures that every group has a voice in shaping a resilient and equitable future.

7.3 Leveraging Climate Finance and Community-Led Mechanisms

Accessing and utilizing climate finance is a cornerstone of effective climate adaptation in Kumbungu District. While national and international funding mechanisms provide significant opportunities, community-led financing models are equally critical to fostering resilience and ownership at the grassroots level. By blending external resources with innovative local approaches, Kumbungu can address its diverse climate vulnerabilities while empowering its residents.

The district must focus on establishing systems that ensure equitable access to financial resources, particularly for women, youth, and marginalized groups who are disproportionately affected by climate change. This requires leveraging large-scale funding opportunities, such as the Green Climate Fund (GCF) and Ghana's National Adaptation Plan (NAP), alongside fostering community-driven solutions like savings groups, crowdfunding platforms, and village-level adaptation funds.

Table 33 outlines key mechanisms for accessing climate finance, specific actions required to operationalize these mechanisms, their expected outcomes, and potential collaborators. This comprehensive approach ensures that the district's adaptation strategies are inclusive, impactful, and sustainable.

Table 33: Leveraging climate finance and community-led mechanisms

Mechanism	Action	Expected Outcome	Potential Collaborators
National and International Climate Finance	Train district staff and CSOs in proposal development aligned with GCF and NAP priorities.	Increased access to large-scale funding for projects like flood-proof roads and irrigation systems.	EPA, UNDP, Ministry of Finance, GCF, Adaptation Fund
	Partner with national agencies for technical support.	Enhanced alignment with national climate goals.	
Community Climate Adaptation Funds (CCAFs)	Establish village-level funds managed by community representatives.	Strengthened community ownership of adaptation initiatives.	Local NGOs, Traditional Leaders, CSOs
	Use pooled resources for local projects like rainwater harvesting and tree planting.	Resources directed to locally relevant projects.	

Mechanism	Action	Expected Outcome	Potential Collaborators
Crowdfunding Platforms	Create digital platforms to raise funds from diaspora, businesses, and supporters.	Increased financial support for high-priority adaptation projects.	Private Sector, CSOs, District Assembly IT Team
	Highlight local adaptation success stories		
Community Bonds	Issue low-risk bonds to finance large-scale projects like solar irrigation and flood-resistant infrastructure.	Mobilized local investments to support critical adaptation needs.	Local Businesses, Banks, Development Partners
Microfinance Programs	Develop low-interest loans tailored for women-led cooperatives and smallholder farmers.	Empowered women and youth entrepreneurs in climate-smart trades and agriculture.	GHAMFIN, Rural Banks, Women-Led Cooperatives, IFAD
	Provide grants for start-up adaptive technologies		
Savings and Loan Associations (VSLAs)	Scale up VSLAs to rural areas, providing accessible financing for household-level adaptation measures.	Increased financial independence for vulnerable households.	Local NGOs, Community Leaders, Microfinance Institutions
Subsidized Inputs and Equipment	Provide affordable access to climate-smart technologies like drip irrigation and drought-tolerant seeds.	Enhanced agricultural productivity and reduced vulnerabilities for smallholder farmers.	MoFA, SARI, Private Sector
Climate Insurance Schemes	Introduce weather-indexed insurance to protect farmers against losses during extreme weather events.	Reduced economic risks for farmers during floods or droughts.	Insurance Companies, Banks, Development Partners, MoFA
	Subsidize premiums for women-led farms.		
Transparent Monitoring Systems	Implement gender-disaggregated tracking of financial resources and project impacts.	Greater accountability and equitable distribution of resources.	District Assembly, Local Communities, CSOs, Auditing Agencies
	Form community oversight committees.		

7.4 Building Resilience Across Sectors

The vulnerabilities identified in the Kumbungu District cut across social, economic, and physical dimensions, requiring integrated, multifaceted interventions. Addressing these challenges involves tailoring strategies to the specific needs of communities while ensuring inclusivity, sustainability, and equitable outcomes. The following approaches outline actionable pathways to build resilience across sectors (**Table 34**).

Table 34: Key action for building resilience across sectors

Sector	Key Actions	Expected Outcomes	Potential Collaborators
Social	**Foster Social Cohesion** • Integrate marginalized groups into adaptation initiatives. • Conduct community-led programs like tree-planting and disaster preparedness.	Increased inclusion of women, youth, PWDs, and migrants.	CSOs, Community Leaders, UNICEF, NADMO

Sector	Key Actions	Expected Outcomes	Potential Collaborators
	Alleviate Caregiving Burdens • Establish mobile childcare centers during climate crises. • Train community volunteers to assist with caregiving.	Greater participation of women in decision-making and economic activities.	
	Strengthen Community Networks • Create village-level adaptation committees for collective action.	Enhanced community preparedness and cohesion	
Economic	**Promote Adaptive Livelihoods** • Support cooperatives in climate-resilient trades like shea processing. • Provide climate-smart agricultural tools and training.	Increased income and financial security for women and youth.	GHAMFIN, MoFA, CARE International, Private Sector
	Expand Financial Access • Develop microfinance schemes and VSLAs. • Provide grants and subsidies for smallholder farmers.	Improved agricultural productivity and sustainability.	
	Strengthen Market Linkages • Facilitate access to markets via digital platforms and cooperatives. • Build processing facilities for value addition in agriculture.	Reduced reliance on climate-sensitive livelihoods.	
Physical	**Invest in Resilient Infrastructure** • Construct flood-proof roads, bridges, and irrigation systems. • Upgrade drainage systems in flood-prone areas.	Reduced infrastructure damage during extreme weather events.	WRC, Forestry Commission, World Bank, SARI
	Develop Water Conservation Systems • Install rainwater harvesting systems and boreholes. • Promote efficient irrigation technologies like drip irrigation.	Improved water availability for households and farms.	
	Implement Land Management Practices • Establish terracing and reforestation programs. • Provide training on sustainable land management practices.	Enhanced soil fertility and long-term agricultural sustainability.	

Moving forward, the next vital step is to develop a comprehensive Climate Action Plan for the Kumbungu District. This plan will outline specific adaptation actions and clearly prioritize interventions tailored to address the district's diverse economic, social, and physical vulnerabilities. It will incorporate community-specific strategies to enhance resilience, paying particular attention to gender equity and the inclusion of marginalized groups. The plan will also identify practical financial mechanisms, exploring options for local and external funding sources, public-private partnerships, and community-based financing schemes. This inclusive and strategic approach will enable the district to proactively respond to climate challenges, securing sustainable and resilient livelihoods for all community members.

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