Volta Flood and Drought Management

ADAPTATION FUND

MISSION TO STRENGTHEN POLITICAL, INSTITUTIONAL AND ORGANIZATIONAL CAPACITIES FOR INTEGRATED MANAGEMENT OF FLOOD AND DROUGHT RISKS IN THE VOLTA BASIN

DOCUMENTS REVIEW AND VISITS REPORT OF THE PILOT SITES OF THE VFDM PROJECT DOWNSTREAM OF BAGRE DAM

JULY 2024

WORLD METEOROLOGICAL ORGANIZATION

AUTORITÉ DU BASSIN DE LA VOLTA — VBA — VOLTA BASIN AUTHORITY

Global Water Partnership West Africa

Table of Contents

List of Figures

List of Tables

Acronyms

Abbreviation	Connotation
AAP	Annual Action Plan
AF	Adaptation Fund
APFM	Associated Programme on Floods and Drought
AU	African Union
CBFDM	Community-based Floods and Drought Management
CCA	Climate Change Adaptation
COM	Community Ownership and Management
CSIR	Council for Scientific and Industrial Research
CSOs	Community Based Organizations
DA	District Assembly
DLDD	Desertification, Land Degradation and Drought
DS-SLM	Decision Support for Mainstreaming and Scaling Out Sustainable Land Management
E2E-EWS-FF	End-to-end Early Warning System and Flood Forecasting
ECOWAS	Economic Community of West African States
EPA	Environmental Protection Agency
FAO	Food and Agricultural Organization
GIDA	Ghana Irrigation Development Authority
GMet	Ghana Meteorological Agency
GSS	Ghana Statistical Service
GWCL	Ghana Water Company Limited
GWP-WA	Global Water Partnership in West Africa
HYDRO	Ghana Hydrological Authority
IFRM	Integrated Flood risk Management
IMFDR	Integrated Management of Flood and Drought Risks
IUCN-PACO	International Union for Conservation of Nature - Programme for Central and West Africa
IWRM	Integrated Water Resources Management
LUSPA	Land Use and Spatial Planning Authority

Abbreviation	Connotation
MESTI	Ministry of Environment Science, Technology and Innovation
MMDAs	Metropolitan Municipal and District Assemblies
MOFA	Ministry of Food and Agriculture
MP	Member of Parliament
NADMO	National Disaster Management Organization
NAP	National Adaptation Programme
NCCAS	National Climate Change Adaptation Strategy
NCCC	National Climate Change Committee
NCWSS	National Community Water and Sanitation Strategy
NDPC	National Development Planning Commission
NGOs	Non-Governmental Organizations
PAGEV	Project for Improving Water Governance in the Volta Basin
SAP	Strategic Action Plan
SEPO	Success Potential Failures and Obstacles
SLM	Sustainable Land Management
SPSS	Statistical Package for Social Science
UNDP	United Nations Development Programme
VBA	Volta Basin Authority
VFDM	Volta Flood and Drought Management
VRB	Volta River Basin
WB	World Bank
WMO	World Meteorological Organization
WRC	Water Resources Commission
WRI	Water Research Institute
WSSDP	Water Sector Strategic Development Plan

1. Context and Rationale

Ghana, a West Africa country, is among the most flood-prone countries in the region due to its frequent floods. At the same time, drought features prominently, especially in the northern parts of the country. These natural disasters cause great harm, especially to the poor. The causes of floods and droughts vary in Ghana. An excessive amount of precipitation combined with excess water spillage from Burkina Faso's Bagre Dam causes constant flooding in the upper reaches of the White Volta Basin in Ghana. Similar to this, the Volta River Basin (VRB) frequently experiences severe droughts and floods, which makes life more difficult for communities already struggling with unpredictable weather. The effects go beyond the loss of human life to include significant financial losses, which emphasizes how urgent it is to implement changes in these susceptible areas.

In response to the problems of flooding and drought in the Volta Basin (VB), the World Meteorological Organization (WMO), the Volta Basin Authority (VBA), the Global Water Partnership in West Africa (GWP-WA) and the relevant national structures of the VBA Member States are implementing the Volta Flood and Drought Management (VFDM) project. Entitled *"Integrating flood and drought management and early warning for climate change adaptation in the Volta Basin*" from June 2019 to mid-2024. The VFDM project, financed by the Adaptation Fund (AF), prioritizes capacity building of hydrometeorological service providers in the six countries bordering the VB; as well as the development of a flood and drought early warning system (EWS) for the basin, considering civil protection services and other actors concerned.

As part of the VFDM project activities, a VoltAlarm flood and drought forecasting and warning platform has been developed and information bulletins are produced by the VBA and the national structures in charge of hydrology, meteorology, disaster management, and agriculture. A regional strategy for integrated flood and drought risk management was developed together with VB stakeholders.

1.1 Objectives, tasks and deliverables/products expected from the mission

In line with the implementation of the project, this study conducted literature review and field surveys in the sampled areas of the Volta basin, along with several local validation workshops. The study was conducted in the month of March-April, 2024. The main objective of these research activities are to aid;

- Improvement in policies, strategies, plans and instruments as well as decision support for long-term integrated management of flood and drought risks to strengthen resilience to climate change (CC) at local, national and transboundary in the basin;
- Capacity building of actors and decision-makers on policies, strategies, plans and instruments for long-term integrated management of flood and drought risks at local, national, and transboundary levels;
- The development of a collaborative process to ensure that policies, strategies, plans and instruments for long-term integrated flood and drought risk management are accepted by local organizations and communities and adapted to the local context.

2. Methodological approach

2.1 Research design

The research applied the mixed methods approach. This involved qualitative secondary review of relevant policies, strategies and planning documents on DRR and CCA in the Volta basin and quantitative analysis from field surveys. This strategy is to ensure a comprehensive analysis by gathering in-depth qualitative insights and survey-based quantitative data. The utilization of both methods facilitated increased reliability.

The desk review entailed a review of literature on all results and products resulting from implementation of the VFDM project as well as the relevant policies, strategies, plans, programs and other instruments and guidance documents on DRR and CCA in the Volta Basin. Other available data on socio-economics and governance issues of drought and floods in the Volta Basin were accessed from national, transboundary and international agencies.

The field study involved a quantitative field survey to collect feedback and suggestions for improvement on floods and drought risk management strategies in an integrated manner, the EWS VoltAlarm and other guidance documents on DRR and CCA in Ghana, and by extension, the Bawku West located in the Volta basin.

2.1.1 Study area

The survey was conducted in Bawku West in the Volta Basin in Ghana. The entire Volta Basin covers several communities from the Eastern North to the Southern North of Ghana, and extends with several tributaries to the transboundary neighbours of Ghana such as Burkina Faso, Cote

d'Ivoire and Togo. Members of communities in the Volta basin, typically depend on services from the basin's ecosystem (Agodzo, 2014). This report outlines the work done in the area downstream of Bagre Dam in Ghana (Figure 2).

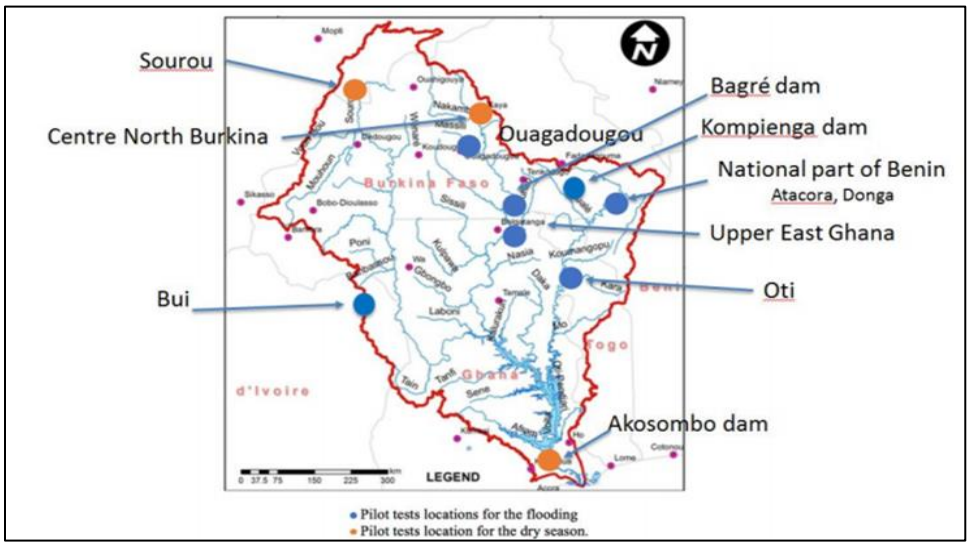


Figure 1: Transboundary Map of the Volta River

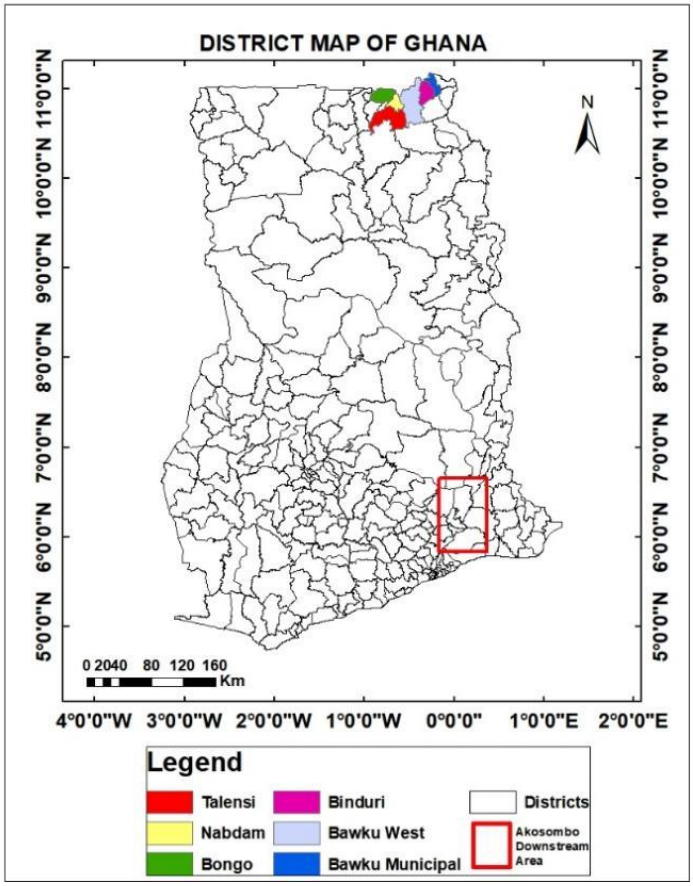


Figure 2: District Map of District Ghana showing selected VFDM Project pilot sites

Bawku West District is one of the fifteen districts in Upper East Region, Ghana. The municipality is located in the eastern part of Upper East Region and has Zebilla as its capital town. It is bordered to the north by the Republic of Burkina Faso, to the east by Binduri District, to the west by Talensi and Nabdam Districts and to the south by East Mamprusi District. The district covers an area of approximately 1,118 Km^2, which constitutes about 12% of the total land area of the Upper East Region. It is the fourth biggest district in the region in terms of land mass.

According to the 2010 population and housing census, the total population was 94,034 representing 9.0 percent of the region's total population. Males constitute 48% and females, 52% of the district's population. Agriculture is the major employment opportunity in the district, noting that majority of the respondents interviewed were employed in the agriculture sector. However, only 27% of respondents indicated they had secondary employment. Also, there was huge dependence on ecosystem services for water and fuelwood. 93% of houses were constructed with mud, with the remaining being fully constructed with cement block.

2.2 Sampling Strategies

A stratified random sampling method was used to select a representative sample of communities within the identified project sites in the Volta Basin based on their geographical location or historical vulnerability to flood and drought risks.

The sample size of at least 200 respondents was distributed using equal weights across the districts. The sample sizes for each identified district was then allowed to be increased up to ten (10) participants to account for non-response and other challenges that could reduce the desired sample size.

2.3 Primary Data Collection

In all, 217 respondents were interviewed in seven selected communities of which 56% were males (Figure 3). The average age of survey respondents was estimated at 43 years old, with the minimum age recorded at 17 and maximum at 91 years. Largely, the respondents interviewed were natives, with only 5% migrants/settlers. Also, a significant proportion of respondents were not literate (70%) while majority of the remaining 30% had primary education.

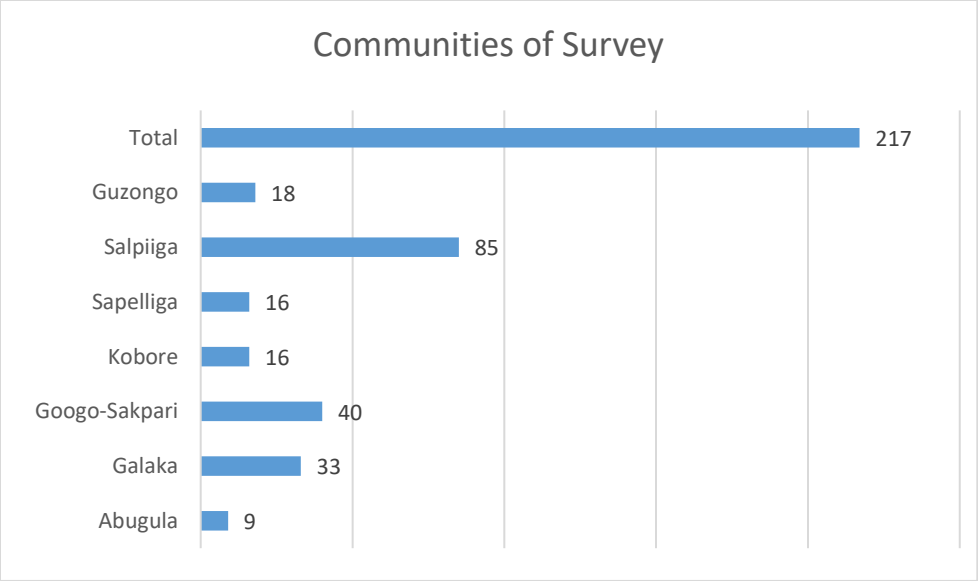


Figure 3: Number of respondents in surveyed communities

The interviews began on the 5th April and ended on the 10th April, 2024. Considering the technical nature of the study and driven by the desire to produce quality work, conscious efforts were made to build and strengthen the technical capacity of the field enumerators/investigators on the survey instrument used for the study. A one-day hybrid training session was organized to train enumerators on survey techniques and survey instruments. In total, five (5) enumerators were used for the data collection process.

To ensure a smooth data collection exercise vis a vis commutation in the communities, the district and assembly person(s) of each community was consulted ahead of time to facilitate the community entry and awareness creation of the exercise in the various communities.

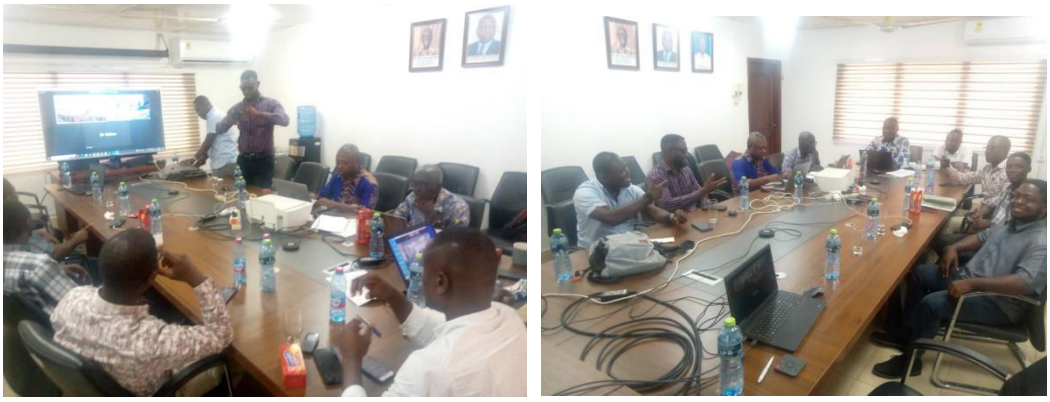


Figure 4: Images from 1-day enumerators hybrid training workshop

2.4 Secondary Data Collection

In total, 32 national, regional, and international documents were reviewed. Out of the total number of documents, 18 were at the national level whereas, 14 were at the regional or transboundary level. The collection of relevant literature for the desk review of the implementation of the VFDM project as well as the relevant policies, strategies, plans, programs, and other instruments and guidance documents on DRR and CCA in the Volta Basin involved in a two-stage task approach. The review process includes a secondary review of documents relevant to the VFDM Project. The review also included suggested documents from stakeholders during a national workshop on Integrated Flood and Drought Management.

The first stage of the review involved collating an identified set of policies, strategies, guidelines and plans proposed by the project along with identified secondary documents from a search of relevant national, regional and international related to disaster risk reduction (DRR) and climate change adaptation (CCA).

In the second stage, the gathered documents were meticulously reviewed and analysed to extract pertinent information and insights. Key search terms and criteria were employed to ensure a comprehensive and collection of relevant data as well as aligning it with broader DRR and CCA strategies. This systematic approach ensured that the desk review was thorough, well-informed, and provided a solid foundation for understanding the project's alignment with existing frameworks while identifying areas for improvement.

2.5 Data Analysis

The study employed mixed data analysis approach, consisting of both quantitative and qualitative analysis for the data collected. The quantitative data were analysed using statistical software such as SPSS, STATA and Microsoft Excel to generate descriptive statistics and inferential analysis to assess the survey data. Qualitative data analysis was conducted using thematic analysis to extract key themes and insights. The qualitative data were thus transcribed, coded by themes and patterns related to the research questions and analysed using qualitative data software such as Atlas TI and GPT-4. The qualitative method provide context to the quantitative finding.

The analysis of secondary data and information focused in particular on the SEPO matrix (Success, Potential, Failures and Obstacles). It is a prospective evaluation tool allowing you to take advantage of lived experiences to improve performance and future interventions. It is mainly used

in a participatory manner so that the opinions of stakeholders in the evaluation experience can be taken into account.

Rapid document analysis of the policy, strategy, orientation and literature documents was also conducted adopting the framework in Table 1.

Table 1: Grid of Elements for review of documents

Document type	Document title	Level	Objectives/ visions	Contribution to the global vision	Type of problems considered	Proposed measure
Risk map, strategy document, consultation report, etc.		(national or regional)				

3. Results and Documentary synthesis

3.1 Legal and regulatory framework

Existing legal and regulatory frameworks relevant to enhance Ghana's drought and flood management as reviewed are presented in **Erreur ! Source du renvoi introuvable.**. Generally, the objectives of the reviewed documents focused on evaluating current flood and drought management policies in the Volta River Basin and improving early warning systems for this purpose. They also include promoting integrated water resources management, sustainable development, and climate resilience by addressing socioeconomic issues and environmental risks. To achieve comprehensive and sustainable management of water resources for the benefit of current and future generations, these objectives seek to promote collaboration, knowledge-sharing, and stakeholder engagement.

Moreover, out of 32 documents that were reviewed, 10 of them had explicit gender-specific objectives, while the others mainstreamed gender into their implementation. The summary of the gender specific objectives is three-fold and are as follows;

- To increase knowledge and capacity building on gender-responsive climate policies and strategies
- To empower and build capacity for equity and gender sensitivity in water governance
- To establish consultation groups and support for flood management plans with considerations for gender and disability.

Table 2 Directory of reviewed legal and regulatory frameworks and their objectives

No	Document full title	Document Objectives/vision
1.	Assessment of plans, policies, and guidelines related to the long-term management of floods and drought in the Volta basin existing at the level of six (6) countries (Ghanaian portion)	•The objective of this assignment is to assess existing policies on flood and drought management for the Volta river basin which includes the Red Volta, White Volta, Black Volta and the Oti River basins •To conduct a desk review and organize virtual or face to face meetings with the National Agencies/partners to identify the status of climate and socioeconomic change in national and transboundary governance plans, policies and guidelines for flood and drought management, including the Strategic Action Program of the Volta basin, the Master Plan for Sustainable Development and Water Management (MPSDWM), etc.
2.	Early warning systems and disaster risk reduction: A comprehensive guide	To equip the reader with knowledge on the different components of an early warning system, their benefits, challenges and the latest technology employed in these life-saving systems
3.	Manual on Community-based Floods and Drought Management in the Volta Basin	a) To contribute, on the specific basis of the VFDM project, to further advance the APFM understanding of the community management of floods and drought b) To highlight the activities implemented, experiences and results of the CBFDM in the Volta Basin countries under the framework of the VFDM project in this regard c) To make available to all those who, from different perspectives (local administrations, technical services, NGOs and civil society organizations, community leaders and communities, the world of scientific research, etc.) are involved in the daily management of floods and drought, a series of concepts, suggestions, and useful tools d) To scan how similar tools, methodologies, and implementation strategies can be applied in other communities of the Volta Basin region having similar needs in managing floods and drought events
4.	Volta Basin Transboundary Diagnostic Analysis	A scientific assessment of the threats to the water resources of the basin and their underlying causes, which will serve as a reliable platform for the drafting of an up-to-date SAP.
5.	Ghana National Climate Change Policy	• Develop climate-resilient agriculture and food security systems. Build climate-resilient infrastructure. • Increase resilience of vulnerable communities to climate-related risks. Increase carbon sinks. Improve management and resilience of terrestrial, aquatic and marine ecosystems. • Address impacts of climate change on human health. • Minimize impacts of climate change on access to water and sanitation. • Address gender issues in climate change. Address climate change and migration. • Minimize greenhouse gas emissions.
6.	Strategic Action Programme for the Volta Basin	The vision for the SAP is: “A basin shared by willing and cooperating partners managing the water resources rationally and sustainably for their comprehensive socioeconomic development.”
7.	Exposure Impact Maps	Generate maps to showcase flood and drought exposure situations for the Volta Basin

No	Document full title	Document Objectives/vision
8.	National Action Programme to Combat Drought and Desertifcation	The purpose of the study was to develop, in line with the provisions of the global desertification convention, a National Action Programme (NAP) for Ghana through a broader consultative approach by identifying the causes of the alarming rate of desertification and impacts at local, national, international and global levels and recommending possible prevention and remedial actions for implementation to reduce the impact of drought on the country and to halt the rate of desertification in the country.
9.	National Biodiversity Strategy and Action Plan	• To address the underlying causes of biodiversity loss by mainstreaming biodiversity into all sectors of government and society programmes; • To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity; • To enhance the benefits of biodiversity to all sectors of the economy; • To enhance implementation of national biodiversity action plan through participatory planning, knowledge management and capacity building.
10.	Volta Basin Authority Strategic Plan 2010-2014	A basin shared by willing and cooperating partners managing the water resources rationally and sustainably for their comprehensive socio-economic development »
11.	National Community Water and Sanitation Strategy (NCWSS)	The vision of the water sector, as per the Water Sector Strategic Development Plan (WSSDP), stipulates that: 'all people living in Ghana have access to adequate, safe, affordable and reliable water service, practise safe sanitation and hygiene, and that water resources are sustainably managed'.
12.	The Sustainable Land Management Mainstreaming Tool	• The objective of the Decision Support for Mainstreaming and Scaling Out Sustainable Land Management (DS-SLM) is to provide elements for the design of operational strategies and action plans for mainstreaming and scaling up SLM. • The aim of DS-SLM mainstreaming strategies is to guide DS-SLM national teams and other SLM-related projects in establishing processes for mainstreaming information on Desertification, Land Degradation and Drought (DLDD) and Sustainable Land Management (SLM) into national and subnational decision-making processes.
13.	National Climate Change Adaptation Strategy	1. Improve societal awareness and preparedness for future climate change; 2. Enhance the mainstreaming of climate change into national development to reduce climate change risks; 3. Increase the robustness of infrastructure development and long-term investments; 4. Enhance the adaptability of vulnerable ecological and social systems by increasing the flexibility and resilience of these systems; 5. Foster competitiveness and promote technological innovation
14.	National Integrated Water Resources Management (IWRM) Plan – Ghana Water Resources Commission	· Strengthen the regulatory and institutional framework for managing and protecting water resources for water security and enhancing resilience to climate change · Enhance public awareness and education in water resource management issues · Improve access to water resources knowledge base to facilitate water resources planning and decision making · Improve trans-boundary and international cooperation in the management of shared water resources · Ensure gender equity in water resources management and planning · Develop and operationalise a national M&E system to track progress in

No	Document full title	Document Objectives/vision
		IWRM implementation
15.	Outlines and Principles for Sustainable Development of the Volta Basin	1. Strengthening policies, legislation and institutional framework; 2. Strengthening the knowledge base of the basin; 3. Coordination, planning and management; 4. Communication and capacity building for all stakeholders; 5. Effective and sustainable operations
16.	Ghana National Water Policy	• To achieve sustainable development, management and use of Ghana's water resources to improve health and livelihoods, reduce vulnerability while assuring good governance for present and future generations
17.	Regional Flood Risk Management Strategy and 2020 -2025 Action Plan	• Improve collaboration and develop synergy among the various institutions involved in flood risk management • Harmonise flood risk management approaches among ECOWAS Member States • Establish and/or strengthen the flood warning system and dissemination of information on climate risks among Member States and in the region • Integrate flood risks in development planning in Member States
18.	National Climate Change Policy Action Programme for Implementation: 2015–2020	• Develop climate-resilient agriculture and food security systems • Build climate-resilient infrastructure • Increase resilience of vulnerable communities to climate-related risks • Increase carbon sinks • Improve management and resilience of terrestrial, aquatic and marine ecosystems • Address the impact of climate change on human health • Minimize the impact of climate change on access to water and sanitation • Address gender issues in climate change • Address climate change and migration • Minimize greenhouse gas emissions.
19.	Action plan for the effective participation of women and vulnerable groups in integrated management and early warning of floods risk in the Volta Basin	• Improve the governance framework of the IFRM and the E2E-EWS-FF processes integrating gender in the Volta basin; • Strengthen the capacities of actors for gender mainstreaming into the IFRM and the E2E-EWS-FF processes including the related PPBS chain at all levels in the Volta basin; • Increase women's engagement and leadership in the IFRM and the E2E-EWS-FF processes in the Volta basin; • Document and promote best practices and successful experiences of effective gender mainstreaming, including women and vulnerable groups, in the IFRM and the E2E-EWS-FF processes in the Volta basin.
20.	IFM Ghana Needs Assessment Report	•Assessing the previous impacts of flooding in Ghana, particularly in the Volta basin. •Performing a vulnerability assessment related to flood risk management, considering economic, social and environment vulnerabilities. •Examining the institutional environment related to flood management in Ghana, including key actors, coordination mechanisms and policy frameworks.
21.	Strategy for flood and drought risk reduction and management in the Volta Basin and its Action Plan	By 2030, the Volta Basin has operational mechanisms (institutional, legislative, and financial) for concerted and integrated flood and drought risk management, ensuring community resilience to climate change, sustainable and inclusive socio-economic development, as well as protection of ecosystems and optimization of water resources.

No	Document full title	Document Objectives/vision
22.	Volta Flood and Drought Risk Profile	The Volta disaster risk profile relates information on natural hazards, specifically floods and droughts, to the basin population and economic exposures and vulnerabilities.
24	"Ghana WASH Sector Development Programme (GWASHSDP) 2021-2030"	•To ensure that efforts to deliver WASH services are well-coordinated in order to achieve national, regional, and global goals and targets. •To address key sector challenges that limit the provision and sustenance of WASH services and the conservation of water resources, through strategic planning, institutional development, and system strengthening. •To encourage wider stakeholder participation in the planning, implementation, monitoring, and reporting processes in water resources management, WASH service delivery and management.
25	National Irrigation Policy, Strategies and Regulatory Measures	•Performance and Growth: Realize the productive capacity of existing irrigation assets Respond to new demands for irrigated production through coordinated public and private initiatives •Socio-Economic Inclusion: Remove constraints to balanced socio-economic engagement with land and water resources Promote equitable access and participation, especially for women •Responsible Production: Raise the environmental performance of all irrigation and agricultural practices Ensure sustainable use of water resources and mitigate negative environmental impacts
26	Land Use and Spatial Planning Authority	•Provide a summary of the background to the Land Use and Spatial Planning Act of 2016 (Act 925) and regulations derived from it. •Explain the structure and functions of planning institutions at the regional and district levels. •Detail the requirements and processes for the preparation of spatial plans at different levels. •Describe the procedures and requirements for granting land use and development permits. •Highlight regulatory compliance and enforcement mechanisms, including notices of infringement and appeal procedures.
27	National Building Regulations 1996(LI 1630)	Providing regulations and guidelines for the application and approval of building plans. Setting standards for plot development, site preparation and landscape design. Establishing requirement for materials used in building construction
28	Water Charter for the Volta River Basin	The general purpose of the present Water Charter is to set out the principles, procedures, rules and modalities for the equitable, coordinated, sustainable use of shared water resources in the Volta Basin as a contribution to the sustainable development of the Volta Basin, in accordance with the mandate of the Volta Basin Authority
29	Environmental Sanitation Policy	the overall goal of the Environmental Sanitation Policy is to develop a clear and nationally accepted vision of environmental sanitation as an essential social service and a major determinant for improving health and quality of life in Ghana

No	Document full title	Document Objectives/vision
30	Ghana: Roadmap for Resilient Infrastructure in a Changing Climate	to identify and propose solutions to address priority adaptation needs in Ghana
31	Ghana Hydrological Authority Bill,2021	The purpose of the Bill is to establish the Ghana Hydrological Authority to promote the delivery of hydrological services for planning, design, execution, operation and maintenance of flood control mechanism, works related to coastal engineering, sewage, drainage improvement and river development, operational and applied hydrology.
32	West Africa Food System Resilience Programme	The programme's development objective is to increase preparedness against food insecurity and build resilience of food systems in participating countries.

3.2 Strategic framework

Out of the 32 documents examined, 18 reported on agreements related to water management, while 14 of themdid not indicate management strategies.. Examples of frameworks identified and recommended for effective flood and drought management include:

a. International Agreements and Commitments:

- Bilateral agreements like the Code of Conduct of the Ghana-Burkina Joint Technical Committee on IWRM provide specific principles for sustainable water resource management.
- Commitment to international laws, protocols, agreements, and declarations strengthens Ghana's water management framework.
- The Convention (2007) ratified by the six countries that led to the establishment of the Volta Basin Authority

b. Institutional Framework:

- Establishment of institutional frameworks at national and local levels, such as the Water Resources Commission (WRC) and river basin boards, to oversee water management.
- The Volta Basin Authority (VBA) plays a crucial role in stakeholder dialogue and integrated water resources management.

c. Role of Specialized Institutions:

- Specialized institutions like AGRHYMET centre and ACMAD are designated to provide forecasts and support on environmental issues.

d. Policy Development and Planning:

- Development of policies such as the National Climate Change Policy and Ghana Water Policy, as well as, the National Integrated Water Resources Management and the Strategy for flood and drought risk reduction and management in the Volta Basin and its Action Plan, provide strategic guidelines for sustainable water management.

- Creation of strategy documents like the Master Plan for Sustainable Water Resources Development and Management outlines policy regulations for water resource management in the \volta Basin.

e. Stakeholder Engagement and Socio-economic Integration:

- Promoting continuous stakeholder dialogue and integrating water resources management to reduce poverty and enhance socio-economic integration in the region.

f. Balancing Economic Development and Ecosystem Preservation:

- Addressing conflicts between economic development and ecosystem preservation is essential in shaping water management strategies.

3.3 Institutional framework

Major organizations were listed in the documents reviewed as proposed stakeholders for implementing measures targeted at improving floods and drought risk management. The main institutions listed as responsible for measures implementation from the documents reviewed are diverse stakeholders from the Ministries and Government Agencies, Development Partners and NGOs/CSOs.

Among the main ministries prominent in the formulation of relevant integrated drought and flood management policies, strategies and guideline include the Ministry of Environment Science, Technology and Innovation (MESTI), Ministry of Sanitation and Water Resources, Ministry of Works and Housing, the Ministry of Food and Agriculture (MoFA), Ministry of Finance and Economic Planning, Ministry of Local Government and Rural Development, Ministry of Energy, and the Ministry of Health

Other government agencies and departments at national and transboundary scales significantly relevant in the development of strategies and management guidelines include the Environmental Protection Agency (EPA), Ghana Hydrological Authority, Ghana Irrigation Development Authority (GIDA), Metropolitan, Municipal and District Assemblies (MMDAs), Ghana Water Company (GWCL), Land Use and Spatial Planning Authority (LUSPA), Ghana Meteorological Agency, Directorate of Humanitarian and Social Affairs, National Climate Change Committee, Water Resources Commission of Ghana, National Development Planning Commission (NDPC), Ghana Statistical Services (GSS), CSIR-Water Research Institute and the Volta Basin Authority (VBA).

As well the review found that prominent international development partners and NGOs key in Ghana's development of flood and drought management strategies include the World Meteorological Organization (WMO), the World Bank, United Nations Development Programme (UNDP), ECOWAS, the Food and Agriculture Organization of the United Nations (FAO), Country Water Partnership (CWP-Ghana) of the Global Water Partnership (GWP), Tomorrow.io and the Community Water and Sanitation Agency (CWSA) of Ghana.

Further, the existence of institutional or organizational frameworks for management in the context of vertical integration, horizontal integration, and cross-sectoral integration is crucial for effective disaster risk reduction and water resources management. The highlighted institutional or organization frameworks include:

1. **ECOWAS Coordination:** The ECOWAS is positioned to collaborate closely with stakeholders and partners to reduce disaster risks and enhance resilience in West Africa, demonstrating vertical integration across regional levels.
2. **Volta Basin Authority (VBA):** Established in 2009, the VBA facilitates stakeholder dialogue, integrates water resources management, and promotes equitable sharing of benefits, showcasing horizontal integration across multiple stakeholders. Further**,** the integration of the Strategic Action Plans (SAP) within VBA's institutional framework showcases vertical integration, with VBA overseeing coordination, implementation, and oversight.
3. **Community Floods and Drought Management Committees:** The establishment of community floods and drought management committees through community constituents highlight vertical integration, ensuring grassroots representation in decision-making processes.
4. **National Inter-Ministries and Inter-Agency Councils:** These entities, responsible for natural resource management, demonstrate horizontal integration across government sectors.
5. **Multi Donor Budget Support:** Donor financial support integrates policies into sectoral programs across ministries, showcasing horizontal integration in budget allocation and implementation.
6. **National Focal Structures:** These facilitate vertical integration by linking VBA with local institutions for effective implementation.
7. **Enabling Institutional Frameworks:** Establishment of Water Resources Commission (WRC) and river basin boards demonstrates horizontal integration at national and local levels.
8. **Legislative Instruments and Bye-laws:** These provide legal frameworks for monitoring and enforcement of water standards, showcasing cross-sectoral integration for regulatory compliance.
9. **Sendai Framework for Disaster Risk Reduction:** Its adoption and implementation underscore international priorities for disaster reduction, demonstrating vertical integration across nations.
10. **State Institutions and Private Companies in Ghana:** These entities, including the Water Resources Commission and Hydrological Services Department, collaborate at national and local levels, showcasing horizontal integration in flood management.
11. **Comprehensive Regional and Nation Flood and Drought Frameworks:** These provide an enabling capacity for sustainable flood and drought management, guiding expertise coordination, enhancing access to information, and supporting mainstreaming of projects, showcasing cross-sectoral integration for effective disaster risk reduction.

12. **National Community Water and Sustainable Land Management Projects:** Projects and programmes supports water, sanitation, and hygiene activities, through operational strategies and action plans. The projects therefore integrate sustainable land management frameworks into national policies, demonstrating cross-sectoral integration for environmental sustainability for a holistic water management.

3.4 Management instruments

The measures proposed for managing droughts and floods in the Volta River Basin from the documents reviewed encompass various strategies, including:

a. **Preventing Excessive Expenditure and Promoting Development:**
   - Enforcing buffer zone laws and the National Water Policy to prevent settlement near riverbanks.
   - Investing in early warning systems (EWS) technology and fostering collaboration among stakeholders including government, research institutions, NGOs, meteorological agencies, and communities.

b. **Adopting Resilient Agricultural Practices:**
   - Cultivating short-cycle and moisture-resistant crops such as Fonio, small millet, and small beans.
   - Avoiding cultivation in fields near water streams and promoting the growth of heat-resistant and long-cycle crops like Millet, Vandzou, and Sorghum.

c. **Building Climate-Resilient Infrastructure and Environmental Conservation:**
   - Constructing infrastructure resilient to climate change.
   - Increasing carbon sinks, minimizing greenhouse gas emissions, conserving ecosystems, and ensuring water quality.

d. **Promoting Socially Acceptable and Sustainable Solutions:**
   - Raising awareness on the environmental implications of desertification reversal.
   - Implementing forestry and wildlife interventions and strengthening policies and institutional frameworks.

e. **Regional Cooperation and Financial Mobilization:**
   - Creating consultative frameworks between riparian countries for joint basin management.
   - Developing national and regional strategies for financial resource mobilization for integrated water resources management.

f. **Enhancing Agricultural and Water Resource Management:**

- Expanding and intensifying irrigated agriculture for food security and poverty alleviation.
- Promoting partnerships between public and private sectors for water resource protection and conservation.

g. **Improving Disaster Preparedness and Gender Mainstreaming:**
   - Establishing flood warning systems and integrating flood risks into development planning.
   - Improving gender mainstreaming in governance processes and enhancing extension support for small-scale irrigated agriculture.

h. **Integration of Indigenous Knowledge and Technological Innovations:**
   - Integrating indigenous knowledge into water resources management.
   - Conducting district-level water resources inventory using remote sensing techniques and expanding small-scale irrigation development.

Implementing flood and drought management strategies in the Volta Basin were shown to encounter a multitude of challenges. Firstly, illegal mining and deforestation activities contribute significantly to environmental degradation, amplifying the risks associated with floods and droughts. This is due to the weak enforcement of environmental laws which exacerbates these issues, allowing harmful practices to persist unchecked. Consequently, poor water quality stemming from pollution sources further complicates management efforts, posing threats to both ecosystems and human health.

Further, the documents highlighted that institutional fragmentation poses another obstacle, as weak coordination among relevant bodies impedes effective planning and implementation of management strategies. Compounding these challenges is the issue of limited funding, which hinders the sustainability of water resource management activities and impedes investment in necessary infrastructure. Furthermore, inadequate data and information on water quantity and flooding hamper informed decision-making and risk assessment processes, undermining the effectiveness of mitigation efforts.

Communication barriers among stakeholders also add further complexity to the situation, inhibiting the sharing of vital knowledge and resources. Moreover, economic and social development pressures, including land-use changes and environmental degradation, contribute to the escalation of flood and drought risks.

Transboundary issues present additional challenges, such as, climate induced changes in water quantity leading to reopening of dams upstream, coastal erosion, invasive species, sedimentation, and loss of vegetation cover. These issues require regional cooperation for effective management. Lastly, the review highlighted that the lack of capacity building among stakeholders on data management and use as well as gender mainstreaming into planning processes, further complicating the task of managing floods and droughts in the Volta Basin.

3.5 Financing mechanisms

In the reviewed documents, 14 out of 32 provided explicit budgetary allocation plans for climate-related actions, indicating a proactive approach towards addressing environmental concerns. This revealed a significant focus on integrating climate-related expenditures into overall budget planning. Moreover, the review showed a positive trend, with 20 documents showcasing commitment towards financing initiatives aimed at climate change management. This includes efforts to secure funding from various sources, indicating a recognition of the importance of financial support in tackling climate challenges.

Conversely, 10 documents lacked indications of innovative financing strategies, suggesting potential gaps or limitations in addressing climate-related issues through financial means alone. This underscores the need for comprehensive strategies to ensure adequate funding for climate adaptation and mitigation efforts.

Four key observations further elucidate the financial landscape surrounding climate change management. Firstly, there is advocacy for dedicating a portion of both national and regional revenues towards climate action, coupled with efforts to garner international support and establish dedicated climate change funds.

Secondly, collaboration with international agencies and financial institutions emerges as a crucial strategy for accessing funding and expertise. Partnerships with entities like the Global Environment Facility and the World Bank can facilitate the implementation of projects addressing climate change and water management.

Thirdly, the importance of robust financial management systems is highlighted, emphasizing the need for efficient planning, budgeting, accounting, and procurement processes to ensure the successful execution of climate-related projects.

Lastly, various resource mobilization strategies are discussed, including public sector investments, private sector participation, and partnerships with regional organizations and donors. These strategies aim to diversify funding sources and enhance the resilience of the water sector against climate impacts.

Furthermore, among the documents, another 14 highlighted the utilization of diverse financial resources to tackle climate change and environmental concerns in Ghana and beyond. These included allocations from national revenue for managing climate events, regional budget allocations for disaster risk management, collaboration with international agencies for knowledge sharing and capacity building, and funding from national budgets, international grants, and specific funds like the National Desertification Fund.

However, it is noteworthy that 18 documents did not explicitly mention the utilization of diverse financial resources. This suggests a potential lack of emphasis on leveraging a variety of funding mechanisms to effectively address climate challenges. Thus, there is a pressing need to promote a comprehensive approach to financial resource mobilization for climate action, encompassing both domestic and international sources, to ensure robust and sustainable climate adaptation and mitigation efforts.

Further, regarding the levels of financial or managerial community cooperation, 18 of the documents indicated the presence of collaborations between communities, while 14 lacked such cooperation. The analysis of the financial or management Cooperation at the community, national and international level revealed that:

Firstly, cooperative strategies emphasised the basin approach towards flood management and transboundary water governance. The basin approach underscores the importance of collaboration between upstream and downstream countries with communities in the Volta basin to share flood information and mitigate risks effectively. This approach aligns with the focus of the Associated Programme on Flood Management (APFM), which prioritizes community-based interventions for better governance of flood and drought events at local, national, and regional levels, showcasing the significance of grassroots involvement in decision-making processes.

Moreover, regional initiatives led by organizations such as the Economic Community of West African States (ECOWAS) demonstrate a concerted effort to mobilize financial resources, support risk evaluation, and build capacity among member states to address water-related risks and disasters. Similarly, initiatives like the Project for Improving Water Governance in the Volta Basin

(PAGEV) by IUCN-PACO highlight efforts to foster dialogue between neighbouring countries such as Ghana and Burkina Faso on transboundary water usage.

Other regional cooperation, as demonstrated by the approval of the Convention for the Volta Basin by multiple countries, illustrates the importance of multilateral agreements and institutional frameworks for transboundary water management. Additionally, the emphasis on collaboration and partnership is evident in the commitment to maintain and strengthen existing collaborations between the Water Resources Commission (WRC) and other agencies and stakeholders. Recognizing water resources as a common heritage that requires collective management and safeguarding, there is an emphasis on the interplay between national and sub-national plans facilitated by effective transboundary cooperation.

At the national level, the active involvement of a wide range of stakeholders in developing the national climate change master plan underscores the significance of inclusive and participatory processes in shaping adaptation and mitigation strategies. Collaboration with donor partners through sector-wide budget support programmes further enables the pooling of resources and untied funds to complement national allocations, enhancing the effectiveness and efficiency of resource utilization. Furthermore, the consultative approach taken in the preparation of strategies such as the National Adaptation Programme (NAP) involved engaging various stakeholders, including local chiefs, district assemblies, and governmental and non-governmental actors, indicating a concerted effort to ensure inclusivity and cooperation in adaptation planning.

Additionally, the National Climate Change Policies emphasizes the integration of climate change considerations into national planning and budgeting processes, reflecting a coordinated effort to align adaptation actions with broader development goals and priorities Furthermore, the establishment of coordination mechanisms such as inter-agency or inter-ministerial committees facilitates information sharing, joint planning, and collaborative decision-making among relevant institutions, enhancing the effectiveness of cross-sectoral cooperation to address interconnected environmental challenges effectively. As well, the emphasis on community ownership and management (COM) underscores the significance of empowering local communities to own and manage their water and sanitation facilities, fostering resilience and sustainability at the grassroots level.

Lastly, the acknowledgment of the need for a mix of public and private, international and domestic sources highlights the importance of a coordinated approach to reinforce existing practices in

national planning and public financial management. Access to comprehensive data from scientific agencies and international organizations like the World Meteorological Organization (WMO) and the Volta Basin authority's development of a strategy for information, communication, and education on flood and drought promotes collaboration through evidence-based decision-making and risk assessment among national governments and local communities, facilitating a unified approach to risk reduction.

In reviewing the financial and managerial cooperation in flood management and transboundary water governance, several gaps emerged. Firstly, while the concept of transboundary water governance is introduced, there is a notable absence of discussion on mechanisms for resolving conflicts and disputes among riparian countries, which is crucial for sustainable water management. Secondly, the documents reviewed presented limited opportunities for financial cooperation. Nonetheless, the few documents that showed financial cooperation were limited in presenting specific financial mechanisms and strategies for cooperative resource mobilization. Lastly, while collaborative planning and decision-making are highlighted, there is insufficient attention given to collaborative monitoring and evaluation mechanisms to assess the effectiveness of cooperation efforts, thereby hindering the ability to learn from past experiences and improve future actions, collectively.

4.0 Field experiments

4.1 Flood risks

The respondents interviewed were largely natives with an average age of 43years, making them very experienced in the flood and drought contexts of their communities. Walkling and Haworth (2020) suggest that understanding the experiences and perspectives of older adults in flood-risk areas is essential for developing effective disaster risk reduction (DRR) strategies that cater to the diverse needs and capacities of at-risk populations.

About 96% of the respondents interviewed noted that they had personally experienced floods in their communities, indicating a high risk to flood events.

The predominance of farming as the primary livelihood for a significant majority of respondents, coupled with the limited presence of secondary employment further exacerbates this vulnerability to livelihoods when floods affect farms, roads and residential or occupational housing. As it

indicates a lack of alternative income sources leading to communities being highly vulnerable to flood risks.

In addition, the results showed that the main material for housing structures in the communities surveyed were largely constructed with mud compared to cement blocks and the remaining 4% made of bricks. Mud houses lack resilience against floods because of the material's vulnerability to water-induced deterioration and structural fragility. This is because, as a building material, mud has a high absorption rate, which means it easily soaks up water during flood (Ayereka and Jaman, 2023; Ahadzie, Mensah and Simpeh, 2022). In a structural survey of flood-damaged houses, Platt et. al., (2020) note that the use of non-flood-resistant building materials contributes to maladaptive outcomes, increasing risks from flooding.

4.1.1 Flooding cases and impacts

Flooding in the Bawku West district (Below Bagre dam) was reported to have resulted in sand deposition on farmland, destruction of farmlands and roads, resulting in loss of trees. This often resulted in food shortages, poverty, and hunger, alongside disease outbreaks and youth migration, which in turn increased social vices.

The communities of the district have suffered loss of income and livestock, with food costs rising significantly. Hardship has increased, grazing areas have reduced, and road networks have deteriorated, forcing many youths to migrate to galamsey (illegal mining) sites and urban areas. There is poor access to drinking water, low crop yields, and increased production costs, along with high temperatures, livestock deaths, and heightened health problems.

The most memorable flood days were observed to have averagely lasted for 16 days. With a maximum of 38 days and a minimum of 1 day. This suggests that on intense flood events, the impact on the district is devastating.

Table 3 Experiences of Communities to flood events

28. What are other notable impacts of the floods on your community?
1. Flooding caused sand deposition on farmland, created streams, and gullies
2. Destruction of farm lands, roads, and loss of trees
3. Food shortages, poverty, and hunger
4. Disease outbreaks, migration of youth, and increased social vices

5. Loss of income, livestock, and high cost of food
6. Shrubs and trees died, erosion, and drying up of water bodies
7. Increased hardship, reduced grazing areas for animals, and poor road networks
8. Migration of youth to galamsey **(illegal mining) sites** and urban areas
9. Poor access to drinking water
10. Flooding led to low crop yields and increased production costs

4.2 Risks of drought

The study explained drought as long period of no rainfall.. The results further showed that, as one moves towards the north of Ghana, the risks of drought increase. Averagely, respondents indicated that the most memorable drought event lasted for 19 months in the area.

85% of the respondents answered that they had experience droughts in the Bawku West district, indicating high incidence of drought events. Nonetheless, the drought risk is further compounded by associated livelihood risks. As a majority agriculture employed district, with limited diversity in alternative livelihood options, respondents noted the livelihood risks associated with the destruction of crops, invasion of pests and diseases, lack of rainfall and drying of water sources.

4.2.1 Drought cases and impacts

In the Bawku West district, the impacts of periods of no rain rainfall and intense heat have had devastating impact on their livelihood and survival.

Respondents noted that the drought had led to significant crop failure, causing economic hardship for individuals due to loss of income and increased food prices. Health issues emerged, including 28 cases in this period. Specifically, there is the increase in mosquito-borne diseases, diseases associated to the poor air quality and in recent years, cerebrospinal meningitis.

Respondents also noted that drought often displaced individuals as the main ecosystem service of water bodies, which people rely on, dry up. Further, households experience psychological distress as people try to cope to the unfortunate condition of sharing water sources with livestock.

As well, environmental degradation and loss of biodiversity are often fuelled by the rampant bush burning. Mobility and access to essential services have been hampered. The combined effects of drought and flooding have compounded the district's challenges, intensifying the overall impact on the community.

Table 4: Thematic Tallies of the Extent of Drought Impacts from the Survey

Experience with drought
Crop failure due to drought
Damage to property and infrastructure due to flooding
Economic hardship resulting from loss of income and increased food prices due to crop failure
Health issues arising from mosquito-borne diseases and poor air quality due to drought
Displacement of individuals and households due to flooding and drought
Psychological distress and emotional impact on affected individuals and communities due to drought
Environmental degradation and loss of biodiversity due to flooding and drought
Loss of livestock due to drought
Hindered access to education and livelihood activities due to flooding and drought
Increased vulnerability to food insecurity due to crop failure and water scarcity
Hindered mobility and access to essential services due to flooding and drought
Destruction of homes and shelter due to flooding and drought

4.3 Disaster reduction and management practices

According to the UNDRR, an Early Warning System (EWS) is a comprehensive framework that integrates hazard monitoring, forecasting, risk assessment, communication, and preparedness activities to enable proactive disaster risk reduction. A functioning EWS is evidenced by the reduction of catastrophes due to better preparedness (Moges and Gebregiorgis, 2013).

Respondents largely noted (77%) that they receive EWS information before or during a flood or drought even. They added that, this EWS does not prioritise the needs of gender. and drought management strategies.

The study further found the main source of EWS information was via the district assemblies and NADMO officers. This was mostly done through radio or television. Other sources such as the Assembly members often than usual used the face-to-face communication and through community radio systems. For respondents that receive the EWS, they noted that they were more likely to receive the news daily or weekly, during imminent climatic events.

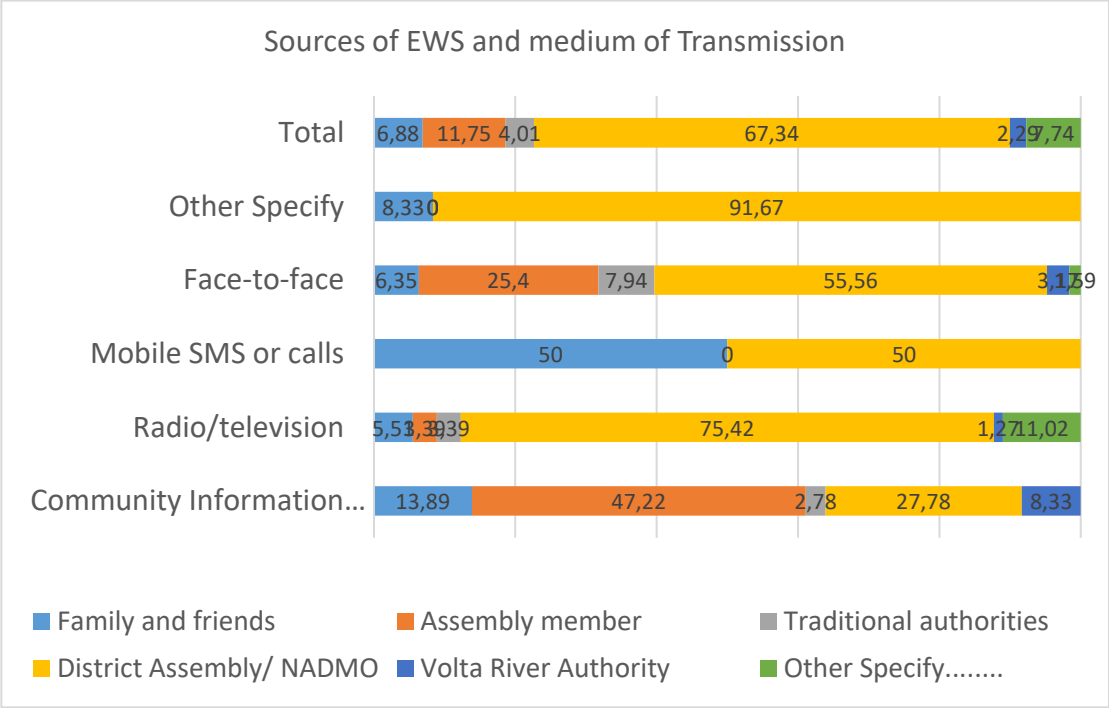


Figure 5 Sources of EWS and mode of communication

However, the results clearly show that the communities along the Volta Basin have substantial experience and knowledge of flood and drought risks. This awareness comes primarily from their lived experiences rather than from educational campaigns.

Further, 96% of the respondents noted that the pre-flood or drought management measures were the most common flood/drought management measure employed by the local authorities.

The main activities of pre-flood/drought management measures are:

- Early Planning and Farming Practices,
- Warnings to avoid of Risky Areas,
- Education and Sensitization,
- Afforestation and Environmental Conservation and
- Creation of Safe Havens and Evacuation Plans

With these, almost half (45%) noted that measures were not at all effective. Although greater percentage 47% noted that measures are effective and 8%, very effective 19% noted measures were never conducted, 38% said they were seldomly conducted, 20% noted that management measures were conducted intermittently, while 22% noted that these activities were done every pre-flood/drought event.

The main activities of post-flood/drought management measures included:

- Relocation to Safe Areas,
- Post-Disaster Assessment and Reconstruction,
- Education and Sensitization,
- Livelihood Restoration and Resilience Building, etc.

Also, about 42% of the respondents said that post-management measures were effective while, 6% mentioned that the measures are very effective. Remaining 52% noted they were not at all effective However, 24% as well answered that their community were NEVER beneficiary of the activities of post-flood or drought management measures.

Further quizzing respondents' experiences to local authorities' flood and drought management, majority (80%) said that they do not know of already existing disaster management strategies in your community, indicating the lack of communal knowledge of local flood and drought risk management strategies.

The overall opinion on implementation of investments in disaster risk reduction (DRR) and climate change adaptation (CCA) in their community was adjudged as poor. Further, more than two thirds of respondents renounced the effectiveness of participatory involvement of the local community in the planning and decision-making processes related to flood and drought management by local authorities.

The respondents opined on the successful implementation of flood and drought management strategies in the Bawku West district. According to the results, the successes can be attributed to several key factors. Early farming practices and timely harvesting play a crucial role, along with environmental conservation measures like afforestation efforts and tree planting along riverbanks. Infrastructure initiatives, including dry season gardening, irrigation systems, dredging activities, and bamboo planting, have also been effective in mitigating flooding. Community engagement and education are vital, with significant efforts to involve local populations in planting trees and adopting new strategies, such as using drought-resistant and early maturing crop varieties.

However, the implementation of these strategies faces several constraining factors. Environmental challenges and natural events pose significant obstacles, along with resource constraints and financial issues. Effective information and education management are crucial for fostering community engagement and compliance. Additionally, infrastructure and management issues, including the availability of seedlings and the supervision of tree planting and management, further complicate efforts. These challenges highlight the need for comprehensive support and resource allocation to ensure the continued success of flood and drought management strategies in the region.

4.4 Lessons learned

The lesson learned from the results of the survey in Bawku West district can view in two instances: (i) opportunities for future effective flood and drought management strategies in the Volta basin and (ii) Recommended additional support or resources local authorities could provide to communities during recovery phase after floods or droughts

Opportunities for future flood and drought management strategies in the Volta basin;

i. **Infrastructure Development and Environmental Conservation:**

- Creating dams, dugouts, and irrigation systems for dry season farming
- Harvesting and directing excess water for irrigation
- Afforestation efforts and tree planting along riverbanks
- Enforcing bylaws to protect riverbanks and prevent environmental degradation
- Combating bush burning and tree cutting through strict regulations
- Promoting early maturing crop varieties for sustainable agriculture

- Providing land for tree planting and engaging communities in environmental initiatives

ii. Community Engagement, Education, and Disaster Management:

- Educating and engaging communities in sustainable farming practices and environmental conservation
- Establishing information centers for public awareness and education on disaster management and environmental issues
- Linking with authorities to regulate water release from dams and manage flood risks
- Involvement of local assemblies and disaster management organizations in coordinating interventions and support during disasters
- Creating job opportunities through intervention projects and community participation

iii. Logistics and Information Management:

- Coordinating logistics for intervention projects and support distribution
- Mounting information for public awareness and education on environmental conservation and farming techniques
- Providing support for tree planting initiatives and ensuring community readiness to participate

Lastly, recommended additional support or resources local authorities could provide to communities during recovery phase after floods or drought include

- **Agricultural Inputs:** This involves providing farmers with necessary resources such as seeds, machines, and inputs like fertilizers. It also includes offering technical assistance, education on farming techniques, and financial support through credit facilities. Additionally, it encompasses ensuring food availability for farmers and facilitating land use after floods for both regular and dry season farming.
- **Community Engagement and Education:** This entails engaging NGOs for support, organizing educational programs, and raising awareness among farmers about flood and drought management strategies. It also involves promoting the use of early maturing crop varieties and fostering broader community involvement in agricultural initiatives.

- **Infrastructure Development:** This focuses on building essential infrastructure like dams and irrigation facilities to support farming activities. It also includes providing water pumping machines to facilitate irrigation during dry seasons.
- **Logistics and Relief:** This involves supplying food, shelter, and relief handouts to farmers affected by floods. It also encompasses organizing logistics for the distribution of support materials.
- **Regulatory Measures:** This pertains to enforcing regulations to prevent farming near rivers, monitoring and reporting on flood situations, and coordinating with authorities regarding dam spillage to mitigate flood risks.
- **Reforestation and Environmental Initiatives:** This includes afforestation efforts and planting more trees to address environmental concerns and enhance ecosystem resilience against floods.

5. Conclusions

The survey and analysis of the Volta Basin's flood and drought management strategies highlight the necessity for a multifaceted approach to disaster risk reduction. Evaluations emphasize integrated water resources management, sustainable development, and climate resilience to address socioeconomic challenges and environmental risks. Effective disaster risk reduction depends on robust institutional frameworks, with entities like the Water Resources Commission and Volta Basin Authority playing pivotal roles. There is a need for innovative financing strategies involving domestic and international sources, basin-level initiatives for sharing flood information, and regional cooperation. Monitoring and evaluation (M&E) strategies are essential for informed decision-making, involving comprehensive frameworks, adaptive management, stakeholder consultations, and capacity building.

The survey results from Bawku West district offer insights for future flood and drought management strategies in the Volta basin, focusing on infrastructure development, environmental conservation, community engagement, education, and disaster management. Recommendations for local authorities during recovery phases include providing agricultural support, community engagement, infrastructure development, logistics and relief efforts, regulatory measures, and reforestation initiatives. These strategies collectively emphasize the need for comprehensive development, engagement, education, logistical coordination, and regulatory measures to effectively manage flood and drought risks and support community recovery in the Volta basin.

6. References

1. Abugri, S. A. (2020). A Study on Farmers' Perception and Preference in Subscribing to Drought-Index Crop Insurance in the Northern Region of Ghana. *Regional Economic Development Research*, 63-76.
2. Agodzo, B. D. (2014). Changes in the ecosystem services of the Volta Lake and their impacts on local livelihoods along its catchment areas in Ghana (Master's thesis, Norwegian University of Life Sciences, Ås).
3. Ahadzie, D. K., Mensah, H., & Simpeh, E. (2022). Impact of floods, recovery, and repairs of residential structures in Ghana: insights from homeowners. *GeoJournal*, *87*(4), 3133-3148.
4. Ayereka, I. K., & Jaman, P. B. (2023). The Impact of Flood on Food Security in Farming Communities in Kumbungu District in the Northern Region of Ghana.
5. Codjoe, S. N. A., Atidoh, L. K., & Burkett, V. (2012). Gender and occupational perspectives on adaptation to climate extremes in the Afram Plains of Ghana. *Climatic Change*, *110*, 431-454.
6. Klutse, N. A. B., Owusu, K., Nkrumah, F., & Anang, O. A. (2021). Projected rainfall changes and their implications for rainfed agriculture in northern Ghana. *Weather*, *76*(10), 340-347.
7. Lente, I., Heve, W. K., Owusu-Twum, M. Y., Gordon, C., Opoku, P., Nukpezah, D., & Klutse, N. A. (2023). Nature of climate change-induced risks in semi-arid northwestern Ghana: Gauged observations, perceptions of smallholder farmers, and perspectives for livelihood adaptation. *Information Development*, 02666669231185323.
8. Moges, S. A., & Gebregiorgis, A. S. (2013). Climate vulnerability on the water resources systems and potential adaptation approaches in East Africa: the case of Ethiopia.
9. Platt, S. L., Erandi, I., Jayasinghe, C., Jayasinghe, T., Maskell, D., Ranasinghe, G., & Walker, P. (2020). Improving the lateral load resistance of vernacular masonry walls subject to flooding. Proceedings of the Institution of Civil Engineers-Construction Materials, 176(3), 94-105.
10. Yakubu, R. N. (2020). Understanding Early Warning Messaging about Climate Stressors in the Northern Region of Ghana. *Natural Hazards Review*, *21*(2), 05020003.
11. Walkling, B., & Haworth, B. T. (2020). Flood risk perceptions and coping capacities among the retired population, with implications for risk communication: A study of residents in a north Wales coastal town, UK. International journal of disaster risk reduction, 51, 101793.

7. Appendices

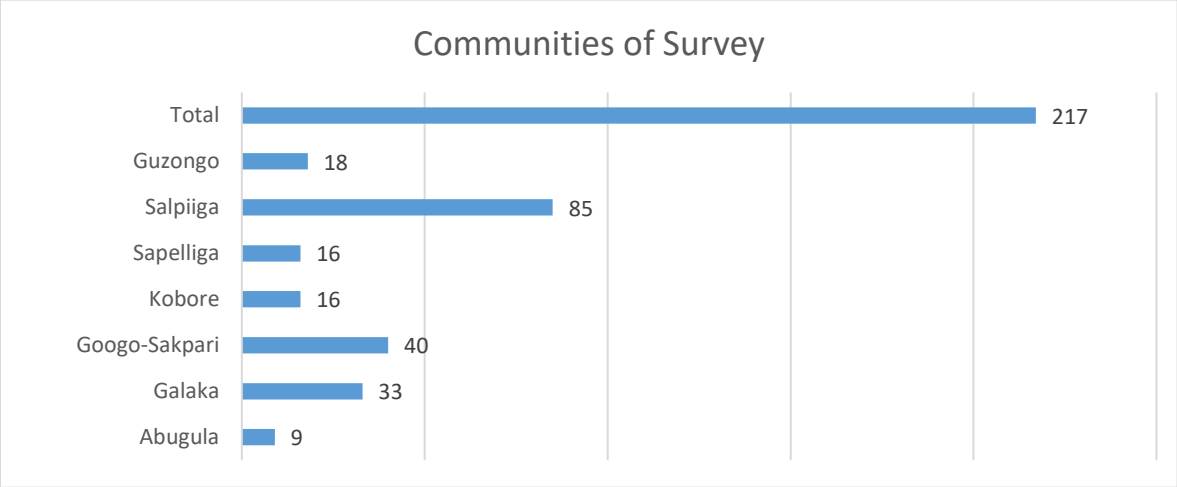
7.1 SEPO Matrix (Success, Potential, Failures and Obstacles)

<table>
<tr>
<td>Success
Early Warning and Information Sharing:
Community Participation and Engagement such as Active involvement of community members in response and evacuation plans.
Education and Awareness Creation: Sensitization campaigns to raise awareness about risk reduction measures and proper responses, Community Engagement and Education
Environmental Conservation Measures: Practices like tree planting, reshaping of lands, and dredging to mitigate flood and drought impacts, afforestation efforts and tree planting along riverbank
Risk Reduction and Management Strategies: Planning and execution of emergency response and evacuation plans.
Support networks within communities, including family and friends, during times of crisis.
Early Farming Practices and Harvesting: Adoption of drought-resistant and early maturing crop varieties
Community involvement in planting trees and adopting new strategies
Infrastructure repair and reinforcement
Moving to safer areas and encouraging residents to build on higher ground
Fish species adaptation
</td>
<td>Potential (Opportunities)
Sustainable Land Use and Management:
The region has ample arable land available for agriculture, afforestation, and sustainable land use, which necessitates reshaping and dredging for improved practices.
Planting trees is essential to prevent erosion and promote environmental sustainability, alongside utilizing effective land management measures and strategies.
Community Engagement and Collaboration:
There is a strong commitment within the community to address flood and drought challenges, fostering collaboration with existing government institutions and community leaders.
Community members are willing participants in finding solutions, and engagement with NGOs and other groups is sought to assist in flood management efforts.
Infrastructure Development:
Infrastructure projects, such as the construction of dams and other water management systems, are essential for mitigating flood risks, as well as dredging river courses to prevent flooding.
Improving early warning systems is crucial for disaster preparedness and effective response to natural disasters.
Harvesting and directing excess water for irrigation
Providing land for tree planting and engaging communities in environmental initiatives
</td>
</tr>
<tr>
<td colspan="2">Failures and Obstacles
Limited knowledge of communities regarding flood and drought management practices.
Poverty hinders the ability to adapt to flood and drought conditions.
Inadequate Information Sharing: Delays and inadequacies in sharing vital information about flood and drought conditions.
Apathy and lack of cooperation among some community members with warning and education efforts.
Environmental Degradation and Improper Practices:
</td>
</tr>
</table>

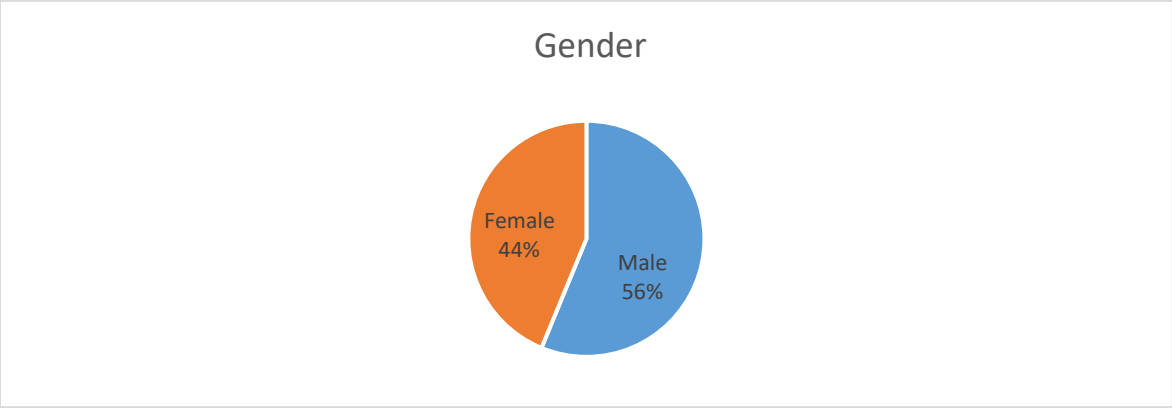
- Cutting down of trees due to poverty, which exacerbates environmental degradation and flood risks and improper farming practices, such as farming on buffers, contribute to flood vulnerability.
- Lack of financial resources
- Inadequate infrastructure
- Natural water drainage patterns
- Environmental Challenges and Natural Events
- Information and Education Management:
- Community Engagement and Compliance
- Seedlings and Supervision of tree planting and management

7.2 Demographics

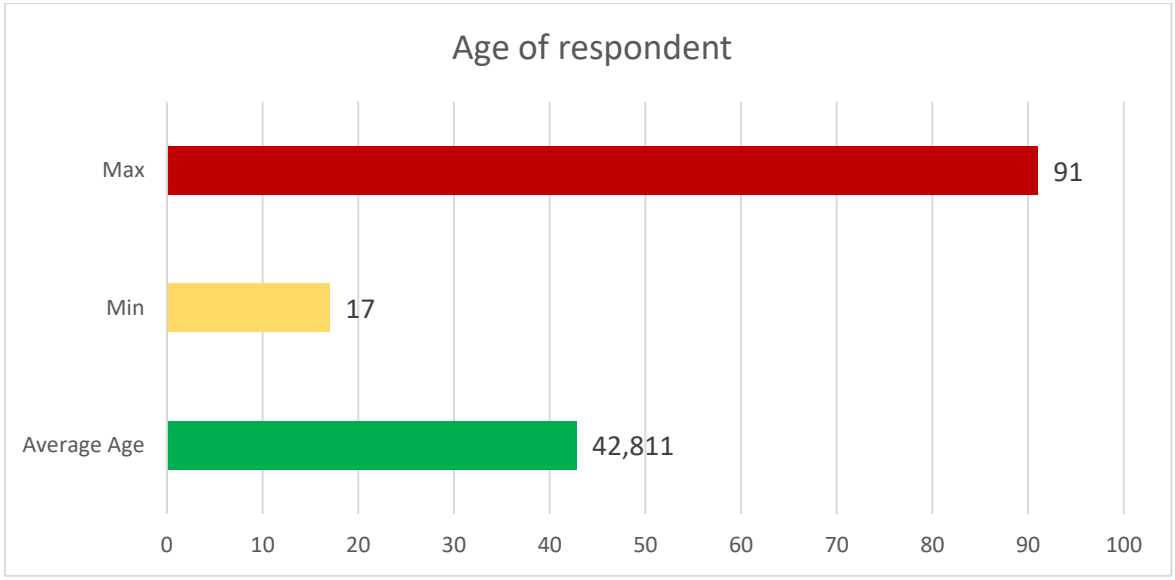
A) Communities of Survey



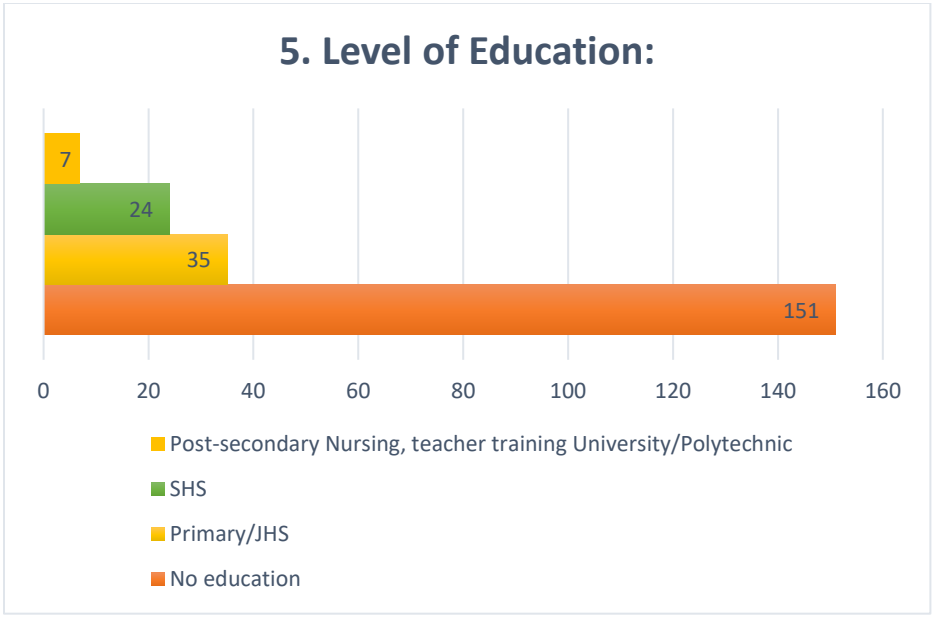
B) Gender of interviewed Respondents



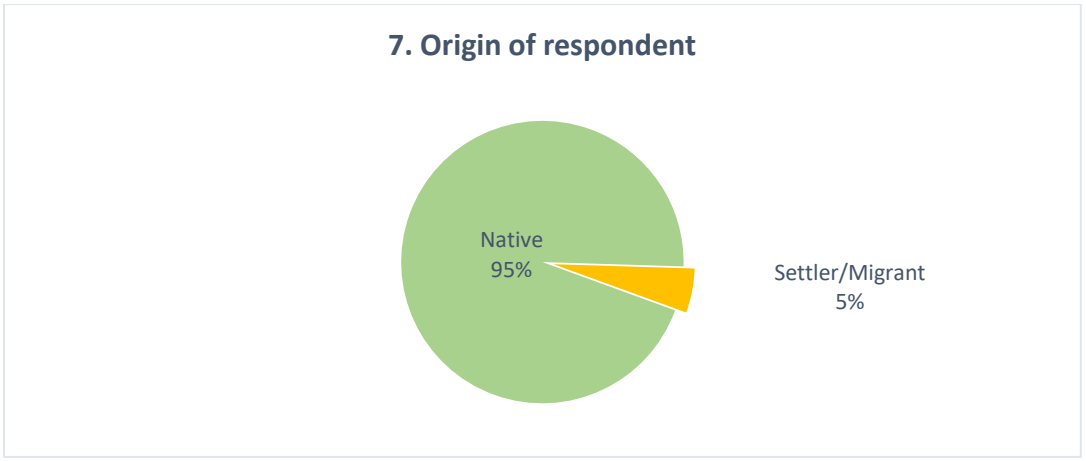
C) Ages of respondents



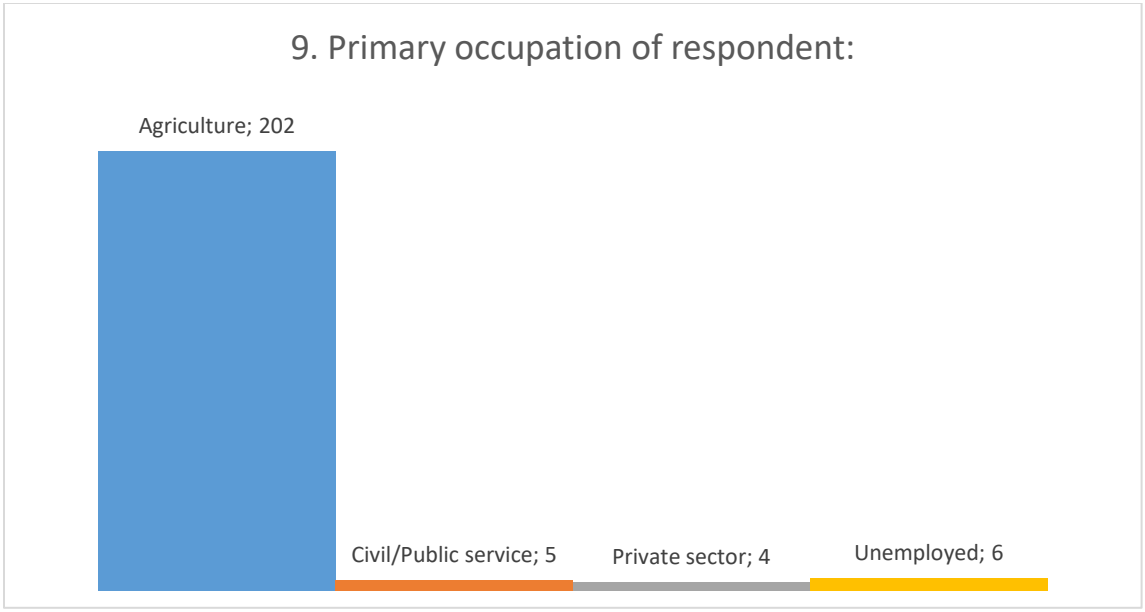
D) Level of Education



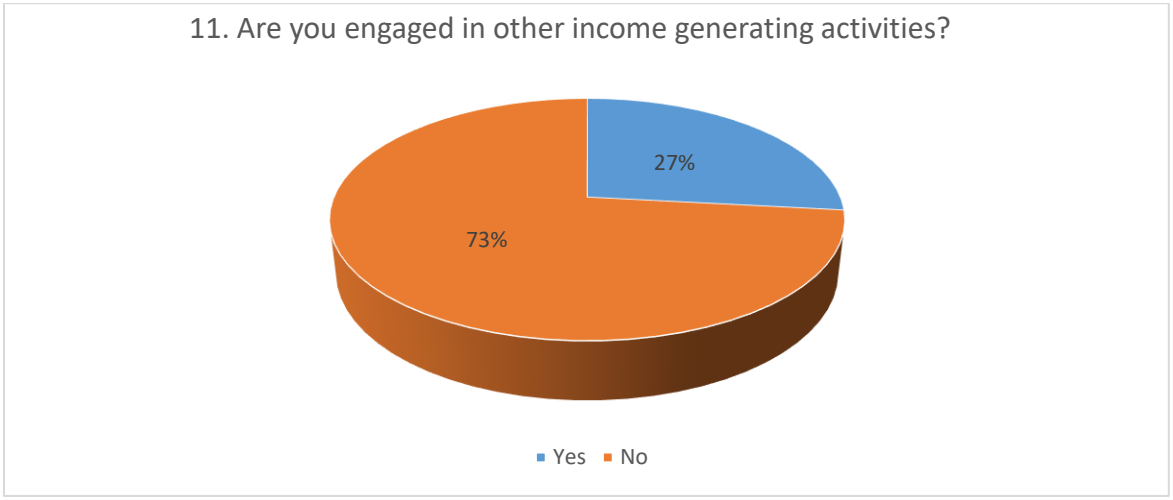
E) Origin of respondents



F) Employment status of respondents

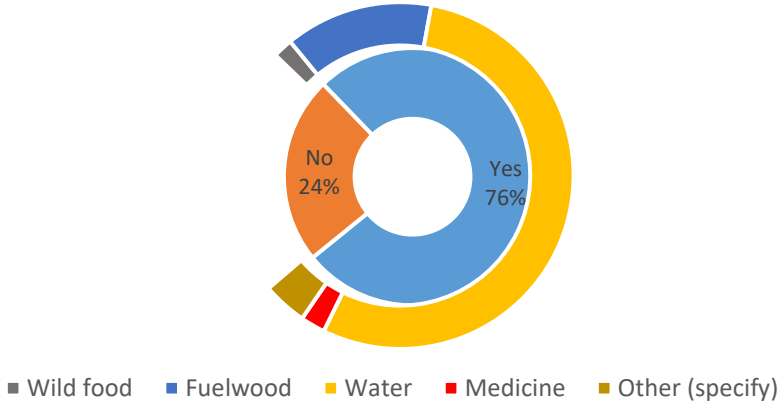


G) Engagement in secondary employment (Alternative livelihood activities)

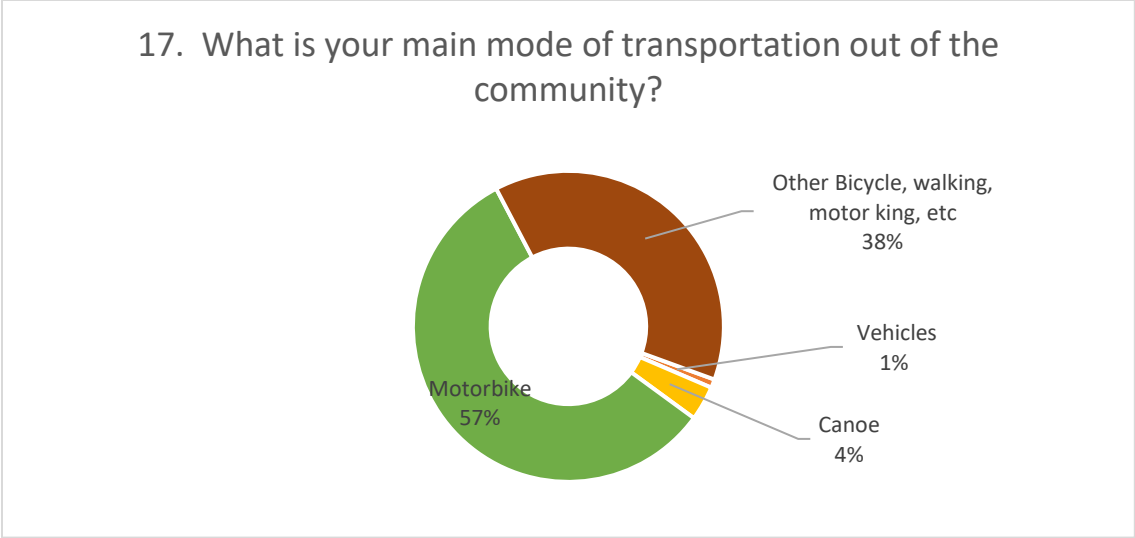


H) Dependence on ecosystem services

Do you depend on ecosystem services in the Volta Basin for income?



I) Mode of Transportation from the community



7.3. Data collection tools

Individual/community interview guide

Brief introduction

- Presentation of the mission and its importance for the development of communities/communities/the nation

Site identification

- Administrative location, geographic coordinates, investigator, etc.

Respondent identification

- First and last name, gender, age, level of education, household size, social status (head of land, community, religious, etc.), cultural affiliation, etc.

Access to resources and living conditions

- Access to land, environmental resources, etc.
- Socioeconomic occupations

- Services from water ressource-related ecosystems
- Modes of housing, transport, GSM communication, etc.

Personal experiences of floods and drought (importance, impacts)

- Understanding floods and drought
- Frequency and scale of disasters (flood, drought, etc.)
- Impacts on livelihoods (social, economic, environmental)
- Share a personal experience of flooding or drought that you have had

Early warning system including community EWS: Participation/Involvement and perception/appreciation of communities

- Knowledge of the existence of EWS (s) (EWS VoltAlarm, Community EWS and other EWS)
- Access, channels and receipt of the alert
- Alert effectiveness
- Decision of the competent authorities
- Responses from communities/vulnerable groups
- Belonging to a social group
- Support or response from state, decentralized, or intermediation structures (NGO, charitable association, etc.)
- Taking gender into account (women, children, young people, disabled people and vulnerable people)
- Feedback, lessons learned/Evaluation and valorization/improvement of EWS
- Sustainability of EWS

Individual/personal and collective adaptation and resilience measures

Structural measures

- Infrastructure construction
- Displacement (emigration, exodus, refugee)
- Adaptation of lifestyle and activities
- Etc.

Institutional measures

- Development and management plans and tools
- Capacity Building
- Establishment of new bodies or partnerships

- Implementation of a new communication system
- Improved governance framework
- Etc.

Interventions of the State and its partners in the reduction and management of flood and drought risks (community perception and assessment)

- Types of intervention at each stage of DRR – preparation, emergency/crisis, rehabilitation and reconstruction
- Constraints: weaknesses and threats
- Advantages: Strengths and Opportunities
- Suggestions for improvement

Experiences of local authorities on flood and drought management

- Types of intervention – pre or post disaster measures, contingency plans, preparation, alert, response, rehabilitation, frequency of interventions related to disasters
- Intervention mechanisms and effectiveness: coordination, IEC/communication for behavior change
- Satisfaction with interventions, personal or community benefits
- Constraints: weaknesses and threats
- Advantages: Strengths and Opportunities
- Suggestions for improvement

Knowledge of/familiarity with long-term flood and drought management strategies (community perception and appreciation)

- Knowledge of regional, national and local planning (integrated flood and drought risk management strategies, EWS VoltAlarm and other guidance documents on DRR and CCA in the BV)
- Knowledge of implementation mechanisms
- Knowledge of monitoring-evaluation and feedback mechanisms
- Suggestion for improvement of these plans/strategies

Community participation and practices in reducing and managing flood and drought risks (community perception and appreciation)

- Community understanding of risks for better management
- Strengthening risk governance to better manage them
- Implementing investments in DRR for better resilience
- Strengthening pre- or post-disaster measures, contingency plans, preparation, alert, response, rehabilitation to risks to intervene effectively and sustainably in the recovery and rehabilitation and reconstruction phase

- Constraints: weaknesses and threats
- Advantages: Strengths and Opportunities
- Suggestions for improvement

Interventions of social intermediation structures (NGOs, associations, foundations, etc.) in the reduction and management of flood and drought risks (community perception and assessment)

- Types of intervention – pre or post disaster measures, contingency plans, preparation, alert, response, rehabilitation
- Perception/assessment of actors on interventions
- Constraints: weaknesses and threats
- Advantages: Strengths and Opportunities
- Suggestions for improvement

Good practices and successful experiences in disaster risk management (floods, drought)

- Practices/experiences (pre or post disaster measures, preparation, alert, response, rehabilitation) in line with at least one of the 4 priorities of the Sendai Framework of Action for DRR
- Good practices will be identified on the basis of the assessment of the evaluation grid of the practices inventoried (during data collection) for this purpose
- Propositions for dissemination actions

7.4 Questionnaire

Project: Integrating flood and drought management and early warning systems for climate change adaptation in the Volta Basin (VFDM Project)

Date: …… Project Site : …….. Community/Town/Village: …… Region……

Latitude: …….. Longitude: …….. Enumerator Name/ ID …….

A. Demographics

1. Name of respondent
2. Contact ……..
3. Gender i) Male ii) Female
4. Age of respondent …….
5. Level of Education: a) No education [ ] b) Primary/JHS [ ] c) SHS [ ] d) Technical/Vocational [ ] e) Post-secondary Nursing, teacher training University/Polytechnic [ ]
6. Marital status a) Single [ ] b. Married [ ] c. Divorced [ ] d. Widowed [ ]
7. Origin of respondent: a) Native b) Settler/Migrant c) Other (specify)…....
8. How long have you been residing in the community? ……..

B. Livelihood Strategies

9. Primary occupation of respondent: a) Agriculture b) Civil/Public service c) Private sector d) Unemployed e = Other (specify).....
10. Please specify occupation: .....
11. Are you engaged in other income generating activities? a) Yes b) No
12. If yes to Question 11, then please specify.....
13. Do you depend on ecosystem services in the Volta Basin for income? a) Yes b) No
14. If yes to Question 13, indicate which kind of services a) Wild food b) Fuelwood c) Water d) Medicine e) Other (specify)
15. What material is your house made of? (*Multiselect*) a) Cement b) Bricks c) Mud d) Other (specify)
16. Do you have access to internet connectivity? a) Yes b) No
17. What is your main mode of transportation out of the community? a) Vehicles b) Canoes c) Motorbike d) Other …….
18. If you use vehicles, do you have access to good road network? a) Yes b) No
19. If you use canoe, are they available to access at your convenience? a) Yes b) No

C. Personal Experiences with Floods and Droughts

20. Have you personally experienced floods in your community a) Yes b) No
21. If yes, indicate how the flooding affected you….. (*Multiselect*) a) House or living structure b) Farm or location of your occupation c) Road network or mode of transportation d) Other (specify) …….
22. Describe the form of impact from flooding experienced …….
23. How long did the most memorable flooding event last? …….. (days)
24. Have you personally experienced drought conditions in your community (Long periods of no rain) a) Yes b) No
25. If yes, indicate how the drought affected you ….. (*Multiselect*) a) House or living structure b) Farm or location of your occupation c) Road network or mode of transportation d) Other (specify) …….
26. Describe the form of impacts of drought experienced …….
27. How long did the most memorable drought event last? …….. (months)
28. What are other notable impacts of the floods or drought on your community? ……

D. Early Warning and Support Systems

29. Do you receive any early warning information before a flood or drought event? a) Yes b) No
30. If yes, from which source? a) Family and friends b) Assembly member or unit committee member c) Traditional authorities d) District Assembly e) Volta Basin Authority f) Other Specify.....
31. Through what medium do you receive the early warning information? a) Community Information Centre b) Radio/television c) Mobile SMS or calls d) Face-to-face e) Other Specify
32. Do you receive any support from any of these actors during or after a flood or drought event? (*Multiselect*) a) Volta Basin Authority b) MP or Central Government c) NADMO or District Assembly d) NGO or CSO e) Social group f) Family or friends g) Other (specify)……
33. How often do you receive such information? a) Daily b) Weekly c) Bi-weekly d) Monthly e) Quarterly f) Other Specify.....
34. Does the early warning system prioritize needs of gender and the vulnerable in society? a) Yes b) No
35. If yes, describe them …….

E. Individual Adaption Measures

36. How have you adapted to the impacts of the flood/drought event? (*Multiselect*) a) Migrated or changed locations b) Reinforced housing or boundaries c) Improved on farm irrigation d) Depending on alternative water source e) Other (specify).....
37. Have you invested in any infrastructure or technology to adapt to flood and drought risks? a) Yes b) No
38. If yes, specify the type of structural addition .....
39. Have you made any changes to your lifestyle or daily activities to cope with these events? a) Yes b) No
40. If yes, describe them ……
41. Are you a member of any social support group or organization? a) Yes b) No
42. If yes, do you receive aid to reduce the impact of the flood/drought event? a) Yes b) No
43. In what form was this aid? (*Multiselect*) a) Monetary b) Food c) Clothing d) Shelter e) Infrastructure f) Other (specify)

F. Experiences to Local Authorities' Flood and Drought Management

44. What is the most common flood or drought management measure employed by the local authorities? a) Pre-flood or drought management measures b) Post-flood or drought management measures
45. What are some activities of pre-flood or drought management measures taught to you by the local authorities? (*repeats 3x)* ……..
46. What are some activities of post-flood or drought management measures taught to you by the local authorities? (*repeats 3x)* ……..
47. How effective are the activities of Pre-flood or drought management measures? a) Very effective b) Effective c) Not at all
48. How often do you receive the activities of Pre-flood or drought management measures? a) Every event b) Intermittently b) Seldomly e) Never
49. How effective are the activities of post-flood or drought management measures? a) Very effective b) Effective c) Not at all
50. How often are you or your community a beneficiary of the activities of post-flood or drought management measures? a) Every event b) Intermittently b) Seldomly e) Never
51. How frequently do you receive updates from local authorities about ongoing flood and drought management efforts? a) Every event b) Intermittently b) Seldomly e) Never

52. What is your overall opinion on implementation of investments in disaster risk reduction (DRR) and climate change adaptation (CCA) in your community? a) Very Poor b) Poor c) Average d) Good e) Very good

53. Explain your rating ……

54. How effective have local authorities been, in involving the community in the planning and decision-making processes related to flood and drought management? a) Very effective b) Effective c) Not at all

55. How accessible is information about flood and drought management strategies to your community? a) Very Accessible b) Accessible d) Not Accessible

56. Do you know of already existing disaster management strategies in your community? a) Yes b) No

57. If yes, name any strategy….

58. Do you know of an already existing local institution responsible for the prevention of floods in your community? a) Yes b) No

59. Do you know of an existing local institution responsible for the prevention of droughts in your community? a) Yes b) No

60. Which institutions do you mainly receive flood/drought adaptation aid from?.....

61. If yes for Q59, name the main institution ……..

62. If no for Q59, has any institution been created to tackle the advent of flood/drought impacts? a) Yes b) No

63. If yes for Q62, name the main institution ……..

64. Have there been any education or awareness programs conducted to inform residents about the flood and drought management strategies for your community? a) Yes b) No

65. What has been the successful factors in current flood and drought management strategies in the Volta basin? (*repeats 3x)*……..

66. What has been the constraining factors to current flood and drought management strategies in the Volta basin? (*repeats 3x)*……..

67. What opportunities exist for future management of flood and drought management strategies in the Volta basin? (*repeats 3x)*……..

68. Based on your experiences, what additional support or resources do you believe local authorities could provide to communities during recovery phase after floods or droughts? ……..

G. Communities'Perspectives on Long-Term Flood and Drought Management Strategies

69. Are you aware of any flood and drought management strategies in the district/region a) Yes b) No

70. If yes, please specify .....

71. Do you perceive that flood and drought management strategies in the district/region are adequately integrated with broader national government plans including national budgets and activities? a) Yes b) No

72. If yes, how effective do you think these programs have been in increasing awareness and understanding within the community? a) Very effective b) Effective c) Not at all

73. In your opinion, are there mechanisms in place at the local level to regularly evaluate and monitor the effectiveness of long-term flood and drought management strategies in the Volta basin? a) Yes b) No

74. How familiar are you with local strategies or plans in place for floods and droughts management in your area? a) Very Familiar b) Somewhat Familiar c) Neutral d) Not Very Familiar e) Not Familiar at All

75. Are you aware of the Flood and Drought Risk Management EWS VoltAlarm (VFDM) strategy implemented in the national portion of the Volta basin? a) Yes b) No

76. If yes, please list any components or measures that you are aware of …….

77. To what extent do you believe local communities are engaged in the implementation of the EWS VoltAlarm (VFDM) strategy? a) Actively Involved b) Somewhat Involved c) Not Involved d) Not Sure

78. Are you aware of any long-term flood and drought management strategies implemented by local authorities of the Volta basin? a) Yes b) No

79. If yes, which of the strategies are you aware of …….

80. Considering potential changes in climate and environmental conditions, what adaptations or updates do you think should be made to the current EWS VoltAlarm (VFDM)? …….

81. Based on your experience in this community, what in your opinion should be some strategies for long term flood and drought management in the community?.....

Thank you!